

# Program of the 82<sup>nd</sup> Annual Meeting of the American Association of Physical Anthropologists

To be held at the

## **Knoxville Convention Center**

701 Henley Street  
Knoxville, TN 37902

### **AAPA Scientific Program Committee:**

Susan C. Antón, Chair and Program Editor

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### **Local Arrangements Committee**

University of Tennessee, Knoxville

Andrew Kramer, Chair  
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Benjamin Auerbach  
Graciela Cabana  
Joanne Devlin  
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Amy Mundorff  
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## Message from the Program Chair

Welcome to the 2013 conference!

The AAPA meetings start on Wednesday night with the **Committee on Diversity Undergraduate Research Symposium** (6-8pm) and the opening reception (8-11pm), and they end with the **Student Awards Reception** Saturday evening. Make special note that the **AAPA Business Meeting and Awards Ceremony** on Friday starts EARLIER this year, at 5:45 just after Friday sessions end. Please join us!

The 2013 program includes 1023 presentations with 13 invited poster symposia and 6 invited podium symposia. The Knoxville Convention Center offers ample room sizes, so all of the podium sessions are housed in rooms that seat at least 400. We hope this means the end to standing in the hallways!

Contributed poster sessions will be held on the Park and Clinch Concourses, with posters on display for an entire day. Authors will be present once in the morning and once in the afternoon. Invited poster symposia meet during either a morning or afternoon session and are scheduled in private rooms where interaction and discussion will be facilitated.

We are pleased to be meeting in conjunction with the *Paleopathology Association (PPA)*, the *Human Biology Association (HBA)*, and the *American Association of Anthropological Genetics (AAAG)*. We have two jointly sponsored podia symposia: “**Infectious Disease in Humans and Other Primates – Origins, Dynamics and Evolution**,” on Thursday morning, organized by Anne Stone and Andrew Kitchen, and co-sponsored by the *AAAG*; and Friday morning, “**The High Price of Success: Costs of Reproductive Effort in Male Primates and Humans**,” organized by Alexander Georgiev and Melissa Emery Thompson and co-sponsored by the *HBA*. This year, the Wiley-Blackwell symposium on Thursday afternoon considers “**The Evolution of Biological Anthropology: Defining a Future Discipline**”, Graciela Cabana and Ben Auerbach, organizers.

Thursday Evening proves to be particularly festive. The **Plenary Poster Session** includes research from across Biological Anthropology and a focus on educational applications of Biological Anthropology and Evolutionary Biology (something of critical importance to highlight these days). Be sure to

check in for some ‘treats’ at each poster and come enjoy the music and other Tennessee fun. Concurrently, we continue this year the **Plenary Fossil Cast Workshop** at which the AAPA-owned *Australopithecus sediba* casts and a newly finished *A. sediba* **standing skeleton reconstruction** will be available for discussion. We invite you to bring other casts and electronic materials to share and discuss. Concluding Thursday evening are the annual **AAPA Live & Silent Auctions** that benefit the Student Travel Awards. The live auction includes a full-size *A. sediba* skeleton reconstruction (save your pennies!). Have a donation? Contact me.

Organizing the AAPA meetings takes a small volunteer village. First and foremost is Ed Hagen, an amazing one-man-show who designed and runs the online registration and abstract submission system as well as the AAPA website. The online system is the tireless workhorse of our review and program production. An online presentation schedule is available at [physanth.org](http://physanth.org). I doubt a day went by from September thru January without an email exchange with Ed. He is an unsung hero.

The program committee ably reviewed symposia proposals and a very large number of abstracts on a tight schedule. And the Executive Committee reviewed symposia. I am profoundly grateful to each of them. And as always, I am grateful for the help of my heroic assistants, Emily Middleton and Myra Laird, who assisted with copy-editing, the auction and other tasks of the ‘Imperial We’.

On the ground in Tennessee, the local arrangements committee (LAC) worked tirelessly on organizing an impossible number of details unseen and unappreciated by most of us. I am especially grateful to their Chair, Andy Kramer, for his hard work, to Ben Auerbach for the LAC website, and to all of the LAC members for their work with vendors, volunteers, registration and the like.

Finally, many members volunteer their time and ideas to our standing and ad hoc committees, most of which meet this week. Please join the receptions and meetings you find of interest (schedules on pages 5-8) and get involved with the AAPA!

See y’all in Knoxville!

**Susan Antón**  
AAPA Vice President and Program Chair

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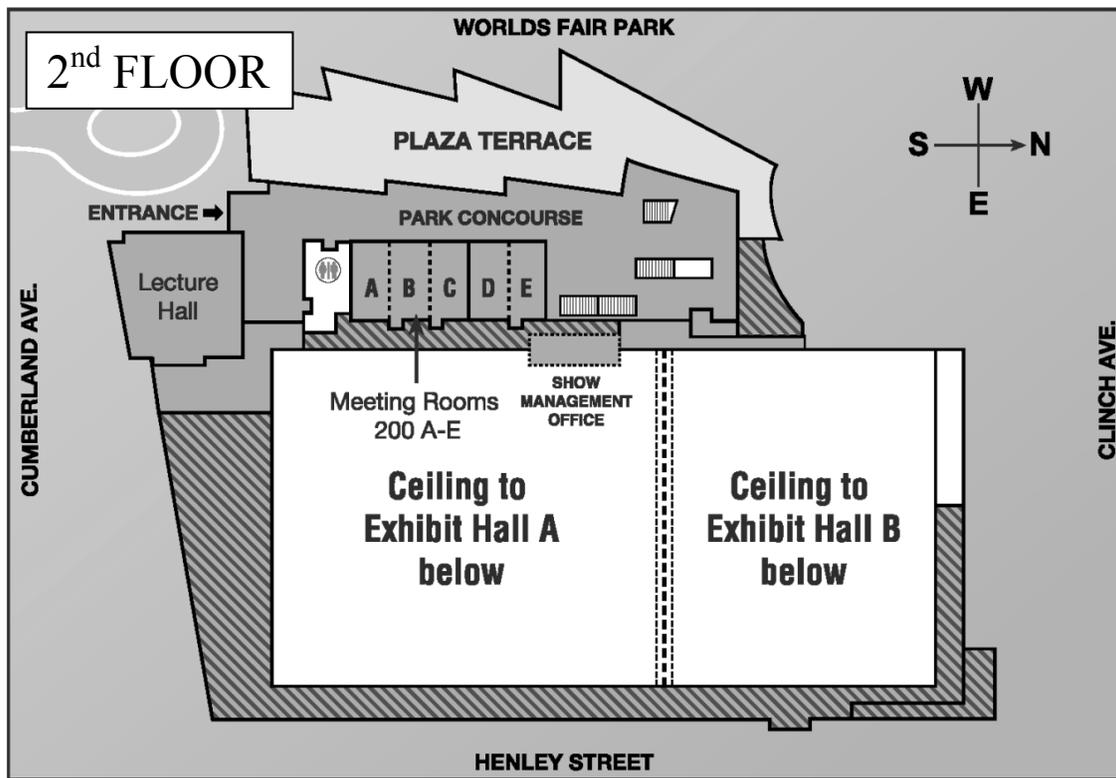
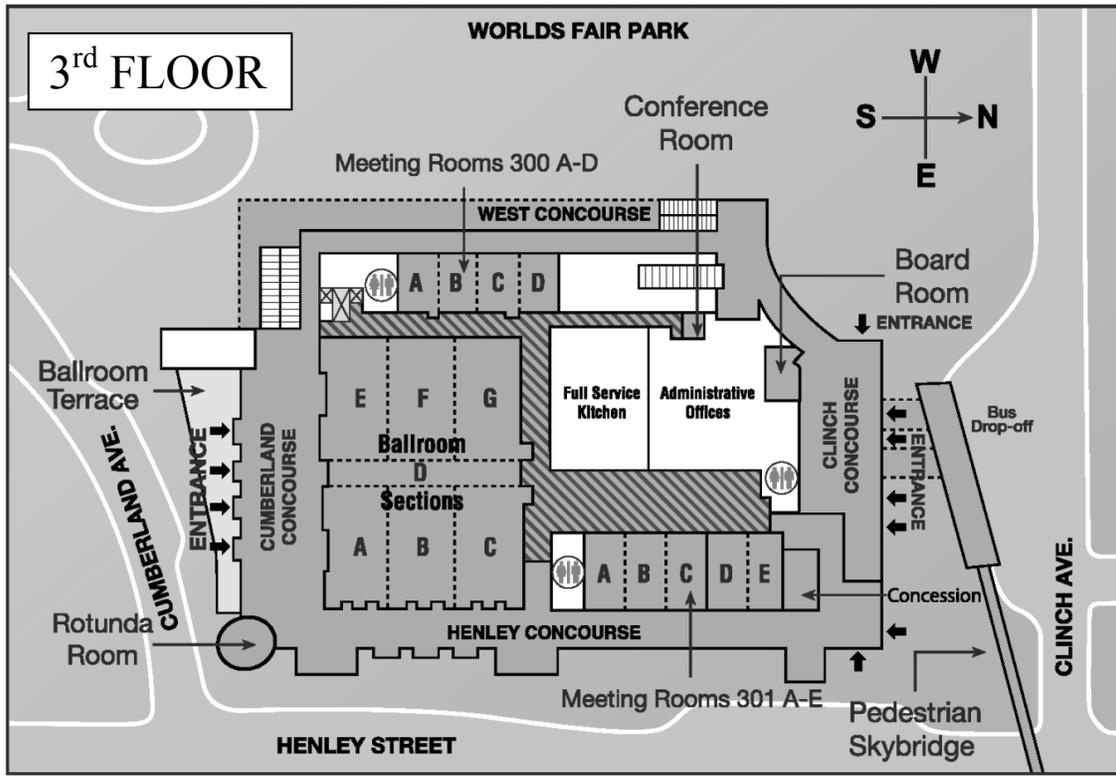
On the cover: The Knoxville Convention Center and the City of Knoxville, Tennessee. Photograph courtesy of the Knoxville Chamber of Commerce.

Supplement 56 was mailed the week of February 25

### KEY TO ACRONYMS:

<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> – Physical Anthropology Women’s Mentoring Network
<b>PPA</b> – Paleopathology Association

### Knoxville Convention Center Floor Plans



## CONFERENCE SCHEDULE DAY-BY-DAY

### Monday Evening and Tuesday All Day

ROOM	TIME	ACTIVITY
<b>Paleopath Association</b>		
HiltonHotel	MON 6-9pm	Paleopathology Association (PPA): Registration
200s	TUES 8-5	PPA: Registration
200A	Tu 8:00-1:00	PPA: Workshop 1
200B	Tu 8:00-1:00	PPA: Workshop 2
200DE	Tu 2:00-5:00p	PPA: Podium Presentations
200DE	Tu 5:00-6:00p	PPA: Students Forum
200ABC	Tu 6:00-8:00p	PPA: Banquet
<b>Human Bio Association</b>		
Concession	Tu 5:00-8:00p	Human Biology Association (HBA): Registration
Board Rm	Tu 6:00-10:00	Human Biology Association: Executive Committee Meeting

### Wednesday Morning (7:30 am -1:00 pm)

ROOM	TIME	ACTIVITY
<b>AAPA</b>		
Board Rm	8:00-12:00	AAPA Executive Committee Meeting
300A	12:00-1:30	American Journal of Physical Anthropology: Editorial Board Luncheon
<b>Paleopath Association</b>		
200DE	8:00-12:00	Paleopathology Association (PPA): Podium Presentations and Registration
Park	All Day	PPA: Posters
<b>Human Bio Association</b>		
300A	7:30-9:00am	American Journal Human Biology: Editorial Board Breakfast
Park	8:00-5:00pm	Human Biology Association (HBA): Registration
Park	8:00-11:00am	HBA Posters (available for viewing all day)
300B	11:30-12:30	HBA Breakout Session 1: Early Career Mentoring
300C	11:30-12:30	HBA Breakout Session 2: HBA student-member roundtable discussion: The Future of Human Biology

### Wednesday Afternoon (1:00 - 6:00 pm)

ROOM	TIME	ACTIVITY
<b>AAPA</b>		
Board Rm	1:00-5:00	AAPA Executive Committee Meeting
Concession	4:00-9:00	AAPA REGISTRATION
<b>Others</b>		
300B	1:00-5:00	American Association Anthropological Genetics (AAAG): Next Generation Sequencing Workshop
300C	1:00-5:00	Dental Anthropology Association (DAA): Executive Committee Meeting
<b>Paleopath Association</b>		
200DE	2:00-6:00	Paleopathology Association: Podium Presentations and Student Awards
Park	All Day	PPA: Posters
<b>Human Bio Association</b>		
Park	8:00-5:00pm	Human Biology Association Registration
301DE	1:00-4:45	HBA Plenary Session: Broader Impacts? Translating Human Biology for the Public Good
301DE	5:00-6:00	HBA Pearl Memorial Lecture: Sir Peter Gluckman

### Wednesday Evening (6:00 - 11:00 pm)

ROOM	TIME	ACTIVITY
<b>AAPA</b>		
Concession	4:00-9:00	AAPA REGISTRATION
300A	5:00-6:30	AAPA Committee on Diversity Mixer
300B	6:00-6:30	AAPA Education Committee Teacher Liaisons
200ABC	6:00-6:30	AAPA Committee On Diversity Undergraduate Research Symposium Reception (participants only)
200ABC	6:30-8:30	<b>AAPA Committee On Diversity Undergraduate Research Symposium and Reception</b>
Park&Plaza	8:00-11:00	AAPA Opening Reception
<b>Human Bio Association</b>		
301ABC	6:00-9:00	Human Biology Association: Dinner

**Thursday Morning (8:00 am - 12:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
Ballroom A	8:00-12:00	<i>AAAG and AAPA Symposium. Infectious Disease in Humans and Other Primates – Origins, Dynamics and Evolution</i>	Session 1	Invited Podium
Ballroom B	8:00-12:00	<b>SKELETAL BIOLOGY: Functional and Evolutionary Morphology</b>	Session 3	Podium
Ballroom C	8:00-12:00	<b>PALEOANTHROPOLOGY: Primate Evolution</b>	Session 4	Podium
200ABC	8:00-12:00	<b>SKELETAL BIOLOGY: Bioarchaeology, Paleopathology and Stress</b>	Session 2	Podium
200DE	8:00-12:00	<b>Current Bioarchaeological Research in the Near East and Circum-Mediterranean</b>	Session 5	Invited Poster
301D	8:00-12:00	<b>Assessing Function via Shape: What is the Roles of Geometric Morphometrics in Functional Morphology?</b>	Session 6	Invited Poster
301E	8:00-12:00	<b>From Kneberg to Now: 75 Years of Skeletal Analysis of Pre-Columbian Tennesseans</b>	Session 7	Invited Poster
<b>Human Bio Association</b>				
301ABC	8:00-12:00	Human Biology Association: Podium Sessions A and B		

**Thursday All Day Activities (8:00 am - 5:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
<i>Authors present: Even-numbered posters 10-10:30 &amp; 2-2:30; Odd 10:30-11 &amp; 2:30-3</i>				
Clinch	8:00a-4:00p	<b>PALEOANTHROPOLOGY: Early Hominins and <i>Australopithecus</i></b>	Session 8	Poster
		<b>PALEOANTHROPOLOGY: Primate Evolution</b>	Session 9	Poster
		<b>PRIMATE EVOLUTION: Anatomy, Relationships and Dimorphism</b>	Session 10	Poster
		<b>PRIMATOLOGY: Sex, Sociality, Ontogeny, Captivity</b>	Session 11	Poster
Park	8:00a-4:00p	<b>ANTHROPOLOGICAL GENETICS</b>	Session 12	Poster
		<b>BIOARCHAEOLOGY: aDNA, Paleodemography, Status and Variation</b>	Session 13	Poster
Park	8:00a-5:00p	EXHIBITORS		
Concession	8:00a-5:00p	AAPA REGISTRATION, HBA REGISTRATION (8-11am) Speaker Ready Room (business center carrels)		
Board Rm	8:00a-5:00p	Job Interviews; Press Room		

**Thursday Afternoon (12:00 - 5:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
300C	12:00-1:00	AAPA COD: Phys Anth Women's Mentoring Network - Lunch (reservation required)		
300D	12:00-1:00	NSF Funding: Process, Proposals and Fiscal Precipices. Discussion with Carolyn Ehardt		
Ballroom A	1:00-5:00	<i>Wiley-Blackwell Symposium: The Evolution of Biological Anthropology</i>	Session 14	Invited Podium
Ballroom B	1:00-5:00	<b>PRIMATOLOGY: Sex, Aggression and Competition</b>	Session 15	Podium
Ballroom C	1:00-5:00	<b>PALEOANTHROPOLOGY: Early Hominins, <i>Australopithecus</i> &amp; <i>Paranthropus</i></b>	Session 16	Podium
200DE	1:00-5:00	<b>Food Materials Testing and its Relevance for Primate Biology</b>	Session 17	Invited Poster
301D	1:00-5:00	<b>Recent Advances in Knowledge of a Major Papionin Taxon: The Kinda Baboon</b>	Session 18	Invited Poster
301E	1:00-5:00	<b>From Paleoamericans to Recent Americans: A Celebration of Richard L. Jantz' Contributions to Biological Anthropology</b>	Session 19	Invited Poster
<b>Human Bio Association</b>				
300 AB	11:45-1:15	Human Biology Association: Awards Luncheon (reservation required)		
301ABC	1:30-4:45	Human Biology Association: Podium Sessions C and D		

**Thursday Evening (after 5:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
Offsite	5:00-7:00	BANDIT – Happy Hour (Preservation Pub, 2 <sup>nd</sup> floor)		
Ballroom A	5:00-6:30	<b>New and Expanding NSF Funding Opportunities: Interdisciplinary Science</b> Discussion with Carolyn Ehardt & Mark Weiss.		
300C	5:00-6:00	AAPA COD: Physical Anthropology Women's Mentoring Network - Mixer		
300D	6:00-8:00	Workshop, Teaching College Bioanthropology in the 21 <sup>st</sup> Century		
Park	5-9; 8-10	<b>PLENARY POSTERS (we have treats!) And Wiley Reception</b>	Session 20	Poster
200DE	6:00-8:00	<b>PLENARY WORKSHOP: Fossil Casts including new Standing Recon of <i>A. sediba!</i></b>		
200ABC	6:00-9:00	<b>AAPA Auction – Silent and Live (including new Standing Recon of <i>A. sediba!</i>)</b>		
<b>Human Bio Association</b>				
301ABC	5:00-6:30	Human Biology Association: Business Meeting		
300AB	7:00-9:30	Human Biology Association: Student Reception (student HBA membership required)		

**Friday Morning (8:00 - 11:30 am)**

ROOM	TIME	ACTIVITY	Session #	Session Type
Ballroom A	8:00-11:45	<i>HBA and AAPA Podium Symposium: The High Price of Success: Costs of Reproductive Effort in Male Primates and Humans</i>	Session 21	Invited Podium
Ballroom B	8:00-11:30	<b>PALEOANTHROPOLOGY: <i>Homo</i></b>	Session 23	Podium
Ballroom C	8:00-11:30	<b>SKELETAL BIOLOGY: Mastication, Jaw and Tooth Form.</b>	Session 24	Podium
200ABC	8:00-11:30	<b>BIOARCHAEOLOGY &amp; ANTHROPOLOGICAL GENETICS: Skeletal, Genetic and Isotopic Approaches to Colonization and Migration</b>	Session 22	Podium
200DE	8:00-11:30	<b>Advances in the Bioarchaeology of Nubia and Central Sudan</b>	Session 25	Invited Poster
301D	8:00-11:30	<b>Modern Morphometrics in Physical Anthropology II: Papers in Honor of Sokal</b>	Session 26	Invited Poster
301E	8:00-11:30	<b>Variation in Human Dental Form: A Symposium in Honor of Edward F. Harris</b>	Session 27	Invited Poster

**Friday All Day Activities (8:00 am - 5:30 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
<i>Authors present: Even-numbered posters 10-10:30 &amp; 2-2:30; Odd 10:30-11 &amp; 2:30-3</i>				
Clinch	8:00a-4:00p	<b>PALEOPATHOLOGY</b>	Session 28	Poster
		<b>SKELETAL BIOLOGY &amp; FORENSIC ANTHROPOLOGY: Age, Microstructure, Taphonomy, DNA, Methods</b>	Session 29	Poster
Park	8:00a-4:00p	<b>FUNCTIONAL MORPHOLOGY: Above the Neck</b>	Session 30	Poster
		<b>HUMAN BIOLOGY</b>	Session 31	Poster
		<b>PALEOANTHROPOLOGY: <i>Homo</i> and Reconstructing Environment</b>	Session 32	Poster
Park	8:00a-5:00p	EXHIBITORS		
Concession	8:00a-5:00p	AAPA REGISTRATION Speaker Ready Room (business center carrels)		
Board Rm	8:00a-5:00p	Job Interviews, Press Room		

**Friday Afternoon (11:30 am - 5:30 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
301AB	11:30-1:30	<b>AAPA LUNCHEON – DR. WILLIAM BASS</b> “The Autopsy of the ‘Big Bopper.’ My Role in Investigating the Death of an Early Rock & Roll Icon”		
300D	12:00-1:00	NSF One-on-One by appointment (contact <a href="mailto:cehardt@nsf.gov">cehardt@nsf.gov</a> for appt)		
Ballroom A	1:30-5:30	<b>Reconciling ‘Stress’ and ‘Health’: What Can Bioarchaeologists Learn from Other Subdisciplines?</b>	Session 33	Invited Podium
Ballroom B	1:30-5:30	<b>LIFE HISTORY, REPRODUCTION AND ENERGETICS</b>	Session 35	Podium
Ballroom C	1:30-5:30	<b>PRIMATE ECOLOGY: Feeding Ecology, Energy and Nutrition</b>	Session 36	Podium
200ABC	1:30-5:30	<b>ANTHROPOLOGICAL GENETICS</b>	Session 34	Podium
200DE	1:30-5:30	<b>Concepts and Realities – Humans in Time and Space: Papers in Honor of Fred Hines Smith</b>	Session 37	Invited Poster
301D	1:30-5:30	<b>Nonhuman Primates in Human-Modified Habitats: Explorations in Ethnoprimateology</b>	Session 38	Invited Poster

**Friday Evening (after 5:30 pm)**

ROOM	TIME	ACTIVITY
<b>AAPA</b>		
200ABC	5:45-7:45	<b>!!Note New Time - AAPA BUSINESS MEETING – Note New Time!!</b>
<b>Others</b>		
Rotunda	7:30-10:30	Journal of Human Evolution: Editorial Board Dinner
Board Rm	7:30-8:30	Human Biology: Editorial Board Meeting
300A	8:00-9:00	Dental Anthropology Association: Business Meeting
300C	8:00-9:00	Primate Interest Group
300D	8:00-9:00	American Dermatoglyphics Association: Business Meeting
301A	8:00-9:00	American Association of Anthropological Genetics: Business Meeting and Cocktail Hour

**Saturday Morning (8:00 am - 12:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
Ballroom A	8:00-12:00	<b>Ethical Practice in Biological Anthropology: Continuing the Dialogue</b>	Session 39	Invited Podium
Ballroom B	8:00-12:00	<b>SKELETAL BIOLOGY and BIOARCHAEOLOGY: Diet and Identity</b>	Session 41	Podium
Ballroom C	8:00-12:00	<b>PALEOANTHROPOLOGY: Later <i>Homo</i></b>	Session 42	Podium
200ABC	8:00-12:00	<b>PRIMATOLOGY: Ranging, Distribution and Genetics.</b>	Session 40	Podium
200DE	8:00-12:00	<b>The Bioarchaeology of Disease Ideologies</b>	Session 43	Invited Poster
301D	8:00-12:00	<b>Forensic Anthropology, Human Rights and Bioarchaeology of the Individual: A Tribute to the Life and Work of Karen Ramey Burns</b>	Session 44	Invited Poster

**Saturday All Day Activities (8:00 am - 5:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
<i>Authors present: Even-numbered posters 10-10:30 &amp; 2-2:30; Odd 10:30-11 &amp; 2:30-3</i>				
Clinch	8:00a-4:00p	<b>BIOARCHAEOLOGY: Subsistence, Methods and Archaeology</b>	Session 45	Poster
		<b>FUNCTIONAL MORPHOLOGY: Locomotion</b>	Session 46	Poster
		<b>SKELETAL BIOLOGY and FORENSIC ANTHROPOLOGY: Cranial Variation, Ancestry, Ecogeography, Size and Sex</b>	Session 47	Poster
Park	8:00a-4:00p	<b>PRIMATE DENTITIONS, DIET AND GROWTH</b>	Session 48	Poster
		<b>PRIMATOLOGY: Feeding, Predation and Ranging</b>	Session 49	Poster
Park	8:00a-4:00p	EXHIBITORS		
Concession	8:00a-5:00p	AAPA REGISTRATION Speaker Ready Room (business center carrels)		
Board Rm	8:00a-5:00p	Job Interviews, Press Room		

**Saturday Afternoon (12:00 - 5:00 pm)**

ROOM	TIME	ACTIVITY	Session #	Session Type
300D	12:00-1:00	NSF: One-on-One by appointment (contact cehardt@nsf.gov for appt)		
301A	12:00-2:00	AAPA Committee on Diversity: <i>Planning Meeting and Strategies for Diversifying your Institution</i>		
301B	12:00-2:00	AAPA Career Development Panel: <i>Interviewing Tips: (Almost) Everything You Need to Know to Land a Job</i>		
301B	2:00-4:00	AAAG Panel: <i>Postdoctoral Training in Anthropological Genetics</i>		
301C	1:00-5:00	AAPA Education Committee: <i>Teacher Outreach Workshop for K-12 teachers</i>		
Ballroom A	1:00-5:00	<b>Understanding Primate Communities Across Spatial, Temporal and Phylogenetic Scales</b>	Session 50	Invited Podium
Ballroom B	1:00-5:00	<b>HUMAN BIOLOGY</b>	Session 52	Podium
Ballroom C	1:00-5:00	<b>SKELETAL BIOLOGY: Postcranial Function and Biomechanics</b>	Session 53	Podium
200ABC	1:00-5:00	<b>PRIMATOLOGY: Ecology, Behavior and Flexibility</b>	Session 51	Podium
200DE	1:00-5:00	<b>Bone to Be Wild: An Invited Session in Honor of George Armelagos' Career and Mentorship</b>	Session 54	Invited Poster
301D	1:00-5:00	<b>CEMENTOCHRONOLOGY</b>	Session 55	Poster

**Saturday Evening (after 5 pm)**

ROOM	TIME	ACTIVITY
Board Rm	5:00-6:00	AAPA Student Awards Committee
Park	5:30-7:00	<b>AAPA Student Awards and RECEPTION</b>

## AAPA Presentation Schedule

### Thursday. Morning Sessions.

<b>Session 1:</b>	<b>Infectious Disease in Humans and Other Primates – Origins, Dynamics and Evolution.</b> <i>AAAG and AAPA Invited Podium Symposium.</i> Organizers: Anne Stone and Andrew Kitchen. <i>Ballroom A.</i>
	The history of infectious disease in humans (and to a lesser extent other primates) has been studied from different perspectives including those of bioarchaeology, medical history, and evolutionary genetics. Technical advances in nucleotide sequencing as well as in the ability to obtain genetic material from difficult sources (such as feces and ancient materials) have enhanced our ability to examine both ancient pathogens and pathogens that are difficult to isolate in nature. Additionally, significant advances in analytic methods have improved our ability to address questions about the evolutionary dynamics of important pathogens, such as the time of pathogen emergence or host jumps, biogeographic patterning, and the impacts of natural selection (both in the host and the pathogen). These advances have combined to provide critical insight into the intimate relationship of primates and their pathogens across multiple evolutionary timescales, from the ancient origins of malaria and lice to the recent emergence of HIV and SARS coronavirus. In this symposium, we bring together researchers to consider our rapidly evolving understanding of pathogens and parasites in the evolutionary history of their human and primate hosts.
	<i>Chair: Andrew Kitchen</i>
8:00-8:15	<b>Revealing the evolutionary dynamics of pathogens in primate populations.</b> A. KITCHEN.
8:15-8:30	<b>DNA analysis of ancient pathogens.</b> A.C. STONE.
8:30-8:45	<b>Primates and emerging infectious diseases.</b> M.P. MUEHLENBEIN.
8:45-9:00	<b>Ancient DNA and the metagenomics of disease.</b> C. WARINNER.
9:00-9:15	<b>Understanding the origins of primate retroviruses: Molecular epidemiology in deep time (and deep oceans).</b> M. WOROBAY, G. HAN.
9:15-9:30	<b>Convergent evolution of escape from hepaciviral antagonism in primates.</b> M.R. PATEL, H.S. MALIK.
9:30-9:45	<b>The evolutionary history of <i>Yersinia pestis</i>.</b> K. BOS, J. KRAUSE.
9:45-10:00	<b>Ancient tuberculosis DNA revealed by Next Generation Sequencing.</b> A.S. BOUWMAN, S. KENNEDY, R. MUELLER, C. ROBERTS, T. BROWN.
10:00-10:15	<b><i>BREAK</i></b>
	<i>Chair: Anne Stone</i>
10:15-10:30	<b>From the mouths of monkeys: Tuberculosis among synanthropic primates.</b> A.K. WILBUR, L. PFISTER, A.C. STONE, L. JONES-ENGEL.
10:30-10:45	<b>On the ecology of leprosy: Tails from phylo-genomics.</b> L. PFISTER, A.C. STONE.
10:45-11:00	<b>The evolution of <i>Treponema pallidum</i> in primates.</b> S. KNAUF, K.N. HARPER.
11:00-11:15	<b>Chimpanzees and malaria parasites: Behavioral strategies to limit the infection.</b> S. KRIEF, A. GRUNER, G. SNOUNOU.
11:15-11:30	<b>Addressing the unresolved phylogeny of Leishmania: A Next-Gen and ancient DNA approach.</b> K.M. HARKINS.
11:30-11:45	<b>Of Lice and men: The study of human evolution from a lousy perspective.</b> D.L. REED, M. ASCUNCE.
11:45-12:00	<b>Discussants,</b> CHARLOTTE ROBERTS AND CHARLES NUNN.
<b>Session 2:</b>	<b>SKELETAL BIOLOGY: Bioarchaeology, Paleopathology, and Stress.</b> <i>Contributed Podium Presentations.</i> Chair: Eric Bartelink. <i>200ABC.</i>
8:00-8:15	<b>Patterns of enthesal changes in modern humans and African great apes.</b> M. MILELLA, C.P. ZOLLIKOFER, M. PONCE DE LEÓN.
8:15-8:30	<b>Investigating activity at the Third Cataract (Nubia): Enteseal remodeling at Kerma and Tombos.</b> S.A. SCHRADER.
8:30-8:45	<b>Osteoarthritis and resource intensification in Prehistoric Central California.</b> C.M. CHEVERKO, E.J. BARTELINK.
8:45-9:00	<b>The relationship between age, sex and severity of arthritis in a turn of the century African American burial ground in Savannah, Georgia.</b> L.K. GRAHAM, F.L. WILLIAMS.
9:00-9:15	<b>Evidence of osteoarthritis during the Tiwanaku State in Bolivia and Peru (AD 500-1100).</b> S.K. BECKER.
9:15-9:30	<b>Knee osteoarthritis and pain: Data from the Osteoarthritis Initiative and their implications for reconstructing past quality of life.</b> E. WEISS.
9:30-9:45	<b>Relating posture to spinal osteoarthritis: Histological evidence.</b> J.F. BAILEY, E. LIEBENBERG, A.J. FIELDS, J.A. MATTISON, J.C. LOTZ, P.A. KRAMER
9:45-10:00	<b>Dental pathology and indicators of environmental stress in the prehistoric population of the Atacama Desert.</b> T. PARDO, M. HUBBE, E. ASPILLAGA, M. URIBE.
10:00-10:15	<b><i>BREAK</i></b>

10:15-10:30	<b>Oral hygiene and patterns of use in teeth of individuals of six sites in northern Caucasus dating from Eneolithic Period to Bronze Age.</b> J. GRESKY, N. BEREZINA.
10:30-10:45	<b>Investigating the emergence of tuberculosis in South Africa.</b> T.J. CAMPBELL, A.C. STONE, R.R. ACKERMANN.
10:45-11:00	<b>Poorhouse portrait: Analysis of the burial population in a New York poorhouse and tuberculosis ward cemetery.</b> E. GUTHRIE, G. VIDOLI, D. SEIB, N. VERSAGGI.
11:00-11:15	<b>The health and status of children from the Middle and Late Mississippian periods in the Tennessee.</b> R. SCOPA KELSO.
11:15-11:30	<b>News from the northern New France: A pathological assessment from the 18<sup>th</sup> Century French military and trading post Fort Michilimackinac.</b> J.L. FUNKHOUSER, M.E. DANFORTH.
11:30-11:45	<b>Population dynamics within graveyards.</b> F. ENGEL.
11:45-12:00	<b>Evaluating the agency of Soviet violence workers through analysis of skeletal trauma in the Tuskulenai case.</b> C.E. BIRD.

### Session 3: **SKELETAL BIOLOGY: Functional and Evolutionary Morphology.**

*Contributed Podium Presentations.* Chair: Lynn Copes. **Ballroom B.**

8:00-8:15	<b>Severely impaired skeletal acquisition in a mouse model of adolescent Type 2 diabetes.</b> M.J. DEVLIN, C. CONLON, M. VAN VLIET, L. LOUIS, M.L. BOUXSEIN.
8:15-8:30	<b>Hormonal contributions to sex differences in baboon skeletal robusticity.</b> L. COPE, H. DROUGHT, T. PATEL, R. BERNSTEIN.
8:30-8:45	<b>Mechanical and metabolic influences on human cortical bone morphology.</b> C.D. ELEAZER.
8:45-9:00	<b>The relationship between thumb reduction and relative carpal volume in African colobines.</b> S. CARNATION, C. ORR, B. PATEL.
9:00-9:15	<b>A study of postcranial indices, ratios and body mass versus eco-geographical variables in an assessment of phenotypic adaptation to climatic conditions.</b> N. SEGUCHI, C.B. QUINTYN, H. TAKAMUKU.
9:15-9:30	<del><b>Evidence for a substantial effect of neutral microevolutionary processes in shaping male and female human pelvic variation at a global scale.</b> L. BETTI, N. VON CRAMON TAUBADEL, A. MANICA, S.J. LYCETT. <i>WITHDRAWN</i></del>
9:30-9:45	<b>Functional morphology of proximal caudal vertebrae in nonprehensile-tailed primates.</b> G. RUSSO, M. SAYRE.
9:45-10:00	<b>Suspensory behaviors and the neck: A comparative analysis of the cervical vertebrae of extant primates.</b> T.K. NALLEY.
10:00-10:15	<b>BREAK</b>
10:15-10:30	<b>Atlantooccipital joint orientation and posture in catarrhines.</b> N.A. GRIDER-POTTER, R.C. HALLGREN.
10:30-10:45	<b>Three-dimensional head kinematics in chimpanzees and humans: Implications for the study of semicircular canal morphology.</b> N.E. THOMPSON, M.C. O'NEILL, B. DEMES, S.G. LARSON.
10:45-11:00	<b>Semicircular canal morphology as a predictor of platyrrhine locomotor behavior.</b> L.A. GONZALES, M.D. MALINZAK, R.F. KAY.
11:00-11:15	<b>Size and shape maturation of the human cochlea.</b> T. WANNAPRASERT, F. SPOOR, N. JEFFERY.
11:15-11:30	<b>Eye size as a selective determinant of vestibular sensitivity.</b> A.D. KEMP, E. KIRK.
11:30-11:45	<b>Pattern of facial and brain anatomical asymmetries in adult eastern lowland gorillas (<i>Gorilla beringei graueri</i>).</b> Y. HEUZÉ, A. BALZEAU.
11:45-12:00	<b>Integrative aspects of the hominoid mandible.</b> N. SINGH.

### Session 4: **PALEOANTHROPOLOGY: Primate Evolution.**

*Contributed Podium Presentations.* Chair: Robert Anemone. **Ballroom C.**

8:00-8:15	<b>Ground-truthing a neural-network based predictive model for locating productive fossil localities in the Eocene of Wyoming.</b> R.L. ANEMONE, C.W. EMERSON, B. NACHMAN, G.C. CONROY, R. WATKINS.
8:15-8:30	<b>Let your fingers do the walking: A simple spectral signature model for "remote" fossil prospecting.</b> G.C. CONROY, C.W. EMERSON, R.L. ANEMONE, B. TOWNSEND.
8:30-8:45	<b>A diverse primate fauna from the early Eocene of southwestern Wyoming.</b> B.A. NACHMAN, R.L. ANEMONE, C. BEARD, R. WATKINS.
8:45-9:00	<b>Allometry of calcaneal elongation in euprimate origins.</b> D.M. BOYER, J.T. GLADMAN, J.I. BLOCH.
9:00-9:15	<b>Morphological variation in adapiform and omomyoid distal phalanges.</b> S.A. MAIOLINO.
9:15-9:30	<b>Dental sexual dimorphism in Eocene euprimates.</b> K.E. FOLINSBEE.
9:30-9:45	<b>Diminutive cercopithecine teeth from Kanapoi, Kenya, and implications for the evolution of body size and diversity in guenons.</b> J. PLAVCAN, C.V. WARD, F.K. MANTHI.
9:45-10:00	<b>Mandibular molar elongation distinguishes <i>Mabokopithecus</i> from other nyanzapithecine genera.</b> R.J. JANSMA, B.R. BENEFIT, M.L. MCCROSSIN.

10:00-10:15	<b>BREAK</b>
10:15-10:30	<b>The evolution of global endocast shape in primates.</b> K.L. ALLEN.
10:30-10:45	<b>A comparative morphometric analysis of cranial ontogeny in hominoids and cercopithecines: Implications for the growth patterns of fossil catarrhines.</b> S.A. KOZAKOWSKI, P. GUNZ, D. BEGUN.
10:45-11:00	<b><i>Kenyapithecus</i> is the earliest plantigrade hominoid.</b> I.D. ARNEY, M.L. MCCROSSIN, B.R. BENEFIT.
11:00-11:15	<b>A phylogenetically-integrated morphological analysis of the hominoid wrist.</b> T.L. KIVELL, A.P. BARROS, J.B. SMAERS.
11:15-11:30	<b><i>In vivo</i>-validated digital models of hip joint range of motion applied to fossil hominoids.</b> A.S. HAMMOND, J. PLAVCAN, L. KORDOS, D.R. BEGUN, C.V. WARD.
11:30-11:45	<b>Reconstructing the ecology of a forest in late Miocene central Europe using stable isotope trace element analysis.</b> L.C. EASTHAM, R.S. FERANEC, D.R. BEGUN, L. KORDOS.
11:45-12:00	<b>Appearance of the modern baboon, <i>Papio hamadryas</i>, in the Plio-Pleistocene fossil record: Evidence from South Africa.</b> C.C. GILBERT, S.R. FROST, E. DELSON.

**Session 5: Current Bioarchaeological Research in the Near East and Circum-Mediterranean. Invited Poster Symposium.** Organizers: Anna Osterholtz, Megan Perry and Sherry Fox. **200DE.**

Over the past 20 years, the contextualized analysis of human skeletal remains has informed archaeological interpretations in many areas of the globe. One region that has seen relatively little bioarchaeological research is the Near East and circum-Mediterranean region. The study of human skeletal remains can address how communities affected and were affected by the domestication of plants and animals and agricultural intensification, the rise of villages and cities, increased trade and exchange, the presence of non-local imperial administrations, and their position at the crossroads of the ancient Old World.

Recently this lacuna has been filled by a number of bioarchaeologists who are integrating skeletal biology into archaeological fieldwork goals and/or revisiting skeletal samples that have long languished in laboratories and museums. This symposium will serve as a forum for researchers interested in the region and present our results to biological anthropologists interested in similar methods and research questions in other areas of the world.

7:30-8:00 am Poster set-up. 11:30-12:00 am Poster take-down.

Even numbered poster authors present - 10:00-10:30 am; Odd numbered poster authors present - 10:30-11:00 am.

1	<b>Hybridization or exploitation? Bioarchaeological evidence for the nature of Corinthian colonial interactions in Albania.</b> L.A. SCHEPARTZ, B. KYLE MCILVAINE.
2	<b>Mapping the spatial distribution of the mortuary remains at Neolithic Alepotrypa Cave, Greece.</b> A. PAPATHANASIOU, S. DESKAJ.
3	<b>Foot for thought? Contextualization of <i>os tibiale externum</i> from two Roman period mass graves at Oyumağaç Höyük, Turkey.</b> S.C. FOX, K. MARKLEIN.
4	<b>The Royal Hypogeum and Tomb VII of the Middle/Late Bronze-Age palace from Qatna (Tell Mishrife, Syria): Burial places of the elite?</b> C. WITZEL, S. DEGENHARDT, H. DOHMANN-PFÄLZNER, P. PFÄLZNER, S. FLOHR.
5	<b>From piles of bones to coffin-boxes: Making sense of commingled and fragmented human remains from the Middle/Late Bronze Age Tomb VII, Qatna (Tell Mishrife, Syria).</b> S. DEGENHARDT, S. FLOHR, H. DOHMANN-PFÄLZNER, P. PFÄLZNER, C. WITZEL.
6	<b>Reconstructing a multiple infant burial from the commingled bone assemblage of Tomb VII underneath the Bronze Age palace of Qatna (Tell Mishrife, Syria).</b> S. FLOHR, S. DEGENHARDT, H. DOHMANN-PFÄLZNER, P. PFÄLZNER, C. WITZEL.
7	<b>A tale of two tombs: Craniosynostoses from the Bronze-Age city of Qatna (Tell Mishrife, Syria).</b> C.C. BAUER, S. DEGENHARDT, C. WITZEL, S. FLOHR, P. PFÄLZNER, K. HARVATI.
8	<b>Bioarchaeology of an Early Bronze Age mortuary complex at Tell Umm el-Marra, Syria.</b> E.K. BATEY.
9	<b>To wean and to die – childhood life course differentials in Middle Bronze Age Sidon.</b> H. SCHUTKOWSKI, C. THOMAS.
10	<b>Marry me, marry my family: Congenital anomalies at Khirbet Qazone.</b> J.L. WALKER, M.A. PERRY.
11	<b>Geographic origins and diet during the Bronze Age in the Oman Peninsula.</b> L.A. GREGORICKA.
12	<b>Cranial depression fractures of the frontal bones from a Bronze Age Arabian commingled tomb.</b> R.P. HARROD, A.J. OSTERHOLTZ, D.L. MARTIN.
13	<b>A feature-based method for the determination of the minimum number of individuals from the Tell Abraq Tomb, UAE.</b> A.J. OSTERHOLTZ, D.L. MARTIN.
14	<b>The children of Amarna: Disease and famine in the time of Akhenaten.</b> K. KUCKENS.
15	<b>Growing up in Akhetaten: A bio-cultural approach to childhood growth.</b> A.E. SHIDNER.
16	<b>A study of <i>cribra orbitalia</i> over time and space in the ancient Nile Valley.</b> N.E. SMITH.

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**Session 6: Assessing Function via Shape: What is the Place of Geometric Morphometrics in Functional Morphology?**

*Invited Poster Symposium.* Organizers: Claire Terhune and Siobhán Cooke. **301D.**

The past twenty years have seen the rapid expansion and adoption of quantitative methodologies designed to capture and describe complex two- and three-dimensional shapes. Chief among these has been the group of methods making up the geometric morphometric toolkit. Geometric morphometrics is very successful at capturing complex shapes, but it has come under criticism when applied to purely functional questions, especially those derived from the biomechanical literature. To highlight some of these issues, this symposium explores the use of geometric morphometric techniques for assessing functional morphology. We ask a simple question, but one that has many answers: can geometric morphometrics and functional shape analyses be used to address similar functional hypotheses? The research presented in this symposium explores this question through topics ranging broadly across taxa and morphological regions. Through this diverse collection of research we hope to stimulate discussion and highlight new directions for future work in this commonly employed but often debated research area.

7:30-8:00 am Poster set-up. 11:30-12:00 am Poster take-down.

10:30-11:30 – Discussion. KIERAN MCNULTY and CHRISTOPHER VINYARD (authors at their posters during this time).

1	<b>Form and function in a sample of platyrrhine primates: A three-dimensional analysis of dental and TMJ morphology.</b> S.B. COOKE, C.E. TERHUNE.
2	<b>Understanding the role of diet in shaping the lemuriform mandible: Comparing traditional and geometric morphometric approaches.</b> K.L. BAAB, J.M. PERRY.
3	<b>Geometric morphometrics as a tool in evolutionary biomechanics.</b> D.S. STRAIT.
4	<b>Visualizing artiodactyl ecomorphology with geometric morphometrics.</b> S.C. CURRAN.
5	<b>What is the role of geometric morphometrics in testing functional hypotheses? A case study using 3D pelvic shape.</b> K.L. LEWTON.
6	<b>Shape as a predictor of intermembral index.</b> M. TALLMAN.
7	<b>The relationship between talar morphology and habitual substrate use among living gorilla taxa assessed using 3D geometric morphometrics.</b> R.P. KNIGGE, M.W. TOCHERI, C.M. ORR, K.P. MCNULTY.
8	<b>The talo-crural joint: Interface of genome and use.</b> K. TURLEY, S.R. FROST.
9	<b>Morpho-functional signals in the wrist of extant hominoids derived from 3D geometric morphometrics: The hamate as a test case.</b> S. ALMÉCIJA, C.M. ORR, M.W. TOCHERI, B.A. PATEL, W.L. JUNGERS.
10	<b>Geometric morphometrics of hominoid infrapinuous fossa shape.</b> D.J. GREEN, J. SERRINS, A.R. MARTINY, P. GUNZ.
11	<b>Functional morphology of the Neandertal scapular glenoid fossa.</b> M.E. MACIAS, S.E. CHURCHILL.

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**Session 7: From Kneberg to Now: Seventy-Five Years of Skeletal Analysis of Pre-Columbian Tennesseans.**

*Invited Poster Symposium.* Organizers: Maria Ostendorf Smith and Tracy Betsinger. **301E.**

The first woman full professor in the College of Arts and Sciences at the University of Tennessee, Knoxville, was anthropologist Madeline Kneberg Lewis (1903-1996). She was an archaeologist, artist, and the primary researcher of the large pre-Columbian skeletal samples archaeologically salvaged in Tennessee during the early years of TVA and WPA (1933-1961) hydroelectric dam construction. She was also a driving force in the creation of the Frank H. McClung Museum. Her efforts inventoried, aged, sexed, and differentially diagnosed pathologies on over 2000 skeletons. She undertook the skeletal analysis for two signature publications (co-authored with TMN Lewis) in Tennessee prehistory: *Hiwassee Island: An Archaeological Account of Four Tennessee Indian Peoples* (1946) and *Eva: An Archaic Site* (1961). This symposium honors her legacy and showcases the current status of research on the osteological collections her research pioneered.

7:30-8:00 am Poster set-up. 11:30-12:00 am Poster take-down.

10:30-11:30 – Discussion. DONNA BOYD.

1	<b>Madeline Kneberg and the birth of Biological Anthropology in Tennessee.</b> F.H. SMITH, B.T. SMITH.
2	<b>Health and disease at Ledford Island: A study of Late Mississippian human remains.</b> L.J. HELMS.
3	<b>Patterns in the adult and subadult pathologies in the Late Prehistoric Hiwassee Island osteological sample from East Tennessee.</b> C.D. PARDO, M.O. SMITH.
4	<b>Temporal patterns of auditory exostosis prevalence in pre-Columbian Tennessee: Controlling for geography and subsistence.</b> C.M. JENKINS.
5	<b>Testing the source of the non-embedded projectile point: Inflicted point or pit fill?</b> L.C. CHISHOLM, M.O. SMITH.
6	<b>A biocultural approach to warfare and violence during the late prehistoric period in the Middle Cumberland Region of Tennessee.</b> H.A. WORNE.
7	<b>Bioarchaeological investigations at Fernvale, a Middle Tennessee Archaic site.</b> S. HODGE, T.B. SAUL.

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8	<b>Subsistence considerations based on the community health in the late prehistoric Thompson Village site from west-central Tennessee.</b> M.O. SMITH, G.M. MOSHER.
9	<b>Regional health in late prehistoric East Tennessee: A meta-analysis of Dallas Phase sites.</b> S.M. OWENS.
10	<b>The co-association of hypoplastic enamel defects, carious lesions, and non-specific stress in subadults from pre-Columbian Tennessee.</b> M.C. WOJCINSKI.
11	<b>Caries prevalence and the late prehistoric Dallas Phase: A regional cultural pattern of female maize consumption in late prehistoric East Tennessee.</b> T.K. BETSINGER, M.O. SMITH.
12	<b>Environmental and dietary variation during the Dallas Phase in East Tennessee.</b> M.S. HARLE, S. MEEKS.

## Thursday. All Day Poster Sessions.

**Session 8: PALEOANTHROPOLOGY: Early Hominins and *Australopithecus*.**  
**Contributed Poster Presentations.** Chair: Adam Sylvester. **Clinch Concourse.**  
 7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm  
 Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

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| 1  | <b><i>Ardipithecus ramidus</i> proximal capitate morphology is most consistent with a locomotor ancestry of palmigrade arboreal clambering.</b> M.S. SELBY, G. SUWA, S.W. SIMPSON, T.D. WHITE, C.O. LOVEJOY.  |
| 2  | <b>An analysis of the <i>Ardipithecus ramidus</i> pelvis reconstruction using 3D geometric morphometric techniques.</b> N.M. WEBB, W.E. HARCOURT-SMITH, H. PONTZER.   |
| 3  | <b>Great expec-toe-tions: Divergence, convergence, and emergence of the modern hallux.</b> Z.J. THROCKMORTON.   |
| 4  | <b>Manual phalangeal curvature and locomotion in Primates.</b> S.A. MATARAZZO.  |
| 5  | <b>Heel-strike and impact transient during bipedal walking: Implications for the acquisition of a habitual bipedal gait.</b> J.T. WEBBER, D.A. RAICHLEN.  |
| 6  | <b><i>Australopithecus afarensis</i> probably lacks a midfoot break.</b> D.J. PROCTOR.  |
| 7  | <b>Reconstructing australopithecine midstance using femoral condyle curvature.</b> A.D. SYLVESTER.  |
| 8  | <b>The original analysis of the manual and pedal phalanges from the Drimolen hominin site, South Africa.</b> D.S. VERNON, C.G. MENTER, A. GALLAGHER.  |
| 9  | <b>The primate upper arm: A study on the deltoid index.</b> S. MATHEWS, M.F. HÄUSLER, P. SCHMID.  |
| 10 | <b>A new ~1.5 Ma hominin distal humerus from Ileret, Kenya.</b> M.R. LAGUE, B.G. RICHMOND, D.J. GREEN, D.R. BRAUN, J.W. HARRIS, E. MBUA, H. CHIRCHIR.   |
| 12 | <b>Changing our focus: Accentuating evolutionary changes of the hominid cranial base.</b> A. BARASH, E. BEEN.   |
| 13 | <b>A phylogenetic analysis of the hominin clade using postcranial characters.</b> K.D. PUGH.  |
| 14 | <b>Comparison of endocranial and ectocranial “symmetry planes” and application to the virtual reconstruction of hominid fossils.</b> S. PRIMA, G. SUBSOL, J. BRAGA, J. GARAMENDI, B. COMBÈS, J. DUMONCEL, D. FALK.  |
| 15 | <b>Cross-sectional morphology of the australopithecine hard palate.</b> M.E. VOSS, C.A. HILL, R.A. MENEGAZ.   |
| 16 | <b>Macro tooth wear patterns amongst the early hominins of South Africa.</b> A.F. CLEMENT, S.W. HILLSON.  |
| 17 | <b>Comparison between <i>Australopithecus afarensis</i> and <i>Pan troglodytes</i> honing facet microwear.</b> M.S. ZOLNIERZ, L.K. DELEZENE, F.E. GRINE, W.H. KIMBEL, M.F. TEAFORD, P.S. UNGAR.   |
| 18 | <b>HOMINIDS agent based model of Toro-Semliki Wildlife Reserve: Incorporating a modern mosaic habitat analogy into interpretations of the paleoenvironment and ranging behavior of <i>Ardipithecus ramidus</i>.</b> A. RICH STOUT, C. DEIMEL, C. GRIFFITH, J. SEPT, K.D. HUNT, B. LONG. |
| 19 | <b>Paleoenvironmental change in Pliocene eastern Africa as inferred from dental microwear texture analysis of fossil Bovidae.</b> J.R. SCOTT, M.C. O'HARA.  |
| 20 | <b>Spatial analysis of bone recovered from FxJj 20 AB, Koobi Fora, Kenya with implications to early hominin behavior.</b> M.A. TUPPER, S.K. HLUBIK.   |
| 21 | <b>Community dynamics through space and time in the Hadar and Turkana Basins, Ethiopia and Kenya.</b> A. VILLASENOR, A.K. BEHRENSMEYER, R. BOBE.  |

**Session 9: PALEOANTHROPOLOGY: Primate Evolution.**  
**Contributed Poster Presentations.** Chair: Biren Patel. **Clinch Concourse.**  
 7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm  
 Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

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| 1 | <b>Human predation of <i>Pachylemur</i>: Evidence of butchery of extinct lemurs in south central Madagascar.</b> A. COX, V.R. PEREZ, B.E. CROWLEY, C. BORGERSON, V. NATALIE, L.R. GODFREY. |
| 2 | <b>Strepsirrhine cranial shape: A multivariate approach.</b> E.E. GRIFFITH, L.R. GODFREY.  |
| 3 | <b>The femoral morphology of <i>Hadropithecus stenognathus</i>: A multivariate evaluation.</b> L.R. MEADOR, L.R. GODFREY.  |
| 4 | <b>Hallucal reduction in sloth lemurs and morphological convergence on orang-utans by <i>Palaeopropithecus</i>.</b> B.A. PATEL, K.E. GOODENBERGER, D.M. BOYER, W.L. JUNGERS.               |
| 5 | <b>New interpretations of the positional behaviors of the Dominican subfossil, <i>Antillothrix bernensis</i>, from the pectoral and pelvic girdles.</b> J.T. GLADMAN, A.L. ROSENBERGER.    |

6	<b>Functional morphology of the primate hallucal metatarsal (Mt1) and implications for inferring hallucal grasping capability in fossil primates.</b> K.E. GOODENBERGER, C.M. ORR, D.M. BOYER, R.L. JACOBS, J.C. FEMIANI, B.A. PATEL.
7	<b>First known tarsals of the earliest primate <i>Purgatorius</i>.</b> S.G. CHESTER, J.I. BLOCH, W.A. CLEMENS.
8	<b>Cochlear labyrinth volume and predicted hearing abilities in <i>Adapis</i>, <i>Necrolemur</i>, <i>Homunculus</i>, and <i>Tremacebus</i>.</b> E.M. LUDEMAN, E. KIRK, A.D. GOSSELIN-ILDARI, A. BLAYLOCK, R.F. KAY, M. GODINOT.
9	<b>New anchomomyin primate from the Late Eocene locality of Sossís (Catalonia, Spain).</b> J. MARIGÓ, R. MINWER-BARAKAT, S. MOYÀ-SOLÀ.
10	<del><b>A glimpse of the fossil <i>Theropithecus</i> wrist.</b> E.H. GUTHRIE. <i>WITHDRAWN</i></del>
11	<b>Morphological diversity and species recognition in South African <i>Cercopithecoides williamsi</i>.</b> M. ANDERSON, S.R. FROST, C.C. GILBERT, E. DELSON.
12	<b>Dental microwear analysis of <i>Cercopithecoides williamsi</i> from the Pliocene caves of South Africa.</b> E. GEISSLER, F.L. WILLIAMS.
13	<b>Dental microwear profilometry of African non-cercopithecoid catarrhines of the Early Miocene.</b> B.M. SHEARER, P.S. UNGAR, K.P. MCNULTY, H.M. DUNSWORTH, W.E. HARCOURT-SMITH, M.F. TEAFORD.
14	<b><i>Proconsul</i>'s basicranial morphology and its implications for understanding catarrhine evolution.</b> A.D. BALES.

### Session 10: PRIMATE EVOLUTION: Anatomy, Relationships, and Dimorphism.

**Contributed Poster Presentations.** Chair: Gary Aronsen. *Clinch Concourse.*

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Trichromacy and red-hued pelages evolved independently in primates.</b> C.P. HEESY, B.J. BRADLEY, J.M. KAMILAR.
2	<b>Activity pattern can only be predicted from eye morphology for haplorhine primates among mammals.</b> M.I. HALL, E. KIRK, J.M. KAMILAR.
3	<b>A comparative analysis of hippocampus size and ecological factors in primates.</b> M. EDLER, C. SHERWOOD, E. GILISSEN.
4	<b>Variable temporal-insular neuroanatomy in primates with attention to Eastern gorillas (<i>Gorilla beringei</i>).</b> S.K. BARKS, A.L. BAUERNFEIND, P.R. HOF, W.D. HOPKINS, M. RAGHANTI, M.R. CRANFIELD, A. MUDAKIKWA, A.A. DE SOUSA, K. ZILLES, C.C. SHERWOOD.
5	<b>Revisiting the social brain hypothesis: Incorporating within-species group size variation into a comparative analysis.</b> A.A. SANDEL, J.A. MILLER, S.K. PATTERSON.
7	<b>Investigating the relationship between endocranial volume and cranial shape in <i>Alouatta</i>.</b> L. HALENAR, M. TALLMAN.
8	<b>Macroevolutionary comparisons of ecological disparity and craniodental disparity in platyrrhine and strepsirrhine primates.</b> E.M. ST CLAIR.
9	<b>Distal radioulnar joint morphology of short-tailed semi-terrestrial cercopithecines and its implications for the evolution of hominoid taillessness.</b> A.E. MACKENZIE, D.R. BEGUN.
10	<b>Sexual dimorphism in catarrhine sacra: Obstetrics versus body size dimorphism.</b> E. MOFFETT, S. MADDUX, C. WARD.
11	<b>Patterns of sexual dimorphism in <i>Pan</i> and <i>Gorilla</i> limb bones.</b> T.L. PEARMAN, R.S. JABBOUR.
12	<b>Relative canine size as a fitness signal: a test for positive allometric scaling in intraspecific samples of adult male baboons.</b> E.B. KLOPP.
13	<b>Quantitative trait variation in purebred baboons and their hybrids.</b> C.C. ROSSOUW, R.R. ACKERMANN.
14	<b>Identifying hominin hybridity in light of taxonomy: Testing a <i>Papio</i> model using craniometrics.</b> A.M. DAUTARTAS, B.F. ALGEE-HEWITT, K. DRISCOLL, C. ELEAZER, K. GODDE, B.I. HULSEY, A. KRAMER.
15	<b>Reassessing guenon craniodental morphology: Closer inspection reveals support for the arboreal and terrestrial clades.</b> S. RAVI, C.C. GILBERT, B.A. PATEL.
16	<b>Gargantua the gorilla: Evaluating skeletal indicators of unique life history events.</b> G.P. ARONSEN, C.J. STAGE, K.A. WILLIAMSON.
17	<b>Multivariate analyses of trabecular bone structure in the proximal femur of living and extinct strepsirrhine primates.</b> B.A. PERCHALSKI, E.R. SEIFFERT, T.M. RYAN.
18	<b>Are pygmy tarsiers phyletic dwarves? An allometric analysis of tarsier limb proportions.</b> N.B. GROW.

**Session 11: PRIMATOLOGY: Sex, Sociality, Ontogeny, Captivity.**  
**Contributed Poster Presentations.** Chair: Christopher Schmitt. **Clinch Concourse.**  
 7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm  
 Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>A preliminary assessment of the primates of Burkina Faso, West Africa.</b> L.P. GINN, J. ROBISON, K.A. NEKARIS.
2	<b>Social flexibility in the cassically monogamous Titi Monkey: A response to increased population pressure.</b> K.A. DINGESS.
3	<b>Measurement of individual differences in novelty seeking in wild vervet monkeys (<i>Chlorocebus aethiops</i>) using a group-based approach.</b> M.B. BLASZCZYK.
4	<b>Using a howler monkey hybrid zone (<i>Alouatta pigra x Alouatta palliata</i>) to understand social variation.</b> L. HO, L. CORTÉS-ORTIZ, T.J. BERGMAN.
5	<b>Behavioral effects of human activity on wild white-faced capuchins (<i>Cebus capucinus</i>) at Curu Wildlife Refuge and Hacienda in Puntarenas, Costa Rica.</b> S.E. WEBB, M.B. MCCOY.
6	<b>Assessing the population of proboscis monkeys and threats to their survival in Balikpapan Bay, East Kalimantan, Indonesia.</b> K. SCOTT, V. NIJMAN, S. CHEYNE, S. LHOTA, Y. RAYADIN.
7	<b>Survey of lemur diversity in Mahavavy-Kinkony Wetland Complex, North-Western Madagascar.</b> M.K. SHRUM, G. DONATI.
8	<b>Aye-aye population genomics: Signatures of natural selection.</b> K. THOMPSON, E. LOUIS, A. RATAN, O. BEDOYA-REINA, R. BURHANS, R. LEI, S. JOHNSON, S. SCHUSTER, W. MILLER, P. GEORGE.
9	<b>The effect of sibling birth on parent-offspring relationships in lemurs.</b> A.L. SCHREIER, N.L. BARRICKMAN, K. KNOTT.
10	<b>Female geladas form strong bonds with close kin.</b> E.T. JOHNSON, N. SNYDER-MACKLER, J.C. BEEHNER, T.J. BERGMAN.
11	<b>Intersexual proximity and female dominance in Verreaux's sifaka (<i>Propithecus verreauxi</i>).</b> K.J. KLING, R.J. LEWIS.
12	<b>Same sex aggression and reproductive competition: collective action in <i>Alouatta caraya</i>.</b> M. KOWALEWSKI, P. GARBER, R. PAVE, V. FERNANDEZ, M. RAÑO, S. PEKER, G. ZUNINO.
13	<b>Male chimpanzee aggression toward females: A test of the sexual coercion hypothesis.</b> J.T. FELDBLUM, E.W. WROBLEWSKI, R.S. RUDICELL, B.H. HAHN, A.E. PUSEY, I.C. GILBY.
14	<b>Intrasexual competition and size dimorphism among polygynous primates.</b> E.M. TENNENHOUSE.
15	<b>Paternity confusion or reassurance? Why pregnant Hanuman langurs (<i>Semnopithecus schistaceus</i>) are proceptive.</b> E.L. PAIN, A. KOENIG, C. BORRIES.
16	<b>Proceptive and attractive behaviors during female pregnancy in black and gold howler monkeys: Preliminary results.</b> M. RAÑO, M. KOWALEWSKI, C. VALEGGIA.
18	<b>Maintaining pair-bonds in red-bellied lemurs (<i>Eulemur rubriventer</i>): A preliminary captive study at Duke Lemur Center, Durham, NC.</b> B. SINGLETARY, N. CORTES, S. TECOT.
19	<b>Copulation calls of <i>Cercopithecus mona</i> in the wild.</b> K. WERLING, K. WORSHAM, M. PATINO, M. RAMSIER, M. GLENN.
20	<b>Explaining the vocal repertoire of <i>Alouatta palliata</i>, the mantled howler monkey.</b> D.L. MCGUIRE, M.F. BEZANSON.
21	<b>Seasonal changes in song structure and calling behaviour of the Bolivian Grey Titi Monkey (<i>Callicebus donacophilus</i>).</b> D. KRÜMBERG, K. DINGESS.
22	<b>Ethological study of manual laterality in sanctuary Chimpanzees (<i>Pan troglodytes</i>).</b> A.N. FRIEND, J.D. NEGREY, L.F. MARCHANT.
23	<b>Hair cortisol concentrations in wild saddle back tamarins (<i>Saguinus fuscicollis weddelli</i>).</b> N. FOURIE, R. BERNSTEIN, L. PORTER, P. GARBER.
24	<b>The interplay between behavior and disease: Investigating pathogen transmission dynamics in wild chimpanzees with social network models.</b> J. RUSHMORE, D. CAILLAUD, R.J. HALL, R.M. STUMPF, L.A. MEYERS, S. ALTIZER.
25	<b>Lousy personalities: Aggression, testosterone, and ectoparasite dynamics in a population of wild brown mouse lemurs.</b> S. ZOHDY, A.D. KEMP, S. TECOT, P.C. WRIGHT, J. JERNVALL.
26	<b>Diagnosing <i>Mycobacterium</i> in marmosets.</b> G. HOUSMAN, V. BOERE, A.D. GRATIVOL, J. MALUKIEWICZ, L. MACHADO PEREIRA, I. DE OLIVEIRA SILVA, C.C. RUIZ-MIRANDA, A. STONE.
27	<b>Genetics and development of obesity in captive vervet monkeys (<i>Chlorocebus aethiops sabaues</i>).</b> C.A. SCHMITT, S. SERVICE, R.M. CANTOR, A.J. JASINSKA, M.J. JORGENSEN, J.R. KAPLAN, N.B. FREIMER.
28	<b>Hair plucking in bonobos (<i>Pan paniscus</i>): A consequence of captivity?</b> C.M. BRAND, L.F. MARCHANT.
29	<b>Changes in social behavior following the application of sensory-integration based therapy in a young adult female chimpanzee (<i>Pan troglodytes</i>).</b> E.J. INGMANSON, T.A. MAY-BENSON, S. BRACCINI, I. PORTON, M.L. BAUMAN.

30	<b>Measuring gestation length in the chimpanzees of Gombe National Park.</b> E.E. BOEHM, A.E. PUSEY.
31	<b>Changes in orangutan brain ontogeny indicate parallel evolution.</b> J.A. CREEL, S.H. RICE, A.C. DURBAND.
32	<b>Using digital photogrammetry to estimate growth in wild geladas.</b> A. LU, A. STINESPRING-HARRIS, C. MCCANN, J.C. BEEHNER.
33	<b>A camera trapping study of orangutans in the Wehea Forest in East Kalimantan, Indonesia.</b> S.N. SPEHAR, B. LOKEN.
34	<b>DNA mini-barcodes as a tool for primate applied diagnostics and species identification.</b> T.G. ROBBINS, V. NIJMAN.

**Session 12: ANTHROPOLOGICAL GENETICS.**

**Contributed Poster Presentations.** Chair: Ellen Quillen. *Park Concourse.*  
7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Novel method for detecting conserved and divergent regions in admixed populations.</b> B.J. KENNEDY.
2	<b>A variance component method for analyzing the effect of ancestry in admixed family-based genetic studies.</b> E.E. QUILLEN, L. ALMASY, R. DUGGIRALA, J.E. CURRAN, M.C. CARLESS, T.D. DYER, J.W. MACCLEUR, D.M. LEHMAN, A. COMUZZIE, H.H. GÖRING, D.C. GLAHN, J. BLANGERO.
3	<b>Y-chromosome library construction for next-generation sequencing.</b> S.M. MCNULTY, A.T. MIRÓ-HERRANS, C.J. MULLIGAN.
4	<b>FTO (rs9939609) and INSIG2 (rs7566605) allele distributions in human populations.</b> M. GNES, L. ANZIVINO, A. GONZÁLEZ DE LA VEGA, F. DE ANGELIS, O. RICKARDS, M. ORERA CLEMENTE, C. MARTÍNEZ-LABARGA.
5	<b>Assessing the correlation between dermatoglyphics and genetic data in worldwide populations.</b> F.L. PACK, A. DAUTARTAS.
6	<b>Distribution of TYRP1 923C allele across Island Melanesia and possible association with hair color phenotype.</b> H.L. NORTON, E.A. CORREA.
7	<b>Founder effect impacts APOE variability in northern Europe.</b> A.E. MANN, R.K. LEITER, C.R. TILLQUIST.
8	<b>Genetic analysis of some mountain communities of central Italy isolated areas.</b> F. MESSINA, A. FINOCCHIO, M. ROLFO, C. MARTÍNEZ-LABARGA, C. RAPONE, F. DE ANGELIS, M. COLETTA, G. BIONDI, A. BERTI, D. COMAS, O. RICKARDS.
9	<b>Multiple loci provide a more complete picture of Native American evolutionary histories.</b> M.P. ROGERS, C. HUGHES, A. OWINGS, D.M. GOLDBERG, R.S. MALHI.
10	<b>Analysis of cytosine methylation in Native American ancient DNA.</b> R.W. SMITH, D.A. BOLNICK.
11	<b>A tale of two sisters: Mitochondrial HVI sequence variation in Accompong Town Maroons.</b> N. MADRILEJO, H. LOMBARD, J.P. BENN TORRES.
12	<b>Evolutionary impact of recent historical events on the Rama Amerindian population from Nicaragua: Evidence from molecular genetics and isonomy markers.</b> N.F. BALDI, O.M. GRAF, P.E. MELTON, M.H. CRAWFORD.

**Session 13: BIOARCHAEOLOGY: aDNA, Paleodemography, Status and Variation.**

**Contributed Poster Presentations.** Chairs: K. Ann Horsburgh and Kara Hoover. *Park Concourse.*  
7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Multiple, distinct biological populations in Iron Age Mongolia: The Xiongnu elite cemetery of Borkhan Tolgoi (Egiin Gol valley) reveals an ancestral Turkish component.</b> R.W. SCHMIDT.
2	<b>Preliminary research on hereditary features of YinXu population.</b> W. ZENG, J. LI, H. YUE, H. ZHOU, H. ZHU.
3	<b>Ancient DNA recovery from Angel Mounds: DNA degradation attributed to archaeological field methods.</b> C. MARSHALL, G. MILLWARD, F.A. KAESTLE.
4	<b>Genetic characterization of the Roman/Parthian Period cemetery at Tall Šeḥ Ḥamad, Syria.</b> J.G. KENNEDY, D.A. MERRIWETHER.
5	<b>Investigating lactase persistence in a Medieval German cemetery: A step towards understanding the rise of the European lactase persistence polymorphism (-13910C/T).</b> A. KRÜTTLI, C. WARINNER, A. BOUWMAN, P. DELLA CASA, F. RÜHLI.
6	<b>Tetracycline labeling in early christian burials from Kulubnarti, Nubia: Measure of class differences.</b> J.A. MARGOLIS, D.P. VAN GERVEN, G.J. ARMELAGOS.

7	<b>The evolution of Africa's domestic cattle: Evidence from complete mitochondrial genomes of modern and archaeological specimens.</b> K.A. HORSBURGH, A. GOSLING, S. PROST.
8	<b>Relationships between European megaliths (6000 year BP) and Southern American cultures: Genetic and archaeological links.</b> A. ARNAIZ-VILLENA, J. ALONSO-RUBIO, V. RUIZ-DEL-VALLE.
9	<b>Using ancient DNA to investigate genetic adaptation to high altitude stressors in Andean populations.</b> L.E. GEORGES, L. FEHREN-SCHMITZ.
10	<b>An ancient crime scene: A genetic investigation of decapitated individuals from prehistoric Pacific Northwest coast warfare.</b> C.E. HUGHES, J.S. CYBULSKI, R.S. MALHI.
11	<b>The Bronocice Sheep Project: The use of ancient mitochondrial DNA analysis of sheep to infer human social interactions during the middle Neolithic in southeastern Poland.</b> M. SHAMOON POUR, J.G. KENNEDY, M. PIPES, S. MILISAUSKAS, J. KRUK, D.A. MERRIWETHER.
12	<b>Postmarital residence in Neolithic Anatolia.</b> M.A. PILLOUD.
13	<del><b>A craniometric approach to the question of postmarital residence in European Mesolithic and Upper Palaeolithic populations.</b> C.P. BREWSTER. <i>WITHDRAWN</i></del>
14	<b>Hands up! - Estimating paleodemographic rates from archeological data.</b> S. WEISE, J.L. BOLDSSEN.
15	<b>Medieval monastic mortality: Hazard analysis of mortality differences between monastic and non-monastic cemeteries in England.</b> J.C. BOULWARE, S.N. DEWITTE.
16	<b>Status and stature: Analysis of the association between socioeconomic status and adult stature in medieval London c. 1350-1538.</b> B.S. WALTER, S. DEWITTE.
17	<b>A comparison of aging methods and hazard analyses using a skeletal sample from the Larsen Village Cemetery (39WW2) in South Dakota.</b> R.J. WILSON-TAYLOR.
18	<b>Demography and health in Roman York.</b> L.J. MCINTYRE.
19	<b>Sub-adults in the Middle and Late Mississippian: Mortality, fertility, and growth rates.</b> R.E. SHATTUCK, K.D. WALLER, K. WILSON, A. NAGEL.
20	<b>Paleodemography and paleoepidemiology in the Middle and Late Mississippian.</b> K.D. WALLER, R.E. SHATTUCK, K. WILSON.
21	<b>"Short people got no reason to live": Long bone length and selective mortality of children in medieval Denmark.</b> M.B. CHALOUX, B.M. USHER.
22	<b>Social differentiation among Hualcayán burials: A bioarchaeological analysis comparing external long bone measurements in the North-Central Highlands, Peru.</b> R.G. WITT, R.E. BRIA, J.J. LESNIK.
23	<b>Status in prehistory: Exploration of Maya social tiers with cross-sectional geometry.</b> L.K. NOLDNER.
24	<b>Dental evidence of changes in female social status during the Middle to Late Woodland transition.</b> J. BECK.
25	<b>Hunter-gatherer resilience after the agricultural transition in prehistoric Kyushu, Japan.</b> K.C. HOOVER, M.J. HUDSON.
26	<b>Regional variation in mandibular morphology in the prehistoric Japanese populations of the Jōmon and the Okhotsk.</b> R.A. ARENAS, K.C. HOOVER.
27	<b>Evidence for behavioral change between the Middle and Late/Final Jomon period using long bone diaphyseal robusticity.</b> D.T. DILLON, D.H. TEMPLE.
28	<b>Changes in skeletal CSG robusticity and sociopolitical changes in central Italy Samnites (800-200 BC).</b> V.S. SPARACELLO, A. COPPA, V. D'ERCOLE.
29	<b>The Bronze Age cemetery from Hăpria, Romania.</b> J.M. WATSON, M. CONSTANTINESCU.
30	<b>Dental variation in Iron Age populations of southern Africa.</b> K.A. WARREN, S. HALL, R.R. ACKERMANN.
31	<b>A comparison of Mesolithic and Neolithic population affinities using the cranium and postcranium.</b> N. VON CRAMON-TAUBADEL, J.T. STOCK, R. PINHASI.
32	<b>Bioarchaeological case studies from the early Medieval Site of Pohansko near Břeclav, Czech Republic.</b> K.L. KEITH, V.I. BĂRCUȚEAN, M.D. JANAS, J.R. MCGINTY, A. OAXACA, M.J. DIETZ.
33	<b>A comprehensive bioarchaeological analysis of a Copper Age society from Rome, Italy.</b> P. CATALANO, F. DE ANGELIS, A. ANZIDEI, M. BRILLI, L. CARBONI, A. CIANFANELLI, S. DI GIANNANTONIO, C. MARTÍNEZ-LABARGA, G. SCORRANO, O. RICKARDS.
34	<b>The use of musculoskeletal stress markers in determining the effects of workload in a Roman Imperial Necropolis (I-III centuries AD).</b> C. CALDARINI, F. ZAVARONI, V. BENASSI, F. DE ANGELIS, P. CATALANO.
35	<b>Exploration of First Intermediate Period burials at Mendes.</b> A.M. LOPINTO.
36	<b>Making people: Sorting commingled remains from the St. Anthony of Padua Cemetery, Minneapolis, MN 1851- 1857.</b> D.M. ALMQUIST, K.T. BLUE.
37	<b>Stress in Archaic Texan hunter-gatherers: An assessment of linear enamel hypoplasias.</b> J. BERBESQUE, G.H. DORAN.
38	<b>Bioarchaeological analysis of Oak View Landing (40DR1): An Archaic population in the Kentucky Lake Reservoir.</b> K.D. GRANT.

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39	<b>An osteological analysis of the Manasota Period Yellow Bluffs site (8SO4) from Sarasota, Florida.</b> A.A. ELGART, S. PAULE.
40	<b>Biological variability of the first forager-farmers in the Sonoran Desert.</b> R.M. BYRD.
41	<b>A review of undescribed human skeletal remains from archaeological sites in Venezuela: Indicators of health, nutrition, and social practices.</b> M.A. DIBRELL, G.P. ARONSEN.
42	<b>Ancient burials from the site of Cardón Mocho, province of Catamarca, Argentina.</b> H.D. DRUBE, B. DESÁNTOLO, G. LAMENZA, A. DI BASTIANO, S. SALCEDA.
43	<b>Regional integration, subsistence, and health during the Formative Period in the Lake Titicaca Basin.</b> D.L. HUTCHINSON, S. JUENGST, K.L. CHAVEZ, S.J. CHAVEZ, L. NORR, T. SCHOBBER.
44	<b>Examining life and community history with 19<sup>th</sup> century bioarchaeological remains from Pontiac, Michigan.</b> T.J. SETZER, T. RAMADAN, S. WARD.
45	<b>Cultural ecology and biological distance among Classic and Postclassic period American Southwest and Mexican populations.</b> C. RAGSDALE, H.J. EDGAR.
46	<b>How trade networks impact phenotypic variation among an archaeological population from the Preclassic Maya site of Colha.</b> B.L. SNOWDEN, A. DURBAND, A.B. HOUK.
47	<b>Tracking Hunnic cultural influences through cranial deformation.</b> W. KELSEY, T.A. CRIST, A.D. SOFICARU.
48	<b>Were the sacrifices in Mound 72 at Cahokia nonlocal? A new perspective from the dentition.</b> A.R. THOMPSON.
49	<b>Burial patterns at the Chelechol ra Orrak cemetery, Republic of Palau.</b> G.C. NELSON, S.M. FITZPATRICK.
50	<b>The quantification and assessment of mortuary practices at Morton Shell Mound (16IB3).</b> J.C. STANTON, N.P. HERRMANN.
51	<b>Burying the child in Post-medieval Poland: Prenatal vs. postnatal remains.</b> A.B. SCOTT, T.K. BETSINGER.
52	<b>The Mummipaedia Project: Crowdsourcing to expand the IMPACT radiological mummy database.</b> A.D. WADE, A.J. NELSON.

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## Thursday. Afternoon Sessions.

### Session 14: **The Evolution of Biological Anthropology: Defining a Future Discipline.**

*Wiley-Blackwell Invited Podium Symposium.* Organizers: Benjamin Auerbach and Graciela Cabana. *Ballroom A.*

In the 60 years since Washburn's call for a "New Physical Anthropology," in part responding first to the Eugenics Movement and then to the Modern Synthesis, biological anthropologists have constantly redefined their role both within anthropology and in relation to associated disciplines. As an outgrowth of this call, researchers in the field have made evolutionary theory and hypothesis testing a priority over descriptive and typological studies. Biological anthropologists have also attempted to integrate study goals with researchers in related fields, such as human genetics, psychology, and organismal biology. Despite these efforts, theoretical developments in these other fields continue to advance at a fast pace, but biological anthropology fails to incorporate those developments into its overall research program. Moreover, our integration with these disciplines, as well as our sibling subdisciplines within anthropology, has been inconstant and inconsistent among biological anthropologists. Without correcting these trends, bioanthropological research might ultimately be courting obsolescence.

This symposium seeks to address these issues with three goals for guiding the future of biological anthropology: 1) ensuring biological anthropology research is based on current knowledge and theoretical developments in associated fields (especially evolutionary biology); 2) reducing the balkanization among anthropological disciplines—even within biological anthropology—and improving interdisciplinary communication with other fields of research; and 3) making ethics and the incorporation of cultural knowledge a centerpiece to the practical application of biological anthropology studies. Using their research as examples, participants will discuss solutions and practical steps toward achieving these goals.

1:00-1:15	<b>Evolving biological anthropology in twelve acts.</b> B.M. AUERBACH, G.S. CABANA.
1:15-1:25	<b>Crossing disciplines to challenge the adaptationist paradigm.</b> R.R. ACKERMANN.
1:25-1:35	<b>Anthropology in the age of phenomics.</b> C.C. ROSEMAN.
1:35-1:45	<b>Integrating data in paleoanthropology: The future role of prehistoric fossils in the genomic present.</b> A.P. VAN ARSDALE.
1:45-2:00	<b>Discussion 1</b>
2:00-2:10	<b>Anthropological primatology: What field primatologists can contribute to the field.</b> J.D. PRUETZ.
2:10-2:20	<b>Narrative, meaning and the future of bioarchaeology.</b> C.M. STOJANOWSKI.
2:20-2:30	<b>Health research in biological anthropology: Integrating evolutionary and biocultural approaches.</b> J.J. SNODGRASS, W.R. LEONARD.
2:30-2:45	<b>Discussion 2</b>
2:45-3:00	<b>BREAK</b>
3:00-3:10	<b>Living on the edge: Interdisciplinarity and the future of biological anthropology.</b> B. HALLGRIMSSON.
3:10-3:20	<b>What kind of anthropologist am I? Boundary crossings and the new one-drop rule.</b> C.C. GRAVLEE.
3:20-3:30	<b>Without anthropology, biological anthropology is just biology, only more poorly funded.</b> J. MARKS.
3:30-3:45	<b>Discussion 3</b>
3:45-3:55	<b>Ethical discourse in biological anthropology: Some things borrowed, something new.</b> T.R. TURNER.
3:55-4:05	<b>Getting the word out: Community consultation and continuing engagement in anthropological genetics research.</b> D.H. O'ROURKE, M.G. HAYES.
4:05-4:20	<b>Discussion 4</b>
4:20-4:45	<b>Discussants,</b> MILFORD WOLPOFF, LESLIE AIELLO, JAMES CHEVERUD

### Session 15: **PRIMATOLOGY: Sex, Aggression and Competition.**

*Contributed Podium Presentations.* Chair: Zarin Machanda. *Ballroom B.*

1:00-1:15	<b>The development of aggressive play behavior in wild chimpanzees.</b> Z.P. MACHANDA, S. KO, M. EMERY THOMPSON, E. OTALI, S.M. KAHLENBERG, M.N. MULLER, R.W. WRANGHAM.
1:15-1:30	<b>Juvenile harassment of adults in bonobos and the exploratory aggression and rank improvement hypotheses.</b> K.J. BOOSE, F.J. WHITE.
1:30-1:45	<b>Effect of opponent distance on post-conflict behavior in wild chimpanzees, Kanyawara, Kibale National Park, Uganda.</b> J.A. HARTEL, C.B. STANFORD.
1:45-2:00	<b>Agonistic relationships among female primates: The axes of despotism.</b> A. KOENIG, C.J. SCARRY, B.C. WHEELER, C. BORRIES.
2:00-2:15	<b>Anticipatory stress, territoriality and hunting in wild chimpanzees.</b> M.E. SOBOLEWSKI, J. BROWN, J.C. MITANI.

2:15-2:30	<b>Short-term consequences of intergroup aggression among tufted capuchin monkeys: Implications for long-term coexistence among unevenly-matched competitors.</b> C.J. SCARRY, M. TUJAGUE.
2:30-2:45	<b>Intergroup aggression and within-group cohesion in wild chimpanzees.</b> M.N. MULLER, Z.P. MACHANDA, D.K. ENIGK, R.W. WRANGHAM.
2:45-3:00	<b>Trade-offs between intra-group reproductive competition and inter-group territorial competition in male chimpanzees.</b> M.L. WILSON, E.E. WROBLEWSKI, D.C. MJUNGU, S. KAMENYA, R.S. RUDICELL, B.H. HAHN, A.E. PUSEY.
3:00-3:15	<b>BREAK</b>
3:15-3:30	<b>Context of copulation calls in wild chimpanzees.</b> M. EMERY THOMPSON, Z.P. MACHANDA, M.N. MULLER, S.M. KAHLBERG, R.W. WRANGHAM.
3:30-3:45	<b>The functional significance of female copulation calls in olive baboons (<i>Papio anubis</i>).</b> J.T. WALZ, D.M. KITCHEN.
3:45-4:00	<b>“Following” in olive baboons (<i>Papio hamadryas anubis</i>) results in deviation from the Priority of Access Model: Consortship behavior and genetic paternity.</b> L.M. DANISH, A. DI FIORE, R.A. PALOMBIT.
4:00-4:15	<b>Male dominance rank, access to females, and mating success in mantled howlers (<i>Alouatta palliata</i>): Testing the Priority-of-Access Model.</b> L.C. COREWYN.
4:15-4:30	<b>A functional imaging study of “jealousy” in captive male titi monkeys (<i>Callicebus cupreus</i>).</b> K.L. BALES, N. MANINGER, T.J. SCHAEFER, W.A. MASON, S.R. CHERRY, S.P. MENDOZA.
4:30-4:45	<b>Male reproductive senescence in the ring-tailed lemur (<i>Lemur catta</i>).</b> J.A. PARGA.
4:45-5:00	<b>Towards a theoretical framework for understanding the variation in sexually-selected traits among multimale-multifemale anthropoid primates.</b> C. DUBUC, J.P. HIGHAM, A. ENGELHARDT.

**Session 16: PALEOANTHROPOLOGY: Early Hominins, *Australopithecus*, and *Paranthropus*.**  
**Contributed Podium Presentations.** Chair: Scott Williams. *Ballroom C.*

1:00-1:15	<b>The endocast of <i>Sahelanthropus tchadensis</i>, the earliest known hominid (7 Ma, Chad).</b> T. BIENVENU, D. FALK, K. SEMENDEFERI, F. GUY, C. ZOLLIKOFER, M. PONCE DE LEÓN, P. TAFFOREAU, H. MACKAYE, A. LIKIUS, P. VIGNAUD, M. BRUNET.
1:15-1:30	<b>The earliest hominins were rigid wristed.</b> C.M. ORR.
1:30-1:45	<b>Complex patterns of selection and constraint explain the evolution of the hominin hip bone.</b> M.W. GRABOWSKI, C.C. ROSEMAN.
1:45-2:00	<b>More than the sum of its parts? Multivariate analysis of locomotor behavior in <i>Ardipithecus ramidus</i>.</b> C. ROLIAN, H.M. DUNSWORTH, K. MCNULTY, P. LEMELIN, W.L. JUNGERS.
2:00-2:15	<b><i>Ardipithecus ramidus</i> and the evolution of the human cranial base.</b> W.H. KIMBEL, G. SUWA, B. ASFAW, T.D. WHITE, Y. RAK.
2:15-2:30	<b>Fossils from Olduvai Gorge come home and go online.</b> J.K. NJAU, J. KIHIOYO, P. MSEMWA, A. KWEKA, J. PARESSO, A. GIDNA, L.J. HLUSKO.
2:30-2:45	<b>Late Miocene hominin biogeography: Comparative analyses of eastern and southern African faunas.</b> A.L. RECTOR, K. O'NEILL.
2:45-3:00	<b>The South African Palaeocave Survey: A regional GIS approach to palaeoanthropological fieldwork.</b> K.L. KUYKENDALL, A. REID, K.L. LEWTON, J. BRINK, B. VILLMOARE.
3:00-3:15	<b>BREAK</b>
3:15-3:30	<b>Potential soft organic tissue preserved in association with the <i>Australopithecus sediba</i> fossils from Malapa cave site, South Africa.</b> R. KEELING, L.R. BERGER.
3:30-3:45	<b>The number of vertebrae in early hominins: Insights from <i>Australopithecus sediba</i>.</b> S.A. WILLIAMS, S.E. CHURCHILL, K.R. OSTROFSKY, P. SCHMID, N. FRATER, L.R. BERGER.
3:45-4:00	<b>A reconstruction of the Sts 65 <i>Australopithecus africanus</i> pelvis with implications for birth in early hominins.</b> J. ROMANO, A.G. CLAXTON, J.M. DESILVA.
4:00-4:15	<b>3D retrodeformation of paleoanthropological fossils based on biomechanical simulation.</b> G. SUBSOL, S. CANU, B. GILLES, J. BRAGA, S. COTIN, F. THACKERAY.
4:15-4:30	<b>Continuous dental eruption and the age at death of Sts 5.</b> B.A. VILLMOARE, K.L. KUYKENDALL, T.C. RAE, C. BRIMACOMBE.
4:30-4:45	<b>Metopism and early human brain evolution.</b> R.L. HOLLOWAY, D.C. BROADFIELD, K. CARLSON.
4:45-5:00	<b>What did <i>Hadropithecus</i> eat? And why should paleoanthropologists care?</b> L.R. GODFREY, B.E. CROWLEY, S.J. KING, K.M. MULDOON, E.R. DUMONT.

**Session 17: Food Materials Testing and its Relevance for Primate Biology.***Invited Poster Symposium.* Organizers: Erin Vogel, Nayuta Yamashita and Barth Wright. **200DE.**

Research on the mechanical properties of primate foods was initiated by the late Dr. Warren Kinzey in the 1970's, but received further impetus in the 1990's from the introduction of portable mechanical devices such as the Darvell HKU tester. Data from these studies have been directed to research questions on topics as diverse as dietary selection, cranio-dental morphology, and social behavior. The results have indicated the mechanical diversity of foods that primates consume and demonstrated how important quantification is for answering these questions. In this symposium, we bring together researchers who have both developed and used some of these methods to try to understand the relationship between the diet, morphology and socioecology of primates. We conclude the symposium with a meta-analysis of the current dataset in relation to primate cranio-dental variation. Such a synthesis is essential for better understanding of the functional significance of variation in cranio-dental morphology within the hominid lineage.

12:00- 1:00 pm Poster set-up. 4:30- 5:00 pm Poster take-down.

1:00-2:00 pm Short Presentations by Authors.

3:30-4:30 pm Roundtable Discussion.

1	<b>New developments in field mechanics.</b> P.W. LUCAS.
2	<b>How hard can it be? Exploring the feeding ecology of sakis.</b> M.A. NORCONK.
3	<b>Finite element model of the <i>Cebus</i> mandible under different loading conditions.</b> C.F. ROSS, L.B. PORRO, C. ORSBON, T. STEWART, A.B. TAYLOR, J. IRIARTE-DIAZ.
4	<b>Applying Extreme Value Analysis in assessing the material properties of the most challenging foods consumed by primates.</b> B.W. WRIGHT, C.J. VINYARD, N. YAMASHITA, E.R. VOGEL.
5	<b>Mechanical food properties and tooth wear differentiate three populations of <i>Lemur catta</i> in southwest Madagascar.</b> N. YAMASHITA, F.P. CUOZZO, M.L. SAUTHER, P.S. UNGAR, A. RIEMENSCHNEIDER, E. FITZGERALD.
6	<b>Tough and then some: New directions for a growing Food Science in primatology.</b> C.J. VINYARD, C.L. THOMPSON, P.J. LUCK, E.A. FOEGEDING.
7	<b>Co-variation between dietary toughness, chewing efficiency, and dental wear in a wild population of geladas.</b> V.V. VENKATARAMAN, H. GLOWACKA, J. FRITZ, M. CLAUSS, P.J. FASHING, N. NGUYEN, C. SEYOUUM, N.J. DOMINY.
8	<b>Developmental perspectives on feeding in wild tufted capuchins (<i>Cebus libidinosus</i>).</b> J. CHALK, B.W. WRIGHT, E.R. VOGEL, P.W. LUCAS.
9	<b>Dietary toughness constrains juvenile feeding efficiency in Phayre's leaf monkeys (<i>Trachypithecus phayrei crepusculus</i>).</b> K. OSSI-LUPO, A. KOENIG.
10	<b>Mechanical properties of <i>Pentaclethra macrophylla</i> seed pods and ingestive strategies of the western pied colobus monkey (<i>Colobus polykomos</i>).</b> D.J. DAEGLING, W.S. MCGRAW, B.R. BURROWS, J.D. PAMPUSH, D.G. BERTIN, F. OURO.
11	<b>Membrane-plate transition in leaf development may influence feeding by Southern Muriquis (<i>Brachyteles arachnoides</i>, ATELIDAE, PRIMATES).</b> M.G. TALEBI, E.A. SALA, P.W. LUCAS.
12	<b>Do food material properties predict jaw and tooth morphology in primates?.</b> E.R. VOGEL, S. COINER-COLLIER, R.S. SCOTT, J. CHALK, P. CONSTANTINO, H. GLOWACKA, L. LOYOLA, K. OSSI-LUPO, M. RAGUET-SCHOFIELD, M. TALEBI, C.J. VINYARD, B.W. WRIGHT, N. YAMASHITA, N.J. DOMINY, P.W. LUCAS.
13	<b>Influence of food material properties and cooking on meat-eating performance in humans.</b> Z. ZHOU, D. WARD, D. SHAPIRO, S. HLUBIK, K.L. DE ROSA, D.J. HOFFMAN, E.R. VOGEL, R.S. SCOTT.
14	<b>Hominin hard object feeding as inferred from dental chipping analysis.</b> P.J. CONSTANTINO, A. EDELMANN.

**Session 18: Recent Advances in Knowledge of a Major Papionin Taxon: The Kinda Baboon.***Invited Poster Symposium.* Organizers: Cliff Jolly, Jane Phillips-Conroy, and Jeff Rogers. **301D.**

Baboons (*Papio*) are among the most extensively researched non-human primates, and their diversity is a staple of comparative primate socioecology, yet the full range of variation in the genus is strikingly under-documented. This symposium will present some of the findings, many of them unexpected, emerging from recent, multi-disciplinary investigation of the Kinda baboon, a taxon that is distinctive and widely distributed, yet previously unstudied in the wild.

12:00- 1:00 pm Poster set-up. 4:30- 5:00 pm Poster take-down.

4:00-4:30 Roundtable Discussion.

1	<b>Kinda baboons in phylogenetic and paleogeographic perspective.</b> A. BURRELL, C. JOLLY, C. BERGEY, J. PHILLIPS-CONROY, J. ROGERS, T. DISOTELL.
2	<b>Whole genome DNA sequence analysis of the kinda baboon (<i>Papio kindae</i>).</b> J. ROGERS, J. PHILLIPS-CONROY, C.J. JOLLY, D. RIO DEIROS, M. RAVEENDRAN, G.L. FAWCETT, K. WORLEY, D.M. MUZNY, R.A. GIBBS.
3	<b>Cranial shape variation in extant and fossil <i>Papio</i> and its implications for the evolution of the Kinda baboon.</b> S.R.

FROST.

4	<b>Adult kinda baboon (<i>Papio kindae</i>) behavior - preliminary results from a two year study .</b> A.H. WEYHER, K.L. CHIOU.
5	<b>A pilot description and categorization of Kinda baboon vocalizations.</b> K.L. CHIOU.
6	<b>Serum prolactin and social behavior of Kindas and other baboons.</b> J.E. PHILLIPS-CONROY, C.J. JOLLY, J. ROGERS, T. ZIEGLER.
7	<b>What can fecal testosterone tell us about the life history of male kinda baboons?</b> J.C. BEEHNER, J. ROGERS, C.J. JOLLY, J.E. PHILLIPS-CONROY.
8	<b>Exploring hormonal correlates of small body size in the Kinda baboon (<i>Papio kindae</i>).</b> H. DROUGHT, J. PHILLIPS-CONROY, C. JOLLY, R. BERNSTEIN.
9	<b>The broader picture. Extension of baboon socio-ecology by adding new findings from Guinea and Kinda baboons.</b> D. ZINNER, J. FISCHER.

### Session 19: From Paleoamerican to Recent Americans: A Celebration of Richard L. Jantz's Contributions to Biological Anthropology.

*Invited Poster Symposium.* Organizers: Steve Ousley and Kate Spradley. **301E.**

Richard Jantz has been a teacher, mentor, and colleague at the University of Tennessee, Knoxville, for over 40 years, and has recently retired. His numerous contributions to understanding human variation (anthropometric, dermatoglyphic, and osteometric) have greatly impacted many facets of biological anthropology. He also oversaw the establishment and preservation of databases including skeletal observations from modern Americans (the Forensic Data Bank), anthropometrics from Native Americans (from Franz Boas), and worldwide dermatoglyphic observations (from Heinz Brehme), which have and will continue to benefit many anthropologists. Most recently he was a litigant in the Kennewick Man case, highlighting his contributions to understanding the earliest Americans. This symposium reflects Richard Jantz's depth and breadth of contributions.

12:00- 1:00 pm Poster set-up. 5:00-6:00 pm Poster take-down.

4:00-6:00 pm Discussion. FRED H. SMITH.

1	<b>The Biological Anthropology Database legacy of Richard L. Jantz .</b> D.R. HUNT, S.D. OUSLEY.
2	<b>Geometric morphometrics and statistical classification: Size matters.</b> S.D. OUSLEY, M. KENYHERCZ.
3	<b>Investigating shape changes in American White and Black cranial dimensions: A 3d geometric morphometric approach.</b> B. DUDZIK, L. MEADOWS JANTZ.
4	<b>The African Diaspora: Assessing cranial secular change using geometric morphometrics.</b> M.K. SPRADLEY.
5	<b>A head for cranial analysis: 3D investigation of endo- and ectocranial sex dimorphism.</b> N.R. SHIRLEY, E. ABDEL FATAH, R.L. JANTZ, M.R. MAHFOUZ.
6	<b>An investigation of craniometric variation in Paleoamericans from different continents.</b> K.T. ALSUP.
7	<b>Geometric morphometric analysis of Arikara craniofacial morphology.</b> A.H. MCKEOWN.
8	<b>Examination of Archaic Period craniometric variation in the Middle Tennessee River Valley.</b> N.P. HERRMANN, S.M. ZALESKI.
9	<b>Temporal changes in Arikara femoral torsion.</b> D.J. WESCOTT, D.L. CUNNINGHAM.
10	<b>Secular change in pelvic sexual dimorphism: A 3D study.</b> K.R. DRISCOLL.
11	<b>Functional morphology and variation: The effects of obesity on the cross-sectional geometry of the humerus.</b> M.K. MOORE.
12	<b>A comparison of fluctuating asymmetry in the craniofacial skeleton of residents of Mexico and immigrants from Mexico to the United States.</b> K.E. WEISENSEE, M. SPRADLEY.
13	<b>Untold tales: Skeletons from the Little Bighorn contrasted with Seventh Cavalry medical documents.</b> P. WILLEY.
14	<b>Post-traumatic bone loss in Civil War soldiers.</b> A. GOOTS, K. BRUWELHEIDE, D. OWSLEY.
15	<b>Paleodemography and perinatal mortality from the Agora well, Athens, Greece.</b> L.W. KONIGSBERG, M.A. LISTON.
16	<b>Aging methods across populations: Focus in Nigeria.</b> E.H. KIMMERLE, L. KONIGSBERG.

**Thursday. EVENING Plenary Session. 5:30-8 pm** (Set-up 5-5:30; Take-down 8-8:30) **Come by for treats...**

<b>Session 20:</b>	<b>PLENARY POSTERS.</b> Chairs: Juliet Brophy and Mark Teaford. <i>Park Concourse.</i>
1	<b>Broader social impacts: Physical Anthropology and the K-12 Classroom.</b> C.M. SCHREIN.
2	<b>Evolutionary biology offers an effective tool for changing high school students' attitudes about healthy food choices.</b> D. SHERRY.
3	<b>Genotyped undergraduates: Better learners and leaders in the personal genomics era.</b> H.M. DUNSWORTH.
4	<b>Finding the place of race in anthropological discourse: A digital textual analysis.</b> M.A. ALGEE-HEWITT, B.F. ALGEE-HEWITT.
5	<b>Exhibiting bodies: Confronting the human remains debate in public museums.</b> C. PENTABONA.
6	<b>Talus, a new mobile application for biological profiling of human skeletal remains.</b> E. NIESPODZIEWANSKI.
7	<b>Best practices for the integration of tablet-based applications into a laboratory course: A case study from the human gross anatomy laboratory.</b> A.F. DOUBLEDAY.
8	<b>Species concepts in anthropology and their relation to research interests.</b> R.A. JOHNSTON, L.W. COWGILL.
9	<b>First Miocene record of <i>Mesopithecus</i> from the Iberian Peninsula based on Turolian remains from Venta del Moro (Valencia, Spain).</b> D.M. ALBA, P. MONTOYA, M. PINA, L. ROOK, J. ABELLA, J. MORALES, E. DELSON.
10	<b>A comparison of dental eruption patterns and their possible life history implications in two sympatric fossil catarrhines from Rudabánya, Hungary.</b> D.R. BEGUN.
11	<b>Analysis of bovid remains from Malapa, South Africa and implications for the paleoenvironment of <i>Australopithecus sediba</i>.</b> J.K. BROPHY, D.J. DE RUITER, L.R. BERGER.
12	<b>A comparison of catarrhine genetic distances against pelvic and cranial morphology: implications for determining hominin phylogeny.</b> S.J. LYCETT, N. VON CRAMON-TAUBADEL.
13	<b>The evolution of brain size and longevity in mammals.</b> M.R. SHATTUCK, S.A. WILLIAMS.
14	<b>Life history transitions and the origin of genus <i>Homo</i>.</b> S.C. ANTÓN, J.J. SNODGRASS.
15	<b>Dental microwear texture analysis and ecological plasticity in <i>Alouatta belzebul</i>.</b> M.F. TEAFORD, A. ALBO, P.S. UNGAR.
16	<b>Effect of posterior curvature on the bending strength of maxillary canines in cercopithecoid monkeys.</b> A.J. RAPOFF, N.T. GARABEDIAN, W.S. MCGRAW, D.J. DAEGLING.
17	<b>Grébouo 1 forest grove in southwestern Côte d'Ivoire is the final refuge for <i>Colobus vellerosus</i> in the Sassandra - Bandama inter-fluvial region.</b> S. GONEDELÉ BI, E.A. BITTY, W.S. MCGRAW.
18	<b>Accelerating deforestation and hunting in protected reserves jeopardize primates in southern Côte d'Ivoire.</b> E. BITTY, S. GONEDELÉ BI, W.S. MCGRAW.
19	<b>Habitat disturbance and fecal cortisol metabolites in a folivorous strepsirrhine, <i>Propithecus edwardsi</i>.</b> S.R. TECOT, M. SILVA, J. JERNVALL, P.C. WRIGHT.
20	<b>Of monkeys and Maya: Primate species identification from Classic Maya iconography.</b> K.E. SOUTH, S.M. FORD.
21	<b>Season and aging affect the expression of a hormonal biomarker of life history in lemurs.</b> D.K. BROCKMAN, P.L. WHITTEN, S. PRUETT.
22	<b>Longitudinal changes in macronutrient and hormone concentration in orangutan milk during peak lactation.</b> L.A. MILLIGAN, R. BERNSTEIN, L. WRIGHT, H. DROUGHT, C. LEWIS, K. MURTOUGH, M. POWER.
23	<b>Bioactive factors in milk: comparisons across nonhuman primates and humans.</b> M.L. POWER, J. SCHULKIN, H. DROUGHT, K. HINDE, R.M. BERNSTEIN.
24	<b>Determining ovarian follicle reserve from Anti-Mullerian hormone as detected using dried blood spots gathered in a remote field setting.</b> F.C. MADIMENOS, M.A. LIEBERT, T.J. CEPON, P. TALLMAN, J.J. SNODGRASS, L.S. SUGIYAMA, T.W. MCDADE.
25	<b>Detection of sickle hemoglobin in febrile patients in Leogane, Haiti.</b> T.E. CARTER, M. VON FRICKEN, C.J. MULLIGAN, G. MEMNON, B.A. OKECH.
26	<b>Spatial analysis of fine-scale Y chromosome variation in Swahili and Yemeni males clarifies the expected distribution of genetic variation in societies with different post-marriage residence norms.</b> R.L. RAAUM.
27	<b>Further studies on dental calculus as a proxy for stable carbon and nitrogen isotopes: Extraordinarily high levels of <math>\delta^{15}\text{N}</math> in prehistoric samples from Chile correspond to findings on traditional biomaterials.</b> G. SCOTT, S.R. POULSON, S.C. KUZMINSKY, V. STANDEN, B. ARRIAZA, I. MUNOZ.
28	<b>Ad sanctos burial and markers of skeletal health in Medieval Asturias, Spain.</b> N.V. PASSALACQUA.
29	<b>Estimating age at death in bioarchaeology: A Rostock approach.</b> S.M. HENS, K. GODDE.
30	<b>Reconstructing stress episode chronology and periodicity among Late/Final Jomon period foragers using incremental microstructures of enamel.</b> D.H. TEMPLE.
31	<b>Fluctuating and directional asymmetry: Skeletal evidence for life history theory and human evolutionary ecological variation in an archaeological South Dakota Arikara population.</b> E.B. WAXENBAUM, B. ERICKSON.

## Friday. Morning sessions.

### Session 21: **The High Price of Success: Costs of Reproductive Effort in Male Primates and Humans.**

*HBA and AAPA Invited Podium Symposium.* Chair: Alexander Georgiev and Melissa Emery Thompson.  
*Ballroom A.*

A foundational and widely supported concept in evolutionary biology is that female reproductive success is limited by access to resources while male reproductive success is limited primarily by access to mates. Thus, research programs have emphasized the substantial costs of female reproductive effort but have tended to focus on variation in the benefits obtained by males. However, the processes necessary to achieve reproductive success may carry a high price for males, and the ability to sustain these costs may determine the success of some males and the failure of others. The nature and extent of these costs is expected to vary by mating system and ecological context and can have far-reaching consequences for social behavior and demographic composition of populations. This symposium highlights studies on costs of male reproductive effort in a variety of primate species, including humans. Our contributors will present new research on male behavior, physiology, life history, demography and health in the context of male mating effort and competition. A key emphasis for discussion will be the theorized trade-off between reproductive effort and survival, and whether some males can maintain high reproductive effort despite the costs throughout their lifespan.

*Chair: Alexander Georgiev*

8:00-8:15	<b>To commit or play the field? Costs and benefits of male mating strategies in hamadryas versus chacma baboons.</b> S. CHOWDHURY, M. PINES, J. SAUNDERS, L. SWEDELL.
8:15-8:30	<b>Seasonal and social influences on androgen secretion in male geladas.</b> D.J. PAPPANO, T.J. BERGMAN, J.C. BEEHNER.
8:30-8:45	<b>Is Fatter sexier? Male reproductive strategies in squirrel monkeys, <i>Saimiri sciureus</i>.</b> A.I. STONE.
8:45-9:00	<b>Reproductive competition in male white-faced capuchin monkeys (<i>Cebus capucinus</i>): variation in testosterone, DHT, and glucocorticoid production.</b> V.A. SCHOOF, K.M. JACK, T.E. ZIEGLER.
9:00-9:15	<b>The costs of seasonal reproductive effort in Cayo Santiago male rhesus macaques.</b> J.P. HIGHAM.
9:15-9:30	<b>The energetics of mate-guarding in wild male long-tailed macaques (<i>Macaca fascicularis</i>).</b> C. GIRARD-BUTTOZ, M. HEISTERMANN, M. AGIL, P. AHMAD FAUZAN, A. ENGELHARDT.
9:30-9:45	<b>BREAK</b>
	<i>Chair: Melissa Emery Thompson</i>
9:45-10:00	<b>Physiological costs of dominance and mating effort in male chimpanzees.</b> A.V. GEORGIEV, M. EMERY THOMPSON, M.N. MULLER, R.W. WRANGHAM.
10:00-10:15	<b>Alpha male status predicts long life expectancy in wild chimpanzees.</b> M.S. MCCARTHY, C.E. FINCH, C. STANFORD.
10:15-10:30	<b>Cost of male mate competition in bonobos.</b> M. SURBECK, T. DESCHNER, A. WELTRING, G. HOHMANN.
10:30-10:45	<b>Male bi-maturism and the costs of reproduction in wild Bornean orangutans.</b> C.D. KNOTT, M. EMERY THOMPSON.
10:45-11:00	<b>From tug-of-war over reproduction to conflict over group membership: A theory of conflict and conflict resolution.</b> M. PORT.
11:00-11:15	<b>Testosterone, immune function, and life history transitions in the Philippines.</b> L.T. GETTLER, S.S. AGUSTIN, A.B. FERANIL, T.W. MCDADE, C.W. KUZAWA.
11:15-11:30	<b>Androgens and immune function in human and nonhuman primates.</b> S.P. PRALL, M.P. MUEHLENBEIN.
11:30-11:45	<b>Discussant,</b> RICHARD W. WRANGHAM.

### Session 22: **BIOARCHAEOLOGY AND ANTHROPOLOGICAL GENETICS: Skeletal, Genetic, and Isotopic Approaches to Colonization and Migration.**

*Contributed Podium Presentations.* Chair: Corina Kellner. *200ABC.*

8:00-8:15	<b>Understanding the colonization of the North American Arctic: The results of whole mitochondrial genome sequencing of Iñupiat populations of the Alaskan North Slope.</b> J. RAFF, M. RZHETSKAY, M. HAYES.
8:15-8:30	<b>Cranial morphological variation among ancient North Americans: a test of the coastal migration hypothesis using three-dimensional imaging and geometric morphometric methods.</b> S.C. KUZMINSKY.
8:30-8:45	<b>A palaeogenetic investigation into the pre-Columbian population history of Central Andean South America.</b> L. FEHREN-SCHMITZ, B. LLAMAS, W. HAAK, E. TOMASTO-CAGIAO, A. COUTINHO, S.R. WILLIAMS, R.A. BENFER.
8:45-9:00	<b>Whole mitochondrial genome sequences from South America: Insights into the demographic history of the continent.</b> E.J. LEE, D. MERRIWETHER.
9:00-9:15	<b>Native American genetic diversity before and after European colonization: Evolution, pathogens, and the environments of the Americas.</b> J. LINDO, R.S. MALHI.
9:15-9:30	<b>Chanka mobility and diet in the Central Highlands of Peru: A multi-isotope analysis.</b> E.M. LOFARO, D.S. KURIN, J. KRIGBAUM.

9:30-9:45	<b>Migration during state expansion in the Nasca region: Strontium isotope evidence from Pataraya, a Wari outpost in Peru (AD 750-1000).</b> C.M. KELLNER, M. EDWARDS, K.J. SCHREIBER.
9:45-10:00	<b>BREAK</b>
10:00-10:15	<b>People on the move: Examining Tiwanaku State expansion in the Cochabamba Valley of Central Bolivia through strontium isotope analysis.</b> C.A. LUCAS, C.M. KELLNER, F.C. RAMOS, K. ANDERSON.
10:15-10:30	<b>Strontium isotope identification of migrants in the collective burials at the Late Neolithic Rego da Murta Dolmens (Alvaiázere, Portugal).</b> A.J. WATERMAN, A. FIGUEIREDO, J.T. THOMAS, D.W. PEATE.
10:30-10:45	<b>Population interaction during the Hungarian Early to Middle Copper Age: A biological distance study using dental metric and nonmetric traits.</b> I.C. PAWN.
10:45-11:00	<b>Ancient Swahili origins: a mitochondrial study of ancient inhabitants of the Kenyan coast.</b> L.G. PROCTOR, S. MOORMAN, K.M. CHAPURUKHA, S.R. WILLIAMS.
11:00-11:15	<b>Bayesian divergence dating of Yemeni mitochondrial haplogroups.</b> D.N. VYAS, A. KITCHEN, V. ČERNÝ, A. AL-MEERI, C.J. MULLIGAN.
11:15-11:30	<b>Reconstructing human colonization of Polynesia using molecular data.</b> S. PROST, A. CLARKE, D. ADDISON, L. MATISOO-SMITH.

**Session 23: PALEOANTHROPOLOGY: *Homo*.**

*Contributed Podium Presentations.* Chair: Leslea Hlusko. *Ballroom B.*

8:00-8:15	<b>A new 1 million-year-old hominid distal ulna and other 2012 fossil discoveries from Olduvai Gorge, Tanzania.</b> L.J. HLUSKO, W.B. REINER, J.K. NJAU.
8:15-8:30	<b>Earliest evidence of distinctive modern human-like hand morphology from West Turkana, Kenya.</b> C.V. WARD, M.W. TOCHERI, J. PLAVCAN, F.H. BROWN, F.K. MANTHI.
8:30-8:45	<b>Structure of the Trinil <i>Homo erectus</i> femora.</b> C.B. RUFF, L. PUYMERAIL, R. MACCHIARELLI, J. DE VOS, R.L. CIOCHON.
8:45-9:00	<b>A multivariate analysis of the Daka calvaria (BOU-VP-2/66) and implications for <i>Homo erectus</i> taxonomy.</b> K.B. CARLSON, B.M. CHRISTY.
9:00-9:15	<b>Early postnatal brain growth in <i>Homo erectus</i>: Incorporating uncertainties.</b> Z. COFRAN, J. DESILVA.
9:15-9:30	<b>Exo- and endocranial ontogeny in hominoid primates.</b> M.S. PONCE DE LEÓN, R. LEDEVIN, C.P. ZOLLIKOFER.
9:30-9:45	<b>Reconstructing phylogenetic relationships and evolutionary processes in early <i>Homo</i> evolution: Genetic drift or selection?</b> L. SCHROEDER, R.R. ACKERMANN.
9:45-10:00	<b>BREAK</b>
10:00-10:15	<b>Bridging the gap between individual fossil evidence, paleopopulation dynamics and hominin evolutionary scenarios.</b> C.P. ZOLLIKOFER, S. CALLEGARI, J.D. WEISSMANN, N. TKACHENKO, M.S. PONCE DE LEÓN, W.P. PETERSEN, G. LAKE.
10:15-10:30	<b>Food processing reduces thermogenesis following meat or tuber meals in a model omnivorous mammal.</b> R.N. CARMODY, S.M. SECOR, R.W. WRANGHAM.
10:30-10:45	<b>Masticatory changes associated with mechanical and thermal processing of meat.</b> K.D. ZINK, D.E. LIEBERMAN.
10:45-11:00	<b>Masticatory and non-masticatory spatial explanations for mandibular symphyseal morphology in extant <i>Homo sapiens</i>.</b> J.E. SCOTT.
11:00-11:15	<b><i>In-vitro</i> analysis of nutrition in Hadza tubers using Hadza simulated cooking techniques.</b> S. SCHNORR, A. CRITTENDEN, F. MARLOWE, A. HENRY.

**Session 24: SKELETAL BIOLOGY: Mastication, Jaw and Tooth Form.**

*Contributed Podium Presentations.* Chair: Andrea Taylor. *Ballroom C.*

8:00-8:15	<b>How does food item size affect optimal tooth sharpness?</b> M.A. BERTHAUME, E.R. DUMONT, L.R. GODFREY, I.R. GROSSE.
8:15-8:30	<b>The evolution of third molar agenesis in humans.</b> K.E. CARTER, S. WORTHINGTON, T.M. SMITH.
8:30-8:45	<b>Tooth root and crown surface areas have different allometric relationships associated with diet in cercopithecines.</b> M.A. HOLMES.
8:45-9:00	<b>Occlusal surfaces and chewing efficiency in modern humans.</b> M.F. LAIRD, H. PONTZER.
9:00-9:15	<b>Mandibular premolar morphology is correlated with mechanically challenging diets in sympatric primates.</b> K. SCHROER, K. RAMIREZ, B. WOOD.
9:15-9:30	<b>Incisor microwear and gouging in callitrichines.</b> P.S. UNGAR, J. FAY SLIGER, S.S. CAPORALE, M.F. TEAFORD, C.J. VINYARD, A.B. TAYLOR.

9:30-9:45	<b>The scaling of jaw-muscle fiber architecture in anthropoid primates.</b> A.B. TAYLOR, T. YUAN, C.F. ROSS, C.J. VINYARD.
9:45-10:00	<b>BREAK</b>
10:00-10:15	<b>Scaling of distance from center of mass to condylar axis in primate mandibles.</b> E.J. PLATTS, T. WALSH, L. HEINS, L. PORRO, A.B. TAYLOR, C.F. ROSS.
10:15-10:30	<b>Mandibular helical axis during feeding in non-human primates.</b> J. IRIARTE-DIAZ, C. TERHUNE, A. TAYLOR, C. ROSS.
10:30-10:45	<b>Feeding behavior and trabecular architecture of the mandibular condyle in extant primates.</b> S. COINER-COLLIER, E.R. VOGEL, R.S. SCOTT.
10:45-11:00	<b>Craniomandibular variation in an experimental model for primate dietary variability.</b> R.A. MENEGAZ, A.F. SZCZODROSKI, T.L. ROLD, T.J. HOFFMAN, M.J. RAVOSA.
11:00-11:15	<b>It's the time of the season for extra chewing: temporal variation in diet and phenotypic plasticity in masticatory elements.</b> J.E. SCOTT, M.M. EASTMAN, J. HLAVATY, A.G. MANCINI, D. MURRAY, J.P. SCOLLAN, JR., K.R. MCABEE, M.J. RAVOSA.
11:15-11:30	<b>Mastication-related and age-related changes in the dentognathic apparatus of hominoids.</b> A. MARGVELASHVILI, C.P. ZOLLIKOFER, M.S. PONCE DE LEÓN.

**Session 25: Advances in the Bioarchaeology of Nubia and Central Sudan.**  
*Invited Poster Symposium.* Organizers: Brenda Baker and Tina Jakob. **200DE.**

During the twentieth century, a biocultural approach to the study of human remains from ancient Nubia was developed as large numbers of cemeteries were excavated during archaeological rescue projects south of Aswan, Egypt. Our understanding of ancient Nubia is based mainly on sites between the First and Dal Cataracts (southern Egypt to northernmost Sudan) because few skeletal samples from Upper Nubia and central Sudan (Third Cataract to the south of the Sixth Cataract of the Nile River) existed prior to the 2000s. Recent bioarchaeological fieldwork and research on human remains from sites south of the Dal Cataract have added significantly to our understanding of ancient Nubian societies from the Paleolithic to Christian (medieval) periods and demonstrate considerable variation from Lower Nubian mortuary contexts. Innovative and theoretically informed bioarchaeological research is advancing our understanding of colonialism, social practices including dental ablation and sacrifice, and the health consequences of conflict and illnesses arising from infectious diseases (e.g., brucellosis) and metabolic conditions (e.g., scurvy). This symposium aims to bring together for the first time researchers working on Upper Nubian and central Sudanese samples to share findings on aspects of health, identity, and mortuary practices. Discussion of these issues and the similarities and differences encountered in various locations and between Upper and Lower Nubian groups will stimulate further research and collaborations within these regions.

7:30-8:00 am Poster set-up. 11:30-11:45 am Poster take-down.

11:00-11:30 am Discussion.

1	<b>An introduction to the bioarchaeology of upper Nubia and central Sudan.</b> B.J. BAKER, T. JAKOB.
2	<b>Bioarchaeology at the multiperiod site of Al Khiday 2, central Sudan.</b> T. JAKOB.
3	<b>Dental pathology at Shabona, a Khartoum Mesolithic site.</b> J.J. CROSBY.
4	<b>New results from an old excavation: The biological "place" of Jebel Moyans in the prehistory of Nubia and Sudan.</b> J.D. IRISH.
5	<b>Revisiting Jebel Sahaba: New apatite radiocarbon dates for one of the Nile valley's earliest cemeteries.</b> D.M. ANTOINE, A. ZAZZO, R. FRIEDMAN.
6	<b>Isotopic variation of geographic origin and diet in Upper and Lower Nubia during the Bronze Age: An examination of sociopolitical effects on population composition and life ways</b> M. BUZON, S. SCHRADER, A. SIMONETTI, G. BOWEN.
7	<b>The cemeteries of Amara West: Investigating the impact of climate and political change on health and living conditions in an ancient town in upper Nubia (13<sup>th</sup>– 8<sup>th</sup> centuries BC).</b> M. BINDER.
8	<b>Dental ablation in Sudan: The construction and performance of social identity.</b> K.L. BOLHOFNER.
9	<b>Going against the grain at Gabati.</b> M.A. JUDD.
10	<b>Analysis of fauna in Post-Meroitic tumuli at the Ginefab School Site, Sudan.</b> J.A. HARRIS, B.J. BAKER.
11	<b>The impact of socio-political changes on activity patterns in a late Meroitic to Christian period community at El-Ginefab, Sudan.</b> B.L. NAGY, B.J. BAKER.
12	<b>Cranial non-metric affinities and kinship ideologies among Post-Meroitic and Christian period Nubians from the 4th Cataract Region, Sudan.</b> K.L. NADO, B.J. BAKER.
13	<b>The descent of Christianity: Religious conversion and social change in Medieval Nubia.</b> A.C. SEIDEL, B.J. BAKER.
14	<b>Early to late Christian burial practices at Mis Island: Religious community and the concept of identity.</b> A. SOLER, C.V. HURST, T.W. FENTON.
15	<b>Life and death in a Medieval Nubian farming community at the Fourth Cataract: An example from Mis Island.</b> C.V. HURST, A. SOLER, T.W. FENTON.

**Session 26: Modern Morphometrics in Physical Anthropology II: Papers in Honor of Sokal.**  
*Invited Poster Symposium.* Organizers: Dennis Slice and Bridget Algee-Hewitt. **301D.**

This symposium brings together experts in both the field of morphometrics and that of physical anthropology to carry on the work begun over a decade ago, at the 2002 AAPA special session, Modern Morphometrics in Physical Anthropology. We argue that there continues to be a great and immediate need to develop new techniques and to make steady improvements upon our preexisting methods in order to resolve the complex biological questions that are emerging within the present data-driven, genomic, and computationally intensive age. The mathematically tractable, highly adaptable, and efficient methods of geometric morphometrics are playing a critical role in ongoing efforts to increase our explanatory power. The goal of this symposium is to reflect upon the current state of the art: to present the latest theoretical advancements and methodological improvements, to highlight the key innovations in scholarship, and to demonstrate how the synergy between these two fields can continue to open up new avenues of research of interest to theoreticians and practitioners alike. The topics of discussion will cover such diverse areas as primatology, paleoanthropology, biological and forensic anthropology, while also adopting a variety of methodological perspectives and addressing the utility of these approaches to many different research ends.

It is with great sadness that we mark the passing this year of Robert R. Sokal, who contributed much to biostatistics, systematics, anthropology, morphometrics, and many other fields. It is to his memory that this symposium is dedicated.

7:30-8:00 am Poster set-up. 11:30-11:45 am Poster take-down.

10:00-11:30 am Discussion. CHARLES OXNARD, CHRIS KLINGENBERG and FRED BOOKSTEIN.

0	<b>Photo-remembrances of Robert R. Sokal.</b>
1	<b>Modern morphometrics 101.</b> D.E. SLICE.
2	<b>After semilandmarks.</b> F.L. BOOKSTEIN.
3	<b>How to measure phenotypic variation in human development and evolution?</b> P. MITTEROECKER.
4	<b>The mechanistic basis for phenotypic variation: an emerging frontier in evolutionary developmental biology.</b> H.A. JAMNICZKY, W. MIO, N.M. YOUNG, R.S. MARCUCIO, B. HALLGRIMSSON.
5	<b>Morphometrics in forensic science: Steps towards the development of population specific standards.</b> C.E. OXNARD, D. FRANKLIN, A. CARDINI, P. O'HIGGINS.
6	<b>Craniofacial variation among American, African and Diaspora populations.</b> A.H. ROSS, E. KIMMERLE.
7	<b>Crania, coordinates, and clusters: Testing a finite mixture modeling approach for the detection of population structure in modern America using high-dimensional data.</b> B.F. ALGEE-HEWITT.
8	<b>Modern human phenotypic variation: Exploring patterns of differentiation within and between continents.</b> M. HUBBE, D.V. BERNARDO, T.F. ALMEIDA, T. HANIHARA, K. HANIHARA.
9	<b>Applying anthropological shape analysis techniques to archaeological research: Overcoming problems and exploring possibilities.</b> U.S. VIDARSDOTTIR, K. PLOMP, C. KING, J. OWEN.
10	<b>Quantitative genetic variation and selection on skull shape in humans.</b> N. MARTÍNEZ-ABADÍAS, M. ESPARZA, T. SJØVOLD, M. HERNÁNDEZ, C.P. KLINGENBERG.
11	<b>Quantitative genetic analysis of morphometric data: Challenges and considerations.</b> R.J. SHERWOOD, K.P. MCNULTY, D.L. DUREN.
12	<b>Use of geometric data in human factors and ergonomic applications.</b> B. CORNER, M. REED, J. HUDSON, G. ZEHNER.
13	<b>A man's face reveals his body height: A GMM approach to ontogenetic and static allometry .</b> K. SCHAEFER, S. WINDHAGER, D.E. SLICE, P. MITTEROECKER.
14	<b>Integrating geometric morphometrics and biomechanics.</b> A.L. SMITH, D.S. STRAIT.

**Session 27: Variation in Human Dental Form: A Symposium in Honor of Edward F. Harris.**  
*Invited Poster Symposium.* Organizers: Heather Edgar, Loren Lease and Helen Liversidge. **301E.**

This symposium is held in recognition of the contributions Edward F. Harris (Professor, University of Tennessee Health Sciences Center) has made throughout his career. Edward received his Ph.D. from Arizona State University in 1977. Following postdoctoral work, his career has been spent in a department of orthodontics. However, his research in dental morphology, metrics, development, and variation has always been anthropological. This research, along with Edward's support, insights, editorship, and camaraderie, has influenced at least two generations of anthropologists. The breadth and depth of his work is inspiring, and the papers in this symposium, reflect that broad impact.

7:30-8:00 am Poster set-up. 11:00-11:30 am Poster take-down.

10:00-11:00 am Discussion. SIMON HILLSON.

0	<b>Introduction.</b> R. SCOTT
1	<b>Tansies in the field: An odontometric assessment of orthodox perspectives on ontogenetic canalization, dental field theory, and sex dimorphism.</b> B.E. HEMPHILL, L.J. HLUSKO.
2	<b>Sinodoty and beyond: Reasserting the relevance of dental anthropology for understanding the peopling of the New World.</b> W.N. DUNCAN, C.M. STOJANOWSKI, K.M. JOHNSON.
3	<b>Secular change in dental development in New Mexican females.</b> A. RAUTMAN, H. EDGAR.
4	<b>A radiographic study of human mandibular permanent tooth eruption and root stage.</b> H.M. LIVERSIDGE, S. WILMOTT.
5	<b>Size does matter: Variation in tooth size apportionment among major regional North and sub-Saharan African populations.</b> M.W. KENYHERCZ, J.D. IRISH.
6	<b>A descriptive study of African American deciduous dentition.</b> L.R. LEASE.
7	<b>First molar dental gluctuating asymmetry and the pace of life history in non-human primates.</b> S.A. MARTIN, D. GUATELLI-STEINBERG, P.W. SCIULLI.
8	<b>The development of the dentition as a complex adaptive system.</b> A.H. BROOK, T. HUGHES, G.C. TOWNSEND, M.D. BROOK O'DONNELL.

## Friday. All Day Poster Sessions.

### Session 28: PALEOPATHOLOGY.

*Contributed Poster Presentations.* Chair: Murray Marks. *Clinch Concourse.*

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Integrating clinical perspectives and bioarchaeological interpretations: Case analyses from Neolithic Çatalhöyük, Turkey.</b> J.W. SADVARI, R. HUNTER, B.J. BETZ, C. LARSEN.
2	<b>Sex-based health differences during the transition to agriculture in Ukraine.</b> J.K. KARSTEN, G.D. MADDEN.
3	<b>A comparison of visual and radiographic methods for detecting oral pathology in a skeletal sample from Ban Non Wat, Thailand.</b> S.A. SHKRUM, N. TAYLES, S.E. HALCROW.
4	<b>Deciduous enamel defects: Perinatal health at Non Nok Tha, Thailand.</b> K.M. HAMMOND, J.L. THOMPSON.
5	<b>High incidence of supernumerary and ectopic teeth from Nuvakwewtaqa (Chavez Pass), AZ.</b> C.R. GRIVAS, K.M. JOHNSON.
6	<b>Caries prevalence in ancient Egyptians and Nubians, ca. 14,000 BCE-1,400 CE.</b> K. TRIAMBELAS, J.D. IRISH.
7	<b>Periodontal health and post-reproductive tooth loss among Mogollon women.</b> A.C. TUGGLE, J.T. WATSON.
8	<b>Age-related trauma incidence in the Gombe chimpanzees.</b> C.A. KIRCHHOFF, M.L. WILSON, D.C. MJUNGU, D. COLLINS, S.M. KAMENYA.
9	<b>The effects of resource stress on rates of traumatic injury in medieval and post-medieval southern German and alpine Austrian populations.</b> L.L. WILLIAMS, G. MCGLYNN, C.S. LARSEN.
10	<b>Evidence of possible interpersonal violence in a female bronze age skeleton from Romania.</b> E. WILLIAMS, M. CONSTANTINESCU, T.A. CRIST, A.D. SOFICARU.
11	<b>Interpersonal violence in the Paleoamericans of Lagoa Santa, Brazil.</b> P. DA-GLORIA, C.S. LARSEN.
12	<b>Conflicting evidence of warfare in Mycenaean Athens, Greece: Bodies versus bronzes.</b> S. SMITH, M. LISTON.
13	<b>Archaic trophy taking in the Eastern Woodlands.</b> A.E. OSTERHOLT, C.W. SCHMIDT.
14	<b>Three cases of trepanation from the Titicaca Basin from 200BC-200AD: Practice and results.</b> S.L. JUENGST.
15	<b>Vertebral joint disease and trauma with horse riding among ancient Mongolian pastoralists.</b> J.T. ENG.
16	<b>Paper Withdrawn.</b>
17	<b>A case of diffuse idiopathic skeletal hyperostosis from Csíksofalyó- Szent Péter és Pál-plébániatemplom site (Harghita county, Romania).</b> I. KOVARI, Z. BERNERT, I. BOTAR, E. FOTHI, K.K. KISS, A. MARCSIK, B. TOTH, T. HAJDU.
18	<b>The interaction of DISH and Obesity on a pathological anterior pubis.</b> K. SAUERWEIN, K.E. STULL, M.D. HAMILTON.
19	<b>Co-occurrence of tuberculosis and an unusual rheumatoid-like arthritis in prehistoric Central California.</b> E.M. BURKE, R.E. VARGHESE, E.A. BULGER, C.L. IBARRA, H.M. OJEDA, R.S. JABBOUR, G.D. RICHARDS.
20	<b>A paleopathology case study from the midwestern Archaic.</b> A.C. CASSERLY, C.W. SCHMIDT, R.A. SHARKEY.
21	<b>Evidence for the intensive-exposure and cross-sex transmission hypotheses in epidemic poliomyelitis mortality patterns in southern Ontario, 1910-1937.</b> H.T. BATTLES.
22	<b>A unique constellation of pathological features in a 13<sup>th</sup> century adolescent male from Illinois: Treponematoses with destructive lesion of the palate, orthopedic complications, and other anomalies.</b> L. COSS, D.C. COOK.
23	<b>Treponematoses in pre-Columbian Denmark: A paleopathological, archaeometric and historical approach.</b> S. SCHWARZ.
24	<b>Diagnosis and evaluation of causative factors for the presence of endemic treponemal disease in a Japanese tropical island population from the Edo period.</b> M. HERNANDEZ, M.J. HUDSON, J.T. STOCK.
25	<b>Is this yaw? Possible treponemal induced cranial vault lesions in a young chimpanzee.</b> S.S. LEGGE, C.A. KIRCHHOFF.
26	<b>The effect of sex and biological stress on the skeletal expression of infectious disease during the reproductive years.</b> J.D. MINSKY-ROWLAND.
27	<b>Paleohistopathology of a Harris line.</b> J.J. MISZKIEWICZ, P. MAHONEY.
28	<b>Skeletal stress markers in Korea's Joseon Dynasty population, and their relationship to burial types.</b> E. WOO, S. PAK.
29	<b>Specifying the nonspecific in paleopathology: A stable isotope investigation of metabolic disorders in North-Central Poland.</b> L.J. REITSEMA, T. KOZŁOWSKI, M. KRAJEWSKA.
30	<b>Anomalous malocclusions in Windover Pond (8BR246): The origins of anterior dental crowding in the Florida Archaic.</b> K.O. MIYAR.
31	<b>8,000 year old case of thalassemia from the Windover, Florida skeletal population.</b> G.P. THOMAS.
32	<b>Multiple myeloma: How a contemporary forensic anthropology case can inform the past.</b> S. PAULE, B. HURTADO-

	KOODRIN, H. WALSH-HANEY, M. BORGES.
33	<b>Cancer-related lesions in a contemporary skeletal collection with known cancer cases.</b> H. MAIJANEN, D.W. STEADMAN.
34	<b>A case of a malign tumour from La Tène Burial Site of Münsingen Rain in Switzerland.</b> N. MOGHADDAM, R. LANGER, S. ROSS, F. MÜLLER, S. LÖSCH.
35	<b>An unusual case of a solitary osteochondroma on the mandibular symphysis.</b> S.H. BLATT.
36	<b>Histopathology and differential diagnosis of a pelvic calcification.</b> M.K. MARKS, M.D. HAMILTON.
37	<b>Ossification of the posterior longitudinal ligament: Reassessing the disease in non-Asian populations.</b> C.N. DARDENNE.
38	<b>Cholesteatomas: The application of paleopathologic and forensic anthropologic knowledge from a classroom.</b> S.A. WADE, H. WALSH-HANEY.

**Session 29: SKELETAL BIOLOGY & FORENSIC ANTHROPOLOGY: Ontogeny, Age, Microstructure, Taphonomy, DNA and Methods.**

*Contributed Poster Presentations.* Chairs: Meghan-Tómasita Cosgriff-Hernández & Amanda Agnew. *Clinch.* 7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>3D analysis of the jaw-basiscranium-cervical skeleton in fetal and infant humans and chimpanzees. Implications for shaping the mandibular symphysis.</b> M. COQUERELLE, J. PRADOS-FRUTOS, P. MITTEROECKER, M. BASTIR.
2	<b>An assessment of the growth and development of the pediatric tongue and mandible within a South African population.</b> E.F. HUTCHINSON, J.A. KIESER, B. KRAMER.
3	<b>A new look at frontal bone ontogeny.</b> C.L. IBARRA, G.D. RICHARDS.
4	<b>Ontogenetic scaling of the human nasal capsule using a longitudinal sample.</b> N.E. HOLTON, T.R. YOKLEY, T.E. SOUTHARD.
5	<b>A preliminary three-dimensional geometric morphometric analysis of fetal and neo-natal maxillary ontogeny in extant <i>H. sapiens</i> using cross-sectional data.</b> C.L. NICHOLAS.
6	<b>Influence of angiogenesis on craniofacial bone morphology.</b> C. PERCIVAL, A. WINKLER, K. KAWASAKI, T. PANKRATZ, E. JABS, L. WANG, J. RICHTSMEIER.
7	<b>Incremental growth lines in melatonin-deficient mice.</b> A.M. PAPAKYRIKOS, Y. WEN, C. AUSTIN, A. KATO, N. TANG, M. ARORA, X. WANG, T.M. SMITH.
8	<b>Vertebral morphometric evaluation of stress in modern pediatric patients.</b> R.L. HUNTER, A. AGNEW.
9	<b>Morphological and ontogenetic variation in three osteological correlates of the longitudinal arch.</b> A.N. HEARD-BOOTH.
10	<b>An examination of pubertal development in human skeletal remains from medieval England.</b> F.C. SHAPLAND.
11	<b>3D analysis of human ribcage ontogeny.</b> M. BASTIR, D. GARCÍA MARTÍNEZ, W. RECHEIS, A. BARASH, M. COQUERELLE, L. RIOS, A. PEÑA-MELIÁN, P. O'HIGGINS.
12	<b>An evaluation of three sternal rib end age estimation techniques.</b> N.L. GESKE.
13	<b>Sternal rib end age estimation: Asymmetry and proxy ribs.</b> K.B. HUFNAGL, D.M. MCCARTHY.
14	<b>Do two age-related characteristics identified in Korean archaeological skeletal samples influence Transition Analysis final age-at-death estimates?</b> J. KIM, D.W. STEADMAN, S. PAK, D. SHIN.
15	<b>The influence of body size on adult skeletal age estimation.</b> C.E. MERRITT.
16	<b>Comparison of the rate of bone degeneration between superior and inferior demifaces of the iliac auricular surface in known-age Portuguese individuals.</b> V. CAMPANACHO, A.T. CHAMBERLAIN, E. CUNHA, J. ALBANESE.
17	<b>New estimates for ages in historic Italian populations derived from Bayesian analysis: Pubic symphyses.</b> K. GODDE, S.M. HENS.
18	<b>Root dentine translucency aging in burned human teeth: A preliminary study.</b> L.A. OLDERSHAW, S.E. BAILEY, R.W. WHITE.
19	<b>Quantifying age related bone loss using measures of anterior cortical width.</b> A.C. BERESHEIM, V.M. DOMÍNGUEZ, C.M. CROWDER.
20	<b>Estimating age at death from the femur using histological methods: Problems and prospects.</b> M.J. COSGRIFF-HERNANDEZ, S.D. STOUT.
21	<b>The use of geographic information system (GIS) software to identify and evaluate the spatial occurrence of drifting osteons in the cortical bone envelope.</b> J.T. HEINRICH.
22	<b>Does she or doesn't she: Change in osteon size with age and sex.</b> M.A. STREETER, J. PURCELL, L. LARSON, B. JUMONVILLE, L. MCCORMICK, J. GOLIATH, M.T. COSGRIFF-HERNÁNDEZ, E. DUBIE, T. SCHROEDER, K. BROWN, M. DRAPEAU, R. LAZENBY.

23	<b>Covariation of haversian structure density and bone resorption in human bone.</b> R.A. WALKER, H.E. CUTLER.
24	<b>Histomorphometric differentiation of human and nonhuman bone.</b> R.M. STRAND, S.R. MAVROUDAS, V.M. DOMINGUEZ.
25	<b>Synchrotron light identifies the biogenic uptake of metacinnabar in a bone sample from an Antigua, West Indies, Royal Naval Hospital Cemetery (1793-1822).</b> T.M. SWANSTON, T. VARNEY, I. COULTHARD, G.N. GEORGE, I.J. PICKERING, R. MURPHY, D.M. COOPER.
26	<b>The ultrastructure of bone: Two new levels of hierarchy revealed by transmission electron microscopy (TEM).</b> H.P. SCHWARCZ, E.A. MCNALLY, G.A. BOTTON, M. LEBON.
27	<b>Intra-individual changes in major bone constituents studied by Solid State Nuclear Magnetic Resonance Spectroscopy.</b> V. URZEL, Y. SCHULIAR, F. ADAM, A. GRÉLARD, C. COURRÈGES, E.J. DUFOURC, H. DUDAY.
28	<b>Microfractures in elderly ribs: Contributions to bone quality.</b> A.M. AGNEW, S.D. STOUT, P.W. SCIULLI.
29	<b>X-ray study on the laterality of the humeral bone mineral density for determination of handedness.</b> F. KANZ, K. GROSSCHMIDT, R. RISY, D.U. RISSER.
30	<b>Investigating the relationship between diabetes mellitus and bone mineral density.</b> S.E. MAY.
31	<b>Evidence of non-bone cellular and microstructure preservation in skeletonized remains from Middle Bronze Age Italy.</b> S.K. DIBBLEY, T.J. SETZER, B.I. SUNDELL-RANBY.
32	<b>The body will eat itself: An investigation into the relationship between bone diagenesis and funerary treatment.</b> T.J. BOOTH.
33	<b>Determining the effects of defleshing methods on the structural integrity of bone through mechanical testing.</b> B.J. LEEPER, S.E. HENDERSON, A.J. ALMARZA, M.A. JUDD, M.I. SIEGEL.
34	<b>Raccoon modification of human skeletal remains.</b> J.A. SYNSTELIEN.
35	<b>The depositional patterning of avian scavenged remains.</b> L.R. PHARR.
36	<b>Eagle Syndrome in two forensic anthropological cases.</b> T. DEVIA, J. CARTIER, H. WALSH-HANEY.
37	<b>Identifying the source of bone marks via optical profilometry 3D images.</b> S.K. WÄRMLÄNDER, J. NJAU.
38	<b>Defining postmortem changes in west central Montana.</b> J.R. SPENCER, T.N. HUEY.
39	<b>Determination of the postmortem interval in western Montana: A preliminary study on perimortem and postmortem characteristics in blunt force fractures.</b> E.R. STEVENS.
40	<b>Using citrate concentration to determine postmortem interval of forensically-significant skeletal material.</b> A.C. ZIMMER, V.F. DETURI, J.L. MULLER.
41	<b>Effects of wrappings on the decomposition process.</b> S.M. BELL, A.C. DURBAND, M.K. SPRADLEY, J.M. CHILDERS.
42	<b>The differential burn patterns in a hanging specimen compared to a specimen positioned on the surface.</b> A.N. WILLIAMS.
43	<b>The Lubischew's test, an useful statistical tool for Forensic Anthropology.</b> J. JIMÉNEZ-ARENAS, J. ESQUIVEL, A. SERRANO-RAMOS.
44	<b>Geometric morphometric analysis of human footprints.</b> J. DOMJANIC, M. FIEDER, H. SEIDLER, S. PETRAK, D. UJEVIC, P. MITTEROECKER.
45	<b>Automated approaches to geometric morphometrics.</b> J. PUENTE, D.M. BOYER, J.T. GLADMAN, I.C. DAUBECHIES.
46	<b>The effects of X-ray irradiation on obtaining CODIS STR profile from X-rayed teeth.</b> E.L. KNAPP.
47	<b>An investigation into the effects of X-ray on the recovery of DNA from skeletal remains.</b> K.L. ZIEGLER, G. CONLOGUE, R. BECKET, T. BLYTH, G. ARONSEN, L. FEHREN-SCHMITZ.
48	<b>Obstacles and results of screening ancient skeletal samples with real-time PCR.</b> M.A. NIEVES-COLON, K.M. HARKINS, A.C. STONE.
49	<b>Assessing damages: Testing the assumptions of a non-destructive protocol for DNA extraction from modern human teeth.</b> C. BOWERS, B.F. ALGEE-HEWITT, G.S. CABANA.
50	<b>Anthropological studies on mummified human brains from archaeological fields in Korea.</b> C. OH, S. LEE, M. KIM, Y. KIM, D. LIM, D. SHIN.
51	<b>Set apart: Why were these men dumped in that grave?</b> K.J. WELCH, T. CRIST, L.L. TAYLOR, M. FARALDO, M. CONSTANTINESCU.

**Session 30: FUNCTIONAL MORPHOLOGY: Above the Neck.****Contributed Poster Presentations.** Chair: Magdalena Muchlinski. *Park Concourse.*

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>What do primate auditory ossicles tell us about hearing patterns in living and extinct taxa?</b> M. COLEMAN, K. MANFREDI.
2	<b>Functional correlates of cochlear shape.</b> A.D. GOSSELIN-ILDARI, E. KIRK, E.M. LUDEMAN.
3	<b>Dendritic morphology of pyramidal neurons across the visual stream: A direct comparison of chimpanzees and humans.</b> B.M. SCHILDER, O. ADEYO, O. GRINKER, A. KNOP, W.D. HOPKINS, B. JACOBS, C.D. STIMPSON, C.C. SHERWOOD.
4	<b>To whisk or not to whisk: Implication of proportions of myosin fiber type on the functional anatomy of vibrissa musculature in primates.</b> M.N. MUCHLINSKI, E.L. DURHAM, T.D. SMITH, L.A. PARR, A.M. BURROWS.
5	<b>Electromyography of chimpanzee mastication: Muscle recruitment order.</b> T. WALSH, E. PLATTS, J. IRIARTE-DIAZ, C.F. ROSS.
6	<b>Aye-aye jaw adductors: Anatomy, architecture, and allometry.</b> J.M. PERRY, A. HARTSTONE-ROSE, K.E. MACNEILL, A.L. HECKLER.
7	<b>Mandibular kinetics of gnawing in the Aye-aye (<i>Daubentonia madagascariensis</i>) and biomechanical modeling of anterior tooth use.</b> M.C. TOLER, C.E. WALL.
8	<b>Relationship of internal and external condylar morphology to feeding behavior and diet in Tai Forest monkeys.</b> K.E. SKORPINSKI, D.J. DAEGLING, W.S. MCGRAW.
9	<b>Spatial variation in mandibular bone stiffness and its effect on structural bending stiffness: A test case using the Tai Forest monkeys.</b> K.N. LE, D.J. DAEGLING, A. DUQUE, J.D. PAMPUSH, W.S. MCGRAW.
10	<b>Mandibular remodeling in sympatric West African cercopithecids.</b> S.E. LAD, D.J. DAEGLING, W.S. MCGRAW.
11	<b>Deciduous enamel thickness and chewing mechanics in human children.</b> P. MAHONEY.
12	<b>Enamel thickness in durophagous and folivorous primate species.</b> J.D. PAMPUSH, S.W. MCGRAW, D.J. DAEGLING.
13	<b>The effects of dietary hardness on occlusal variation and the masticatory apparatus of savanna baboons.</b> E. MUZZALL, R. CAMPBELL, M. CAMPBELL, R.S. CORRUCINI.
14	<b>Does the primate zygomatic arch respond to food material properties?</b> H.M. EDMONDS.
15	<b>The placement of the maxillo-zygomatic suture in primate midfacial skeleton: An investigation on Old World Monkeys and New World Monkeys.</b> Q. WANG, J. MAKEDONSKA, C. BYRON, D. STRAIT.
16	<b>Cranial suture complexity alters sutural mechanical behavior: An FEA investigation.</b> C.J. ZAMBRANO, R.J. SADLEIR, D.J. DAEGLING.

**Session 31: HUMAN BIOLOGY.****Contributed Poster Presentations.** Chair: Michael Masters. *Park Concourse.*

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>C-reactive protein, early life, and growth in the Gambia.</b> H. SHATTUCK-HEIDORN, M. REICHES, S.E. MOORE, A.M. PRENTICE, P.T. ELLISON.
2	<b>Characterization of human cortical gene expression across development in relation to glucose utilization.</b> M.R. MCGOWEN, K.N. STERNER, J.L. BAKER, C.C. SHERWOOD, C.W. KUZAWA, H.T. CHUGANI, L. LIPOVICH, L.I. GROSSMAN, D.E. WILDMAN.
3	<b>Evolutionary ecology of nausea and vomiting of pregnancy in Yasawa Island, Fiji.</b> L.J. MCKERRACHER, M. COLLARD, J. HENRICH.
4	<b>Exploring potential risk factors of fetal origins of diabetes: Maternal stressors during pregnancy and birth outcomes among women in a hospital in the municipality of Caguas, Puerto Rico.</b> J. ARROYO, E. CHO, C. NOBLE, K. PEREZ.
5	<b>Associations between metabolic hormones and macronutrients in human milk.</b> E.A. QUINN.
6	<b>Preferences for male voices and faces among breastfeeding and non-breastfeeding women in Manila.</b> M.J. ESCASADORNE.
7	<b>Heightened diurnal endocrine levels in healthy women with a family history of hypertension: Reproducibility over the menstrual cycle.</b> G.D. JAMES.
8	<b>The relationship between clinical markers of frailty and measured physical activity using accelerometers: Results of a SAGE sub-study among older adults in India.</b> M.A. LIEBERT, J. SNODGRASS, T.J. CEPON-ROBINS, T.E. GILDNER, A. MATHUR, S.R. WILLIAMS, P. KOWAL, S. CHATTERJI.

- 9 **Cerebral hemisphere dominance and craniofacial constraint of the visual system: Evidence for the development of astigmatism and reduced visual acuity in humans.** M.P. MASTERS, S. RISSER.
- 10 **Hierarchical analysis of population structure by isonymy in the city of Binghamton, NY.** K.E. SHERIDAN, S.P. INGRASSIA.
- 11 **Is sickle-cell trait as benign as is usually assumed?** C.N. FLANSBURG, A. STONE, D. GODFREY, L. MADRIGAL, E. GONZALEZ.
- 12 **The decline of tuberculosis: A study of mortality rates.** K.L. HOLLOWAY, M. HENNEBERG.

**Session 32: PALEOANTHROPOLOGY: *Homo* and Reconstructing Environment.**

**Contributed Poster Presentations.** Chair: Katarina Harvati. **Park Concourse.**

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

- 1 **Ecomorphology of the bovid astragalus: Body size, function, phylogeny, & paleoenvironmental reconstruction.** W. BARR
- 2 **Serengeti micromammals: Testing the predictive ability of owl pellet assemblages for reconstructing paleohabitats.** S.J. CASTEDO, D.N. REED, W. DIRKS, T. HARRISON.
- 3 **Microtomographic assessment of mineralization patterns to inform isotope paleoenvironment reconstruction.** D.R. GREEN, T.M. SMITH, P. TAFFOREAU.
- 4 **Investigating paleoclimate in the Levant: Carbon and nitrogen isotope analysis of gazelles and rodents.** A.M. COWPER, J. LEICHLITER, K. HACK, M. BELMAKER, M.J. SPONHEIMER.
- 5 **New calculation of habitable land area during glacial periods and its implications for Pleistocene hominin population size.** J.R. GAUTNEY, T.W. HOLLIDAY.
- 6 **Distinguishing cut marks from carnivore tooth marks using scale-sensitive curvature of mark profiles.** B. KEEPERS, M.A. GLEASON, J.A. PARKINSON, J.S. RETI, P. WEIS, T. PLUMMER, R.S. SCOTT.
- 7 **What 1<sup>st</sup> metatarsal cortical thickness distribution reveals about locomotion of Sterkfontein and Swartkran hominins.** T. JASHASHVILI, M.R. DOWDESWELL, K.J. CARLSON, D. STRATFORD, M. DAMIANO, R. NSHIMIRIMANA.
- 8 **Comparative analysis of intercuspal dimensions and crown morphology between the deciduous second molar and permanent first molar within the same maxillary arcade.** K.S. PAUL, S.E. BAILEY.
- 9 **Endostructural morphology of the late Early Pleistocene human dental remains from Uadi Aalad and Mulhuli-Amo, Danakil (Afar) depression of Eritrea.** C. ZANOLLI, L. BONDIOLI, F. CANDILIO, A. COPPA, D. DREOSSI, D.W. FRAYER, Y. LIBSEKAL, L. MANCINI, L. ROOK, T. MEDIN, C. TUNIZ, R. MACCHIARELLI.
- 10 **Caries and other oral pathology in the Broken Hill (Kabwe) cranium.** S.A. LACY.
- 11 **The health of early *Homo*.** L. VAN BLERKOM.
- 12 **Pathology of LB1 (Flores, Indonesia): Down syndrome considered.** R. ECKHARDT, S. CHAVANAVES, M. HENNEBERG
- 13 **A quantitative approach for the late Pleistocene hominins brain size.** A. SERRANO-RAMOS, J. JIMÉNEZ-ARENAS, J. ESQUIVEL-GUERRERO.
- 14 **A morphometric analysis of the frontal squama in fossil and recent humans.** S. ATHREYA, J. DE LA CUÉTARA, T. MARKS, E. BRUNER.
- 15 **Zygomaxillary suture morphology in Pleistocene and Holocene *Homo*.** C.E. BURNS, A.N. SPORLEDER, S.D. MADDUX.
- 16 **Renewed paleontological investigations in the Olteț River Valley of Romania and the new paleontological locality of Râpa.** C.E. TERHUNE, S. CURRAN, A. PETCULESCU, C. ROBINSON, M. ROBU, E. STIUCA.
- 17 **New Neanderthal remains from Kalamakia cave, Mani peninsula, Southern Greece.** K. HARVATI, A. DARLAS, S.E. BAILEY, T.R. REIN, S. EL ZAATARI, L. FIORENZA, O. KULLMER, E. PSATHI.
- 18 **Variation in the Neandertal pelvis.** C. VANSICKLE.
- 19 **Human childbirth: An obstetrical dilemma or a solo act.** N.L. FALK-SMITH.
- 20 **Culture-genetic models of information exchange among Pleistocene human populations.** M. KISSEL.
- 21 **New ways of understanding hand stencils in French and Spanish cave art.** R.M. HARRISON, P. PETTITT.
- 22 **Tooth wear and culture in the Middle Paleolithic humans from Near East.** L. FIORENZA.
- 23 **Cervicometrics and intra-Iberomaurusian phenotypic variability.** C.L. CARVER, C.M. STOJANOWSKI.
- 24 **Regional variation in the cross-sectional geometric properties of southern African Later Stone Age foragers: An examination of humeri from three distinct ecoregions.** M.E. CAMERON.
- 25 **Sexual differentiation in humeral bilateral asymmetry during the Late Holocene at Roonka Flat, South Australia.** E.C. HILL, A.C. DURBAND, K. WALSH.
- 26 **Is thicker better? Testing adaptation hypotheses for cranial vault thickness.** H.E. MARSH.
- 27 **Ancient footprints in Ciur-Izbuca Cave, Romania: Preservation and re-analysis.** D. WEBB, M. ROBU, O. MOLDOVAN.

## Friday. Afternoon Sessions. Don't forget the Business Meeting @ 5:45, Ballroom A.

### Session 33: **Reconciling 'Stress' and 'Health': What Can Bioarchaeologists Learn from Other Sub-disciplines?** *Invited Podium Symposium.* Organizers: Laurie Reitsema and Britney McIlvaine. *Ballroom A.*

Stress models in bioarchaeology account for synergistic interactions of environmental constraints, biology, cultural buffering systems, and psychological disruption in contributing to a physiological stress response. One potential adverse impact of stress at both the individual and the population level is decreased health. However, there is only an imperfect relationship between stress and health: certain skeletal stressors may not engender a decline in overall health, and vice versa. Furthermore, health is an abstract concept with a continuum of expressions and with no single individual or population representing perfect health. Despite an indirect correlation between stress and health, many bioarchaeological studies commonly claim to measure health in ancient populations. What is actually being measured is skeletal stress, which is then used as a proxy for health. This symposium begins to bridge the concepts of stress and health by using modern perspectives to quantify their interrelatedness. The papers drawn together here provide new insight into our current understanding of health in bioarchaeological populations.

*Chair: Laurie Reitsema*

1:30-1:45	<b>A look at the literature: Recent developments and long-term trends in the interpretation of skeletal stress markers and ancient health.</b> B.K. MCILVAINE, L.J. REITSEMA.
1:45-2:00	<b>Defining, operationalizing, and assessing the relationship between stress and health in contemporary Tanzanian mothers and children.</b> W.M. WILSON, J.A. DECARO.
2:00-2:15	<b>Intra-household variation in anemia status and its relationship with self-perceived health in the Mexican Family Life Survey: Implications for Bioarchaeology.</b> B.A. PIPERATA, M. HUBBE, K. SCHMEER.
2:15-2:30	<b>Stress, social inequality, and growth retardation: Exploring the multidimensionality of stature variation in past populations.</b> G. VERCELLOTTI.
2:30-2:45	<b>Health and disease: Exploring the consequences of infection on nutritional status.</b> S. TANNER.
2:45-3:00	<b>In sickness and in death: What do age, stress, and illness in life tell us about skeletal remains?</b> R. LEAHY, D.E. CREWS.
3:00-3:15	<b>Dental bioindicators of health: At the intersection of bioarchaeology and contemporary human biomonitoring programs.</b> A.E. DOLPHIN.
3:15-3:30	<b>Integrating pathophysiology, human biology, and epidemiology in studies of human remains: Towards a clearer vision of stress and health in bioarchaeology.</b> H.D. KLAUS.
3:30-3:45	<b><i>BREAK</i></b>
	<i>Chair: Britney McIlvaine</i>
3:45-4:00	<b>Addressing the osteological paradox using high resolution stable isotope analysis.</b> P.A. SANDBERG, M. SPONHEIMER, J. LEE-THORP, D. VAN GERVEN.
4:00-4:15	<b>Apples, oranges, and incremental lines: A fresh look at enamel formation and long bone growth in prehistoric Illinois.</b> D.C. COOK.
4:15-4:30	<b>Health in post-Black Death London (1350-1538): Age patterns of periosteal new bone formation in a post-epidemic population.</b> S. DEWITTE.
4:30-4:45	<b>Childhood physiological stress and longevity.</b> R.H. STECKEL.
4:45-5:00	<b>Paradox and promise: The role of recent advances in paleodemography and paleoepidemiology to the study of ancient "health" patterns.</b> J.J. WILSON.
5:00-5:15	<b>Discussant,</b> ALAN GOODMAN.
5:15-5:30	<b>Discussant,</b> DANIEL TEMPLE.

### Session 34: **ANTHROPOLOGICAL GENETICS.** *Contributed Podium Presentations.* Chair: Moses Schanfield. *200ABC.*

1:30-1:45	<b>Genomic copy number variation within and between species is a major driver of primate evolution.</b> O. GOKCUMEN, R. ISKOW, Q. ZHU, P. BABB, W.E. JOHNSON, A.C. STONE, Y. GILAD, C. LEE.
1:45-2:00	<b>Evolvability and integration in human and non-human primate limbs.</b> B.I. HULSEY.
2:00-2:15	<b>Potential genetic determinants of dental arch form.</b> S.F. MILLER, K. VELA, C. TAKEUCHI, P. HANCOCK, T.E. SOUTHARD, D. GRATTON, L.M. MORENO URIBE.
2:15-2:30	<b>The genetic architecture and evolution of brain folding and neural network in a pedigreed <i>Papio</i> population.</b> E.G. ATKINSON, J. ROGERS, M.C. MAHANEY, L.A. COX, J.M. CHEVERUD.
2:30-2:45	<b>Natural selection acts to maintain diversity between Out of Africa and sub-Saharan African populations in genes related to neurological processes and brain development.</b> J.A. HODGSON, A. AL-MEERI, C.J. MULLIGAN, R.L. RAAUM.
2:45-3:00	<b>The signature of language and geography on the genetic structure of human populations in Africa.</b> M.E. SCHAEFFER, S.R. JOYCE, J.C. LONG.

3:00-3:15	<b>The origin of two Ethiopian communities according to HLA genes: Admixture with Asian and Sub-Saharan people.</b> F. DE ANGELIS, A. GARZOLI, A. BATTISTINI, A. IORIO, G. DE STEFANO.
3:15-3:30	<b>The partition of genetic distance into drift and admixture components.</b> A.J. KOEHL, J.C. LONG.
3:30-3:45	<b>BREAK</b>
3:45-4:00	<b>The correlation of skeletal and molecular data: Concordance of cranial, dental, mitochondrial DNA, and Y-Chromosome DNA.</b> B.C. HERRERA, T. HANIHARA, K. GODDE.
4:00-4:15	<b>Genetic diversity in indigenous populations from Central Mexico and its implications for the peopling of the Americas.</b> M.G. VILAR, R. GOMEZ, H. ZILLGES, D. BROOKS, A. SANDERS, J.B. GAIESKI, A.C. OWINGS, M.A. MERAZ, T.G. SCHURR, THE GENOGRAPHIC CONSORTIUM.
4:15-4:30	<b>Global patterns of ABO polymorphism suggest strong balancing selection and very low effective population size after the human colonization of America.</b> F.A. VILLANEA, K.N. SAFI, J.W. BUSCH.
4:30-4:45	<b>Neolithic human mitochondrial haplogroup H genomes and the genetic origins of Europeans.</b> W. HAAK, P. BROTHERTON, J. TEMPLETON, G. BRANDT, J. SOUBRIER, C.J. ADLER, S.M. RICHARDS, C.S. DER SARKISSIAN, R. GANSLMEIER, S. FRIEDERICH, V. DRESELY, M. VAN OVEN, J. KORLACH, S.Y. HO, L. QUINTANA-MURCI, D.M. BEHAR, H. MELLER, K.W. ALT, A. COOPER, THE GENOGRAPHIC CONSORTIUM.
4:45-5:00	<b>Analysis of archaic introgression in Ötzi the Tyrolean Iceman, a 5300 year-old prehistoric modern human.</b> A. SAMS, J. HAWKS.
5:00-5:15	<b>Preliminary report on the anthropology of 15 X STR loci.</b> M.S. SCHANFIELD, D. TIESMA, T. DIEGOLI, M. COBLE, M. CRAWFORD.
5:15-5:30	<b>Genome-wide associations for Parkinson's disease on the X chromosome.</b> M.F. KELLER, M.A. NALLS, A. SINGLETON.

### Session 35: LIFE HISTORY, REPRODUCTION AND ENERGETICS.

*Contributed Podium Presentations.* Chair: Herman Pontzer. **Ballroom B.**

1:30-1:45	<b>Comparison of the metabolic costs of feeding in a range of food types in small-bodied primates.</b> C.E. WALL, J. HANNA, M.C. O'NEILL.
1:45-2:00	<b>Does pregnancy really inhibit women's mobility? Insights from a longitudinal energetic study.</b> C.M. WALL-SCHEFFLER.
2:00-2:15	<b>Measuring and predicting daily energy expenditure of highly active humans in natural environments.</b> C. OCOBOCK, H. PONTZER, J. GOOKIN.
2:15-2:30	<b>Daily caloric intake in relation to food abundance and female reproductive state in wild Bornean orangutans (<i>Pongo pygmaeus wurmbii</i>) in a peat-swamp habitat.</b> T.D. BRANSFORD, M.A. VAN NOORDWIJK, E.R. VOGEL.
2:30-2:45	<b>Primate energy expenditure and life history.</b> H. PONTZER, D.A. RAICHLEN, A.D. GORDON, K.K. SCHROEPFER, B. HARE, H.M. DUNSWORTH, B.M. WOOD, M.T. IRWIN, R.W. SHUMAKER, E.V. LONSDORF, S.R. ROSS.
2:45-3:00	<b>Measuring constraints on selection in human and chimpanzee life histories.</b> J.H. JONES.
3:00-3:15	<b>Trade-offs between reproduction, aging and lifespan: Biomarkers, confounders and genetic factors.</b> G. JASIENSKA.
3:15-3:30	<b>Rethinking lifetime reproductive effort in humans: does early weaning provide the fuel to extend the human lifespan?</b> J.M. BRAGG, B. BOGIN, C.W. KUZAWA.
3:30-3:45	<b>BREAK</b>
3:45-4:00	<b>The fertile window in the human ovarian cycle.</b> R.D. MARTIN.
4:00-4:15	<b>The neuroendocrinology, behavioral pharmacology and frontal neuroanatomy of dopamine in mother-reared and nursery-reared rhesus monkeys (<i>Macaca mulatta</i>).</b> S.B. SERAPHIN, P.L. WHITTEN, M.M. SANCHEZ, J.T. WINSLOW.
4:15-4:30	<b>Bioactive factors in macaque milk: Relationships with maternal physiology and infant growth.</b> R. BERNSTEIN, H. DROUGHT, M. WECHSLER, K. HINDE.
4:30-4:45	<b>Does personality matter? Early life behavioral phenotype and subsequent survival, growth, and reproduction in female rhesus macaques.</b> K. HINDE, J.P. CAPITANIO.
4:45-5:00	<b>Country roots: Non-urban environments and the impact of socio-economic status on growth in a British cemetery assemblage.</b> E.M. GAROFALO, C.B. RUFF.
5:00-5:15	<b>Growth and development in the genus <i>Pan</i>: A life history approach.</b> C.S. BRIMACOMBE.
5:15-5:30	<b>First molar eruption and life history in living wild chimpanzees.</b> T.M. SMITH, Z. MACHANDA, A. BERNARD, R. DONOVAN, A.M. PAPAKYRIKOS, M.N. MULLER, R. WRANGHAM.

### Session 36: PRIMATOLOGY: Feeding Ecology, Energy and Nutrition.

*Contributed Podium Presentations.* Chair: Mitchell Irwin. **Ballroom C.**

1:30-1:45	<b>Digestive strategies: Scaling of feeding time and gut retention.</b> L. YAO, K. ISLER, R.D. MARTIN, C.F. ROSS.
1:45-2:00	<b>Age and sex differences in the behavior, diet, and gut microbial communities of wild black howler monkeys (<i>Alouatta pigra</i>).</b> K.R. AMATO, S.R. LEIGH, A.D. KENT, C.J. YEOMAN, R.M. STUMPF, M. TORRALBA, M. GILLIS, B.A.

WILSON, K.E. NELSON, B.A. WHITE, P.A. GARBER.

2:00-2:15	<b>Characterization of the gastrointestinal bacterial communities of western lowland gorillas (<i>Gorilla gorilla gorilla</i>).</b> A. GOMEZ, C.J. YEOMAN, B.A. WHITE, K. PETRZELKOVA, A. TODD, R.M. STUMPF, K.E. NELSON, M. TORRALBA, M. GILLIS, B.A. WILSON, S.R. LEIGH.
2:15-2:30	<b>Cross-comparison of the use of ketones and urinary C-Peptide of insulin as a means of assessing energetic status in wild bonobos (<i>Pan paniscus</i>);</b> Iyema Forest, DR Congo. A.K. COBDEN.
2:30-2:45	<b>Nutritional content of fallback and preferred foods in the diet of the Sanje mangabey (<i>Cercocebus sanjei</i>),</b> Udzungwa Mountains National Park, Tanzania. G. PAGES, C.L. EHARDT.
2:45-3:00	<b>Comparison of the nutritional composition of foods consumed by howler monkeys (<i>Alouatta pigra</i> and <i>A. caraya</i>) in Mexico and Argentina.</b> N. RIGHINI, V.A. FERNANDEZ, J.M. ROTHMAN.
3:00-3:15	<b>Nutritional ecology and nutrient balancing in a rainforest sifaka.</b> M.T. IRWIN, J.M. ROTHMAN, D. RAUBENHEIMER, J. RAHARISON, C.A. CHAPMAN.
3:15-3:30	<b>Effects of fruit odor on fruit consumption and seed dispersal by <i>Microcebus murinus</i> and <i>M. ravelobensis</i> in a tropical dry forest in northwestern Madagascar.</b> K. VALENTA, R.J. BURKE, S.A. STYLER, D.A. JACKSON, S.M. LEHMAN.
3:30-3:45	<b>BREAK</b>
3:45-4:00	<b>Is there a role for color-sensitive foraging in folivorous sifaka (<i>Propithecus verreauxi</i>)?</b> C.C. VEILLEUX, D.A. BOLNICK, A. DI FIORE, R.J. LEWIS.
4:00-4:15	<b>Are primate folivores ecologically constrained? A comparative analysis of behavioral indicators of within-group feeding competition.</b> K.M. ELLIS.
4:15-4:30	<b>The meaning of weaning in wild Phayre's leaf monkeys (<i>Trachypithecus phayrei crepusculus</i>).</b> C. BORRIES, E. LARNEY, A. LU, K. OSSI-LUPO, A. KOENIG.
4:30-4:45	<b>Social learning of food preferences in juvenile chimpanzees.</b> V. WOBBER, F. WARNEKEN.
4:45-5:00	<b>The ontogeny of sex differences in ring-tailed lemur feeding ecology: Costs of reproduction and niche partitioning.</b> T. O'MARA.
5:00-5:15	<b>Responses to resource bottlenecks in a sympatric hylobatid community.</b> A.A. ELDER.
5:15-5:30	<b>Differences in food availability may guide the foraging decisions of captive marmosets (<i>Callithrix</i> spp.).</b> D.F. GOMES, J. BICCA-MARQUES.

**Session 37: Concepts and Realities – Humans in Time and Space: Papers in Honor of Fred Hines Smith.**  
*Invited Poster Symposium.* Organizers: James Ahern and Ivor Jankovic. **200DE.**

Fred Hines Smith, former AAPA president, has had a lasting influence on various fields of research on human origins and evolution. His conceptual ideas and models, his meticulous studies of fossils, his involvement in the development of the field of paleoanthropology in Croatia, his influence on generations of students, many of which are now scholars of human origins themselves, are just some among many contributions that he had over the years. This year's AAPA meetings are held in Fred's home state and in the place where he first held an academic position. Furthermore, the sequel to one of Fred's most influential works (edited with Frank Spencer), *Origins of Modern Humans: A World Survey of the Fossil Evidence* is in publication. Thus, it is now appropriate to honor Fred's many contributions. This symposium brings together an array of papers that all share a common theme that has been central to Fred's work: conceptual understanding built upon detailed analyses of human biology in time and space. Reflecting Fred's own body of work, many of the contributions are on later human evolution, while some focus on variation and evolution of more recent populations.

12:30-1:30 pm Poster set-up. 5:00-5:30 pm Poster take-down.

4:30-5:00 pm Discussion. ERIK TRINKAUS, MILFORD WOLPOFF, FRED H. SMITH.

1	<b>Exploratory multivariate analysis of shape in commingled fossil assemblages.</b> T. COLE, M. COLE, D. CUNNINGHAM.
2	<b>Peeling back the layers: additional evidence for the date of the Petralona skull (<i>Homo heidelbergensis</i>), Greece.</b> M.A. LISTON, A. BARTSIOKAS.
3	<b>Reconsideration of the mandibular mental foramen position in the genus <i>Homo</i>.</b> R.M. QUAM, J. ARSUAGA.
4	<b>The developmental and evolutionary significance of occipital bunning: A comparative morphometric study.</b> M.E. UTZINGER, R.G. FRANCISCUS, T.E. SOUTHARD.
5	<b>Long bone growth trajectories in late Pleistocene <i>Homo</i>.</b> A.M. BUSBY, M. SESELJ.
6	<b>Re-evaluating the functional and adaptive significance of Neandertal nasofacial anatomy.</b> T.R. YOKLEY, N.E. HOLTON.
7	<b>Three-dimensional geometric morphometric analysis of late Pleistocene femora: Taxonomy and functional morphology.</b> V.T. HUTCHINSON.
8	<b>Fred Smith and the Croatian Paleoanthropology.</b> I. JANKOVIC.
9	<b>Is there evidence for assimilation in Australasia?</b> A.C. DURBAND.
10	<b>The evidence for modern human origins in Central Europe: 30 years since Smith's seminal review.</b> J.C. AHERN.

11	<b>The diet of Neandertals at Krapina: Evidence from dental microwear texture.</b> W.M. KARRIGER, C.W. SCHMIDT.
12	<b>Comparative analysis of covariance structure in the skull and postcranial skeletons of living apes.</b> P.S. VINYARD, A.B. TAYLOR, C.J. VINYARD.
13	<b>Microevolutionary change in the human mandible.</b> D.C. BOYD, C. BOYD, W.L. HYLANDER.
14	<b>Ten thousand years of population interaction at the Prairie-Woodland Interface in the upper Midwest and contiguous areas of Manitoba and Ontario.</b> S.M. MYSTER.
15	<b>Resolving missing and unidentified persons cases: Results of multidisciplinary efforts and new data collection technologies.</b> A.B. FALSETTI, C.R. SKORY, F. GAJATE, W. CRANE.
16	<b>Sleep may provide a molecular model of the functional impact of increasing brain size.</b> L. NEVELL, M. MUCHLINSKI, R. DIOGO.

**Session 38: Nonhuman Primates in Human-Modified Habitats: Explorations in Ethnoprimatology.**  
*Invited Poster Symposium.* Organizer: Kerry Dore. **301D.**

It has become increasingly difficult for primatologists to study free-ranging non-human primates that are not significantly impacted by anthropogenic disturbances. The emergent field of ethnoprimatology combines theories and methods from primatology, cultural anthropology, endocrinology, parasitology, epidemiology, geography, history and others to provide nuanced understandings of the interactions between humans and non-human primates. These studies often elucidate varied conservation strategies that are custom-fit to the needs of the country, environment and human cultural context in which these non-human primates are situated.

The posters in this symposium include a survey of current ethnoprimatological studies and highlight new theoretical approaches to ethnoprimatology. Topics include: the use of geographic information systems and GPS in ethnoprimatology; overlapping resource use between humans and non-human primates; the effect of anthropogenic habitat disturbance and/or tourism on non-human primate behavior, stress and parasite load; disease transmission between humans and non-human primates; conflict dynamics between humans and non-human primates (e.g., crop-damage, hunting) and the place of non-human primates in local cultures. The goal of this symposium is to facilitate collaboration between researchers utilizing approaches from different disciplines to examine human and non-human primate interactions. As humans and human-modified habitats will play an increasingly larger role in studies of non-human primates in the near future, the results of ethnoprimatological research are especially important and relevant.

12:30-1:30 pm Poster set-up. 5:00-5:30 pm Poster take-down.

4:00-4:30 pm Roundtable Discussion.

1	<b>A preliminary report on the interactions between humans and squirrel monkeys in the southern Costa Rica countryside.</b> L. KAUFFMAN.
2	<b>The rhesus macaques (<i>Macaca mulatta</i>) of India: A liminal animal.</b> L.D. WOLFE.
3	<b>Using a hierarchical generalized linear model to predict crop damage by vervet monkeys (<i>Chlorocebus aethiops</i>) in St. Kitts, West Indies.</b> K.M. DORE.
4	<b>Shared space in a sacred forest: Habitat use by humans and Javan gibbons (<i>Hylobates moloch</i>).</b> M. REISLAND, J. LAMBERT.
5	<b>The role of exotic and ornamental plants in the feeding ecology of mouse lemurs (<i>Microcebus murinus</i>) at Berenty Private Reserve, Madagascar.</b> K. FISH.
6	<b>Varying responses to tourist interactions by white-faced capuchins (<i>Cebus imitator</i>) and mantled howlers (<i>Alouatta palliata</i>) in a Costa Rican wildlife refuge.</b> T. MCKINNEY.
7	<b>Monkey tourism in Japan: How travel health knowledge, attitudes and practices may influence pathogen transmission.</b> H.N. DEHAYS, M.P. MUEHLENBEIN.
8	<b>Habituation to tourists: Protective or harmful?</b> J.L. WESTIN.
9	<b>Extending ethnoprimatology: An exploration of human/orangutan interactions in an urban zoological garden.</b> A. PALMER, N. MALONE, J. PARK.
10	<b>The looming legacy of deforestation for red colobus monkeys in Kibale National Park.</b> K.M. MILICH.
11	<b>How Mentawai Island primate characteristics affect hunters' prey choice.</b> L.M. PACIULLI, K. SABBI.
12	<b>Nonhuman primates and "Others": Multispecies ethnography in the Dzanga Sangha Dense Forest Reserve (RDS), Central African Republic.</b> M.J. REMIS, C.A. JOST ROBINSON.
13	<b>Anthropogenic impacts on primate distribution and matrix-edge dynamics in a Bolivian forest.</b> I.I. DIAZ.
14	<b>Primate habitat selection near humans in northern Madagascar: The edge of a primary forest vs. forest fragments.</b> B.Z. FREED.
15	<b>An ethnoprimatological assessment of human impact on the parasite ecology of silky sifaka (<i>Propithecus candidus</i>).</b> J.E. LOUDON, E.R. PATEL, C. FAULKNER, B. SCHOPLER, R. KAMER, C.V. WILLIAMS.

## Saturday. Morning sessions.

### Session 39: Ethical Practice in Biological Anthropology: Continuing the Dialogue.

*Invited Podium Symposium.* Chair: M. Elle Saine and Heather Shattuck-Heidorn. *Ballroom A.*

During the 2012 AAPA Open Forum, “The Ethics of Practice and the Practice of Ethics: an open dialogue among bioanthropologists”, it became clear that many researchers felt that the available ethical training and resources do not adequately address the unique needs of researchers in biological anthropology. Participants identified several areas of focus as deserving attention within our community, including the ethics inherent in field work, common challenges in working with skeletal remains, and the need for intradisciplinary conversation concerning professional relationships within our field. This symposium aims to address these identified needs, as well as other ethical challenges in our field. The symposium offers perspectives both on the application of ethics to procedural topics such as repatriation, field site management, and gaining family consent, and to emerging ethical topics that necessitate discussion, such as the Open Access movement. It is our sincere hope that by extending the current discourse on ethics, we can work to address the unique ethical challenges and questions that biological anthropologists engage during their research.

*Chair: Heather Shattuck-Heidorn*

8:00-8:15 **Ethical practice in biological anthropology: An introduction to the 2013 symposium.** M. SAINÉ, H. SHATTUCK-HEIDORN.

8:15-8:30 **Applying the Belmont principles to physical anthropology.** S. STINSON.

8:30-8:45 **Ethics of field site management and oversight.** K.B. CLANCY.

8:45-9:00 **Building a code of best practices for field primatology.** K.C. MACKINNON, E.P. RILEY.

9:00-9:15 **Ethical questions in human reproductive ecology.** M.W. REICHES.

9:15-9:30 **Laying the Yanomami to rest: The endless saga of the blood samples.** K.M. WEISS.

9:30-9:45 **Informed consent and building a skeletal sample.** K.M. HARTNETT.

9:45-10:00 **Ethical practices for outdoor anthropological research facilities with willed body donation programs.** S.R. MAVROUDAS.

10:00-10:15 **BREAK**

*Chair: M. Elle Saine*

10:15-10:30 **“Stand fast and suffer long”: The ethics of repatriation.** J.T. WATSON, J. MCCLELLAND, T. PITEZEL.

10:30-10:45 **Ethical challenges for biological anthropologists working in mass fatality contexts.** B.J. FIGURA.

10:45-11:00 **Do biological anthropologists have an ethical obligation to identify themselves as anthropologists? Reflections at the AAPA x AAA intersection.** K.B. STRIER.

11:00-11:15 **Professional publishing and professional ethics in biological anthropology.** P.T. ELLISON.

11:15-12:00 **DISCUSSION,** GRACIELA CABANA and TRUDY TURNER.

### Session 40: PRIMATOLOGY: Ranging, Distribution and Genetics.

*Contributed Podium Presentations.* Chair: Kate Detwiler. *200ABC.*

8:00-8:15 **Tangible or intangible frontiers: Qualifying interactions between humans and chimpanzees in fragmented landscapes.** S. BORTOLAMIOL, M. COHEN, M. CIBOT, S. KRIEF.

8:15-8:30 **The role of ecology and human activities in determining abundance and occupancy within fragmented primate communities of northern Madagascar.** M.A. BANKS, J. OCLIN.

8:30-8:45 **Carnivore-Primate Interactions across fragmented and contiguous forests in N.E. Madagascar.** Z.J. FARRIS, B. GERBER, E. PATEL, S. KARPANTY, M.J. KELLY.

8:45-9:00 **Stable isotopes indicate forest fragmentation affects cheirogaleid lemurs.** B.E. CROWLEY, M.B. BLANCO, S.J. ARRIGO-NELSON, M.T. IRWIN.

9:00-9:15 **Is the fit right? Lemur species-area curves in a fragmented landscape.** T.S. STEFFENS, S.M. LEHMAN.

9:15-9:30 **Are lorises really slow? Ecological context of rapid locomotion in slow lorises (*Nycticebus*).** K.A. NEKARIS, C.R. STARR.

9:30-9:45 **Evaluating the utility of GPS collars for studies of ranging by large-bodied, arboreal, forest-dwelling primates.** A. DI FIORE, A. LINK.

9:45-10:00 **Distribution of the Indochinese Silvered langurs in the Mekong Delta Region of Vietnam.** H.H. COVERT, D.M. HOANG.

10:00-10:15 **BREAK**

10:15-10:30 **Ancient DNA genomics of Madagascar’s extinct subfossil lemurs: *Palaeopropithecus ingens* genetic diversity.** G. PERRY.

L. KISTLER, C. HUGHES, Y. CUI, A. RATAN, B.E. CROWLEY, L.R. GODFREY, R. LEI, S. SCHUSTER, E. LOUIS, A. YODER, R. MALHI, W. MILLER.

10:30-10:45	<b>Evolutionary history of nocturnal galagids: New insights using a multilocus approach.</b> L. POZZI.
10:45-11:00	<b>Genetic diversity and phylogenetics of two hybridizing Atlantic forest marmoset species, common marmosets (<i>Callithrix jacchus</i>) and black-tufted marmosets (<i>Callithrix penicillata</i>).</b> J. MALUKIEWICZ, V. BOERE, L.F. FUZESSY, A.D. GRATIVOL, L.C. PEREIRA, I. DE OLIVEIRA SILVA, C.R. RUIZ-MIRANDA, A.C. STONE, Y.M. VALENÇA.
11:00-11:15	<b>Analysis of multi-locus sequence data indicates complex speciation in the evolutionary history of the Papionina.</b> E.E. GÓMEZ GUEVARA, M.E. STEIPER.
11:15-11:30	<b>Females select mates that are less related than expected among the Gombe chimpanzees.</b> K.K. SCHROEPFER-WALKER, A. PUSEY, R.S. RUDICELL, M.A. RAMIREZ, B.H. HAHN, E. WROBLEWSKI.
11:30-11:45	<b>Major histocompatibility complex (MHC) variation in a population of wild chimpanzees.</b> E.E. WROBLEWSKI, P.J. NORMAN, R.S. RUDICELL, M.A. RAMIREZ, B.H. HAHN, A.E. PUSEY, P. PARHAM.
11:45-12:00	<b>Lesula: A remarkable new species of <i>Cercopithecus</i> monkey from Congo's Central Basin.</b> K.M. DETWILER, J.A. HART, C.C. GILBERT, A.S. BURRELL, J.L. FULLER, M. EMETSHU, T.B. HART, A. VOSPER, E.J. SARGIS, A.J. TOSI.

**Session 41: SKELETAL BIOLOGY AND BIOARCHAEOLOGY: Diet and Identity.**

*Contributed Podium Presentations.* Chair: Isabelle De Groote. **Ballroom B.**

8:00-8:15	<b>Investigating inter-laboratory variability in stable isotope data.</b> W.J. PESTLE, M.T. WEIRAUCH, B.E. CROWLEY.
8:15-8:30	<b>Dietary reconstruction of the Fishergate House juveniles using a new method of dentine microsampling for stable isotope analysis.</b> N.M. BURT.
8:30-8:45	<b>Cultural replacement and diet in Peru's prehispanic central coast.</b> K. GERDAU RADONIC, G. GOUDE, K. MAKOWSKI, P. CASTRO DE LA MATA, G. ANDRE, H. SCHUTKOWSKI.
8:45-9:00	<b>Living on the seashore: A consideration of lifestyle among Formative Period fisherpeoples of northern Chile.</b> C. TORRES-ROUFF, W.J. PESTLE, K.J. KNUDSON, F. GALLARDO.
9:00-9:15	<b>Stable isotopic analysis of human diet in the Cape region of Baja California Sur.</b> T.M. SCHOBER.
9:15-9:30	<b>Immigration and diet in Montreal during the 17<sup>th</sup> and 18<sup>th</sup> centuries: An isotopic analyses of archaeological populations.</b> J. VIGEANT.
9:30-9:45	<b>Dietary patterns in Medieval northern Spain.</b> A.T. MACKINNON, E.J. BARTELINK, N.V. PASSALACQUA.
9:45-10:00	<b>From valley to coast: An isotopic study of Albanian diet across three millennia.</b> S.A. KLINE, E.J. BARTELINK, T.W. FENTON.
10:00-10:15	<b>BREAK</b>
10:15-10:30	<b>Oral health and dietary change during the Epipalaeolithic-Neolithic transition in Northwest Africa.</b> I. DE GROOTE, L. HUMPHREY.
10:30-10:45	<b>Foodways and polity Formation: A bioarchaeological analysis of the Xiongnu using dental microwear texture analysis and pathological conditions.</b> J.J. BEACH, C.W. SCHMIDT.
10:45-11:00	<b>Resource and mortuary patterns as an interpretation of spatial use at Cerro Mangote, Panama.</b> A.E. HUARD.
11:00-11:15	<b>Middle Cumberland regional relationships and the Mississippian geopolitical landscape.</b> G.M. VIDOLI, H. WORNE, D.W. STEADMAN, C.R. COBB.
11:15-11:30	<b>Grasshopper's children: Bioarchaeological reconstruction of social age identity.</b> D. NIKITOVIC.
11:30-11:45	<b>The use of the body in the creation of collective identity: A bioarchaeological examination of Wisconsin Effigy Mound mortuary ritual.</b> W.L. LACKEY-CORNELISON, L.G. GOLDSTEIN.
11:45-12:00	<b>Markers of corporate identity: Variation in postmortem treatment and burial deposition in the Wisconsin Late Woodland effigy mound tradition.</b> J.B. CORNELISON, L.G. GOLDSTEIN, W.L. LACKEY-CORNELISON.

**Session 42: PALEOANTHROPOLOGY: Later *Homo*.**

*Contributed Podium Presentations.* Chair: P. Thomas Schoenemann. **Ballroom C.**

8:00-8:15	<b>Orangutan sleep architecture: A comparison between orangutan, chimpanzee and human sleep behavior.</b> D.R. SAMSON, R.W. SHUMAKER.
8:15-8:30	<b>Sense and sensitivity in Neandertals and Denisovans.</b> J. HAWKS.
8:30-8:45	<b>Honey exploitation by chimpanzees and hunter-gatherers indicates an ancient use of fire by humans.</b> R.W. WRANGHAM, Z. MACHANDA.
8:45-9:00	<b>Structural asymmetries in the human brain assessed via MRI.</b> L.M. KITCHELL, P. SCHOENEMANN, M. LOYET.
9:00-9:15	<b>Skhul V segmentation and Broca's region asymmetries in Neandertal endocasts.</b> P. SCHOENEMANN, R.L. HOLLOWAY.

9:15-9:30	<b>Impact of Tool Use on brain development of non-human primates.</b> A.R. BRITTINGHAM, D.R. HURST, P. SCHOENEMANN, B. AVANTS, J.C. GEE.
9:30-9:45	<b>Evidence of a common neural substrate for stone toolmaking and language syntax: An activation likelihood estimate metanalysis.</b> K. BABCOCK, R.A. MAHANEY.
9:45-10:00	<b>Using formal languages to determine the similarity of Paleolithic stone toolmaking and language syntax.</b> R.A. MAHANEY.
10:00-10:15	<b>BREAK</b>
10:15-10:30	<b>Trabecular bone architecture in the thumb of recent <i>Homo sapiens</i>, <i>Pan</i>, and Late Pleistocene <i>Homo</i>: Taxonomic differences and evidence for handedness.</b> N.B. STEPHENS, T. KIVELL, N. NGUYEN, D.H. PAHR, T. GROSS, J. HUBLIN, M.M. SKINNER.
10:30-10:45	<b>Reconstructing the craniofacial maturation of Neandertals.</b> F.L. WILLIAMS.
10:45-11:00	<b>The use of Arctic samples as a proxy for Neandertals: Cautions and advances from incisor microwear texture analysis.</b> K.L. KRUEGER.
11:00-11:15	<b>A radiogenic strontium isotope analysis of Neandertal prey movement patterns in the Dordogne Valley of France.</b> J.M. HODGKINS.
11:15-11:30	<b>Neandertal lumbopelvic anatomy and the biomechanical effects of a reduced lumbar lordosis.</b> M.C. FOX, K.K. WHITCOME.
11:30-11:45	<b>Variation in running foot strike patterns in two habitually unshod Kenyan populations.</b> K.G. HATALA, D.E. LIEBERMAN, H.L. DINGWALL, E.R. CASTILLO, R.E. WUNDERLICH, P. OKUTOYI, T. SIGEI, A. ANJILA, Y. PITSLADIS, B.G. RICHMOND.
11:45-12:00	<b>Anatomically modern humans as a 'self-domesticated' species: Insights from ancestral wolves and descendant dogs.</b> R.G. FRANCISCUS, S.D. MADDUX, K. WIKSTROM SCHMIDT.
12:00-12:15	<b>Dental connections between Late Pleistocene and Holocene Khoesan populations in southern Africa.</b> W. BLACK, R.R. ACKERMANN, J. SEALY.

**Session 43: The Bioarchaeology of Disease Ideologies.**  
*Invited Poster Symposium.* Organizers: Carlina de la Cova and John Crandall. **200DE.**

Anthropologists have long documented illnesses, disease, and stress among the remains of past peoples. Bioarchaeologists, those studying ancient human biocultural interactions, have long diagnosed and described illnesses, identified the physically handicapped and sought to understand the evolution and ecology of ancient diseases. Increasingly, anthropology has pointed out the ways that health afflictions, injuries, and disabilities also have social lives. Through contextualized, careful archaeological research, bioarchaeologists have advocated placing health and disease data in cultural, regional, and temporal contexts to comprehend the social experience of disease and disability. Papers in this session build on this work to understand the symbolic, social and political dimensions of illness in the past using the concept of disease ideologies. Disease ideologies refer to communities' understandings of illness or disability phenotypes. These etiologies include cultural comprehension of disease causation, moralization of the ill or an illness, and the ways social metaphors make sense of sickness. By using the concept of disease ideologies, we explicitly draw on theories commonly used in medical anthropology. In doing so, papers in this session seek to initiate greater dialogue between medical and cultural anthropologists, bioarchaeologists, and paleopathologists in order to bring their expertise to bear in unraveling the social and biological complexities of illness, disease, and disability in the past.

7:30-8:00 am Poster set-up. 11:30-12:00 am Poster take-down.

	<b>10:00-11:30</b> Participants will present in the order in which they appear, followed by discussant CHARLOTTE ROBERTS
1	<b>Bioarchaeology and "disability": Using the present to inform interpretations of past impairment.</b> C.A. ROBERTS.
2	<b>Functional impairment and physical stress in the past: How physiotherapy ideologies can contribute to bioarchaeological interpretations.</b> R.J. GILMOUR, M. BRICKLEY, T. PROWSE.
3	<b>Presentation Withdrawn.</b>
4	<b>Lives of deprivation or lives of industry: Possible cerebral palsy on the <i>Mary Rose</i>.</b> R. DREW.
5	<b>Normative ideologies of sample construction in bioarchaeological studies.</b> R.J. WATKINS.
6	<b>Race, disease, disability, and medical ideologies tied to the American anatomical collections.</b> C.M. DE LA COVA.
7	<b>The past as prologue: Changing disease ideologies surrounding HIV/AIDS in Zimbabwe.</b> D.S. SIMMONS.
8	<b>Infectious diseases, beliefs and treatment before antibiotics: Examples from Portuguese culture and skeletons.</b> A. SANTOS, J. SUBY.
9	<b>Illness, identity and the Mesoamerican infant: A regional perspective.</b> J.J. CRANDALL, D.L. MARTIN, J.L. THOMPSON.

10	<b>Frailty, social identity and treponemal disease in the Southeastern US.</b> S.A. MATHENA, M.K. ZUCKERMAN, N.P. HERRMANN.
11	<b>Identifying traumatically induced brain injury (TBI) and disability in Medieval England AD1066-AD1600.</b> J. PEACOCK.
12	<b>Religious and medical healing in Medieval Irish society.</b> R.E. SCOTT.
13	<b>The violence of everyday life: Pathology, trauma, and community membership at Harappa.</b> E. BLEVINS, B. COX, G. ROBBINS SCHUG.

**Session 44: Forensic Anthropology, Human Rights and Bioarchaeology of the Individual: A Tribute to the Life and Work of Karen Ramey Burns.**

*Invited Poster Symposium.* Organizer: Megan Moore. *301D.*

Modern Biological Anthropology owes much of its current focus and direction to the work and contribution of Dr. Karen Ramey Burns. She helped to develop and mentor forensic teams around the world. Her reach extended all across the Americas to North Africa, Europe, and Melanesia. She testified as an expert witness in trials at the local, state, and international levels. She helped to identify individuals from mass graves in Guatemala and Bosnia, among others. As a Fulbright Scholar, she spent a year as a faculty member of Universidad de los Andes in Bogotá, Colombia, where she was a founding member of the non-governmental forensic anthropology team EQUITAS. With DMORT, she worked with recovery and identification of national mass disasters of the World Trade Center and Hurricane Katrina. She helped teach courses for the International Criminal Investigative Training Assistance Program of the US Department of Justice. She had her hand in the bioarchaeology of a Roman necropolis looking for evidence of an early documented genocide. Kar Burns investigated the bioarchaeology of the individual, namely the cases of Amelia Earhart and Revolutionary War hero Casimir Pulaski. These contributions are the inspiration for this symposium, with friends/contributors speaking to each of the areas of biological anthropology that she helped to shape.

7:30-8:00 am Poster set-up. 11:30-12:00 am Poster take-down.

10:30-11:30 Roundtable Discussion by the authors and discussant, MICHAEL WARREN.

1	<b>Dr. Karen Burns: Pioneer in forensic anthropology at the University of Florida.</b> M.W. WARREN.
2	<b>The legacy of Dr. Karen Ramey Burns: A focus on the individual in forensic and bioarchaeological contexts.</b> J.D. BETHARD, M.K. MOORE.
3	<b>The human in what remains: Reflections of Dr. Karen Ramey Burns.</b> F.J. BAIRES.
4	<b>Human rights in Colombia and the creation of EQUITAS, an independent organization for the support of victims.</b> A. GUATAME-GARCIA.
5	<b>Training and empowerment in Forensic Anthropology on an international level: How the life's work of Dr. Karen Ramey Burns has inspired training in Colombia.</b> E.A. DIGANGI.
6	<b>What happened to Wilma? Demonstrative evidence in an FBI cold case.</b> A.M. SMITH, C. DARDENNE, W. WOODWARD, B. BENSON.
7	<b>The legacy of Dr. Karen Ramey Burns: A focus on the individual.</b> S.A. HOLTZMAN, W. HAGLUND, M.K. MOORE.
8	<b>Presenting evidence concerning human remains: Improving expert testimony.</b> J.M. MCCULLOUGH, C.N. DARDENNE.

## Saturday. All Day Poster Sessions.

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**Session 45: BIOARCHAEOLOGY: Subsistence, Methods, and Archaeology.**  
*Contributed Poster Presentations.* Chair: Christopher Knusel. *Clinch Concourse.*  
 7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm  
 Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

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1	<b>Application and use of Cyclododecane, Part II: En Bloc removal of osteological remains.</b> A.E. FAZLOLLAH, M.J. WOOD, B.M. WRAY-MILLER.
2	<b>Bioarchaeology in 3D: Employing three-dimensional technology in the field and in the lab.</b> C.J. KNUSEL, S.D. HADDOW, J.W. SADVARI, N. DELL'UNTO.
3	<b>Reconciling old maps with their curated collections: The implementation of technology to the riddle of curated commingled remains.</b> M.N. PANAKHYO, J. FUNKHOUSER.
4	<b>Putting pieces together again: Statistical formula for os coxa and sacrum.</b> M. MILLER.
5	<b>Increasing the quality of your bioarchaeological data through the use of tablet-based software.</b> A.E. AUSTIN.
7	<b>Distinguishing between stone tool burnishing and pot polish.</b> D.V. KOPP, J. RABB.
8	<b>Human bone artifacts as markers of prehistoric populations: Critical assessment of evidence from Central California.</b> H.M. OJEDA, J.Y. ANDERSON, M.D. CEBULA, E.A. BULGER, G.D. RICHARDS.
9	<b>Diet in the mountains: Using dental pathology to assess subsistence strategies in Paa-ko, New Mexico.</b> E.C. BLANKENSHIP-SEFCZEK, T.D. RANDALL.
10	<b>Bioarchaeological analysis of dental health and diet in Tonga.</b> C. STANTIS.
11	<b>Dental microwear: A window into dietary texture during the Late Bronze Age and Early Iron Age in East Lokris Greece.</b> J.R. DE GREGORY, N.P. HERRMANN.
12	<b>Microwear texture analysis of mandibular molars recovered from four Medieval sites in England and Ireland.</b> N.A. SCHMALZ, T.J. FINAN, J.M. ORGAN.
13	<b>Dental microwear texture analysis at Tell Dothan.</b> R. VAN SESSEN, C. SCHMIDT, S. SHERIDAN, J. ULLINGER, M. GROHOVSKY.
14	<b>Age as a factor in inter-tissue spacing of stable carbon isotopes in juvenile human remains.</b> A. NORRIS, L. WILLIAMS, T. DUPRAS, S. WHEELER.
15	<b>High spatial resolution isotopic analysis of human primary bone: New methods for reconstructing short-term environmental and dietary change using the endosteal lamellar pocket.</b> C.M. MAGGIANO, C.D. WHITE, F.J. LONGSTAFFE.
16	<b>Validation of bone apatite purification protocols for stable isotope analysis in bioarchaeology by Solid-State Nuclear Magnetic Resonance spectroscopy.</b> K. SALESSE, V. URZEL, E. DUFOUR, D. CASTEX, J. BRUZEK, E.J. DUFOURC.
17	<b>Using stable isotopes to ascertain paleo-foraging strategies through the study of woodland bison behavior.</b> B.F. KENNEY, B.E. CROWLEY.
18	<b>Isotopic measures of intra-individual variation in fetal bone collagen and apatite.</b> L. WILLIAMS, A. NORRIS, T. DUPRAS, S. WHEELER, M. TOCHERI.
19	<b>Dietary variation of individuals from the Angel Site and Caborn-Welborn Villages: Implications on the Vacant Quarter Hypothesis.</b> E.E. ALONZI, M.R. SCHURR.
20	<b>Whet your apatite: A dietary reconstruction using stable carbon isotopes from human tooth enamel at Tell Dothan.</b> R.M. AUSTIN, J. FRIEDMAN, L. GREGORICKA, J. ULLINGER, S. SHERIDAN.
21	<b>A methodological comparison for stable carbon and nitrogen isotope analysis and applications to diet reconstruction.</b> M. SNEAD, M. MIKULSKI, M. SCHIRTZINGER, L. GREGORICKA, J. ULLINGER, S. GUISE SHERIDAN.
22	<b>Stable isotope analysis of human bones from Roman Ephesus (Turkey, 2<sup>nd</sup> and 3<sup>rd</sup> ct. AD).</b> S. LÖSCH, N. MOGHADDAM, K. GROSSSCHMIDT, D.U. RISSER, F. KANZ.
23	<b>Neolithic transition in central and south-eastern Italy: An isotopic approach.</b> G. SCORRANO, R. LELLI, F. DE ANGELIS, G. BIONDI, M. BRILLI, M. CALATTINI, C. CONATI BARBARO, O.E. CRAIG, M. GORGOGNONE, A. MANFREDINI, C. MARTÍNEZ-LABARGA, F. RADINA, M. ROLFO, M. SILVESTRINI, C. TOZZI, O. RICKARDS.
24	<b>Human dietary reconstruction from stable carbon and nitrogen isotope analysis in Anglo-Saxon England.</b> C.A. DETER, P. MAHONEY.
25	<b>A death in the borderlands: Oxygen isotope evidence for mobility from a Pithos Burial at Oğlanqala, Azerbaijan.</b> S.E. NUGENT.
26	<b>Water isotopes of Ontario: Investigating the applications of hydrogen and oxygen isotopes as geographical indicators.</b> M.L. MANT, A.N. NAGEL, H. POINAR, T. PROWSE, M. KNYF.

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**Session 46: FUNCTIONAL MORPHOLOGY: Locomotion.***Contributed Poster Presentations.* Chair: Patricia Kramer. *Clinch Concourse.*

7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Comparing forelimb skeletal anatomy in gray squirrels and primates.</b> S.A. GREEN, H. PONTZER.
2	<b>Scaling of forearm muscle architecture in primates.</b> A. HARTSTONE-ROSE, K.L. ALLEN, K.E. MACNEILL, K.M. REILLY, D. MARCHI.
3	<b>The comparative and functional anatomy of the forelimb musculature of Humboldt's woolly monkey (<i>Lagothrix lagotricha</i>).</b> L. HAYS, V. WHEELER, M. MUCHLINSKI, J. ORGAN, S. ABSHIRE, T. BUTTERFIELD, A. DEANE.
4	<b>Three-dimensional moment arms and architecture of chimpanzee (<i>Pan troglodytes</i>) leg musculature.</b> N. HOLOWKA, M.C. O'NEILL.
5	<b>Hand postures during vertical clinging and grasping: Implications for digit length in primates.</b> L.E. JOHNSON, D. SCHMITT.
6	<b>Cross-sectional geometry of chimpanzee finger bones.</b> I.J. WALLACE, B.A. PATEL.
7	<b>Preliminary investigation of forelimb use among cercopithecoid primates in Côte d'Ivoire's Tai Forest.</b> E.E. KANE, E.A. BITTY, D. DAEGLING, W.S. MCGRAW.
8	<b>Exploring the influence of suspension on ulna articular surface shape in anthropoid primates.</b> T.R. REIN, K. HARVATI.
9	<b>Clavicular curvature and locomotion in anthropoid primates: A 3-D geometric morphometric analysis.</b> N. SQUYRES.
10	<b>Fiber type composition of spinal extensors is geared toward facilitating rapid spinal extension in the leaper, <i>Galago senegalensis</i>.</b> E. HUQ, A.B. TAYLOR, C.E. WALL.
11	<b>The relative effects of locomotion and posture on vertebral scaling.</b> M. CARTMILL, K. BROWN.
12	<b>Extensive convergence between giant panda and hominoid vertebral formulae.</b> L.A. PETRULLO, M.R. SHATTUCK, S.A. WILLIAMS.
13	<b>Segment-specific analysis of prehensile tail use and morphology in <i>Cebus capucinus</i> and <i>Alouatta palliata</i>.</b> A.C. NISHIMURA.
14	<b>A preliminary quantitative comparison of the internal trabecular architecture of the ilia of chimpanzees and orangutans by high-resolution x-ray computed tomography (HRXCT).</b> D. SHAPIRO.
15	<b>The bicondylar angle in modern humans and its relationship to joint stresses and locomotor economy.</b> M.R. DARR, H. PONTZER, A. WARRENER.
16	<b>Lower limb joint mechanics in men and women.</b> A.G. WARRENER.
17	<b>Predicting impact stiffness and rate of loading during human walking and heel-strike running.</b> B.J. ADDISON, D.E. LIEBERMAN.
18	<b>Size or sex—which is more important for determining optimal velocity?</b> P.A. KRAMER, S.G. LAUTZENHEISER, M. OUCHIDA.
19	<b>The effect of burden, velocity and gradient on the energetic expenditure of walking in females.</b> J. EYRE, S. VIJGEN, P.A. KRAMER.
20	<b>Effects of bipedal infant-carrying on thoracic and pelvic rotations in walking gait.</b> K.E. JELENC, K.K. WHITCOME.
21	<b>Costly courtship: The energetic burden of walking together.</b> J.M. WAGNILD, C.M. WALL-SCHEFFLER.
22	<b>Complications in cross-species comparisons of joint kinematics: An example from the primate foot.</b> T.M. GREINER.
23	<b>Does footwear change energy expenditure? Application to understanding the energetics of extinct bipeds.</b> S.G. LAUTZENHEISER, P.A. KRAMER.
24	<b>The effect of the achilles tendon on trabecular structure in the primate calcaneus.</b> S. KUO, M.J. DEVLIN, J.M. DESILVA.
25	<b>Locomotor diversity and midfoot mobility in gorillas.</b> C. PRANG, M.W. TOCHERI.
26	<b>Skeletal correlates of climbing behavior in the ankles of rainforest hunter-gatherers.</b> T.S. KRAFT, V.V. VENKATARAMAN, J.M. DESILVA, N.J. DOMINY.
27	<b>The A.L. 333-160 fourth metatarsal from Hadar compared to that of humans, great apes, baboons and proboscis monkeys: Non-evidence for pedal arches or obligate bipedality in Hadar hominins.</b> J. MELDRUM, P.J. MITCHELL, E.E. SARMIENTO.
28	<b>Scaling patterns of talar articular surfaces within Euarchonta.</b> G.S. YAPUNCICH, D.M. BOYER.
29	<b>Human walking and developmental bone morphology: An integrated functional perspective.</b> T.M. RYAN, D.A. RAICHLEN, Z.R. HUBBELL, S.M. SUKHDEO, J.H. GOSMAN.
30	<b>Postnatal growth of the long bones in the African apes.</b> A. GALLAGHER.
31	<b>The effects of locomotor category on the ontogeny of skeletal robusticity in two strepsirrhine species.</b> C.J. PAYETTE, T. PATEL, S.M. TOMMASINI, L.E. COPEs, R. BERNSTEIN.

- 32 **Changes in long bone strength correspond to shifts in locomotor behavior during development in chimpanzees (*Pan troglodytes*).** L.A. SARRINGHAUS.
- 33 **Locomotor anatomy of gray langurs (*Semnopithecus entellus*).** C.E. UNDERWOOD, D.R. BOLTER, A.L. ZIHLMAN.
- 34 **Strategies in below branch locomotion in non-specialized quadrupeds.** P.K. WOOLDRIDGE, M.C. GRANATOSKY, D. SCHMITT, C.E. MILLER.
- 35 **Locomotor anatomy of patas monkeys (*Erythrocebus patas*).** A. ZIHLMAN, C. UNDERWOOD.

**Session 47: SKELETAL BIOLOGY AND FORENSIC ANTHROPOLOGY: Cranial Variation, Ancestry, Ecogeography, Sex and Size.**

**Contributed Poster Presentations.** Chairs: Heather Garvin and Sabrina Sholts. *Clinch Concourse.*  
7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

- 1 **Craniofacial variation I: Within-population Procrustes analysis in a sample of Armed Services personnel.** C.J. BERKLEY, B. CORNER, D.E. SLICE.
- 2 **Craniofacial variation II: Head shape prediction from anthropometric measurement and ancestry.** K.J. SODA, B.D. CORNER, D.E. SLICE.
- 3 **Craniofacial variation III: Efficient, landmark-free superimposition of head surface scans.** B.J. POMIDOR, B. CORNER, D.E. SLICE.
- 4 **Craniofacial variation IV: Visualization of surface variation derived from whole head scans.** D.K. STOYANOVA, B. CORNER, D.E. SLICE.
- 5 **The reality of virtual anthropology: Testing the utility of computer generated models for the quantitative assessment of the cranium.** A.D. WHEAT, B.F. ALGEE-HEWITT.
- 6 **Covariance patterns in the human skull: A phylogenetic approach to the structure of human cranial variation.** D.V. BERNARDO, W.A. NEVES, T.F. ALMEIDA.
- 7 **Modularity and integration in the human cranial vault.** T.S. YUZWA, S.D. OUSLEY.
- 8 **Shape analysis of the human zygomatic bone – Data evaluation.** A. RÜDELL, S. SCHLAGER.
- 9 **Shape analysis of the human zygomatic bone - Surface registration.** S. SCHLAGER, A. RÜDELL.
- 10 **Craniofacial changes between children with otitis media with effusion and control.** A.P. CULLEN DOYLE, J. SWATRZ, M.L. CASSELBRANT, W.J. DOYLE.
- 11 **The relationship between dental crowding and cephalometric measurements in contemporary New Mexicans.** S.R. DANESHVARI, H.J. EDGAR.
- 12 **Association between gonial angle and mandibular torus.** K. COSCUNA, A. MARTINETTI.
- 13 **Investigating the relationship between mandibular skeletal form and Stafne’s defect using geometric morphometrics.** S.B. SHOLTS, S. WÄRMLÄNDER.
- 14 **Investigating sexual dimorphism of the mandible using 3D geometric morphometrics.** K.A. HAUTHER, B. DUDZIK.
- 15 **Sexual dimorphism in the hyoid of recent human populations: A functional morphometric approach.** M.K. BLUME, T.D. WEAVER.
- 16 **The lateral angle and cranial base sexual dimorphism: A morphometric evaluation.** N. LYNNERUP, M. DUQUESNEL.
- 17 **Morphological variation of modern human browridges.** H.M. GARVIN.
- 18 **Human craniometric sexual dimorphism and Rensch’s Rule.** D.L. MESSER, S.D. OUSLEY, P. TUAMSUK.
- 19 **Quantifying sexual dimorphism in the cranium: A preliminary analysis of a novel method.** A.M. CASADO.
- 20 **Sexual dimorphism in human skull: The effect of size correction.** T.F. ALMEIDA, D.V. BERNARDO, M. INGLEZ, W.A. NEVES.
- 21 **Non-metric cranial and pelvic traits as a measure of sexual dimorphism in a modern South African population.** K.E. STULL, M.W. KENYHERCZ, E.N. L’ABBÉ.
- 22 **Variation by variation: Differences in sexual dimorphism of the skull between African-Americans and European-Americans.** A.G. KITTOE.
- 23 **Sexual dimorphism and health in prehistoric Thailand.** A.L. CLARK, N. TAYLES, S.E. HALCROW.
- 24 **Regional variation in sexual dimorphism among African and Diaspora populations.** A.L. HUMPHRIES, M.L. TISE, E.H. KIMMERLE.
- 25 **Pelvic and appendicular skeletal variability in humans.** H.K. KURKI.
- 26 **Trunk modularity in recent human populations: A preliminary look at rib and pelvis covariation.** E.R. MIDDLETON.
- 27 **Environmental plasticity of intralimb indices.** E.E. POWELL, M.H. ROTH, H.M. GARVIN.

28	<b>Ecogeographic patterning in maxillary sinus form among modern humans.</b> L.N. BUTARIC.
29	<b>Form variation in human long bone joints: A comparative geometric morphometric analysis of variation in the knee and elbow.</b> S.D. STEVENS, U.S. VIDARSDOTTIR.
30	<b>Variability in bone length and proportions of the arm and hand.</b> K.R. RECTENWALD.
31	<b>Introducing new variables into morphometric body mass reconstruction.</b> C.W. RAINWATER, E.R. MIDDLETON.
32	<b>Secular changes in robusticity of limb bones in Americans.</b> A.K. STROMQUIST, S.D. OUSLEY.
33	<b>Going out on a limb: Does obesity have a systemic effect on limb bone morphology?</b> N.M. REEVES.
34	<b>Secular change in the knee joint and the effects of obesity.</b> K.I. HARRINGTON, D.J. WESCOTT.
35	<b>Secular change in the length and breadth of the bones of the upper limb.</b> A.C. SMITH.
36	<b>The influence of body mass on humeral strength: An ontogenetic perspective.</b> C.L. GIROUX, L.W. COWGILL.
37	<b>Does height matter? Evaluating the need for height specific stature estimation equations.</b> X.D. LAUCH.
38	<b>Comparative study of metric sexing software using the os coxa.</b> B. MCMULLAN.
39	<b>The subpubic angle: A new method for assessing sex in a single os-coxa.</b> K. MCGUIRE.
40	<b>Sex estimation of juvenile human crania using 3D assessment of craniofacial architecture.</b> M.K. STOCK, D. REYNOLDS, A.J. MASTERS, T.G. BROMAGE.
41	<b>Sex determination by discriminant function analysis of lumbar vertebrae.</b> K.R. OSTROFSKY, S.E. CHURCHILL.
42	<b>Current practices in physical anthropology for sex estimation in unidentified, adult individuals.</b> A.R. KLALES.
43	<b>The determination of sex and ancestry of patellae and calcanei from the Hamann-Todd Anatomical Collection.</b> P.S. URDZIK.
44	<b>Ancestral estimation using E.A. Marino's analysis of the first cervical vertebra applied to three modern ethnic groups.</b> V.M. SWENSON.
45	<b>Variation in nonmetric traits of the pelvis between population groups.</b> G.T. LAVALLO, K.M. SPRADLEY.
46	<b>Is dental metric variation more sensitive to differences among regional populations than dental morphology? A case study from coastal Kenya.</b> A.R. HUBBARD.
47	<b>Applying statistical classification methodologies to morphological dental trait data in forensic studies.</b> F. CANDILIO, L. BONDIOLI, A. CUCINA, M. LUCCI, A. COPPA.
48	<b>Dental morphological analysis of Roman-Era burials from the Dakhleh Oasis, Egypt.</b> S.D. HADDOW.
49	<b>A world apart: Dental variation and the New York African Burial Ground.</b> A.T. MAYES, L. RANKIN-HILL, M. BLAKEY.
50	<b>Are socioethnic groups biologically meaningful entities? A tooth size allocation analysis of the Baltis of northern Pakistan.</b> M. GUZMAN, B.E. HEMPHILL.
51	<b>Using admixture mapping to identify genetic linkages with variation in human facial shape.</b> D.K. LIBERTON, P. CLAES, S. BELEZA, G. BARSH, H. TANG, M.D. SHRIVER.
52	<b>Assessing the forensic utility of the zygomaxillary suture in ancestry estimation.</b> A.N. SPORLEDER, C.E. BURNS, S.D. MADDUX.
53	<b>Determination of ancestry in historical skeletal populations: Two case studies from French colonial sites in the U.S.</b> H. GUZIK, M. DANFORTH, D.N. COOK, T. CARGILL.
54	<b>Cranial variation among three regional groups in Mexico.</b> C. FIGUEROA-SOTO, M. SPRADLEY.
55	<b>Are there 40 kinds of Hispanics in New Mexico?</b> H.J. EDGAR, S. BLOOM, K. RUSK, M. HEALY, C. MOSLEY, K.L. HUNLEY, T. LANE.
56	<b>Forensic anthropometry: Reconstructing body dimensions of partially hidden persons in CCTV surveillance images.</b> T. SCOLERI, M. HENNEBERG.
57	<b>Determination of body surface area from a whole-body CT scan.</b> C. PRIMEAU, C. VILLA, H. HOUGEN, N. LYNNERUP, B. HESSE.

**Session 48: PRIMATE DENTITIONS, DIETS AND GROWTH.**

*Contributed Poster Presentations.* Chair: Mary Kelaita. *Park Concourse.*  
7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>A tooth atlas for the developing dentition of <i>Hylobates lar</i> based on radiography and histology.</b> W. DIRKS, A.P. BARROS, C. DEAN.
2	<b>Pace of dental eruption and epiphyseal fusion in captive <i>Macaca mulatta</i>.</b> A.R. ELLER, S. BUCKLEY, T. EDWARDS, S.R. FROST, F.J. WHITE.

3	<b>Pattern differences in the resorption and exfoliation of deciduous teeth between captive and wild <i>Pan troglodytes</i>.</b> E.E. HAMMERL.
4	<b>Molar development and life history in four macaque species.</b> N. TANG, A. KATO, K. HINDE, E. MILLER, T.M. SMITH.
5	<b>Molar enamel thickness in four macaque species.</b> A. KATO, N. TANG, A.M. PAPAKYRIKOS, K. HINDE, E. MILLER, Y. KUNIMATSU, E. HIRASAKI, D. SHIMIZU, T.M. SMITH.
6	<b>Stable isotope time-series in teeth: Targeting the innermost enamel layer.</b> S.A. BLUMENTHAL, K.L. CHRITZ, T.E. CERLING, T.G. BROMAGE, R. KOZDON, J.W. VALLEY.
7	<b>Dietary variability yields novel dental microwear textures for geladas.</b> A.E. SHAPIRO, V.V. VENKATARAMAN, P.J. FASHING, N. NGUYEN.
8	<b>Molar wear in a wild population of known-age mountain gorillas from Volcanoes National Park, Rwanda.</b> H. GLOWACKA, K.K. CATLETT, G.T. SCHWARTZ, A. MUDAKIKWA, T.G. BROMAGE, M.R. CRANFIELD, K.A. FAWCETT, S.C. MCFARLIN.
9	<b>Preliminary examination of buccal dental microtexture in primates.</b> A. ALIAGA, A. ROMERO, J. GALBANY, A. PÉREZ-PÉREZ.
10	<b>Anterior dental microwear in sympatric <i>Callicebus brunneus</i> and <i>Ateles marginatus</i>.</b> L.K. DELEZENE, M.F. TEAFORD, P.S. UNGAR.
11	<b>A new method for assessing dietary differences using interproximal tooth wear analysis.</b> A.L. WARREN.
12	<b>Revisiting incisor allometry and diet (again): New 2D and 3D approaches to an old question.</b> A.S. DEANE, M. JUSMA.
13	<b>Dental metric variation in two species of howler monkeys and their hybrids.</b> M.A. KELAITA, P.A. DIAS, L. CORTES-ORTIZ.
14	<b>Modularity and shape variation of upper P4-M1 teeth in modern humans.</b> A. ROMERO, S. TORRIJO, J. GALBANY, F.V. RAMÍREZ-ROZZI, J. DE JUAN, A. PÉREZ-PÉREZ.
15	<b>Morphological integration of the maxillary dentition and the cranium in hominoids.</b> A. NESBITT, K.L. BAAB.
16	<b>A geometric morphometric analysis of lower deciduous first molars and their succedaneous dentition.</b> K. ZEJDLIK.
17	<b>A survey of the frequency of supernumerary teeth in non-human hominids.</b> T.L. CAMPBELL.

#### Session 49: PRIMATOLOGY: Feeding, Predation and Ranging.

**Contributed Poster Presentations.** Chair: Michelle Bezanson. **Park Concourse.**  
7:30-8:00 am Poster set-up. 4:00-4:30 pm Poster take-down.

Even numbered poster authors present for discussion - 10:00-10:30 am and 2:00-2:30 pm

Odd numbered poster authors present for discussion - 10:30-11:00 am and 2:30-3:00 pm

1	<b>Dominance rank and exposure to predators in wild Blue monkeys (<i>Cercopithecus mitis stuhlmanni</i>).</b> D. WESTPHAL, C. MUTAI, M. CORDS.
2	<b>The dual role of vigilance behavior in tufted capuchin monkeys.</b> V.M. MULE, C.J. SCARRY.
3	<b>Effects of predator presence on the behavior of bald-faced saki monkeys (<i>Pithecia irrorata</i>) in the Peruvian Amazon.</b> D.B. ADAMS, D.M. KITCHEN, A. HURST.
4	<b>Introduced mammal predation of wild lemurs at Beza Mahafaly Special Reserve, Southwestern Madagascar: An assessment of predator scat samples.</b> M.J. STRINDEN, M.L. SAUTHER, F.P. CUOZZO, J.I. YOUSOUF.
5	<b>Forest meat consumption in rural northeastern Madagascar: Its extent, incentives, and impact on local lemur and human populations.</b> C. BORGERSON, L.R. GODFREY.
6	<b>Competition for woodland and forest resources between humans and nonhuman primates in Tana River, Kenya.</b> J. WIECZKOWSKI, L. ALLEN, D.N. MBORA.
7	<b>Spatial position in feeding trees and its relationship to nutritional quality in wild howler monkeys (<i>Alouatta palliata</i>).</b> C.H. LIPROT, J.M. ROTHMAN, E.R. VOGEL.
8	<b>Feeding ecology of Gray's bald-faced saki monkey (<i>Pithecia irrorata</i>) during a single dry season in southeastern Perú.</b> A.L. HURST, J.E. LAMBERT, D.B. ADAMS.
9	<b>Resource use by yellow-tailed woolly monkeys in disturbed and undisturbed forests.</b> F.M. CORNEJO, M. CHOCCE, N. VEGA, C. TELLO.
10	<b>Local-level habitat differences and patterns of feeding ecology in groups of <i>Propithecus coquereli</i>, NW Madagascar.</b> K.C. MCGOOGAN, S.M. LEHMAN.
11	<b>Nitrogen limitation in Bornean orangutans in a peat swamp habitat.</b> E.F. BALLARE, C. KNOTT, E.R. VOGEL.
12	<b>Diet composition of savanna chimpanzees at Toro-Semliki Wildlife Reserve, Uganda.</b> C. DEIMEL, M. HIRSCHAUER, K.D. HUNT.
13	<b>The role of the hunter: Stable isotope evidence of hunting in adult male chimpanzees.</b> G.E. FAHY, M.P. RICHARDS, J. RIEDEL, J. HUBLIN, C. BOESCH.

- 14 **Patterns of ant-fishing for carpenter ants (*Camponotus* spp.) by Gombe and Mahale chimpanzees.** R.C. O'MALLEY, H. NISHIE.
- 15 **Seasonal intake of polyphenols and cellulose in two wild lemur populations (*Lemur catta* and *Propithecus verreauxi*).** A. FOGEL, J. WILLIAMS, N. YAMASHITA.
- 16 **It's all in the wrist: Manipulative dexterity in white-handed gibbons (*Hylobates lar*).** J.M. PRIME.
- 17 **Assessing site specific changes in endocranial shape associated with frugivory in primates.** D.R. HURST, P. SCHOENEMANN, B.B. AVANTS, J.C. GEE.
- 18 **Ingestive behavior of the red (*Procolobus badius*) and black and white (*Colobus polykomos*) colobus monkeys in the Taï Forest, Côte d'Ivoire.** B.R. BURROWS, W.S. MCGRAW, D. BERTIN, F. OURO, D.J. DAEGLING.
- 19 **Prepping for pregnancy: Energy balance, hormone production and diet quality during preception in Sanje mangabeys (*Cercocebus sanjei*).** G.M. MCCABE, D. FERNÁNDEZ.
- 21 **Microbial adaptations facilitate non-ruminant *Theropithecus gelada* grazing behavior in northern Ethiopia.** G.A. BRITTON, C.J. YEOMAN, P.J. FASHING, N. NGUYEN, L. SWEDDELL, B.A. WHITE, B.A. WILSON, R.M. STUMPF, K.E. NELSON, M. TORRALBA, M. GILLIS, S.R. LEIGH, N. DOMINY.
- 22 **Roundworms on the Red Island: Gastrointestinal parasite intensity in four lemur species from the Tsinjoarivo region, Madagascar.** K.L. ALLDREDGE, M.T. IRWIN, L.R. GODFREY.
- 23 **Cross-species parasite patterns: Pinworm prevalence in captive lemurs.** I.A. SCHNEIDER-CREASE, R. SCHOPLER, L.J. DIGBY.
- 24 **Do capuchins change the forest through the trees? C.** ZIPPER, E. PHILLIPS, A.M. THOM, S.M. WATTS, M. BEZANSON.
- 25 **How many points does it take to determine a home range? A meta-analysis of home range calculation methods from GPS collar data.** A.R. KLEGARTH, A. FUENTES, H. HOLLOCHER.
- 26 **GIS analysis of the ranging behaviors of red-capped mangabeys (*Cercocebus torquatus*) from Sette Cama, Gabon.** C.A. COOKE, R. MOUSSOPO.
- 27 **Ranging patterns of solitary floater owl monkeys.** M. CORLEY, A. SAVAGIAN, M. ROTUNDO, E. FERNANDEZ-DUQUE.
- 28 **Edge effects on body mass and habitat use in two sympatric species of mouse lemurs in a Madagascan tropical dry forest.** R.J. BURKE, S.M. LEHMAN.
- 29 **Living on the edge: Patterns of habitat use in *Saguinus midas*.** M.J. VERES.
- 30 **Seasonal variation in group movement patterns in the Sanje mangabey (*Cercocebus sanjei*), Udzungwa Mountains National Park, Tanzania.** E.K. LLOYD, C.L. EHARDT.
- 31 **Habitat preferences and population assessment of *Microcebus murinus* in the remaining transitional littoral forest of Petriky, South-East Madagascar.** M.M. MALONE, G. DONATI.
- 32 **Sleep site selection of proboscis monkeys (*Nasalis larvatus*) in West Kalimantan, Indonesia.** K.L. FEILEN, A.J. MARSHALL.
- 33 **Differences in owl monkeys (*Aotus* spp.): An examination of nesting site preference and behavioral budgets in three species of captive *Aotus*.** L. CASE, K. GRAHAM.
- 34 **Living together in the night: Abundance and habitat use of sympatric and allopatric populations of slow lorises and tarsiers (*Nycticebus* and *Tarsius*).** R.A. MUNDS, K. NEKARIS, V. NIJMAN, B. GOOSSENS.
- 35 **Densities, distribution and detectability of a small nocturnal primate (Javan slow loris *Nycticebus javanicus*) in a montane rainforest.** V. NIJMAN, J.A. PAMBUDI, D. ACHMED, K.A. NEKARIS.
- 36 **Predicting subgroup size in a lemur with high fission-fusion dynamics.** S.M. HOLMES, A.D. GORDON, E.E. LOUIS, S.E. JOHNSON.
- 37 **Preliminary evidence suggests that two-male siamang (*Symphalangus syndactylus*) groups at Way Canguk live in larger, higher quality home ranges than monogamous groups.** S. LAPPAN, L. MORINO, M. KINNAIRD, T. O'BRIEN, N. ANDAYANI.
- 38 **When animals disappear: An examination of factors influencing which individuals disappeared from a wild population of lemurs.** R.J. LEWIS.
- 39 **Locomotion of Angolan black and white colobus monkeys (*Colobus angolensis palliatus*) in coastal Kenya's Diani Forest.** N.T. DUNHAM, W. MCGRAW.
- 40 **Locomotor kinematics of two semi-wild macaque species (*Macaca assamensis* and *M. arctoides*) in Thailand: A preliminary report.** E. HIRASAKI, S. MALAIVIJITONOND, Y. HAMADA.

## Saturday. Afternoon sessions.

### Session 50: **Understanding Primate Communities Across Spatial, Temporal and Phylogenetic Scales.** *Invited Podium Symposium.* Organizers: Jason Kamilar, Lydia Beaudrot and Kaye Reed. *Ballroom A.*

Understanding the factors influencing the diversity of primate communities is important for studies of primate evolutionary history, primate behavioral ecology, and the development of conservation strategies. Previous research on primate communities has focused largely on present day communities of primates with less attention given to historical communities, the role of spatial scale in structuring communities, or interactions between primates and other taxa. It has been more than 10 years since a symposium on primate communities has been convened. During this time, there have been important advances in GIS, ecological informatics, macroecology, and phylogenetics, which have enabled scientists to address new questions in community ecology research and have focused attention on the importance of variation in spatial, temporal and phylogenetic scales for structuring communities. This symposium will uniquely include a wide variety of perspectives to understand the diversity of both present and past primate communities across a variety of scales. We will discuss the current state of primate community ecology and paleoecology research, the availability of new methods and data, and future directions in the field. Participants will come from several specialties relevant to primate communities, including behavioral ecology, conservation biology, biogeography, and paleoecology. This will promote valuable discussion among scientists and undoubtedly draw attention to promising directions for synthetic research across subfields.

*Chair: Jason Kamilar*

1:00-1:15	<b>Why study primate communities? The importance for anthropology and ecology, current knowledge, and future directions.</b> J.M. KAMILAR, L. BEAUDROT, K.E. REED.
1:15-1:30	<b>Correlates of dispersal limitation in African mammal communities.</b> L. BEAUDROT, J.M. KAMILAR, K.E. REED.
1:30-1:45	<b>Using spatial structural equation modeling as a novel approach to understanding primate community composition and diversity.</b> K.H. BANNAR-MARTIN.
1:45-2:00	<b>Exploring phylogenetic beta diversity in Neotropical primate assemblages: historical, ecological and neutral processes underlying patterns of nestedness and turnover.</b> M.M. GAVILANEZ, R.D. STEVENS.
2:00-2:15	<b>Evolutionary ecology of pitheciinae communities: Evidence for energetic equivalence or phylogenetically structured environmental variation?</b> S.M. LEHMAN.
2:15-2:30	<b>Feeding niche overlap and differentiation among sympatric vertebrate frugivores at Gunung Palung National Park, West Kalimantan, Indonesia.</b> A.J. MARSHALL.
2:30-2:45	<b>Primates on the menu: Predation as a factor affecting primate communities.</b> L.R. BIDNER.
2:45-3:00	<b>Shifting the focus in primate community ecology: Utilizing patch focals to study unhabituated dry habitat chimpanzees.</b> S.M. RUSSAK.
3:00-3:15	<b>BREAK</b>

*Chair: Kaye Reed*

3:15-3:30	<b>Parasites and primate communities: Amplification and dilution effects.</b> C.L. NUNN, H.S. YOUNG, R.H. GRIFFIN, J. CLARK.
3:30-3:45	<b>African primate, carnivore and ungulate communities exhibit a proclivity toward random phylogenetic structure.</b> K.E. REED, J.M. KAMILAR, L. BEAUDROT.
3:45-4:00	<b>Biogeographic evolution of Madagascar's primate communities: Endemism, elevation, and the fossil record.</b> K.M. MULDOON, L.R. GODFREY.
4:00-4:15	<b>The dietary competitive environment of early Eocene euprimates in North America.</b> L.K. STROIK.
4:15-4:30	<b>Primate paleocommunities in the early Miocene of Africa: Why are apes and monkeys so rarely found together?</b> A. GROSSMAN.
4:30-5:00	<b>DISCUSSANT,</b> JOHN FLEAGLE.

### Session 51: **PRIMATOLOGY: Ecology, Behavior and Flexibility.** *Contributed Podium Presentations.* Chair: Monica Wakefield. *200ABC.*

1:00-1:15	<b>Primate socioecology: Where are we, what are we doing here, and where are we going?</b> A. FUENTES.
1:15-1:30	<b>Individual and group level factors shape the social sphere of individual mountain gorillas (<i>Gorilla b. beringei</i>).</b> D. CAILLAUD, F. NDAGIJIMANA, V. VECCELLIO, T.S. STOINSKI.
1:30-1:45	<b>Weaning in the Virunga mountain gorilla (<i>Gorilla beringei beringei</i>) – factors causing variation in weaned age.</b> W. ECKARDT, A.W. FLETCHER.
1:45-2:00	<b>The function of long calls in western gorillas (<i>Gorilla gorilla</i>): Behavioral flexibility in ape communication.</b> R. SALMI, D.M. DORAN-SHEEHY.

2:00-2:15	<b>Acoustic determination on the dialects of wild chimpanzee (<i>P.t. verus</i>) calls in Sierra Leone.</b> A.R. HALLORAN, C.T. CLOUTIER, T.S. KARIMU, S. MONDE.
2:15-2:30	<b>An investigation of a Shigellosis outbreak in a rhesus macaque population: The importance of rank and status.</b> J.A. IDA, A.V. RUIZ-LAMBIDES, A.S. DIETRICH.
2:30-2:45	<b>Meat transfer among savanna chimpanzees at Fongoli, Senegal: The female perspective.</b> S. LINDSHIELD, J.D. PRUETZ.
2:45-3:00	<b>A cross community comparison of female chimpanzee (<i>Pan troglodytes schweinfurthii</i>) social behavior in Kibale National Park Uganda.</b> M.L. WAKEFIELD, K.D. WILD.
3:00-3:15	<b>BREAK</b>
3:15-3:30	<b>Stress and affiliation in wild black-handed spider monkeys: Do females tend-and-befriend?</b> M.A. RODRIGUES.
3:30-3:45	<b>Impact of early life experience on fitness-relevant demographic outcomes in wild white-faced capuchin (<i>Cebus capucinus</i>) males in Lomas Barbudal, Costa Rica.</b> S.E. PERRY.
3:45-4:00	<b>Hungry, tired, and stressed: Why are lemur females dominant to males?</b> M. LAFLEUR, M. SAUTHER, F. CUOZZO, N. YAMASHITA, R. BENDER.
4:00-4:15	<b>“Top-down” socialization of sex-typed behavioral development in <i>Lemur catta</i>?</b> S.L. MEREDITH.
4:15-4:30	<b>Timing of hibernation bouts in eastern dwarf lemurs.</b> M.B. BLANCO, P.H. KLOPPER.
4:30-4:45	<b>Too hot, too cold, or just right: Thermal challenges facing mantled howling monkeys (<i>Alouatta palliata</i>) in a dry tropical forest.</b> C.L. THOMPSON, S.H. WILLIAMS, K.E. GLANDER, M.F. TEAFORD, C.J. VINYARD.
4:45-5:00	<b>What’s eating <i>Microcebus</i>? Endo- and ectoparasite ecology of <i>Microcebus griseorufus</i> at Beza Mahafaly Special Reserve, Madagascar.</b> I.A. RODRIGUEZ, E. RASOZANABARY, L.R. GODFREY.

### Session 52: HUMAN BIOLOGY.

*Contributed Podium Presentations.* Chair: Julienne Rutherford. *Ballroom B.*

1:00-1:15	<b>Population variation of level 2 detail in dermatoglyphics: A study of heritability and environmental influence.</b> N.A. FOURNIER.
1:15-1:30	<b>Ethnic variation of DNA methylation identified in Leptin’s C/EBP<math>\alpha</math>TFBS.</b> M. MOSHER, H. AL-AZZAWI, R. STÖGER, M. SCHANFIELD.
1:30-1:45	<b>Botanical medicines for diuresis: Cross-cultural comparisons.</b> R.A. HALBERSTEIN.
1:45-2:00	<b>The impact of testosterone fluctuations on competition in women.</b> L.L. BECKER, S. PRALL, E. SHATTUCK, M. MUEHLENBEIN.
2:00-2:15	<b>A sensitivity analysis of the impact of householed consumer-producer ratios on the hazard of out-migration among the Karen.</b> D. PARKER, J. WOOD, S. TOMITA, S. DEWITTE, J. SIRICHAISINTHOP, L. CUI.
2:15-2:30	<b>Changes in selection on height and BMI during the demographic transition: The case of rural Gambia.</b> A. COURTIOL, I.J. RICKARD, V. LUMMAA, A.M. PRENTICE, A.J. FULFORD, S.C. STEARNS.
2:30-2:45	<b>Beyond stress: “Biological Sensitivity to Context” as an evolutionary construct and its implications for psychosocial markers in field research.</b> J.A. DECARO, C.L. BOXMEYER, A. GILPIN, J.E. LOCHMAN, J. PIERUCCI, M. MCINNIS, L. JIMENEZ, M. THOMAS.
2:45-3:00	<b>Phenotypic plasticity in humans: Lessons from the immune system.</b> N. SHORT, K. KEETON, R. FERNANDEZ-BOTRAN, F. CRESPO.
3:00-3:15	<b>BREAK</b>
3:15-3:30	<b>The effect of maternal stress on newborn birth outcome and methylation profiles: Efficiency of RRBS technology in population studies.</b> C.J. MULLIGAN, D.A. HUGHES, N.C. D'ERRICO.
3:30-3:45	<b>Influence of placental characteristics on birth weight and evidence for population differences in placental morphology: A preliminary report from Cebu, Philippines.</b> J.N. RUTHERFORD, V.A. DEMARTELLY, N.R. LEE, D.E. WILDMAN, C.W. KUZAWA.
3:45-4:00	<b>What can we predict from first birth interval?</b> I. NENKO, G. JASIENSKA.
4:00-4:15	<b>The benefits of girlhood in the patriarchy: Natal familial composition, institutional care setting and child health outcomes in Jamaica.</b> R.G. NELSON.
4:15-4:30	<b>Childhood social disadvantage, cardiometabolic risk, and chronic disease in adulthood.</b> A.L. NON, M. REWAK, I. KAWACHI, E. LOUCKS, S. BUKA, L.D. KUBZANSKY.
4:30-4:45	<b>Body frame variation and adiposity in development, a longitudinal study of 'Cape Coloured' children.</b> T.A. LUCAS, M. HENNEBERG.
4:45-5:00	<b>Prevalence of Portuguese preschool obesity and associations with family characteristics and child behaviours.</b> C. PADEZ.

**Session 53: SKELETAL BIOLOGY: Postcranial Function and Biomechanics.***Contributed Podium Presentations.* Chair: Scott Simpson. *Ballroom C.*

1:00-1:15	<b>Bilateral asymmetry of humeral torsion and length in African apes and humans.</b> A.P. BARROS, C. SOLIGO.
1:15-1:30	<b>Skeletal estimates of upper limb effective mechanical advantage do not predict joint strength or speed in living humans.</b> J.M. MAKI.
1:30-1:45	<b>The biomechanics of power generation during human high-speed throwing.</b> N.T. ROACH, D.E. LIEBERMAN.
1:45-2:00	<b>Differentiation of bone functional adaptations in the forelimb and hind limb.</b> K.J. CARLSON, I.J. WALLACE, S. JUDEX.
2:00-2:15	<b>Why do knuckle-walking African apes knuckle-walk?</b> S.W. SIMPSON, C.O. LOVEJOY, B. LATIMER.
2:15-2:30	<b>Gait mechanics of inverted walking: Implications for the evolution of suspensory locomotion.</b> M.C. GRANATOSKY, D. SCHMITT.
2:30-2:45	<b>Activity and functions of the human gluteal muscles in walking, running, sprinting and climbing.</b> J.L. BARTLETT, B.J. SUMNER, R.G. ELLIS, R. KRAM.
2:45-3:00	<b>Stance and swing phase joint mechanics in chimpanzee bipedal walking.</b> M.C. O'NEILL, L. LEE, B. DEMES, N. THOMPSON, S.G. LARSON, J.T. STERN, JR., B.R. UMBERGER.
3:00-3:15	<b><i>BREAK</i></b>
3:15-3:30	<b>Locomotor ontogeny and limb bone length and strength proportions in mountain and lowland gorillas.</b> M.L. BURGESS, C.B. RUFF, S.C. MCFARLIN, A. MUDAKIKIWA.
3:30-3:45	<b>Femoral morphology and evolution of hominoid locomotion: Insight from fetuses of humans and great apes.</b> N. MORIMOTO, C. ZÖLLIKOFER, M. PONCE DE LEÓN.
3:45-4:00	<b>Activity type and level influence growth rate, remodeling, and diaphyseal geometry of cortical bone.</b> K.N. RABEY, D.J. GREEN, D.R. BEGUN, B.G. RICHMOND, S.C. MCFARLIN.
4:00-4:15	<b>Ontogenetic changes in the human tibial and femoral diaphyses: Mechanobiological analysis of cortical shape from a whole-bone perspective.</b> Z.R. HUBBELL, J.H. GOSMAN, C.N. SHAW, T.M. RYAN.
4:15-4:30	<b>Ontogeny of bipedalism: Changes in the location and direction of the ground reaction force in toddlers.</b> A. ZEININGER.
4:30-4:45	<b>Relationship between foot proportions and gait performance in modern bipeds.</b> K.K. WHITCOME, R.E. DYER, E.E. MILLER.
4:45-5:00	<b>Effects of limb proportions on sloped terrain locomotion.</b> R.W. HIGGINS.

**Session 54: Bone to Be Wild: An Invited Session in Honor of George J. Armelagos' Career and Mentorship.***Invited Poster Symposium.* Organizers: Molly Zuckerman and Debra Martin. *200DE.*

George Armelagos's research has delved into several of the most profound theoretical and practical issues in physical anthropology: the health impacts of the Neolithic transition, the fallacy of the biological race concept, the origins of syphilis, the great human epidemiological transitions, the utility of evolutionary approaches to studying human variation, ancient diseases, and food choice, diet, and nutrition. He has also played a central role in the establishment and development of bioarchaeology, now a highly influential and interdisciplinary field within anthropology. His scholarly accomplishments are surpassed only by his commitment to mentorship and collaboration. In that spirit, this symposium brings together research from his several generations of grad students as well as others who trained under him. The posters reflect the interdisciplinary and biocultural frameworks that he pioneered, and the cross- and inter-generational collaborations that he fostered.

12:00- 1:00 pm Poster set-up. 4:30- 5:00 pm Poster take-down.

Even numbered poster authors present for discussion - 2:00-2:30 pm

Odd numbered poster authors present for discussion - 2:30-3:00 pm

1	<b>Life and death in 19<sup>th</sup> century Peoria, Illinois: Taking a biocultural approach towards understanding the past.</b> A.L. GRAUER, L.A. WILLIAMS, M.C. BIRD.
2	<b>Reflections on an education in Biocultural Anthropology at Emory University.</b> T.G. SCHURR.
3	<b>George Armelagos and changing idea about the realities of race, human variation, and racism.</b> A.H. GOODMAN, M. BLAKEY, J.L. JONES.
4	<b>Achieving synthesis: New York's African Burial Ground and the influences of George J. Armelagos.</b> M.L. BLAKEY, L.M. RANKIN-HILL.
5	<b>Searching for the invisible people in the African Diaspora: Biocultural perspectives.</b> L.M. RANKIN-HILL.
6	<b>George Armelagos and four-field Anthropology: A force against future fission of the discipline.</b> P.J. BROWN.
7	<b>Moving beyond genetic race: Developmental contributions to human variation in New Zealand.</b> Z.M. THAYER, C.W. KUZAWA.

8	<b>Evolution, ecology and political economy: Biocultural perspectives on nutrition and disease in the works of George Armelagos.</b> T. LEATHERMAN, A. GOODMAN, B. THOMAS.
9	<b>Taking a closer look at the institutionalized: The late 19th century Colorado Insane Asylum.</b> A.L. MAGENNIS.
10	<b>Excavating method, theory and data with George: Bringing together bioarchaeology and social theory.</b> D.L. MARTIN.
11	<b>Disease dynamics in Åland, Finland - 1750 to 1950.</b> J. MIELKE.
12	<b>A bioarchaeological legacy: The academic family tree of George Armelagos.</b> V.R. PÉREZ, H. BAUER-CLAPP.
13	<b>Orthodontist needed! Crooked teeth at the New Kingdom site of Amarna, Egypt.</b> J.C. ROSE, K. BRAICH, K.E. STILES.
14	<b>Were calories really a problem for the Classic Maya of Copan and K'axob? Evidence from paleopathological indicators.</b> R. STOREY.
15	<b>Explorations in paleodemography: An overview of the artificial Anasazi agent-based modeling project, with new observations on demographic estimation.</b> A.C. SWEDLUND, L. SATTENSPIEL, R.S. MEINDL, G.J. GUMERMAN.
16	<b>"From man's sweat and God's love, beer came into the world": The significance of beer and brewing in reconstructing the health and nutrition of ancient agriculturalists.</b> B.L. TURNER, M.J. LIVERMORE.
17	<b>The biological impact of cultural transformations and economic differences in ancient Nubia.</b> D.P. VAN GERVEN, P.A. SANDBERG, G. ARMELAGOS.
18	<b>Stable isotopes and the three evolutionary forces in Biomedical Anthropology.</b> C.D. WHITE, F.J. LONGSTAFFE.
19	<b>The people behind the pox: Paleoepidemiological approaches to treponemal disease.</b> M.K. ZUCKERMAN, K.N. HARPER.
20	<b>Food for thought: The contributions of George Armelagos to food and culture studies.</b> R.J. WIDMER.
21	<b>Reconstructing early-life lead exposure and biocultural beginnings: The Armelagos Effect in African diasporic bioarchaeology.</b> J.L. JONES, A.H. GOODMAN, D. AMARASIRIWARDENA, M.L. BLAKEY, M.E. MACK.

**Session 55: CEMENTOCHRONOLOGY.**

**Contributed Poster Presentations.** Chairs: Stephan Naji, Thomas Colard and Benoit Bertrand. **301D.**

**12:00- 1:00 pm** Poster set-up. **4:30- 5:00 pm** Poster take-down.

**2:00-2:30 pm** All authors will be present for discussion.

1	<b>Cementochronology, to cut or not to cut?</b> S. NAJI, T. COLARD, B. BERTRAND, E. D'INCAU, L. LANTERI, E. BRANDT, J. BLONDIAUX.
2	<b>Cementochronology: A test of accuracy by age groups on a reference population.</b> T. COLARD, B. BERTRAND, S. NAJI, A. DEBROUCKER, P. MARCHANDISE, J. BLONDIAUX.
3	<b>Microstep by microstep across dental cementum - Microanalysis of the alternating yearly deposits.</b> B. BERTRAND, T. COLARD, S. NAJI, P. MARCHANDISE, L. GEANT, G. FALGAYRAC.
4	<b>Age-at-death estimation of pathological individuals. A complementary approach using teeth cementum annulations.</b> G. ROBBINS SCHUG, B. BERTRAND, T. COLARD, S. NAJI, C. POLET.
5	<b>Adult individual age, reliability of estimation using cementochronology.</b> C. RUCKER.
6	<b>Cementochronology (TCA) - Evaluation of a semi-automated counting software.</b> M. KUENZIE.
7	<b>Testing inter-teeth variability in adult individual age-at-death estimate using cementochronology (TCA).</b> L. LANTERI, A. SCHMITT, B. FOTI, S. NAJI.
8	<b>Functional morphology of the human dentition and its probable influence on tooth cementum thickness and incremental line count.</b> G. GRUPE, A. LIPPITSCH.
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## ABSTRACTS - AAPA PRESENTATIONS

### Crossing disciplines to challenge the adaptationist paradigm.

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In the wake of the Modern Synthesis, Sherwood Washburn's appeal for a new physical anthropology explicitly called for a shift towards a process-oriented view of evolution. Like others at the time, Washburn overwhelmingly emphasized the role that selection plays in shaping diversity, and biological anthropologists soon began to embrace the idea of interpreting human variation and evolution in terms of underlying selective processes. Today, explanations for phenotypic variation in human evolution remain largely functional/adaptive, despite the strong challenges to the adaptationist paradigm mounted outside of biological anthropology in the past few decades. In this paper, I will discuss our current understanding of the important role that random genetic drift and gene flow have played in shaping phenotypic diversity in hominins. This fuller understanding of the underlying processes responsible for variation has necessitated engaging with other disciplines (e.g. evolutionary biology, quantitative genetics). We have much to gain from modifying the methodological approaches and theoretical developments within those disciplines to our own ends, including a more sophisticated interpretation of the fossil record. As one example, the emerging genomic evidence for gene flow among archaic human populations (e.g. Neanderthals, Denisovans) might have been less surprising (to those for whom it was a surprise) were it not for methodological approaches couched within a lingering adaptationist perspective that has failed to provide a sufficiently nuanced understanding of the evolutionary prevalence and phenotypic consequences of the 'other' evolutionary forces. *Research funded by the National Research Foundation of South Africa and the University of Cape Town.*

### Effects of predator presence on the behavior of bald-faced saki monkeys (*Pithecia irrorata*) in the Peruvian Amazon.

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Predation is an important selective pressure on prey populations but its influence on primate evolution remains hotly debated. While some researchers argue predation has little effect on group-living in primates, others maintain that constant threats of death strongly impact behavior. Here, we explore the effects of predator presence on saki monkey (*Pithecia irrorata*) behavior. We hypothesized that saki monkey behavior would differ in high and low use predator areas.

Data were collected from June to July 2012 at Centro de Investigación y Capacitación

Río Los Amigos in Peru. Over 78 hours of scan and focal sampling were collected on 8 saki monkeys. During 10-minute focal follows, we recorded activity, canopy height, intragroup spacing, vigilance, and number of alarm calls emitted. To determine high and low use predator areas, we conducted a 30-day camera trap survey within the focal group's home range.

During 30 trap nights, we documented four felid species (jaguar, puma, ocelot, and margay) on 11 separate occasions. Camera trap data indicates a pattern of higher predator densities within parts of the sakis' home range. Analyses of behavioral data suggest that sakis maintain closer associations and engage in less rest and social behavior in high predator areas (Chi-square:  $P < 0.05$ ). However, alarm calling and canopy height are not associated with predator presence (Chi-square:  $P > 0.05$ ). Surprisingly, individuals seem to exhibit less vigilance in high predator areas, which may be related to habitat differences. Our future research will include an assessment of factors such as habitat quality and seasonality on antipredator behavior.

### Predicting impact stiffness and rate of loading during human walking and heel-strike running.

BRIAN J. ADDISON and DANIEL E. LIEBERMAN. Human Evolutionary Biology, Harvard University.

Heel-striking during human walking and running generates impacts beneath the foot. These impacts produce large forces over short time periods and occur millions of times per foot per year. In order to understand how the human body evolved to cope with these repetitive impacts, we must first understand how impact force parameters are generated beneath the foot in walking and running. Therefore, we used mass-spring models to predict stiffness and the rate of loading during the impact phase of gait. These models were tested on 20 human subjects walking and running on a rigid surface and four substrates of varying stiffnesses. All subjects walked and ran at Froude numbers of 0.28 and 1.2, respectively. Three-dimensional kinematic and kinetic data were collected using Qualysis motion capture software and an instrumented treadmill. Results indicate that impact stiffness on various substrates can be predicted accurately using knowledge of substrate stiffness and impact stiffness measured a rigid surface. Results also indicate that rate of loading scales predictably with impact stiffness. Importantly, declines in substrate stiffness of 94% produce only 17% declines in impact stiffness during walking compared to 55% declines in impact stiffness during running. This finding suggests that the human foot plays a greater role than substrate in governing impact forces during walking compared to heel-strike running. The performance differences in walking versus running provide a biomechanical context for interpreting morphological changes thought to be

related to resisting impact forces, including variations in hominin calcaneal morphology.

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### Microfractures in elderly ribs: Contributions to bone quality.

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Rib fractures can affect morbidity and mortality in elderly individuals and the risk of their occurrence increases significantly with age. Clinical diagnoses of bone fragility often fail to measure the contribution of poor bone quality. An inefficient remodeling process in aging individuals results in disrepair of microfractures, allowing their accumulation to reach harmful levels. While it is established that microfractures contribute to catastrophic bone failure, it is unknown to what extent they exist in human ribs and their role in determining bone quality. Additionally, the loads habitually applied to the rib during respiration are difficult to determine and therefore absent from many discussions on adaptive responses to loading. The objective of this research is to explore individual variation in microfractures which accumulate *in vivo* in elderly ribs. Samples from sixth rib pairs were removed from ten elderly cadavers, stained *en bloc* in Basic Fuchsin Hydrochloride, and transverse thin-sections prepared. A two-way mixed model analysis of variance (ANOVA) reveals significant differences in microfracture accumulation between individuals, but not within (left vs right rib). Only insignificant differences were found in crack location, with slightly more microfractures accumulating in the cutaneous cortex. These findings suggest that microfracture accumulation in the elderly has the potential to contribute to differential fragility. Additionally, based on crack distribution, the priority may be to preferentially maintain a higher bone quality in the pleural cortex. Knowledge of the mechanisms involved in bone quality deterioration is vitally important to establish methods to combat fragility fractures in the high-risk elderly population.

### The evidence for modern human origins in Central Europe: 30 years since Smith's seminal review.

JAMES C.M. AHERN. Department of Anthropology, University of Wyoming.

Fred Smith's seminal review of the late hominin fossil record of Central Europe was published nearly thirty years ago (1984). This work helped highlight the importance of this region at a time when much of the debate about modern human origins was focused on the Western European record. The present paper reassesses Smith's interpretation of the evidence in light of recent research and discoveries. New

discoveries at a variety of sites, especially in eastern Central Europe, have provided more information on the period and process of the Neandertal – modern transition. New dating techniques and their direct application to fossil remains have provided more chronological clarity. The genetic revolution, including the sequencing of the Neandertal genome, has shifted our field's theoretical focus twice: 1) from a perspective that favored overall regional continuity, as favored in Smith's original review, to one of complete replacement and 2) from complete replacement to a more nuanced understanding of the dynamics of origins and admixture. In addition to a review of the overall state of the Central European evidence, this paper provides new results on and interpretations of the record of the Neandertal – modern transition as documented in recent discoveries from Vindija and other Middle and Upper Paleolithic sites in Croatia. The available evidence from Central Europe is most commensurate with the Assimilation Model of modern human origins, although some other models cannot be ruled out. The exact patterns of admixture between Neandertals and modern humans must await further evidence and analyses.

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**First Miocene record of *Mesopithecus* from the Iberian Peninsula based on Turolian remains from Venta del Moro (Valencia, Spain).**

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The extinct genus *Mesopithecus* (Primates: Cercopithecoidea) includes small to medium-sized colobine monkeys distributed from the late Miocene through the Pliocene across Europe, southwestern Asia, Pakistan and China. In spite of such a wide distribution, until now its occurrence in the late Miocene of the Iberian Peninsula had not been conclusively documented. Here we report dental remains of this taxon from the Turolian (MN13, late Miocene) locality of Venta del Moro (Valencia, Spain). The new fossils include most of the deciduous dentition and the unerupted germs of the first molars of a single infantile individual, as well as two lower lateral incisors from two additional individuals. On the basis of morphometric comparisons, mainly based on the lower first molars, these remains are attributed to

the late Miocene species *Mesopithecus pentelicus*. They represent a significant addition to the knowledge of the deciduous dentition of this taxon, much less well-known than the permanent dentition. The reported remains therefore considerably extend southwestwards the known geographic distribution of *Mesopithecus*. The presence of this taxon at Venta del Moro must be understood within the framework of the significant faunal turnover that took place in European faunas during the latest Turolian (the second Messinian mammalian dispersal), which is further documented at this locality by the occurrence of other eastern immigrants. At the same time, the presence of *Mesopithecus pentelicus* at Venta del Moro agrees well with previous paleoenvironmental and sedimentological evidence for this locality, indicating a lacustrine depositional environment with strong hydrologic seasonality.

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**Crania, coordinates, and clusters: testing a finite mixture modeling approach for the detection of population structure in modern America using high-dimensional data.**

BRIDGET FB. ALGEE-HEWITT. Department of Anthropology, University of Tennessee.

Finite mixture model-based clustering (FM-MBC) methods are showing promise for revealing structured human variation and teasing-out patterned information useful for craniometric-based classification without the need for reference samples or *a priori* group-identifiers. FM-MBC studies have revealed that it is possible to detect latent population structure within a mixture of craniometric distributions, that craniometric-based structure is hierarchical, that statistically inferred clusters correspond closely to predefined populations and that the best results are produced using a geographically diverse sample. What remains to be resolved is if FM-MBC analyses can be improved for finer levels of subdivision. Preliminary tests of substructure in contemporary America suggest that the relationships between the individual cluster allocations and true group memberships is complicated by admixture, secular change, and variability in self-identification. As 3-D coordinate data better captures the shape of the cranium, these problems may be overcome by incorporating geometric morphometric methods. This project applies these two powerful resources to the detection of finer-grained, within-population structure using a dataset of digitized landmarks representing the craniofacial morphology of 600 self-declared American Blacks, Whites and Hispanics from the Forensic Anthropology Databank. This study assesses the cluster-solutions generated using the coordinate dataset and compares these to the cluster-patterns

and misclassifications produced using inter-landmark distances for 900 individuals. It asks if FM-MBC can be effectively applied to high-dimensional data, if 3-D data offers improved classifications, and if the potential for improvement warrants the increased analytical complexity. Recommendations are offered for the combined application of these methods and use of open-source software.

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**Finding the place of race in anthropological discourse: a digital textual analysis.**

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The discourse of "race" has a complex history in biological anthropology. While understanding the distributional patterns of human biological variation remains a well-recognized step towards revealing population structure, tracing human evolution, and making identifications in forensic contexts, race has come frequently under fire. At best, critics claim that race is a cultural construct, lacking biological reality; at worst, population-based classification is accused of perpetuating the dark histories of typology and human taxonomy. But our understanding of the evolution of this discourse is complicated by the interactions between perceptions and practice: the discipline of physical anthropology lacks a comprehensive and critical understanding of the patterns that the language of race has assumed throughout the recent disciplinary past. Has the discourse of race remained constant over time? Has the emergence of forensics and genetics altered how we interpret concepts such as race, ancestry or ethnicity? Are there recognizable patterns of discourse shaping our understandings of race?

The project reconstructs race's history using the novel methodologies of computational linguistics. Our work analyzes the semantic and lexical patterns in a corpus of 2000+ articles from the *American Journal of Physical Anthropology*, *Current Anthropology* and the *Journal of Forensic Sciences* using topic modeling, sentiment analysis and frequency analysis. In doing so, we investigate *quantitatively* the ways in which the language of race has helped shaped the evolution of anthropology and, in turn, how methodological and critical advances in the discipline have shaped the ways in which we talk about and understand the concepts of race.

**Preliminary examination of buccal dental microtexture in primates.**

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Studies of dental microwear on enamel surface have been one of the most commonly used approaches for reconstructing diets of extant hominines. Over the years, two methodologies have been developed for analyzing both the occlusal and buccal surfaces, obtaining interesting results with both techniques. Basically, these techniques are based in the identification of features on dental enamel through Scanning Electron Microscopy (SEM) to obtain two-dimensional images. However, in recent years the research of occlusal microwear has given way to techniques that analyze the microtexture surface in 3D, obtaining good results in several species. Here we analyze for the first time 3D microtexture data on primate buccal dental surfaces from high resolution tooth replicas belonging to extant primates: *Chlorocebus aethiops* (n=12), *Cercopithecus sp.* (n=9), *Gorilla gorilla* (n=13), *Pan troglodytes* (n=9), *Papio ambuis* (n=22) and *Colobus sp.* (n=19). Genus were compared using a multivariate analysis of variance model (MANOVA) of the 6 standard variables that characterize microtexture attributes (Asfc, Smc, epLsar<sub>1,8 mm</sub>, TfV, HASfc<sub>9 cells</sub>, and HASfc<sub>81 cells</sub>), and single-classification ANOVAs for each variable. Our results show that these parameters present significant differences in the analyzed primates, being similar than those obtained by 2D buccal dental microwear analyses, and suggesting that microtexture analyses on buccal dental surfaces is a good approach to determine feeding ecology and dietary differences in primates.

#### **Roundworms on the Red Island: Gastrointestinal parasite intensity in four lemur species from the Tsinjoarivo region, Madagascar.**

KRISTEN L. ALLDREDGE, MICHELL T. IRWIN and LAURIE R. GODFREY. Department of Anthropology, University of Massachusetts Amherst.

The lemurs of Madagascar are hosts to a number of infectious agents, including many taxon-specific gastrointestinal parasites. Parasite loads affect individual fitness, social systems, and behavior; their consideration is therefore vital to conservation planning. The Tsinjoarivo region of Madagascar's central high plateau contains nine species of lemurs, all of which are threatened by anthropogenic forest fragmentation. This makes it an ideal location to study effects of fragmentation on lemur parasitic loads.

In this study, we used fecal floatations to analyze parasite intensity in four species of lemurs (*Hapalemur griseus*, *Propithecus diadema*, *Microcebus murinus*, and *Avahi laniger*) and four species of domestic animals (*Canis familiaris*, *Bos indicus*, *Sus scrofa*, and *Oryctolagus cuniculus*) in the Tsinjoarivo region. Parasite eggs and larvae were counted and photographed within 24 hours of fecal collection. Collection priority was given to fecal samples from *H. griseus* and *P. diadema*. The most

common parasites across all species were nematodes of the family *Strongylidae*. Subject species had low levels of parasite intensity (0-50 eggs/larvae), with the exception of *H. griseus*, which consistently maintained the highest parasite intensity and diversity. Three hypotheses explaining higher parasite loads in *H. griseus* include 1) increased exposure to parasites due to lower preferred canopy height, 2) grooming behavior that does not adequately target strongyles, and 3) overcrowding effects from landscape fragmentation, which preferentially affect *H. griseus* due to their reliance on bamboo commonly found along fragment edges. Data regarding the behavior of *H. griseus* and strongyle lifecycles provide support for the fragmentation hypothesis.

#### **The evolution of global endocast shape in primates.**

KARI L. ALLEN. Evolutionary Anthropology, Duke University.

It has long been suspected that encephalization may be associated with aspects of cranial form that distinguish extant anthropoids from strepsirrhine primates. However, it is unknown how encephalization correlates to overall brain shape and cranial form across the primate order. This project addresses these questions using geometric morphometric (GM) shape analyses of both the cranium and endocast of living primates and Oligocene anthropoids from the Fayum deposits of Egypt.

Three-dimensional landmarks were collected on virtual endocasts, segmented from micro-CT scans of thirty-one extant primate species and two fossil anthropoids from the Fayum of Egypt: *Parapithecus* (DPC18651) and *Aegyptopithecus* (CGM85785). Fourteen endocast landmarks and twenty-six cranial landmarks were chosen to reflect extant variation in overall cranial and endocranial form. Shape was explored using Principal Component (PC) Analysis of Procrustes-aligned shape variables. PC scores were found to have a high degree of phylogenetic signal (Pagel's lambda value approaching 1.0). As such, PC scores were examined for correlation to absolute and residual endocranial volume (ECV) using PGLS regression techniques.

PC1 scores from both the endocast (en) and cranial (cr) analyses are significantly correlated with residual ECV ( $p < 0.05$ ), while PC1cr and PC2en are significantly correlated with absolute ECV. The fossil specimens are aligned with living strepsirrhine primates in both endocranial shape (low endovortex, rostrally projecting olfactory bulb, etc.) and size, but more closely resemble modern anthropoids in overall cranial form, thus illustrating that a historical approach is crucial to our understanding of the evolutionary and developmental factors that cause variation in cranial form among primates.

#### **Sexual dimorphism in human skull: the effect of size correction.**

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The differences observed among males and females of a species, the sexual dimorphism, plays an important role along the evolutionary story of a lineage. This phenomena is detected among anatomical modern humans, majoritarily expressed as differences of stature and robusticity among human males (M) and females (F). In this context, in despite of the difficulties of an accurate and reliable system of sexual assignment of human skeletal remains, mostly of the studies focused on the morphological aspects of the human history consider M and F separately. In this study, we evaluated the differences observed among M and F human crania after a size correction treatment. To reach our goal, we used a large sample constituted of 9,287 human skulls represented by means of 24 measurements. These crania are distributed into 161 populations of worldwide dispersion. Each population was represented by the coefficient of mean variation (CMV) of their centroid, after the size correction. The entire sample was classified into three analytical groups, according with their composition: A) mixed samples (n=66); B) male samples (n=42); C) predominantly male samples (n=53). The distributions of CMV observed in each analytical group was compared through t tests. The analysis did not show statistical differences ( $p < 0.01$ ) among these analytical groups. Additionally, the same analytical procedure showed that the differences among observations before and after the size correction treatment showed statistically significant ( $p < 0.000$ ). Our results suggests that samples composed by male and female crania can be considered together once their size component has been properly adjusted.

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#### **Making people: Sorting commingled remains from the St. Anthony of Padua Cemetery, Minneapolis, MN 1851- 1857.**

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Sorting commingled remains serves the purpose of returning identity to the individual. In 2005, the skeletal remains of multiple individuals were found in a construction site in Minneapolis, MN. Research determined the location to be the St. Anthony of Padua Catholic Cemetery, in use from 1851 to 1857. A salvage operation at the site resulted in the collection of approximately 2,233 commingled skeletal elements lacking individual identity. The collection, known as H413, suffered extensive damage as well, creating a challenge in identifying and assigning bones to specific individuals. This project details the utility of several approaches for sorting commingled remains, including various forms of osteometric sorting, length and stature estimation of long bones, sex and age determination methods,

observations of pathology and staining, and ancestry affiliation. Articulation points were also used to match long bones to torso elements such as the scapula, clavicle and the innominate. The project determined the presence of 18 individuals, including nine adults and nine juveniles. While not complete sets of remains, these individuals' identity has now been partially restored.

**Morpho-functional signals in the wrist of extant hominoids derived from 3D geometric morphometrics: the hamate as a test case.**

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Accurately assessing the relationship between bone shape and function in extant species is an indispensable first step before making functional inferences for extinct taxa. Here we analyze hamate functional morphology among extant hominoids using 3D geometric morphometrics (3DGM). The sample includes 114 hominoid specimens of known sex, comprising all extant great ape genera, hylobatids and modern humans. Thirty-one 3D coordinates were collected from surface models using *Landmark Editor*. These coordinate data were analyzed using generalized Procrustes methods, principal components analysis (PCA) and multivariate regression of shape on locomotor substrate preference categories (based on published data) using *MorphoJ*. The shape changes associated with each PC axis were visualized by exporting the coordinates of the shape-change vector into *Landmark Editor*, so that each 3D model could be morphed into any desired axis position. Overall the first three PC axes accurately segregate each of the hominoid taxa, and the regression of shape onto substrate preference categories explained a significant portion of the total shape variance in our sample ( $p < 0.0001$ ). These results show that 3DGM can capture the subtle and complex shape differences among the hamates of living hominoids and can help decompose the portion of the shape variability explained by locomotion and other factors (e.g., size and sex). Thus, the potential to infer manual adaptations to suspensory, terrestrial, and possibly manipulative behaviors on the basis of hamate morphology in extinct hominoid taxa is promising.

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**Dietary variation of individuals from the Angel Site and Caborn-Welborn Villages: Implications on the Vacant Quarter hypothesis.**

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The Vacant Quarter Hypothesis argues that the North American midcontinent was mostly depopulated well before the contact period. Many large Middle Mississippian chiefdom centers and their peripheral sites were abandoned before A.D. 1500, yet the Caborn-Welborn phase, which arose 50 km to the west of the Angel Chiefdom around the time of its abandonment, persisted throughout this time. Stable isotope evidence from human burials at the Caborn-Welborn villages of Hovey Lake and Mann and the Angel Site tests the hypothesis that the Caborn-Welborn phase began as a resettlement of the displaced Angel people. These data also serve to examine the effects of the social instability inherent in the Vacant Quarter Hypothesis through evidence for movement between Caborn-Welborn groups.

The average  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  dietary values for individuals at these three sites are significantly different ( $p < 0.05$ ;  $p = 0.04$ ). The average  $\delta^{13}\text{C}$  values for the individuals at the Angel, Hovey Lake, and Mann sites are  $9.1 \pm 2.3\text{‰}$  ( $n=61$ ),  $9.7 \pm 1.4\text{‰}$  ( $n=13$ ), and  $10.3 \pm 0.8\text{‰}$  ( $n=13$ ), and the average  $\delta^{15}\text{N}$  values were  $9.0 \pm 0.9\text{‰}$  ( $n=61$ ),  $9.3 \pm 0.2\text{‰}$  ( $n=13$ ), and  $9.8 \pm 0.5\text{‰}$  ( $n=13$ ) respectively. These differences suggest that the Caborn-Welborn phase likely developed *in situ* rather than as a movement of the Angel people as a result of chiefdom collapsed. Additionally, the Mann site exhibits two significantly different clusters of  $\delta^{15}\text{N}$  diets, with one averaging  $10.2 \pm 0.1\text{‰}$  ( $n=7$ ) and the other  $9.28 \pm 0.5\text{‰}$  ( $n=6$ ); ( $p=0.0$ ). This indicates the fusion of distinct Caborn-Welborn groups, perhaps due to turmoil and social instability in connection with the implications of the Vacant Quarter.

*Support for this research was provided by the Undergraduate Research Opportunity Program, University of Notre Dame. The samples were analyzed at the Center for Environmental Science and Technology, University of Notre Dame.*

**An investigation of craniometric variation in Paleoamericans from different continents.**

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The composition of craniometric samples utilized in Paleoamerican research plays an important role in the development of migration models and theories. Many previously proposed theories were developed with data skewed towards one of the American continents; yet

conclusions are often made encompassing the entire New World.

The purpose of this poster is to investigate the craniometric relationships of a Paleoamerican sample, including individuals from North, Central and South America, in order to assess the appropriateness of a pooled Paleoamerican sample in modeling migration scenarios.

A sample of 33 crania, with published dates of 7000 years BP or older, were investigated. 18, shared cranial measurements were utilized. Cranial variation was analyzed through the calculation of Mahalanobis distances between each pair of crania. A principal coordinate analysis was used to visualize the general patterns of relationships among the crania.

The distance relationships among the Paleoamerican crania suggest a separation between the South American and North and Central American specimens with few exceptions. The North Americans have two loose groupings. In addition, several North and Central American crania can be considered the most distinctive within the overall sample. There does not appear to be distinct differences among the South American specimens from different areas and sites, suggesting pooling these specimens may be appropriate.

The heterogeneity among the complete Paleoamerican sample makes it inadvisable to pool them into one large group. Further analysis of why these differences exist may be of interest in modeling the first migration(s) into the Americas.

**Age and sex differences in the behavior, diet, and gut microbial communities of wild black howler monkeys (*Alouatta pigra*).**

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Adult female and juvenile primates require more energy and nutrients than adult males for processes like reproduction and growth. To meet these requirements individuals must increase intake, decrease metabolic consumption, and/or increase assimilation

efficiency of energy and nutrients. Behavioral shifts allow primates to alter food intake rates and decrease metabolic requirements, but when diet and activity are constrained, shifts in the composition of the gut microbial community may be essential to enhance digestive efficiency. We investigated age- and sex-based variation in activity, foraging behavior, and gut microbial community composition and function across seasons in wild black howler monkeys (*Alouatta pigra*) in Palenque National Park, Mexico. Data describing individual diet and activity budget were collected from two groups of howlers (N = 16 howlers) from September 2010 to June 2011 (1,522 focal hours). Fecal samples for microbial 16S rDNA analysis were collected bi-weekly. Howlers exhibited similar behavior and diet, and hosted similar gut microbial communities (ANOSIM R = <0.10, p > 0.20), regardless of age or sex. However, gut microbial communities were more stable over time in adults compared to juveniles, and females tended to undergo a shift in microbial community composition during pregnancy and lactation (ANOSIM R range: 0.19 to 0.57, p range: 0.04 to 0.12). Thus, shifts in the gut microbial community appear to be a natural part of juvenile development and may play a critical role in female reproductive ecology. Additional data identifying the specific bacterial taxa that drive these shifts and how they influence host digestive efficiency are discussed.

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#### **Morphological diversity and species recognition in South African *Cercopithecoides williamsi*.**

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Taxonomy of the South African fossil colobine *Cercopithecoides williamsi* has been debated by paleoprimateologists for decades. It has been suggested that the cranial morphology of specimens from Makapansgat (MP), Sterkfontein (STS/SWP), and Bolt's Farm (BF) shows more variation than expected for a single species. Thirty-seven three-dimensional landmarks were collected on a target sample of six specimens of *Cercopithecoides williamsi* from these three sites. Additionally, a comparative sample of 287 extant and fossil colobine crania representing 17 species was also landmarked. Principal components analysis (PCA), regression, and Procrustes distances (PD) were used to compare shape differences within

and among taxa to assess variation in the target sample.

Multivariate analyses show high levels of variation in the target sample, but not more than that seen in some extant species. Brow ridge thickness and brow ridge curvature have wide ranges of variation, but still fall within the ranges observed for four and three extant species respectively. BF 43 and MP 113 stand out as having relatively broad interorbital regions and increased levels of brow ridge curvature compared to other specimens in the target sample. In brow thickness, one particularly thin-browed specimen (MP3a) increases variation in the sample, while the other target specimens fall within a normal species range of variation. Based on these and the PD and PCA, we cannot reject the hypothesis of more than one species being represented in *Cercopithecoides williamsi*. However, the variation in cranial morphology seen in South African *Cercopithecoides williamsi* also appears consistent with a single species model.

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#### **Ground-truthing a neural-network based predictive model for locating productive fossil localities in the Eocene of Wyoming.**

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Remote sensing and other tools and methods from the geographic information sciences have the potential to revolutionize how paleoanthropological fieldwork is performed. We trained a neural network to analyze remotely sensed imagery and multiple GIS data and analytical layers in order to recognize different land cover classes, including productive localities, in Eocene deposits of the Great Divide Basin of southwestern Wyoming. *Post hoc* testing of the model indicated that the model was able to recognize the spectral signatures of productive localities and other land cover classes with a high degree of accuracy (84% correctly classified). Our predictive model was constrained by geology (limited to outcrops mapped as Wasatch formation), by topography (minimum required slope was 5%), and was limited to pixels which resembled known localities at the 98% probability level. Ground truthing of the model took place during the summer 2012 field season.

The first area we surveyed yielded characteristic Eocene fossils (turtle, fish, crocodile, gastropod, bivalve) in deposits whose lithology (paper shales and stromatolites) suggested a lacustrine origin. We confirmed that these deposits have been mistakenly mapped as Wasatch formation and should be attributed to the Green River formation. In the second area,

the lithology was clearly fluvial and the rocks were typical of the Wasatch formation (sandstones and mudstones). The area indicated by our model as having a high priority of being fossiliferous was in fact a large outcrop of heavily eroded sandstone that yielded typical Eocene terrestrial mammals, including *Hyracotherium* and *Hyopsodus*.

*This fieldwork was funded by several grants from Western Michigan University to RLA and CWE. Fieldwork was facilitated by the Wyoming State Office of the Bureau of Land Management (Paleontological Resources Use Permit 287-WY-PA95).*

#### **Revisiting Jebel Sahaba: new apatite radiocarbon dates for one of the Nile valley's earliest cemeteries.**

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Jebel Sahaba (site 117), a Paleolithic cemetery located near the 2<sup>nd</sup> Nile Cataract, was excavated by Fred Wendorf in the 1960s as part of the UNESCO High Dam Salvage Project. The skeletal remains of 46 adults and 13 subadults, as well as other fragmentary remains, were recovered from single and multiple burials. The assemblage was generously donated to the British Museum in 2001 and now forms part of the Wendorf collection. The skeletons are well-known for showing signs of a violent death, with several individuals with cut marks and embedded lithics, which may represent evidence of organized warfare. In 1988, a single skeleton was radiocarbon dated to 13,740 BP +/- 600 and Jebel Sahaba is generally regarded as one of the earliest cemeteries in the Nile valley. Unfortunately, collagen preservation at the site is poor, additional AMS dating was unsuccessful and some regard the dating as unreliable. The collection is central to several projects investigating the early inhabitants of the middle Nile Valley, including their biological affinity, and it was deemed necessary to confirm the dating of the site. Using the apatite fraction provides an alternative to collagen and four skeletons from across the site were selected for bone, enamel and dentine apatite radiocarbon dating (9 samples). The results suggest that the cemetery is at least 11,600 years old, confirming this burial site belongs to the Epipaleolithic and the Qadan culture. The range of results indicates that the samples were affected by diagenesis and the site may actually be older.

#### **Life history transitions and the origin of genus *Homo*.**

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We use an integrated dataset of fossil, archaeological and human biological data to

consider the origin and early evolution of genus *Homo*. These data provide new perspectives on three important shifts in human evolutionary history: 1) the emergence of *Homo*; 2) the transition between non-*erectus* early *Homo* and *H. erectus*; and 3) the appearance of regional variation in *H. erectus*. Using new fossils we compare size and dimorphism in *Australopithecus* and early *Homo*, and among their species and we estimate their total daily energy expenditures (TDEEs). Although our understanding of body size and intra-/interspecific variation has been changed by recent fossil finds, the data still suggest that body and brain size increase in early *Homo*. An increase in TDEE appears to signal a marked dietary shift. These differences became more pronounced in *H. erectus* but the transformation was almost certainly not as extreme as previously envisioned. Regional variation is similar to that in modern humans and likely reflects the importance of local adaptive pressures and perhaps developmental plasticity. Many aspects of the human life history package, including reduced dimorphism, likely occurred later in evolution than previously envisioned. These analyses suggest that regional variation in *H. erectus* reflects the combined influences of shifts in extrinsic mortality rates and differences in resource sufficiency and quality. We describe a positive feedback model for the origin and evolution of *Homo* that incorporates cooperative breeding, diet, cognitive abilities, body composition, and extrinsic mortality risk as central elements.

#### **Regional variation in mandibular morphology in the prehistoric Japanese populations of the Jōmon and the Okhotsk.**

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Eleven metric traits were compared among the mandibles of Jōmon and Okhotsk sites in order to analyze potential impacts on mandibular morphology due to regional dietary differences. The Middle Jōmon (5,000 - 3,000 BP) was marked by climate stability, population growth, cultural homogeneity, and an abundance of resources. Middle Jōmon sites were expected to share comparable robusticities across all regions based on social and economic continuity. The Late/Final Jōmon (4,000 - 2,000 BP) coincided with a cooling climate, population crash in Honshu, and regionally divergent cultures and economies. Late/Final Jōmon sites were expected to show mandibular reduction in the Honshu interior which had engaged in plant cultivation and emergent agriculture as opposed to populations on the Hokkaido and Honshu coast which engaged in marine subsistence. The success of agriculture resulted in an expansion across Honshu, pushing marine subsistence communities northeastward to Hokkaido where the tradition persisted as the Epi-Jōmon until the arrival of the immigrant populations of the Okhotsk from mainland Asia through Sakhalin

(1,000-600 BP). Epi-Jōmon and Okhotsk sites were expected to share comparable robusticities based on their shared practice of marine subsistence. The hypothesis for the Late/Final Jōmon and Epi-Jōmon/Okhotsk were not supported suggesting a potential of more diversified and complex subsistence practices or the possibility of cultural mitigation in food processing.

#### **Relationship between European megaliths (6000 Years BP) and Southern American cultures: Genetic and archeological Links.**

ANTONIO ARNAIZ-VILLENA, JAVIER ALONSO-RUBIO and VALENTIN RUIZ-DEL-VALLE. IMMUNOLOGY, UNIVERSITY COMPLUTENSE.

There are indications that a cultural influx occurred in America coming from Europe in Solutrean times (20-17,000 years BC). There is also genetic evidence that Azores Islands, placed in Middle Atlantic, were already occupied by Oriental people before the Portuguese arrival according to HLA genes. In addition, Pacific HLA alleles, including Australia, Islands and southern Asia, are shared with present day Amerindians. Thus, America peopling could have been more complicated than thought, particularly through trans-oceanic routes.

In the present paper, we show evidences that relate Megalithic Atlantic culture (6,000 years BC) with southern America cultures based on stone functional construction structures. Moreover, both Atlantic and Pacific HLA markers seem to be shared with Amerindians and Azores Oriental genes.

Results are discussed in the frame of genetic and archeological similarities of First American Inhabitants, with Atlantic and Pacific inhabitants, particularly in Megalithic European times (6,000 years ago). This is the first time that these striking similarities are described. Taken all these data together, it may be hypothesized that frequent Oceanic routes were used to reach America at different times before Columbus arrival et 1492 AD.

#### ***Kenyapithecus* is the earliest plantigrade hominoid.**

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Plantigrade foot posture during terrestrial locomotion, where the heel strikes the ground first, is an adaptation that is uniquely shared by African apes and humans. All other primates utilize a semi-plantigrade foot position with a heel-elevated posture or have adapted their feet for suspension without heel contact with the substrate.

The foot of *Kenyapithecus africanus* from Maboko Island displays features for plantigrady in common with African apes. The most notable feature of *Kenyapithecus* is enlargement and plantad orientation of the navicular tuberosity (KNM-MB 31335), where

the tendon for tibialis posterior inserts. The navicular tuberosity extends distally beyond the cuneiform facets, as in gorillas. During the mid-stance phase of terrestrial walking, the plantar portions of gorilla and chimpanzee tarsals contact the substrate. Since African apes lack longitudinal arches, weight-bearing tubercles are produced on the plantar sides of the tarsals. This orientation and development of the navicular tuberosity is not present among other Miocene hominoids. Another African ape-like feature is the enlargement, plantad orientation and laterally extensive nature of the peroneal tubercle of the fifth metatarsal (KNM-MB 28397), which is oriented plantarly.

The evolution of terrestrial plantigrady among African apes and humans is not well understood. Dating from 15 Ma, *Kenyapithecus africanus* is the first Miocene hominoid to display terrestrial plantigrade features and provide context for understanding the origin of African ape and human locomotion. The foot of *Kenyapithecus* indicates that the last common ancestor of African apes and humans was ape-like and not monkey-like as claimed from *Ardipithecus* foot remains.

#### **Gargantua the gorilla: evaluating skeletal indicators of unique life history events.**

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Accurately identifying skeletal markers of life history stressors can be difficult, as detailed information on any given individual is often lacking from museum records. Here, we describe the skeleton of a famous gorilla named Gargantua, formerly Buddy. Available records indicate that this lowland gorilla (*Gorilla gorilla gorilla*) was collected in Africa as an infant, and suffered an acid attack to the face before being donated and cared for by a wealthy menagerie owner in Brooklyn, NY. On reaching adulthood, Gargantua was subsequently transferred to the Ringling Brother & Barnum and Bailey Circus, where he was a media star from 1938 until his death in 1949. Following a necropsy by primate anatomist Adolph H. Schulz, Gargantua's skeleton was donated to the Yale Peabody Museum of Natural History, where it was mounted for exhibit.

The Gargantua skeleton shows skeletal pathologies consistent with available life history data. The cranium and face show bilateral asymmetry and scarring associated with the acid incident, and craniometric data indicate that Gargantua's skull development followed a different trajectory than wild gorillas. Postcranial metric data suggest a smaller body size relative to wild gorilla males. Skeletal evidence of severe dental disease, respiratory ailments, and postcranial arthritic changes are concordant with the recorded captive environment. By reviewing documents and historical material, we are able to provide a clearer picture of the gorilla who had captivated the American public, but whose life and death illustrate the importance of modern captive management and enrichment programs.

*This work was supported by the Yale Peabody Museum of Natural History and by the Yale University Department of Anthropology.*

**Exploring potential risk factors of fetal origins of diabetes: Maternal stressors during pregnancy and birth outcomes among women in a hospital in the municipality of Caguas, Puerto Rico.**

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Puerto Rico exhibits the highest prevalence of diabetes, low birth-weight, and the second highest prevalence of preterm-birth in U.S. and its non-incorporated territories. Maternal psychosocial stressors during pregnancy have been associated with low birth-weight, preterm-birth, type 2 diabetes and immune-inflammatory dysregulations. Current evidence points toward epigenetic fetal metabolic-programming as the mechanism underlying the increased risk for these. However, psychosocial stressors involved in adverse birth outcomes and clinical complications have not been well studied. The present study seeks to identify stressors that may contribute to the high prevalence of low birth-weight and preterm-birth in the population of Puerto Rico. Participant mothers (n = 68) answered a questionnaire composed of five validated scales for measuring maternal stress during pregnancy. Data on birth outcomes and clinical complications were collected from the medical records of mothers and babies. Correlations were found between birth-weight and maternal weight before giving birth ( $p = 0.010$ ), weight gain ( $p = 0.038$ ), and BMI before giving birth ( $p = 0.020$ ). Birth-term was found to be correlated with maternal weight gain ( $p = 0.022$ ), and BMI before giving birth ( $p = 0.023$ ). None of the scores from the stress scales was significantly correlated with any birth outcome. Preliminary analyses of continuous data suggest that maternal weight, BMI, and weight gain during pregnancy may have a more significant influence on birth outcomes than maternal stress. Future research should evaluate biological markers of stress, and the possibility of stress having an effect on maternal body composition during pregnancy.

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**A morphometric analysis of the frontal squama in fossil and recent humans.**

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Most studies of frontal bone morphology have focused on the browridge or have analyzed

the entire bone, thus mixing information from the neurocranium and facial skeleton. Yet, the frontal squama is considered to be diagnostic for modern *H. sapiens* who are described as having vertical or bulging frontals. The morphology of the frontal squama is influenced by its position and orientation relative to other cranial components. Hence, in this study we analyzed the shape of the frontal squama alone, independent of its orientation relative to other cranial components, and quantified its variation in Pleistocene and recent humans. We examined 37 Middle and Late Pleistocene fossils from throughout Eurasia and Africa as well as 83 recent humans from 10 different populations. We analyzed frontal squama outlines taken from the supratral sulcus to bregma using coordinates superimpositions and multivariate statistics. Our results demonstrate that modern and archaic humans are clearly separated on the basis of frontal curvature and bulging. However, there is some overlap among modern and non-modern groups, making it difficult to use this trait when diagnosing the taxonomic affinity of individual specimens. There is no separation of fossil and recent modern humans. Among modern humans, the majority of populations are distributed along a continuum characterized by frontal flattening at one end and frontal bulging at the other. However, according to this preliminary survey the Khoisan display a different morphology from the rest of the modern sample because of their marked frontal curvature.

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**The genetic architecture and evolution of brain folding and neural network in a pedigreed *Papio* population.**

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Elevated cognition is a hallmark of the primate clade. Cognitive capacity is determined both by number of neurons in the brain and the network of information exchange between brain regions. Increased folding (gyrification) of cerebral cortex allows more neurons to fit within the skull with minimal overall volume increase. The arrangement of folds (sulci) across cerebral cortex indicates the connectivity network; due to selection for the most efficient information-processing strategy, regions experiencing the highest level of crosstalk tend to be anatomically co-located along a gyrus and those least connected functionally tend to be separated

anatomically by a sulcus. Despite its importance, the genetic and evolutionary underpinnings of primate brain gyrification remain unknown.

In this project, we answer pivotal questions about the genetic architecture of baboon cortical gyrification, differing cognitive strategies across the primate clade, and the evolutionary mechanisms responsible for their formation. We use a pedigreed baboon population (N=980) to assess the genetic basis, modularity, and morphological integration of cortical folding in primates and identify the chromosomal regions and candidate genes affecting these traits. Heritability of 25 brain traits has been quantified (average  $h^2 = 31.1\%$ ) in the population, asymmetry assessed (Pearson's T-test  $p=0.0345$ ) and phenotypic variation mapped to the genome using QTL analysis (highest peak: trait Left acruate rectus spur; baboon chromosome 4, 628Mb-707Mb). Four genes of interest are present in this region, including brain-specific angiogenesis inhibitor 3. *This project was funded by the National Science Foundation, grant BCS-0725068.*

**Evolving biological anthropology in twelve acts.**

BENJAMIN M. AUERBACH and GRACIELA S. CABANA. Department of Anthropology, The University of Tennessee.

As biological anthropology has progressed in the sixty years since Washburn's call for a paradigm shift in the field, researchers have generally embraced the hypothesis-driven evolutionary approach advocated in the New Physical Anthropology. Along with the growth in the breadth of specialties within biological anthropology since 1951, researchers expanded collaborations with individuals in related fields. Yet, as we find ourselves increasingly relying on method and theory developed by other disciplinary researchers, a resultant anxiety is that we have had little novel theory of our own to offer, and therefore find ourselves at the margins of those collaborations. Even more problematic, researchers in other fields may address questions in the name of biological anthropology while not working with biological anthropologists. Our collective concern is exacerbated by the fact that we tend to have access to fewer financial resources along with greater teaching responsibilities relative to related fields.

This paper and accompanying symposium explore the sources for these impressions and work to prescribe solutions by showcasing productive approaches undertaken by researchers in specialties within biological anthropology. We demonstrate that biological anthropologists have a shared, unique perspective and methodology that are in fact integral to these multi-field partnerships. A key component of this vision is an emphasis on long-term cultural effects on biology. Moreover, we conclude that rather than constantly evaluating ourselves against sixty year-old measurements of progress, biological anthropologists should focus on these strengths to seek a more enterprising and goal-setting perspective as we forge an interdisciplinary future.

### **Increasing the quality of your bioarchaeological data through the use of tablet-based software.**

ANNE E. AUSTIN. Interdepartmental Archaeology Program, UCLA.

In bioarchaeological research design, the quality of data is fundamentally based on the precision, accuracy, and quantity of data collected during fieldwork. My research focuses on developing data collection software utilizing Open Data Kit (opendatakit.org) to maximize the quality of data through the use of mobile devices and tablets. I have developed an application available for any Android-based device which standardizes the order and instructions for data collection utilizing pre-established bioarchaeological methods outlined in Buikstra and Ubelaker (1994) as well as the Global History of Health Project codebook.

In order to assess the efficacy of this application, I conducted a comparison study with traditional paper forms. Skulls were observed on both paper and on the tablet by a group of volunteer undergraduates who have taken at least one introductory Osteology course. I measured the amount of time per entry, number of improperly entered or missing fields, and the interobserver variability in cranial metrics. Students saved on average over four minutes per entry while using the tablet. They also made at least three fewer errors in data collection while using the tablet. Finally, there was on average 3-5% less interobserver variability per cranial metric recorded.

Consequently, this program increases the quality of data while also decreasing the amount of time needed to record an element or individual. Finally, the tablet is advantageous over paper forms since it can automatically record timestamps and GPS coordinates, making it an extremely effective tool for survey.

### **Whet your appetite: A dietary reconstruction using stable carbon isotopes from human tooth enamel at Tell Dothan.**

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Stable isotope analysis represents an effective means of reconstructing diet in ancient populations. In this study, stable carbon isotope values were used to assess diet among individuals from Tell Dothan's Western Cemetery, located in the modern-day West Bank. Carbonate was isolated from human maxillary left first molars (n=34) and faunal (n=6) teeth, and analyzed using an isometric ratio mass spectrometer (IRMS). We hypothesized that there would be significantly different <sup>13</sup>C enrichment between teeth from the Late Bronze (1400-1300 BC; Level 1; n=17) and Early Iron

(1200-1100 BC; Level 4; n=17) Ages, possibly reflecting significant cultural changes – including increased trade, migration, and political unrest – that occurred in the region during this time. We also hypothesized that samples would exhibit depleted  $\delta^{13}\text{C}_{\text{ap}}$  values due to a diet high in C<sub>3</sub> grains, widely thought to be the standard diet of the period.

Results showed homogeneity and continuity between the Late Bronze and Early Iron Ages at Tell Dothan, with no statistically significant difference in  $\delta^{13}\text{C}_{\text{ap}}$  values (Mann-Whitney U, p=0.9) or variance (Levene's test, p=0.6) between Level 1 (-11.9 ± 0.4‰) and Level 4 (-11.9 ± 0.6‰). These data suggest that the inhabitants of Tell Dothan consumed mostly C<sub>3</sub> grains, with few C<sub>4</sub> or marine resources, and maintained a similar diet over time despite considerable cultural changes. Faunal samples had a less negative mean  $\delta^{13}\text{C}_{\text{ap}}$  ratio (-9.2 ± 1.9‰), indicating that domesticated animals at the site consumed more C<sub>4</sub> resources than their human counterparts.

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### **Understanding the role of diet in shaping the lemuriform mandible: Comparing traditional and geometric morphometric approaches.**

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As chewing biomechanics are influenced by the underlying geometry of the skull, it stands to reason that functional morphological analysis may benefit from explicit consideration of this geometry, which can be quantified by landmark data. Here, we present biomechanically-informed analyses of two sets of variables measured from lemuriform mandibles: a set of standard linear functional variables and a set of landmarks representing the endpoints of those linear dimensions. We performed principal components analyses (PCA) of both sets of variables, followed by regression of the PC scores on dietary variables. We also compared the linear dimensions and landmark configurations of closely related (and similarly-sized) species that differ in their diets.

The first PC in both cases differentiated more frugivorous lemurs from folivores / seed-predators, and highlighted similar morphological differences between these groups. The correlation between Euclidean distances based on PCs 1-3 was also moderately high. Yet, despite the broad congruence of the two analyses, the ordinations were not identical, and both the functional linear and landmark PCAs were also comparable to PCs computed from sets of randomly generated linear measurements based on these same landmarks. Linear regressions of the PC scores on dietary variables confirmed that both analyses captured a dietary signal, but again highlighted differences in the

two analyses. One advantage of incorporating landmark analyses was the ability to visualize the morphological transformations underlying the differences in linear dimensions. Future functional analyses of two dimensional morphological data would benefit from consideration of patterns in corresponding 3D data.

### **Evidence of a common neural substrate for stone toolmaking and language syntax: An activation likelihood estimate metanalysis.**

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Recent neuroimaging studies of stone toolmaking have found evidence of an overlap between brain circuits involved in both stone toolmaking and language production. However, no study has directly compared stone toolmaking with language tasks. In this meta-analysis, we performed Activation Likelihood Estimate (ALE) on imaging studies in the following domains: seven syntax, six sequential movement, and four stone toolmaking studies. The stone toolmaking studies include Oldowan and Acheulean replication by novice and experts. ALE is a coordinate-based technique for the convergence of activation foci from different studies.

Conjunction of stone toolmaking+syntax found overlapping activation in the left inferior frontal gyrus, left and right primary association cortex, left premotor cortex, and right ventrolateral prefrontal cortex. Conjunction of stone toolmaking+sequential movement estimates found overlapping activation in the left inferior frontal gyrus, left somatosensory association cortex, left and right primary motor cortex, and right primary sensory cortex. These results support the interpretation of earlier studies hypothesizing a common neural substrate for some language processes, sequential movement, and stone toolmaking. These results also support the contentions of Wynn (2002) and Holloway (1969) who have proposed that, at the scale of evolutionary history, changes in Paleolithic technology may be indicative of changing hominid cognitive capacities.

### **Relating posture to spinal osteoarthritis: histological evidence.**

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Age-related intervertebral disc degeneration is prevalent among humans and is often attributed to orthograde posture, but

whether or not posture is the cause of disc degeneration is difficult to test. Rhesus macaques (*Macaca mulatta*) are a comparable model because they sit upright, which vertically loads their spines, and exhibit polyarticular osteoarthritis, including spinal osteophytosis and decreased disc height. Under similar compressive loading, therefore, the rhesus macaque disc should demonstrate similar degenerative pathology as humans.

We analyzed mid-sagittal disc histology of thoracolumbar spines from six rhesus macaques (T9-L1, n=18 discs, ages 19-35 years) and lumbar spines from seven humans (T12-S1, n=44 discs, ages 51-67). Histology images of discs were rated for Thompson grade (a grade of disc degeneration based on gross morphology) and scored for specific degenerative features of the disc and adjacent bone (e.g. osteophytosis, disc tears, bony endplate lesions). While Thompson grade is significantly correlated with most degenerative features (p values range from < 0.001 to 0.048) in both humans and rhesus macaques, radial disc tears correlated with degeneration in humans, (p < 0.001), but not in rhesus macaques (p=0.99). This difference could derive from functional differences due to the different spinal curvature of humans, where T12-S1 is lordotic, and rhesus macaques, where T9-L1 is kyphotic.

Spinal osteoarthritis is prevalent with age in modern humans and also found among hominins (e.g. *Homo neanderthalensis*). Relating differences among extant species in posture to spinal osteoarthritis (e.g., location of osteophyte formation) may facilitate understanding the unique postures of extinct hominins.

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#### **The human in what remains: Reflections of Dr. Karen Ramey Burns.**

FRANCISCO J. BAIRES. School of Anthropology, University of Arizona.

My first question to Karen following her presentation at the University of Tennessee nearly ten years ago was, "Where do you find the inspiration to do this?" Without so much as a thought while packing up her things, she said, "El Pueblo"(The People). My silence must have spoken volumes. So began a mentorship that has lasted ever since. Although I never took a course from her nor worked directly with her, through her work and in the words she spoke in many communications throughout the years, Karen taught me the most fundamental principles of anthropology that have guided my work along our Southern Border with Mexico. This work revolves around the countless people who have come to be called "Unknown Border Crossers" (UBCs). Karen taught me that we must never place people's humanity behind a case number. She taught me that any real anthropologist, regardless of their sub-discipline or specialization, must always proceed with that in mind. As anthropologists, our discipline

demands that we focus on the human in what remains.

My work in Arizona consisted of interviewing Law Enforcement Officials and the staff at Medical Examiner's offices along the entire border to ascertain best practices for dealing with the remains of people who have come to die while migrating through our borderlands. In the spirit of Dr. Karen Ramey Burns, it is my hope that this work not only helps identify the decedents, but also helps us all remember to keep the human in what remains.

#### **An introduction to the bioarchaeology of Upper Nubia and Central Sudan.**

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Bioarchaeological research began during the first Archaeological Survey of Nubia (1907-1911), necessitated by heightening of the Low Dam at the First Cataract of the Nile, near Aswan, Egypt. Through the pioneering work of medical professionals such as Smith, Jones, Ruffer, and Derry, a biocultural approach to the study of ancient Nubians was initiated, reflecting population-based statistics as well as case studies. During the early 1900s, Reisner also excavated monumental sites (e.g., Kerma, el-Kurru, Nuri) in Upper Nubia. Unlike the campaigns in Lower Nubia, little attention was paid to the human remains from sites investigated in northern and central Sudan. Thus, until recently, most of what is known about ancient Nubian biological affinities, lifeways, health, and identity derives from human remains excavated from the early 1900s-1960s in the northern reaches of Nubia.

New fieldwork and restudy of collections is overturning assumptions, revealing remarkable variability in mortuary behavior, expression of social identity, and health status from Epipaleolithic to Medieval periods along the Middle Nile Valley. The array of sites represented both temporally and geographically allows comparisons among contemporaneous populations and across periods of apparent environmental/climatic alteration, subsistence shifts, socio-political and religious changes. Through such studies, continuity is noted in practices such as dental ablation, while dental pathology often contradicts expectations based on assumed subsistence practices. Organizing principles of cemeteries shift with the adoption of Christianity, signaling changes in social structure. Incorporation of multiple lines of evidence in bioarchaeological studies will continue to solidify our understanding of past people along the Nile.

#### **Evolutionary impact of recent historical events on the Rama Amerindian population from Nicaragua: Evidence from molecular genetics and isonomy markers.**

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Surname markers were used in conjunction with mitochondrial DNA (mtDNA) haplogroup variation to approximate the evolutionary impact of recent historical events on the population structure of seven Rama communities from the Miskito coast of Nicaragua. A sample of 267 individuals was sequenced for hypervariable region-I (HVR-I) from mitochondrial DNA (mtDNA) and confirmed using restriction fragment length polymorphisms (RFLP). Haplogroups were assigned based on PhyloTree.org nomenclature, revealing the majority of individuals belonged to B2 (74%) or A2 (25%), with the remaining 1% of variation comprised by C1b and L3. These results contrast previous studies that observed high frequencies of haplogroup A2 (> 65%) and moderate levels of B2 (20-30%) among Central American Chibchan speaking matrilineages. Surname analysis included test statistics for inter- and intra-population variation, consanguinity estimates, and isolation by distance while mtDNA analysis employed median-joining networks and multidimensional scaling plots. Mantel tests illustrated a correlation (r = 0.4; P < 0.05) between distance matrices derived from surname and geographic markers among Rama communities.

Surname analysis indicates that a pattern of geographic distribution exists, linking kinships in major subpopulations to remote family-based villages. This is consistent with the maternal genetic lineage where haplogroup B2 is commonly found among peripheral communities and A2 is more frequent in central subpopulations. Ethnographic accounts of sub-population fissions and subsequent forced migrations after the 18<sup>th</sup> century, congruent with these results, leads to the conclusion that the disruption of the Rama's traditional way of life by non-indigenous migrants has had significant consequences on their population structure.

#### ***Proconsul's basicranial morphology and its implications for understanding catarrhine evolution.***

ASHLEY D. BAIRES. Anthropology, New York University, Anthropology, New York Consortium of Evolutionary Primatology.

Basicranial morphology, particularly in the region of the petrous temporal, indicates that *Proconsul* is a stem catarrhine. Thirty characters from the temporal and occipital region were coded for 10 species of extant anthropoids, as well as for *Proconsul* and *Victoriapithecus*. Both metric and non-metric characters were used. Metric data were analyzed using two separate methods. First they were discretized, as is standard practice for dealing with continuous characters in phylogenetic analyses, using Simons' homogeneous subset method. The second analysis applied Goloboff's method, which avoids discretization by treating continuous characters as additive and ordered,

allowing direct application of Farris' algorithm. Although the characters included in the phylogenetic analysis were not able to produce a fully resolved anthropoid tree, consistent with anthropoid relationships derived from molecular data, they were able to accurately determine the relationships between major clades. The results of this study show that *Proconsul* does not express any synapomorphies in its basicranium that would link it with crown Hominoidea. In addition, a principal components analysis demonstrates that *Proconsul* is phenetically similar to *Victoriapithecus*, grouping *Proconsul* with cercopithecoids rather than hominoids. Not only, as has been observed in the past, is *Proconsul* postcranially 'monkey-like', but it also retains a primitive 'monkey-like' morphology in the basicranium. These findings highlight the importance of additional detailed and fine-scale phylogenetic analyses to help resolve the question of *Proconsul*'s phylogenetic position within Catarrhini.

**A functional imaging study of "jealousy" in captive male titi monkeys (*Callicebus cupreus*).**

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Understanding the neurobiology of social bonding in non-human primates is a critical step in understanding the evolution of monogamy. Titi monkeys (*Callicebus cupreus*) form strong pair-bonds, characterized by selective preference for their pair-mate, mate-guarding, physiological and behavioral agitation upon separation, and social buffering. In the current study, we used functional imaging to examine how males viewing their pair-mate in close proximity to a rival male would induce "jealousy" and change central glucose uptake. Animals were injected with 1 mCi/kg of [F-18]-fluorodeoxyglucose, returned to their cage for 30 min of conscious uptake, placed under anesthesia, and then scanned for 1 hour on a microPET P4 primate scanner. During the uptake period, males (n = 8) had a view of either their pair-mate next to a stranger male ("jealousy" condition) or a stranger female next to a stranger male (control condition). Positron emission tomography was co-registered with structural magnetic resonance imaging. Mixed-models analysis found that the left lateral septum and right posterior cingulate cortex showed higher glucose uptake in the jealousy condition compared to the control condition (p<0.05). The lateral septum has been shown to be involved in mate-guarding and mating-induced aggression in monogamous rodents, while the cingulate cortex has been linked to territoriality. There was a trend for higher left caudate uptake in the "jealousy" condition (p<0.10). Left caudate activity was also positively correlated with duration and frequency of lipsmacking (affiliative) behavior during the uptake period. Putamen (another part

of the "reward system") activity was also correlated with lipsmacking behavior.

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**Nitrogen limitation in Bornean orangutans in a peat swamp habitat.**

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Bornean orangutans (*Pongo pygmaeus wurmbii*) prefer to consume fruit but rely heavily on fallback foods when fruit is scarce. Although some fallback foods (e.g. leaves) have higher protein than fruits, previous research in a Dipterocarp forest has shown that the total amount of protein ingested per day is lower when fruit is scarce, primarily because the total amount of food consumed is lower. Very little is known about nutrient intake in lower-quality peat-swamp forests, where fruit masting is rare and the percentage of fruiting trees remain relatively low year-round. Thus, the ability to consume, process, and metabolize fallback foods becomes critical to maintain a steady-state of protein balance. We tested the hypothesis that during periods of fruit scarcity, orangutans have lower protein intake and lower urea concentrations, suggesting nitrogen recycling. We also examined ketone bodies in urine as evidence of ketosis. Urine samples were collected from habituated orangutans at the Tuanan Research Station in Central Kalimantan, Indonesia. We analyzed 63 urine samples from 12 individuals collected between 2009-2010.

Preliminary analyses indicated a positive relationship between urea concentration ( $\mu\text{M}$  urea/ $\mu\text{M}$  creatinine), protein availability, and protein intake (total grams/day). There was some evidence of age-class and sex differences in urea concentration for specimens sampled during the same months: independent immature males and females without offspring had lower urea concentrations. Our data suggest that Bornean orangutans in this peat swamp habitat are able to maintain a positive or neutral protein balance state by recycling nitrogen in the form of urinary urea.

**The role of ecology and human activities in determining abundance and occupancy within fragmented primate communities of northern Madagascar.**

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Human population trends in many of the countries that support tropical forests where the majority of the world's biodiversity resides,

often exceeds a 3% annual growth rate, a pattern which reflects a growing interface between humans and wildlife. As management strategies aimed at conserving wildlife are considered, a critical step involves distinguishing between the impact of human activities and natural phenomena on wildlife populations. We censused diurnal primates using standardized line transect methodology (>1200 km walked between July 2013 and July 2012) and sampled ~1.5 ha in intensively studied forest fragments in northern Madagascar (n=12) using botanical assessment techniques. During the same period we repeatedly visited a subset of smaller (<100 ha) forest fragments to assess primate presence-absence patterns across the landscape. We quantified factors associated with the spatial, structural and compositional characteristics of forests in addition to those describing patterns of human disturbance. We used generalized linear mixed models to assess the relative impact of these factors on primate abundance and occupancy, controlling for site identity. Results varied across species yet collectively, ecological factors (e.g. substrate type and sympatric primate density) were the most informative in explaining variation in primate densities and occupancy patterns. Despite the strong relative importance of ecology, human driven factors (e.g. fire) did improve the predictive power of some models without sacrificing overall model fit. These results reinforce the importance of multi-factorial approaches to modeling primate densities and distribution while highlighting the value of stratified sampling to address both local and regional management considerations.

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**Using spatial structural equation modeling as a novel approach to understanding primate community composition and diversity.**

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Primate community composition and diversity has largely been explained by three separate processes: (1) niche-based processes (deterministic), (2) dispersal limitation and environmental stochasticity (stochastic), and (3) biogeographic dispersal barriers (biogeographic processes). However, no communities are shaped purely by a single process and discerning the extent to which these processes affect community composition is not possible without the use of an integrated model. Here I show how spatial structural equation modeling (SSEM) is a novel approach for estimating the roles of deterministic, stochastic, and biogeographic processes on measures of community composition and diversity, while also considering spatial dependence. SSEM allows for the examination of causal links and spatial dependence in models of process and community metrics simultaneously. SSEM is an extension of structural equation modeling (SEM), and allows for explicit modeling and testing of theoretical considerations underlying the spatial structure of

the data. In contrast to traditional multiple regression models (which can only deal with one response variable), SEMs allow the consideration of hypothesized causal relationships in datasets with more than one dependent variable and the effects of dependent variables on one another. I provide an SSEM of the processes that shape primate and mammal community composition and diversity in Madagascar and Australia. Understanding the roles deterministic, stochastic, and biogeographic processes have in determining patterns of diversity have practical implications for predicting community responses to anthropogenic change and for distinguishing the extent to which each process has shaped both extinct and extant communities.

**Changing our focus: Accentuating evolutionary changes of the hominid cranial base.**

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The evolutionary changes of the hominid cranial base have been studied and debated extensively. Most authors tend to contrast pongids with humans, usually examining the midline, especially the basicranial angle. Studies of shape changes of the endocranium tend to focus on cortical expansion in humans, perhaps overshadowing other evolutionary process that happened in the lower endocranium.

In order to assess changes within the lower endocranium, we used 3D geometric morphometric to capture the shape of the whole endocranium in humans and chimpanzees (n=30). 229 landmarks and semilandmarks were acquired for the whole endocranium, and 122 landmarks and semilandmarks were acquired separately for the lower endocranium. A color-coded vector map was produced to visualize shape differences between groups. Data was analyzed in three parts: we compared the whole endocranium without omitting size; the same was done while omitting size, thus observing just shape. Finally, we compared the shape of the lower part of the endocranium.

We found that while including size, the upper part of the endocranium, contributes mostly to shape changes. Omitting size brings out the changes in the frontal and parietal area, and some changes within the cranial base, such as anterior movement of the foramen magnum. Looking just at the lower endocranium, the evolutionary changes become clear: anterior movement and angular changes of the posterior cranial fossa; expansion of the temporal lobes; and expansion of the cerebellar areas.

Adding australopithecines into the analysis emphasizes the fact that major morphological changes took place long before brain expansion.

**Variable temporal-insular neuroanatomy in primates with attention to Eastern gorillas (*Gorilla beringei*).**

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In primates, the Sylvian fissure lies on the lateral side of each cerebral hemisphere, separating the temporal lobe from the frontoparietal operculum. In this study we describe an atypical feature of the neuroanatomy in this region that is selectively present in a minority of primate species. We have observed fusion of the posterior temporal and parietal cortices present in most Eastern gorillas, but rarely in other primates. This fusion occurs between the temporal lobe (often including Heschl's gyrus in great apes) and the posterior dorsal insula, such that a portion of insular cortex is isolated from the Sylvian fissure.

We examined magnetic resonance images and Nissl-stained and immunolabeled (for parvalbumin, calbindin, neurofilament proteins, and VGLUT2) histological sections from 26 primate genera. A fusion between temporal cortex and posterior insula was observed in most Eastern gorilla (*Gorilla beringei beringei* and *G. beringei graueri*) specimens, but rarely in other great apes. Four monkey genera (*Aotus*, *Alouatta*, *Callicebus*, and *Saguinus*) and six strepsirrhines (*Avahi*, *Eulemur*, *Indri*, *Loris*, *Otolemur*, and *Varecia*) showed occasional temporal-insular fusion. Fusions were categorized by hemisphere and were found bilaterally in almost all Eastern gorilla specimens, but were equally likely to be bilateral or unilateral without directional bias in other species.

We suggest that this fusion between auditory and somatosensory cortex is an example of a rare and randomly distributed neuroanatomical feature that has become common in Eastern gorillas, likely through a bottleneck effect. Characterizing the phylogenetic distribution of this morphology highlights a derived feature of these great apes.

**Ecomorphology of the bovid astragalus: body size, function, phylogeny and paleoenvironmental reconstruction.**

W. ANDREW BARR. Department of Anthropology, University of Texas at Austin.

Many antelopes (bovids) are habitat specialists, making them valuable for paleoenvironmental reconstruction. Astragali are frequently the most abundant postcranial skeletal element in fossil collections. Thus, bovid astragali offer a robust statistical sample for inferring past habitats, provided astragalar morphology reflects habitat preference. Bovid are known to differ in degree of cursoriality due to habitat-dependent strategies of predator avoidance.

Previous work on the ecomorphology of the bovid astragalus relied heavily on raw measurements with little or no functional justification. Indeed, a recent study (Klein et al., 2010. *Journal of Archaeological Science* 37:389–401) suggests that prior work on astragalar ecomorphology merely captured body size differences between habitat groups. The functional links between bovid astragalar morphology and habitat are poorly understood.

In this study, I test two functional hypotheses relating astragalar morphology to habitat preference. Highly cursorial bovids living in structurally open habitats are hypothesized to have (1) greater parasagittal range of motion at the ankle and (2) more pronounced “spline-and-groove” morphologies promoting lateral joint stability compared with less cursorial bovids occupying structurally closed habitats.

I laser-scanned 100 bovid astragali from 35 different extant species across the habitat spectrum. I collected a dataset of 10 measurements with predicted functional relevance, corrected them for body size using a geometric mean of all measurements and used Phylogenetic Generalized Least Squares (PGLS) to control for phylogeny. Results demonstrate significant morphological differences between habitat groups consistent with functional hypotheses. This study validates the use of the bovid astragalus as a habitat predictor.

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**Bilateral asymmetry of humeral torsion and length in African apes and humans.**

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While forelimb asymmetries have been well documented in the human skeleton, few studies have documented such asymmetries in the African apes, even though these are potentially informative about the origins of functional lateralization in humans and non-human primates. We report the magnitude (absolute asymmetry) and direction (directional asymmetry) of asymmetries in humeral torsion and humeral length in paired humeri of 40 *Gorilla gorilla*, 40 *Pan troglodytes* and 40 *Homo sapiens*. Here, we test whether absolute (%AA) and directional (%DA) asymmetries differ

between measurements, between species and between sexes. Our results show that: (1) humans are unique in being strongly right-lateralized for both measurements, which is consistent with handedness patterns; (2) humans are also more asymmetric than apes in length, suggesting the presence of pressures favoring the maintenance of limbs of similar lengths in apes and/or larger more dominant right arms in humans; (3) contrary to expectation, torsion asymmetries in apes occur in the same magnitude as in humans, suggesting that individual preferences are responsible for functional lateralization in apes, whereas in humans this is a population-level pattern; (4) sex differences in torsion directionality are observed in gorillas, but not chimpanzees, consistent with behavioral differences linked to body size dimorphism in this species, and sex differences in length asymmetry are found in humans, consistent with previous studies; finally, (5) torsion asymmetries are more pronounced than length asymmetries in all samples, consistent with higher levels of plasticity in humeral torsion in response to biomechanical stimuli and greater genetic canalization of lengths.

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#### **Activity and functions of the human gluteal muscles in walking, running, sprinting and climbing.**

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Enlargement of the gluteus maximus (GMAX) was an important adaptation in the evolution of human locomotion, but the functional purpose of this enlargement is less certain. No single study has quantified GMAX activation across the range of locomotor gaits and speeds for the same subjects, thus comparing relative electromyography (EMG) amplitudes has not been possible. Therefore, we assessed the EMG activity of the gluteal muscles during walking, running, sprinting and climbing. We hypothesized that the inferior and superior GMAX would be most active during sprinting and climbing. To gain further insight into the contribution of the gluteal muscles during running, we measured muscle activity during walking and running with external devices that either increased the torso's moment of inertia or the hip extensor torque, increasing or decreasing the need to control forward trunk pitch. We hypothesized that the superior GMAX EMG would be most active when the need for trunk pitch control was increased and vice versa. We found that GMAX activity was greatest in sprinting, similar in running and climbing, and least in walking. Further, only the inferior GMAX significantly increased in activity when forward trunk pitch increased. Our data suggests that the large size of the GMAX reflects its role during rapid and powerful movements such as sprinting and climbing and that the superior GMAX does not control forward trunk pitch.

Although this study is not extensive enough to make any definitive evolutionary conclusions, it demonstrates that the GMAX plays an important role in numerous modes of locomotion.

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#### **3D analysis of human ribcage ontogeny.**

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Detailed knowledge of 3D-thoracic growth is poor despite the obvious morpho-functional implications for respiratory function, and the development and evolution of body shape. A major problem in studying ribcage growth is the difficulty to quantify the 3D-curvature and relations of the ribs and spine. Thus, most studies have so far relied on analyzing traditional measurements such as distances and indices on single or a few ribs.

On the basis of such analyses it is currently known that: 1) adult-like thoracic shape is achieved early, by the end of the second postnatal year, transforming the circular cross-section of the newborn thorax to the ovoid shape of adults; and 2) that the ribs become inclined such that their anterior borders are inferior to their posterior ones.

We revisit growth changes by using geometric morphometrics. We digitized 402 (semi)landmarks on 3D reconstructed ribcages to assess growth changes in 24 CT-scanned modern humans representing newborns to adults of both sexes.

Our analyses show a curved ontogenetic trajectory. Adult thoracic morphology is achieved later than predicted, by diverse modifications in different anatomical regions during different ontogenetic stages. Besides a marked relative increase in antero-posterior dimensions, there is increase in medio-lateral dimensions in the upper thorax, relative to a decrease in the lower thorax. This transforms the pyramidal-shaped infant thorax into the barrel-shaped one of adults. Rib descent is produced by complex changes in 3D curvature.

We discuss developmental differences in upper and lower thorax units regarding respiratory function and the ontogeny of body shape.

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#### **Bioarchaeology of an Early Bronze Age mortuary complex at Tell Umm el-Marra, Syria.**

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From 2000 to 2006, excavations of an Early Bronze Age, elite mortuary complex at Tell Umm el-Marra, Syria, have yielded human skeletal remains of at least 35 individuals buried over the course of about three centuries (ca. 2500--2200 BC). The author collected standard bioarchaeological data from the remains recovered up through the 2006 field season. Results of preliminary analyses of the data are reported here, and future research directions are considered. The assemblage represents at least 35 individuals---19 adults and 16 juveniles---and general preservation is good. Of the adults, males and females are equally represented. Most juveniles are neonates and were frequently buried with equid skeletons in separate installations outside the tombs. Overall, individuals exhibit good dental health with few caries or evidence of periodontal disease. Periostitis is the most common pathological lesion, and two individuals exhibit cribra orbitalia. One interesting case of paleopathology is an adolescent with extensive osteoporosis. Carbon and nitrogen stable isotope ratios, derived from skeletal and dental collagen, support archaeobotanical evidence for a diet based heavily on cereal grains and ovicaprids. The presence/absence of dental nonmetric traits may reflect some relatedness of individuals buried within the complex. Although the small sample size limits interpretation of these results, future excavation and analyses (ancient DNA) could provide more information on the biology of the elites (and, perhaps, nonelites) buried during a period of development at the site and urbanism in western Syria.

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#### **Evidence for the intensive-exposure and cross-sex transmission hypotheses in epidemic poliomyelitis mortality patterns in southern Ontario, 1910-1937.**

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Poliomyelitis was a major emerging epidemic disease in the early 20<sup>th</sup> century, and models of its epidemiology continue to be revised. Nielsen and colleagues have recently presented two new hypotheses: 1) that polio severity is related to intensity of exposure, creating a U-shaped age curve rather than a linear increase in severity with age, and 2) that polio severity increases when transmission occurs between opposite sexes, and therefore the sex ratio in severe polio cases will be more equal when family sizes are larger.

Data for polio deaths in Ontario's Wentworth and York Counties from 1900-1937 were gathered from a variety of archival sources, including birth, marriage, and death registrations and census records, and entered into an Excel database.

Analysis of mortality patterns in this sample revealed two distinct stages within the study period, discussed in part here. Stage One (1910 to 1927) is characterized by an equal sex ratio and a median known family size of 4. Stage Two (1928 to 1937) is characterized by excess male deaths and a median known family size of 2. For 1910-1937 inclusive, the sex ratio for ages 0-19 was 2.6 in families of 1-2 children and 0.9 in families of  $\geq 3$  children. A U-shaped age curve was observed in the 1928-1937 period, with a dip at ages 7-8, but not in 1910-1927. These results support Nielsen and colleagues' cross-sex transmission hypothesis and intensive-exposure model, tying polio mortality patterns to demographic shifts in the early 20<sup>th</sup> century and indicating further research is warranted.

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#### **A tale of two tombs: Craniosynostoses from the Bronze-Age city of Qatna (Tell Mishrife, Syria).**

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Craniosynostosis is a rarely occurring premature obliteration of cranial sutures. Well-preserved cases are extremely rare in the archaeological record. Here we present two specimens likely exhibiting this condition, which were found in the "Royal Hypogeum" and Tomb VII, two rock cut tombs discovered underneath the Royal Palace of the Bronze-Age city of Qatna, Syria, one of the most important cities of the region in the 2nd millennium BCE. The tombs were excavated between 2002 and 2010 by a team from the University of Tuebingen, Germany.

External examination and Computed Tomography of the two crania revealed indications for craniosynostosis. A well preserved adult cranium (q1235-401) from Tomb VII exhibits a distinct turri-/ oxycephaly. It is assumed that premature obliteration of the sagittal and the coronal sutures is responsible for the deviant shape of the cranium. Additional signs, supporting the diagnosis of craniosynostosis, are abnormal thinning of the bones of the cranial vault (< 1 mm), in both parietals and a distinct beaten-copper-pattern on the internal surface of the frontal bone. The second cranium (MSH02G q1076) is from a 14-16 year old individual from the Royal

Hypogeum. Parts of the sagittal suture exhibit beginning premature obliteration.

Considering the very low incidence of craniosynostosis and its congenital nature, the discovery of a possible case in each tomb could represent a long-sought link between the two separate tombs. It is suggested that these individuals might be related and that members of the same royal or elite family were buried in both tombs.

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#### **Foodways and polity formation: A bioarchaeological analysis of the Xiongnu Using dental microwear texture analysis and pathological conditions.**

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The current study applies the technique of dental microwear texture analysis (DMTA) to archaeological populations from Mongolia to address what role, if any, foodways played in the formation of the first nomadic polity in eastern Eurasia, the Xiongnu (500 B.C.-A.D. 155). Previous anthropological studies have examined the development of the Xiongnu polity through the lens of dependency theory, meaning the polity was only able to fully develop and maintain its power through a web of connections between themselves and sedentary outsiders. This is highlighted in the Chinese ethnohistoric record that outlines numerous accounts of the Xiongnu's desire to obtain agricultural foods through raiding or trading with Chinese border markets. The current research uses DMTA variables (anisotropy and textural fill volume) and dental pathological conditions to compare two distinct time periods in Mongolian prehistory: the Late Bronze-Early Iron Age (1200-300 B.C.; characterized by the growth and expansion of mobile pastoralism) and Xiongnu period (characterized by increased interaction with China and the rise of the Xiongnu polity). The low occurrence of dental pathological conditions (14/167 individuals had carious lesions) and texture results (high anisotropy and low textural fill volume) indicate that little to no difference can be viewed between these two time periods, thus suggesting that among the observed samples little dietary variation can be accounted for between the two time periods.

#### **Correlates of dispersal limitation in African mammal communities.**

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A variety of factors, including local ecology, historical biogeography, and

interspecific competition, influence species distributions and co-occurrence patterns. Unlike other large-bodied animals, communities of primates are more strongly structured by dispersal limitation than by environmental filtering in tropical forests. Here we investigate the extent to which primates may be outliers compared to broader mammalian communities.

We compiled species presence-absence data from the published literature for 260 mammal species at 206 sites across Africa. For each site we compiled geographic coordinates and environmental data on rainfall, temperature and altitude. We conducted a cluster analysis to identify biogeographic regions containing sites with similar communities of species. We then performed partial Mantel tests for each cluster to determine the relative influence of environmental conditions and geographic distance between sites on community composition in each region. Results show that communities of primates are not outliers when compared to the broader mammal community, but are instead representative of the processes structuring their respective communities. Moreover, analyses revealed a latitudinal gradient with equatorial regions more strongly structured by dispersal limitation and an increase in the importance of environmental factors with increasing distance from the equator. We investigate the role of functional traits in producing this pattern.

Our results suggest that positioning primate communities within a broader phylogenetic context provides insight into mammalian community patterns at large spatial scales and allows understanding of the role of primates within this larger context. We highlight the need for analogous inquiry in other biogeographic regions.

#### **Dental evidence of changes in female social status during the Middle to Late Woodland transition.**

JESS BECK. Department of Anthropology, University of Michigan.

The Middle to Late Woodland transition in the lower Illinois River valley (2000-1100 BP) is well documented both archaeologically and bioarchaeologically. Previous studies have generally focused on a single health variable within a given sample, and illustrate the biologically deleterious consequences of the increasing dependence on agriculture for local populations. Importantly, recent models of Woodland social organization have posited a shift in the economic power of females over the course of the transition, as mortuary treatments become more egalitarian and household architecture reflects a shift from communal long houses to nuclear domiciles. The biological import of this change in female social status has yet to be investigated.

Here I test of the hypothesis that the increasing economic power of Late Woodland females had significant, skeletally visible health consequences. Data were collected on four dental health indicators (caries, linear enamel hypoplasias, abscesses and antemortem tooth loss), for a sample of 43 Middle Woodland and

42 Late Woodland individuals, controlled to balance age structure, sex and skeletal completion. In contrast to previous research, this study examines multiple dental health indicators simultaneously while testing the bioarchaeological significance of changes in Woodland social organization. Statistical tests reveal significant trends in multifactorial aspects of dental health, which address the relationship between increases in female economic power and skeletal indicators of dental health during the Middle to Late Woodland transition.

#### **The impact of testosterone fluctuations on competition in women.**

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The body of literature regarding male competition for mates is robust; the same cannot be said of female intrasexual competition. Female primates invest heavily in their offspring and are choosy when it comes to mate selection, yet this does not mean they do not compete for access to high-quality mates. Two types of indirect competition most favored by women are derogation of competitors and competition through self-enhancement. Recent research has indicated that women may experience a change across the menstrual cycle in certain behaviors that could foster this competition, particularly sexual initiative, mood, assertiveness, and self-esteem. Testosterone has been suggested as a possible mediator in these competitive behaviors, although studies of testosterone and competition have returned conflicting reports in humans. The present study followed 36 women through 2 menstrual cycles using physiological sampling, psychological surveys and competitive play in an Ultimatum game. There was a significant direct correlation between the interaction of testosterone across the cycle (levels and change) and direct competition in the Ultimatum game. Overall assertiveness was not significantly correlated with testosterone levels, although some of the interactions of assertiveness variables were, indicating a possible relationship between some aspects of assertiveness and testosterone. These results indicate a possible role of testosterone in mediating female intrasexual competition, although these connections require further study.

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#### **Evidence of osteoarthritis during the Tiwanaku State in Bolivia and Peru (AD 500-1100).**

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Osteoarthritis (OA) from approximately 1,235 adults was used to evaluate Tiwanaku peoples for changes in activity and movement between the core of the state in highland Lake Titicaca, Bolivia and colony sites in the lower

elevation Moquegua Valley, Peru. Of primary importance to this study was the pattern and level of involvement, as OA is part of a family of degenerative joint diseases potentially indicating repetitive movement in various areas of the body. As such, data from 25 different articular surfaces within seven joints, shoulder, elbow, wrist, sacroiliac, hip, knee, and ankle, were evaluated and for the presence/absence and scalar differences of OA. Statistical comparisons using Generalized Estimating Equations with the chi-square statistic showed evidence of higher modeled rates, more intense joint use, and significant results in the core area of the Tiwanaku state in both the upper and lower body. These results point to repetitive movement differences among those living in the core and lesser repetitive tasks among Tiwanaku colonists, which was the less expected result if Tiwanaku was a traditional hierarchical and centralized state. Highland females also had OA joint differences in areas of the body, such as the sacroiliac, while female colonists had higher modeled rates in the lower limbs, indicating greater mobility among these women. Additionally, age-related OA differences were noted in individuals from both regions, especially from peoples who died in their thirties during the Tiwanaku state.

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#### **What can fecal testosterone tell us about the life history of male kinda baboons?**

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Recently, it was shown that male testosterone profiles from three non-seasonally breeding primates (yellow baboons, *Papio cynocephalus*, chacma baboons, *P. ursinus*, and geladas, *Theropithecus gelada*) track life history variables, including the start and end of the reproductive period within the lifespan. Here, we examine testosterone profiles from male kinda baboons (*Papio kindae*), a species whose life history and reproductive behavior are little known. We use age-specific testosterone profiles from these other three species to speculate on the reproductive trajectory of kinda males. Testosterone was extracted from fecal samples (N=30) collected during trapping conducted in 2011 near Chunga Camp, Kafue National Park, Zambia. Ages of males were estimated from dental eruption and wear patterns. Overall, results indicate that kinda male testosterone profiles exhibit the typical inverse-U pattern across age. Kinda males exhibit adult levels of testosterone at an earlier age (~5 y) than the

other three species. Additionally, kinda males demonstrate sustained levels of testosterone into older age categories. To the extent that high testosterone is associated with reproductive activity, the kinda profile suggests that males may mature earlier than other closely-related species. Further, rather than a discrete window of testosterone secretion (and reproduction, as exhibited by geladas and chacma baboons), kinda males continue to have elevated testosterone beyond prime age categories (similar to yellow baboons). If further samples confirm this profile, then this suggests that kinda baboons may not have high reproductive skew associated with male dominance. Confirmation of this prediction will have to await longitudinal behavioral data.

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#### **A comparison of dental eruption patterns and their possible life history implications in two sympatric fossil catarrhines from Rudabánya, Hungary.**

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*Rudapithecus hungaricus*, a stem hominine, and *Anapithecus heryaki*, a stem catarrhine, are both known from the late Miocene locality of Rudabánya, in northern central Hungary. Fossils of both taxa are found in close proximity, providing strong evidence of sympatry. Both taxa were arboreal, at least partly suspensory, frugivorous and possibly overlapping in body mass. Though there are differences in the details of diet and positional behavior, it is interesting to examine other possible distinctions that may have allowed them to inhabit the same forest at the same time. One specimen of a juvenile *Rudapithecus* with a nearly complete dentition is known (RUD 14 + 11 & 70). Several specimens of juvenile *Anapithecus* are also known.

*Anapithecus* experienced extremely rapid development and eruption of the dentition, possibly including loss of the deciduous incisors before birth (Nargolwalla et al., 2005). More complete individuals have fully formed crowns and roots of most of the teeth, as in some prosimians. In contrast, RUD 14 shows a modern catarrhine pattern of dental eruption. Canine eruption is delayed (crypts are preserved) and the M<sub>3</sub> is not crown complete, while the premolars and M<sub>2</sub> are just entering into occlusion. This pattern distinguishes *Rudapithecus* from *Anapithecus* and aligns the former with extant hominids. Life history differences are far more pronounced than other behavioral differences in distinguishing *Rudapithecus* and *Anapithecus*. It is possible that pliopithecoid-hominid sympatry in Eurasia provided selection for the delayed life history strategies that characterize extant hominids.

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### Effects of wrappings on the decomposition process.

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Decomposition is a process that happens to every deceased individual. Understanding how decomposition works and how long each stage takes is crucial to being able to determine Time Since Death (TSD) or the Post Mortem Interval (PMI) in forensic cases. There have yet to be many studies done looking into the effect of wrappings or coverings, other than clothing, in retarding decomposition of a corpse. The purpose of this research is to improve our understanding of how a body being wrapped in various materials affects the decomposition process.

This study was conducted at the Forensic Anthropological Research Facility in San Marcos, Texas. Since human cadavers were not available at the time of study, three pigs were used as replacement specimens. One was wrapped in a plain, cotton bed sheet while the other was placed into black garbage bags. The third pig was left uncovered and served as the control. All three pigs were placed inside a cage intended to deter scavengers. Data such as outdoor daily temperature and conditions, written and photographic documentation of visual observations, and internal temperature of the specimen was collected. It was hypothesized that the coverings would have an accelerative effect on the decomposition process. The garbage bag accelerated the decomposition process while the sheet slowed the process to an extent. The results from this research will help shed light on one of the many variables of the decomposition process and assist in the calculation of TSD and PMI in forensic cases.

### Stress in Archaic Texan hunter-gatherers: An assessment of linear enamel hypoplasias.

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Digital photographs taken under controlled conditions were used to examine the incidence of linear enamel hypoplasias (LEHs) in the Buckeye Knoll population (41VT98 Victoria county, Texas). These burials span the Early to Late Archaic (ca. 2500-6500 B.P. uncorrected radiocarbon). This method provides an archive for Buckeye Knoll which is of utmost importance, as the skeletal material from Buckeye Knoll has subsequently been repatriated and reinterred. We analyzed incidence and

developmental timing of LEHs in permanent canines only. This population had a mean of 1.28 LEHs and a mode of 1 defect (N=78). There was no significant difference in the number of defects found on maxillary versus mandibular canines. Fifty-nine percent of permanent canines had at least one defect. Average age at first insult was 3.88 years (range 2.7- 4.9 years). The mean overall age of all defects was 4.15 years old (range 2.8-5.3 years). Having an earlier age of first insult was associated with having more LEHs ( $\rho = -.367$ ,  $n = 53$ ,  $p = .007$ ). The range of ages of weaning for hunter-gatherer societies is from 1 year old to 4.5 years old ( $n = 40$  societies in the Standard Cross Cultural Sample). Age of the mean earliest defect for Buckeye Knoll is within this range (mean = 3.88). However, this mean age of insult could also support the hypothesis that developmental timing of most LEHs may be due to greater susceptibility of metabolic disruptions to enamel formation during this developmental window (2-4 years) rather than weaning.

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### Quantifying age related bone loss using measures of anterior cortical width.

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Age related bone loss is effectively quantified through cortical bone histology and past research demonstrates that patterns of cortical bone loss in weight bearing elements tend to be sex specific. Compared to females, males exhibit greater appositional growth and less endosteal expansion over time. Recent research involving the analysis of femoral wedges indicates that anterior cortical width (thickness) is not significantly correlated with age in males but has a significant negative correlation with age in females. This study expands upon these previous findings by evaluating relative cortical thickness, which corrects for body size, to determine its potential as a variable in sex-specific equations for histological age estimation and to evaluate changes to bone mass associated with sex-specific life events (i.e. parity, menopause).

Anterior cortical width (An.Ct.Wi), total cortical width (T.Ct.Wi), and relative cortical width (Rt.Ct.Wi; An.Ct.Wi/T.Ct.Wi) were collected from midshaft femur cross-sections. This study is comprised of 280 known-age individuals (137 females, 143 males), ranging in age between 22 and 97 years. Two-way ANOVA analyses with age and sex as independent variables were evaluated.

Results indicate that a significant negative relationship exists between all measures of cortical width and age in females, but there were no significant relationships found in males. Stepwise regression analysis using multiple histological variables and cortical width

significantly improves age prediction models for females. This study corroborates literature regarding the disparate age-related changes in cortical bone loss between males and females previously observed and reaffirms the importance of using sex-specific equations in histological age estimation.

### Craniofacial variation I: Within-population Procrustes analysis in a sample of Armed Services personnel.

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Characterization of morphometric variation within a targeted population is a critical component in the design of personal protective equipment and the establishment of standards for its effective fitting. In this poster, we report on the initial evaluation of a large set of facial landmark data for a sample of U.S. Marines. Generalized Procrustes analysis removed variation from the data introduced by location, scale, and orientation. The effect of size was reintroduced, leaving only information about form. A principal component analysis revealed patterns of covariation in the data. The first three principal component axes captured 21%, 14%, and 8% of the total variation respectively, while 21 axes were required to capture 90%. Visualization of the first two principal component axes suggested that the first accounts for face size and the second accounts for face height versus width; results that are consistent with previous research into facial variation related to respirator fit testing. Visualization of the third principal component axis accounts for interpupillary breadth relative to face size. This analysis is the first step in developing models that will exploit these patterns in the prediction of overall head shape from craniofacial landmarks and ultimately provide the tools for exploiting much larger, but incomplete, data sets that could be used to inform the design, manufacture, and fitting of protective and therapeutic head gear in military, industrial, and medical fields.

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### Covariance patterns in the human skull: a phylogenetic approach to the structure of human cranial variation.

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Although being a recent field of evolutionary biology, the study of the genetic variance/covariance (V/CV) matrix (G-matrix) is

a promising approach to the investigation of the evolution of complex traits, like the human skull. Assuming the expressive correspondence among G-matrix and their phenotypic counterpart, the phenotypic (V/CV) matrix (P-matrix), we can infer the evolutionary history by means of the quantification of the similarities between P-matrices. In this work our objective is access the structure of the human cranial variation through the investigation of the patterns of covariance of P-matrices inferred from a sample represented by 9,287 skulls from 161 autochthones populations. Each skull was represented for 24 measurements taken in accordance with the Howell's protocol. The P-matrices were constructed for different association groups, following different associative criteria, as location and chronology of the samples. The similarities of P-matrices in each analytical level were inferred through random skewers method, assuming a distribution of 1,000 vectors. Only similarities with statistical significance ( $p < 0.05$ ) were considered. Our results show that P-matrices were not constant among human populations, although the expressivity of the divergence observed between them was generally low. These results are in accordance with similar investigations carried out for another anthropoids and suggests that P-matrices remained relatively similar along the human evolutionary history. Notwithstanding, lower amounts of similarity were observed within minor grouping levels, suggesting that in despite of the general stasis detected in the global pattern, specific evolutionary conditions at population levels played important role in the diversification of the human skull.

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#### **Bioactive factors in macaque milk: relationships with maternal physiology and infant growth.**

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Mother's milk contains nutrients, hormones, and growth factors that exert immediate and long-lasting physiological effects on infants. Several maternal factors are known or thought to have direct effects on relative concentrations and patterns of numerous milk constituents. We investigated 1) whether several bioactive factors, previously not measured in nonhuman primate milk, were detectable in the milk of rhesus macaques, and 2) whether concentrations of these constituents reflected maternal (age, mass, parity, rank) and infant characteristics (growth). We used 177 milk samples from 59 macaque mothers (each contributing samples from early, peak, and late lactation) housed in the outdoor breeding colony at the California National Primate Research Center. Using standard parallelism and recovery tests, we validated enzyme immunoassays (R&D Systems, Minneapolis) measuring epidermal growth factor (EGF), its receptor (EGF-R),

adiponectin, transforming growth factor beta-2 (TGF- $\beta_2$ ), and insulin-like growth factor II receptor (IGF-IIR). Linear mixed models, controlling for total milk volume and repeated measures, show that adiponectin, EGF, and EGF-R all increased significantly from early to peak, and peak to late lactation. Increases from peak to late lactation were noted in TGF- $\beta_2$  and IGF-IIR. Younger mothers had higher milk adiponectin concentrations than prime or aged mothers. Adiponectin and EGF varied with rank in an inverted U-shape; mid-ranking mothers had higher concentrations than did high- or low-ranking mothers. Lastly, infant daily growth rate was positively correlated with the concentration of EGF in milk. These results illuminate new pathways for the investigation of early life programming through the transfer of bioactives in milk.

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#### **How does food item size affect optimal tooth sharpness?**

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Models of the masticatory process suggest that tooth shape is correlated with the internal material properties of the foods that animals eat, while the size of food items is correlated with tooth size. Here, we investigate the idea that during fracture of a brittle hemisphere with constant material properties, optimal tooth sharpness is constant regardless of food item size.

We utilized finite element analysis (FEA) and a parametric model of a bunodont maxillary molar to test this hypothesis. Tooth sharpness was varied in the buccolingual and mesiodistal directions while all other parameters were held constant. We tested four isometrically-scaled hemispherical food items, in which the radii of the hemispheres were equal to 1/3, 2/3, 3/3 and 4/3 the distance between the cusps. Optimal tooth shape was defined by maximizing the optimality function (tensile stresses in the food item) / (tensile stresses in the enamel). We developed a morphospace for each hemisphere size using the Taguchi method to randomize tooth sharpness values, and compared the optimal morphologies from each morphospace.

As the size of the hemispheres increased, the hemisphere went from interacting primarily with the valleys between the cusps to interacting with the cusps themselves, fundamentally changing the contact mechanics between the food item and the tooth. This altered the stress distributions in both the hemisphere and the

tooth. The results caused us to reject our null hypothesis. It appears instead that optimal tooth sharpness changes as food item size changes, even when food item material properties and shape are held constant.

This work is supported by the National Science Foundation Physical Anthropology HOMINID program (BCS 0725126, 0725147, BCS 0725078, 0725183, and 0725141) and the National Science Foundation Biomechanics Grant (DBI 0743460). NSF was not involved in this research.

#### **Microstep by microstep across dental cementum: Microanalysis of the alternating yearly deposits.**

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Although the ultrastructural nature of the dental cementum is still an open question, appositional layers are used more reliably than other morphological or histological traits of the adult skeleton to estimate individual age-at-death. Considering that the alternating dark and light rings seen under light microscope reflect cementum composition and organisation variations, the ability to follow elements into the tooth matrix may provide an objective technique to identify alternating deposits.

By means of Environmental Scanning Electron Microscopy equipped with Energy-Dispersive X-ray Spectroscopy and Raman Spectrometry, dental cementum was studied in selected modern teeth of known individuals. The organic content, mainly collagen and the major elements of the inorganic content, mainly apatite, were measured along linear paths crossing the cementum deposit to verify if the position of the peaks and their number correspond to the number and positions of the layers in light microscopy. Linescans suggest a link between chemical composition variations across the width of cementum and incremental lines. Spot analyses have been done with the aim to discuss intra-dental variation in elements concentrations and reveal for some deposits a significant difference in calcium proportion.

A first application of this methodology to archaeological samples excavated from the Saint Amé's Collegiate Church (A.D. 950-1797) in Douai (Northern France) is presented and discussed.

**The legacy of Dr. Karen Ramey Burns: A focus on the individual in forensic and bioarchaeological contexts.**

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Since the emergence of both forensic anthropology and bioarchaeology, scholars have spent considerable amounts of time describing skeletal remains of individuals. As a student of the late William Maples who was known for his analyses of notable individuals such as the conquistador Francisco Pizarro and President Zachary Taylor, Karen Ramey Burns was trained in this intellectual tradition. During her remarkable career, Kar Burns contributed to the study of the individual through her analysis of well-known cases such as the Polish-born Revolutionary War hero Casimir Pulaski and the American aviator Amelia Earhart. Burns also spent time placing emphasis on individuals such as those victims from the Raboteau Massacre in Haiti. In the ensuing trial, Burns initiated the first use of physical evidence in a Haitian court that led to the successful prosecution of many perpetrators of human rights abuses, including military leaders. Recently, bioarchaeologists have embraced the individual as a discrete unit of analysis in an emerging body of work included within a framework of social bioarchaeology. These scholars generate osteobiographies of individual skeletons in order to examine social contexts of identity and life-history. Analyzing individual skeletons has allowed scholars to consider new questions on topics ranging from physical impairment to political resistance. Using a published case of an individual skeleton recovered from the DeArmond site in Roane County, Tennessee during the illustrious WPA-era excavations of the 1940s, we hope to contribute to the discussion related to the study of individuals and the bioarchaeology of impairment and social constructions of disability.

**Caries prevalence and the late prehistoric Dallas phase: A regional cultural pattern of female maize consumption in Late Prehistoric East Tennessee.**

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Oral health, as a proxy for diet, has been illustrative in exploring within-group and between-groups patterns of consumption reflective of larger cultural trends. Frequently, maize agricultural groups in the Americas have demonstrated higher rates of dental caries and, thus, greater consumption of corn by females, which is often attributed to sexual division of labor and/or pregnancy. However, this pattern is by no means universal and notable exceptions have been reported for several sites, including in prehistoric East Tennessee. The purpose of this paper is to examine the broader trends of oral

health in this region, to assess whether the trend is unique to the cultural group in question, and to investigate potential cultural explanations for the observed patterns.

A total of 475 adult dentitions (219 males, 223 females) were assessed for dental caries, antemortem tooth loss, and dental calculus from five Dallas phase (AD 1300-1550) sites. Statistical comparisons were conducted using chi-square and Fisher's exact ( $p < 0.05$ ). Results indicate that dental pathology does not differ between males and females; however, in an earlier Late Woodland/Early Mississippian period (The Hamilton Mortuary Complex, AD 900-1100), the female prevalence was equivalent to the Dallas phase but males were markedly lower. The lack of temporal difference in female caries rates suggests that patterns of consumption changed in the male segment of society. Comparing the Dallas phase results to Mississippian samples from contemporary and geographically adjacent northern Georgia suggests that this pattern is unique to East Tennessee, reflecting specific cultural consumption patterns of maize.

**Evidence for a substantial effect of neutral microevolutionary processes in shaping male and female human pelvic variation at a global scale.**

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Human pelvic shape variation has often been interpreted in the light of thermoregulatory adaptation and sex-related obstetrical requirements. Although these factors play a role in explaining human pelvic morphology, their effect cannot be fully understood without first taking into consideration the influence of past population history and neutral evolutionary processes. Here, we use a global dataset of human pelvic variation, quantified using 3D geometric morphometric methods, to represent the complex shape of the innominate in both male and female individuals. The quality of pelvic variation was examined via global patterns of apportionment of variance, and by fitting an Out-of-Africa serial founder effect model, which is known to reduce neutral genetic diversity. The possible effects of obstetrical constraints on the female pelvis were explored by contrasting neutral patterns in the male and female datasets, and by comparing variation in the false and true pelvis, whereupon greater constraints in the latter might be predicted. Our results reveal an overall neutrality of pelvic variation, and the preservation of population history effects. In accordance with prediction, obstetrical constraints appear to affect differently the true versus the false pelvis, but no difference in their strength was found between sexes. Although our analyses do not contradict the effect of selective pressures and adaptation on the human pelvis, they do highlight a strong neutral component to

variation, similar to that previously found for cranial morphology.

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**Primates on the menu: predation as a factor affecting primate communities.**

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Predation is widely considered to have driven morphological, behavioral, and cognitive changes in primate prey species throughout their evolution. However, the extent to which predation has affected the coexistence of primates within ecosystems has rarely been examined. To investigate the effect of predators on primate communities, I compared the presence of major primate predators and their potential mammalian prey communities, including preferred and non-preferred mammals within reported prey body size ranges, at eight sites in four biogeographic regions. Results show that African and neotropical sites, all inhabited by both large felids and eagles, had mammalian prey communities with similar proportions of potential primate ( $x=0.24$ ) to non-primate prey ( $x=0.76$ ). In these regions, those sites with more non-primate species that are preferred prey of large felids and/or eagles had communities with higher proportions of primates. The latter trend was not found in Asia or Madagascar where either large felids or eagles are absent and where primates make up higher proportions of prey communities (Asia  $x=0.35$ , Madagascar  $x=0.5$ ).

These results suggest that predation pressure from the combination of large felids and eagles affect primate communities in different regions in similar ways, and that the presence of many species of non-primate preferred prey may release primates from predation pressure, indirectly influencing primate community structure. Further research on past predator presence, current rates of predation on members of primate and non-primate communities, and human effects on predators and prey in each region are needed to help determine the impact of predators on primate communities.

**The endocast of *Sahelanthropus tchadensis*, the earliest known hominid (7 Ma, Chad).**

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Fossil remains assigned to *Sahelanthropus tchadensis* were found in the Toros-Menalla fossiliferous area (Djurab Desert, Northern Chad), in continental sediments dated to 7 Ma by both radiochronologic and biochronologic methods. These fossils, including the famous male holotype cranium TM 266-01-060-1 nicknamed Toumaï, display a number of derived cranial and dental characters, making *Sahelanthropus tchadensis* the earliest known hominid (= sister group of Panids) species.

Fossil hominid endocrasts are the only direct evidence of human brain evolution. The endocrast of TM 266-01-060-1 opens a unique window on the first steps of this evolution just after the split between humans and chimpanzees. As the cranium is filled with highly mineralized matrix, and the inner table of cranial bone is fragmented and distorted, classical methods of endocrast extraction could not be applied. Thus, a special protocol was developed for this cranium, involving 3D X-ray synchrotron microtomography, propagation phase contrast, semi-automated segmentation of the inner table, and correction of postmortem distortion based on both rigid and thin-plate spline transformations. The reconstructed endocrast of TM 266-01-060-1 is compared with older fossil anthropoid endocrasts, modern endocrasts (great apes and humans) and australopithecine endocrasts, taking volumetric, linear and angular measurements and performing a Generalized Procrustes Analysis.

The endocranial volume of TM 266-01-060-1 confirms the data (360-370 cc) already published for the 3D cranium reconstruction. It falls within the variability range of chimpanzees. The studies are still in progress, but numerous features of the brainstem, occipital lobes, and prefrontal cortex, already confirm the hominid status of *Sahelanthropus tchadensis*.

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**The cemeteries of Amara West: Investigating the impact of climate and political change on health and living conditions in an ancient town in Upper Nubia (13<sup>th</sup>– 8<sup>th</sup> centuries BC).**

MICHAELA BINDER. Department of Archaeology, Durham University, UK.

Amara West, located on the left bank of the Nile near the Dal Cataract in northern Sudan, served as the administrative capital of Egyptian-occupied Upper Nubia during the late New Kingdom between 1250 and 1070 BC. Settlement continued after Egyptian control ended until the 8<sup>th</sup> century BC, coinciding with a period of climatic deterioration affecting the

Middle Nile region during the late 2<sup>nd</sup> and early 1<sup>st</sup> millennium BC. Archaeological and paleoenvironmental data from the ongoing multidisciplinary study of the settlement, cemeteries and surrounding landscapes support the notion of significant cultural and environmental changes after the breakdown of colonial control.

This study aims to investigate the impact of these climatic and political changes, likely to have been significant factors in the abandonment of the site, on the health and living conditions of the town's inhabitants. Macroscopic examination of multiple markers of physiological stress and disease including cribra orbitalia, non-specific infection (periosteal reactions on long bones and ribs, maxillary sinusitis, endocranial changes), trauma, stature, osteoarthritis and dental pathology was conducted on human skeletal remains (N=140) recovered from two cemeteries. Both cemeteries contain New Kingdom and post-New Kingdom graves, allowing evaluation of diachronic changes in the inhabitants' health status. Several factors, such as decreasing stature, age-at-death, and high levels of subadult mortality indicate an increasingly challenging living environment during the post-New Kingdom period. An increase in postcranial fractures during the later phase, particularly affecting the axial skeleton, may suggest different subsistence strategies prompted by the changing environment.

**A reappraisal of ancient hypotheses on stress markers using cementochronology.**

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Since Walker and colleague's paper (2009) and the publication of the History of Health in the Western Hemisphere, the causes and demo-dynamique impact of the so-called markers of stress have not been re-addressed. Nevertheless, a general consensus around diet deficiencies and infections during growth periods prevail among bio-archeologists.

The issue of their impact on survival of adults with lesions described as cribra orbitalia (CO), cribra femoris (CF) and hypoplasia (LEH), was tested on two adult French samples (Nurban = 355 and Nrural=250; AD 250-550) whose individual age-at-death was estimated using cementochronology.

No correlation was found between skeletons with and without signs of LEH, while a highly significant difference (> 10 years) was found in favor individuals unaffected by CO and CF.

When compared to a pooled sample of Tuberculosis (TB) skeletons, the survival curves of cribras samples are similar while the TB one looks significantly better. LEH has no impact on the adult median age at death and survival curve

but CO and CF have a significant one (> 10 years).

If the etiology of both cribras occurred during the developmental phases of life, mainly during population crisis, it is difficult to hypothesize why after recovery the healed individuals experienced such a declining life expectancy. A chronic infection or lasting deleterious life conditions associated with very low social status could be the logical explanation.

**Evaluating the agency of Soviet violence workers through analysis of skeletal trauma in the Tuskulenai Case.**

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The Soviet Union's state security apparatus (NKVD) has been characterized as an efficient bureaucracy, which specialized in the identification, detention, and punishment of enemies throughout the Soviet Republics. In particular, Soviet authorities mandated that the only legitimate means of execution was by fusillade, or gunshot to the back of the head. While historical data has largely focused on state officials who organized violence, less attention has been given to agents who actually performed violence in the name of the state. Skeletal analysis of trauma provides researchers with the opportunity not only to study the death experiences of victims, but also to evaluate the behavior and motivation of violence workers. This study analyzes the sex and age of victims, and the nature of trauma in a sample of prisoners executed by the NKVD in the Lithuanian Soviet Socialist Republic from 1944 to 1947. Specifically, this project attempts to understand how patterns of violence differ between two primary execution squads. Based on historical data, no difference in trauma patterns was expected. Preliminary results indicate that the majority of prisoners were young and middle aged males. Additionally, evidence for perimortem trauma differ between the execution squads, with one squad exhibiting up to 90% compliance with state standards while the other demonstrated as low as 50%. Thus, this study reveals that state agents did not consistently adhere to guidelines as established by bureaucratic elites and proposes explanations for the improvisation of violence.

**Accelerating deforestation and hunting in protected reserves jeopardize primates in southern Côte d'Ivoire.**

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Few countries have experienced greater deforestation than Côte d'Ivoire and most

remaining forest is now confined to small protected areas. These habitat islands have become increasingly threatened by an influx of migrants from northern Côte d'Ivoire and other non-forested areas within the country following the contested 2010 election. Conversion of forest into cocoa plantations combined with escalating hunting threatens wildlife in these reserves, including several endangered primate taxa. This paper provides an assessment of primate distributions and abundances based on reconnaissance surveys of six protected forests carried out in 2010-2012. Line transect data are used to estimate group densities and intensity of poaching in each reserve.

Four of six reserves surveyed in southern Côte d'Ivoire have been completely transformed into cocoa farms and have lost 80 – 100% of their primate taxa. Two coastal reserves - Dassioko Sud and Port Gauthier - harbor 50 - 75% of their primate taxa, including two threatened cercopithecids: *Cercopithecus diana* rowley (0.002 groups/Km in Dassioko Sud) and *Cercocebus atys lunulatus* (0.002 groups/Km in Port Gauthier and 0.004 groups/Km in Dassioko Sud). Chimpanzees are believed present in both reserves. Despite the protected status of both reserves, approximately 90% of the undergrowth has been cleared, large trees are being felled/ burned and poaching is abundant: shotgun shell and trap encounter rates are 0.45 - 0.52/km and 0.87 - 0.96/km, respectively. Given the threatened taxa present, urgent conservation action is needed to preserve the Dassioko Sud and Port Gauthier reserves before they and their inhabitants are destroyed.

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#### **Dental connections between Late Pleistocene and Holocene Khoesan populations in southern Africa.**

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Studies of dental variation can provide important insight into the morphological, and presumably genetic, relationships among people across time and space. Although previous studies of crania have suggested a degree of morphological/genetic continuity between Holocene Khoesan hunter-gatherers and earlier Late Pleistocene people, comparably detailed studies of dental variation have not been done. Here, we present an overview of metric and non-metric dental variation in Holocene Khoesan peoples, then compare these data to Late Pleistocene specimens from southern Africa. Khoesan dental data were collected from >400 archaeological samples. Late Pleistocene samples include specimens from Cave of Heaths, Border Cave, Die Kelders, Hoetjiespunt, Hofmeyr, Klasies River Mouth and Sea Harvest Cave. Results suggest that previously published summaries of dental variation in the Khoesan may not be accurate, perhaps due to reliance on recent (admixed?)

populations. There are not significant tooth size differences between Late Pleistocene and Holocene hunter-gatherers. Although only 26 non-metric traits could be evaluated on Late Pleistocene teeth due to preservation and wear, 19 of these demonstrate similarity in both datasets, including shovelling, upper M1 Carabelli's trait, lower M2 Y-groove pattern and lower M1 cusp 7. These data support previous work linking Late Pleistocene with Holocene people, supporting morphological/genetic continuity in southern Africa.

#### **Achieving synthesis: New York's African Burial Ground and the influences of George J. Armelagos.**

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The African Burial Ground of New York City is the most prominent bioarchaeological project at the turn of the 21<sup>st</sup> century. An 18<sup>th</sup> century cemetery for approximately 15,000 enslaved Africans, 419 human remains underwent comprehensive recordation and were interpreted within the context of archaeological and historical studies guided by research questions derived from the descendant, African American, community. The theoretical approaches included the biocultural synthesis taught by Armelagos and many of his former graduate students participated in the study. This approach was well suited to a synthesis with both the critical and activist approaches traditionally employed by African diasporic social intellectuals and political economists, setting the epistemological and ethical framework of the study. This poster examines the process and results of research.

#### **Timing of hibernation bouts in eastern dwarf lemurs.**

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The nocturnal dwarf lemurs of Madagascar hibernate between 3-7 months a year, during the period when high quality resources are in short supply. The triggering stimuli have yet to be identified, though, along with daylength, there are indications that thyroid levels, fat stores, and temperature all play a role. Another aspect of the timing of hibernation, i.e., the time of day when the first hibernation bout occurs, has yet to be documented. It makes energetic sense for hibernation to commence after the daily activity and prior to the individual's resting phase, as then the animal can take advantage of the lower nocturnal temperatures to commence its extended torpor. In order to examine this, we report the timing of hibernation bouts in 10 dwarf lemurs belonging to two sympatric species (3 *Cheirogaleus sibreei* and 7 *C. crossleyi*) from Tsinjoarivo forest, a high-altitude forest in central-eastern Madagascar. Hibernation bouts were identified

by a drop in skin temperature approximating ambient temperature. We employed circular statistics for data analysis and found significant differences, with concentration of hibernation bouts between 22:00 and 4:00 (Rao' Spacing Test,  $p < 0.01$ ) supporting our prediction. Moreover, individuals who experienced hibernation bouts while occupying nests (which are less insulated than tree holes or underground hibernacula) generally began arousals in concordance with peaks of ambient temperature, i.e., noon or early afternoon. Obviously, more research is needed to unveil all of the factors involved in the timing of hibernation.

Margot Marsh Biodiversity Foundation, CI/Primate Action Fund, Primate Conservation Incorporated, Duke Lemur Center.

#### **Diet in the mountains: Using dental pathology to assess subsistence strategies in Paa-ko, New Mexico.**

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Severity, frequency, and location of dental caries have long been used as indicators of subsistence practices, particularly reliance on agriculture. This study uses dental caries data, periodontal disease frequency, and attrition rates to address dietary habits within the prehistoric community of Paa-ko, New Mexico. Reliance on agriculture intensified in western New Mexico around AD 200-550 (Schollmeyer and Turner 2004) while the occupation of Paa-ko began around AD 1300 (Lambert 1954). Therefore, agriculture was introduced in the region prior to the Paa-ko occupation. Despite this, archaeological evidence suggests this population practiced a mixed subsistence economy of foraging and farming (Lambert 1954). It was hypothesized that dental pathology data would support the archaeological findings, reflecting that Paa-ko did not rely solely on agricultural practices as their primary food source. Standard protocol data collection was used for assessing pathology. Dental caries frequency was within the range of agricultural populations (18.4%; Turner 1979). However, the frequency of interproximal caries was relatively low, suggesting there may have been dietary supplementation. Attrition was severe, even in younger adults, suggesting an abrasive diet. Frequencies of abscesses and antemortem tooth loss were also high. These findings suggest that the people of Paa-ko primarily subsisted on agricultural crops, but also supplemented their diet for portions of the year.

#### **Measurement of individual differences in novelty seeking in wild vervet monkeys (*Chlorocebus aethiops*) using a group-based approach.**

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

In order to investigate the behavioral ecology of temperament differences in natural populations, tests to measure these differences in a field setting need to be validated. In captive vervets a group-based approach is used to measure individual differences in novelty seeking. This approach was adapted for use in two field experiments conducted on wild vervet groups in South Africa, focusing on adults and subadults (N=30 nonjuveniles in large group; N=10 in small group). The novel stimuli used were two inflatable boats placed side by side, and an arrangement of non-native, non-toxic potted plants, respectively. For each experiment, the novel stimulus was placed in the center of an open area, and all approaches to within 10m and 1m were recorded. In the boat test with the large group, 15% of nonjuveniles observed in the testing area approached to within 10m and none to within 1m, while none in the small group approached to within 10m. In the plant test, 74% of observed nonjuveniles in the large group approached to within 10m and 43% approached to within 1m. In the small group, 40% of nonjuveniles approached to both within 10m and 1m. A far greater proportion of subadults than adults approached to within 1m of the plants, but no sex differences were found. I compare the age-sex distribution of these responses with those of previous studies investigating responses to novelty in primates, and also examine the challenges encountered in adapting novelty seeking tests developed for captive populations for use in wild populations.

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#### **An unusual case of a solitary osteochondroma on the mandibular symphysis.**

SAMANTHA H. BLATT. Department of Anthropology, The Ohio State University.

Osteochondroma is a neoplasm caused by faulty ossification of the growth plate resulting in an outgrowth of cortical and trabecular bone continuous with the parent bone and capped with hyaline cartilage. Osteochondroma is the most common benign bone tumor, primarily afflicting femoral metaphyses. This case study describes a basketball-sized, isolated, sessile osteochondroma on the mandible of 30-34 year old female from the Late Prehistoric (1490 B.P. ± 70) Buffalo site, West Virginia. There are only a handful of archaeological cases of osteochondroma reported, all postcranial and Old World, and only 50 modern clinical cases reported in the mandible. The uniqueness of this case adds to knowledge of neoplastic lesions in antiquity, health in the prehistoric New World, and comparative material aiding future diagnoses.

The spherical tumor extends from the right hemi-mandible, measuring 24 cm in diameter. The primary center of the neoplasm appears to expand from the mandibular symphysis. The afflicted side is grossly deformed with the alveolar and teeth displaced,

extending infero-laterally to the gonial angle of the left hemi-mandible. Macroscopic and roentgenographic examination reveals the outer cortical surface and inner trabecular architecture of the tumor is continuous with the mandible. The cortex is smooth, irregular, and lobulated, reminiscent of the expected hyaline texture in life. These characteristics are pathognomonic of osteochondroma, especially since most clinical cases of mandibular osteochondroma are reported in females around age 40. The etiology and mechanical disability imparted by this tumor, as well as differential diagnoses of aggressive ostblastoma and osteosarcoma, are discussed.

#### **The violence of everyday life: Pathology, trauma, and community membership at Harappa.**

ELAINE BLEVINS, BRETT COX and GWEN ROBBINS SCHUG. Department of Anthropology, Appalachian State University.

The Indus Civilization has generally been viewed as an exceptionally 'peaceful' realm, a rare example of a heterarchical prehistoric state, based on corporation rather than exclusion. This paper questions the view that Indus state formation was exceptional in this way. We examined evidence for mortuary treatment, pathology, and trauma in three burial communities at Harappa—one of the largest cities in the Indus River Valley Civilization. We compared prevalence and patterning of traumatic injury and infectious disease in skeletal samples from an 'elite' urban cemetery (R-37), a post-urban cemetery (H), and an ossuary located outside the city, near a sewer drain (Area G). Our results demonstrate heterogeneity in the treatment of the dead and in the epidemiological profiles of different burial communities through time. The prevalence of violence and infectious diseases increases through time; women were more frequently affected in the urban cemetery populations through time; and, men, women and children interred in the ossuary were most affected by both trauma and infectious diseases. We suggest the different burial treatments, combined with the patterning of trauma and disease, support the hypothesis that community membership, exclusion, and structural violence determined who suffered in the everyday life at Harappa.

#### **The leprosarium of Saint Thomas d'Aizier, the cementochronological proof of the medieval decline of Hansen disease in Europe?**

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By counting cementum annulations to estimate individual age-at-death, paleodemographers have an incomparable tool to reconstruct demography of past populations. Until now, osteo-archaeological collections from medieval leprosia have never been specifically studied in a paleodemographic perspective thus keeping in the dark crucial parameters for our understanding of the demo-dynamique of leprosy in Medieval Europe.

Our hypothesis is based on the comparison of adult median age-at-death and survival curves estimated using cementochronology on a pooled sample of sites (N = 20 ; AD 450-1600, N individuals = 1550). The possible bias of dental hygiene which might affect cementum has been simultaneously analyzed.

Among all the observed series, the survival curve from the leprosarium of Saint Thomas d'Aizier is the most statistically catastrophic. Dental health does not differ from other samples of various social statuses and is thus discarded as a bias.

The abnormal high mortality from all age group of the forced population of the Saint Thomas leprosarium unexplained by leprosy only, emphasizes the hypothesis of the influence of systematic isolation of contagious individuals (mainly from easily identifiable lepromatous signs) in an incarcerating environment rife with malnutrition, abuses, promiscuity and tuberculosis, particularly at the end of the medieval period when this disease was rapidly disappearing.

Cementochronology should obviously be implemented on other similar sites in order to strengthen this hypothesis in addition to comparative isotopic analyses to better identify and estimate diet deficiencies.

#### **Sexual dimorphism in the hyoid of recent human populations: a functional morphometric approach.**

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Accurately estimating sex of human skeletal remains is crucial for developing the biological profile (age, sex, stature, and ancestry). Methods for identifying other components of the biological profile are most reliably applied when sex is known. Preferred methods for sex estimation using the innominate, cranium, and long bones are not always possible; associated elements may be absent, unreadable due to damage, or yield ambiguous results. Therefore, alternative and supplementary methods for sex estimation are desirable. Recent literature suggests the hyoid may be a reliable source for sex estimation comparable in accuracy to many preferred methods.

This study builds upon previous research by exploring sexual morphometric variation and incorporating a functional perspective with

respect to sexual dimorphism in the geniohyoid muscle attachment site. The geniohyoid is associated with sexual dimorphism in the positioning of the hyoid and stresses of vocalization. A total of 61 hyoids (18 female, 43 male) obtained from the Maxwell Museums' Documented Skeletal Collection (University of New Mexico, New Mexico) were examined. Data were subjected to principal component analysis (PCA) and discriminant function analysis (DFA). PCA revealed no sexual variation in shape, but it did show sexual variation in size. DFA produced two discriminant functions and when subjected to cross validation achieved an overall maximum classification accuracy of 90.1% (95.3% males, 77.8% females) when the geniohyoid attachment depth was included. Results further support use of the hyoid when assessing the sex of unknown skeletal remains.

#### **Stable isotope time-series in teeth: targeting the innermost enamel layer.**

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Stable carbon and oxygen isotopes in vertebrate tooth enamel are commonly used to understand the diets and environments of modern and fossil animals. Isotope variation within the lifetime of individual animals can be recovered by microsampling enamel along the direction of growth. Intra-tooth oxygen isotope profiles can be used to reconstruct seasonal changes in environmental parameters and document paleoseasonality in the human fossil record. However, conventional sampling of the enamel surface provides highly time-averaged records. The innermost enamel layer, about 10  $\mu\text{m}$  in width, rapidly mineralizes after formation and may record less attenuated signals. We used secondary ion mass spectrometry (SIMS) to sample with approximately 4  $\mu\text{m}$  spots the innermost enamel of a woodrat incisor from an animal included in a controlled water-switch experiment. SIMS oxygen isotope values are compared with values obtained from the enamel surface and breath  $\text{CO}_2$ , a proxy for body water and the primary input signal. The range in isotope values from the enamel surface (12.1‰) was reduced compared to breath (16.0‰). The innermost enamel profile captured the full shift (15.9‰), and exhibited more variability than the conventional profile. Because rodent incisors mineralize rapidly, the amplitude of the surface enamel profile was already similar (75%) to the primary signal. Signal resolution increased to 99% when sampling the innermost enamel layer. However, an increase of 24% in signal amplitude

would be negligible in teeth recording natural environmental variation. This approach will be more beneficial in taxa with more slowly mineralizing and thus more highly time-averaged enamel.

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#### **Measuring gestation length in the chimpanzees of Gombe National Park.**

EMILY E. BOEHM and ANNE E. PUSEY. Evolutionary Anthropology, Duke University.

The chimpanzees (*Pan troglodytes schweinfurthii*) of Gombe National Park, Tanzania, have been studied since the early 1960s. Since that time, dozens of offspring have been born into the Kasekela community, and researchers have typically assigned conception dates retrospectively following a live birth. Previous estimates of gestation from captive and wild populations have ranged from 224.5 to 231.5 days. However, a review of all the births since the beginning of the study has not been undertaken in 15 years. Using daily records from the long-term database, we examined observations of sexual swellings before each live birth between 1970-2008. Of these, 36 gestations from 18 females were supported by observations complete enough to assign the last day of maximal swelling of the conceptive cycle, which is considered the day of conception. The average gestation length for singletons is 226.5 days ( $n=33$ ;  $sd = 8.05$ ) and 201 days ( $n=3$ ;  $sd = 2$ ) for twins. Gestation length is normally distributed ( $n=36$ ;  $mean = 224.6$ , Shapiro-Wilk Test  $W = 0.97$ ,  $p = 0.5753$ ). Twin gestations are significantly shorter than the singleton gestations ( $t(11) = -14.33$ ,  $p < .0001$ ). Because many births are characterized in our long-term data by long gaps between observations of the female during gestation, these analyses can be used to inform estimates of conception date where sightings of sexual swellings are insufficient. There is variation across the sample, even within singleton births (range in gestation length: 214-248 days), and future research will focus on possible drivers of this variation.

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#### **Dental ablation in Sudan: the construction and performance of social identity.**

KATELYN L. BOLHOFNER. School of Human Evolution and Social Change, Arizona State University.

Dental ablation is a personal and communal experience that plays a role in the expression of social identity through the alteration of physical appearance. This practice has a long history in Sudan, though its social significance changes through time. Dental ablation is portrayed as a male rite of passage in

Neolithic Sudan and in ethnographic and clinical literature; however, this pattern is not found in Meroitic (c. 350 BC-AD 350) to Christian (c. AD 550-1400) period samples. For this study, 409 Meroitic individuals were examined from the Second Cataract Semna South site. Thirty (7.3%) individuals, 17 of 164 (10.3%) males and 13 of 168 (7.7%) females, show dental ablation. Of these, 18 of 30 (60%) show ablation of one to four mandibular incisors and 14 of 30 (40%) show a pattern involving both mandibular and maxillary incisors. A previous study of 96 late Meroitic through Christian period individuals from the Fourth Cataract Ginefab School site revealed similar frequencies of affected males and females, though these exclusively involved ablation of one to three mandibular incisors. Chi-Squared Tests of Independence confirmed that there is no statistically significant sex bias in regard to instance or pattern of ablation in either sample.

This study demonstrates that shifts in socio-political climates may alter the meaning of cultural practices, while not altering the practice itself. The social significance of skeletal markers of body modification should be investigated as temporally fluid, elucidating the evolution and function of cultural practices in the construction of social identity.

#### **After semilandmarks.**

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

In the 2005 proceedings volume that derived from the predecessor of today's symposium, I plotted an alternate biometrical future "after landmarks" that freed the bioscientist from many severe restrictions of that formalism by instead emphasizing semilandmarks (SL's), which incorporate more anatomical realism than what is possible via the classic anthropometric notion of the landmark point. Today it is time for the same iconoclasm regarding the successor method of SL's, which, like the Procrustes/thin-plate-spline workbench for landmarks, has become canonical prematurely. I will review three domains where optimism about the SL methods may be warranted: heterochrony, bilateral symmetry, and forensic detection. But I will take more time exposing two contexts into which I think the extension of the SL tools will NOT be justified without massive investments in deeper biomathematics. One is the articulation of the SL methods to contexts of bioengineering and biotechnology where dominant scalar summaries such as kinetic, chemical, or elastic energy have no tidy relationship to either of the two principal scalars of the Procrustes approach. The other concerns the context of morphogenesis – there, morphometrics offers far too impoverished a domain of meaningful anatomical descriptions to cope with the biological dynamics of valid diachronic explanations. To summarize in an aphorism, for truly biological problems, the Procrustes class of methods has proved a Procrustean bed, which amputates too much of

the actual scientific context in the quest for methodological tidiness. To transcend this dilemma will require new biomathematical structures, not just tinkering with matrix algebra.

**Juvenile harassment of adults in bonobos and the exploratory aggression and rank improvement hypotheses.**

KLAREE J. BOOSE and FRANCES J. WHITE. Anthropology, University of Oregon.

Dominance hierarchies in primates are often established during development and are important to lifetime reproductive success. Harassment of mature group members functions as a way for juveniles to explore the nature of dominance interactions and as a mechanism to improve rank. In chimpanzees, where all males out-rank all females, harassment of mature females by juvenile males is the first step in their ascension of the group hierarchy. In contrast, dominance relationships in bonobos are complex and females often hold the very highest rank positions. This study presents data on harassment behavior (N=81) in the Columbus Zoo bonobo colony (N=16 individuals). Similar to chimpanzees, harassment was spontaneous, juveniles harassed significantly more than adolescents or infants ( $G=24.551$ ;  $P<0.001$ ) and males harassed significantly more than females ( $G=6.581$ ;  $P<0.05$ ). In contrast to chimpanzees, targets were more likely to be males than females ( $G=6.581$ ;  $P<0.05$ ) and there was a negative correlation between target rank and amount of harassment received (Spearman  $r = 0.850$ ,  $P<0.01$ ). Frequency of types of responses to harassment was dependent on sex, where male bonobos, like female chimpanzees, reacted more with aggressive and submissive behaviors than with neutral behaviors, whereas female bonobos reacted equally with aggressive, submissive, and neutral behaviors ( $G=4.946$ ,  $P<0.05$ ). We also present preliminary results of urinary hormonal analyses, including on testosterone and cortisol. This pattern of harassment behavior supports the proposed functions of exploratory aggression and rank improvement while highlighting key difference in the social structures of the *Pan* species.

**The body will eat itself: An investigation into the relationship between bone diagenesis and funerary treatment.**

THOMAS J. BOOTH. Archaeology, University of Sheffield.

The internal microstructure of archaeological human and animal bone is often altered by characteristic micro-foci of destruction (MFD). There is evidence to suggest that the majority of MFD are produced in the early post mortem period as a result of the exploitation of bone proteins by endogenous bacteria associated with putrefaction. Funerary processes that affect the proliferation of putrefaction bacteria or separate the bones from the gut microflora in the early post-mortem period should leave characteristic signatures of biotic decay within the bone microstructure. The purpose of this

project is to investigate the extent to which bone diagenesis reflects funerary rite and how far it may aid in the taphonomic reconstructions of mortuary processes.

Levels of bioerosion have been assessed in bone samples of 216 human individuals from 22 European archaeological sites using thin section light microscopy and the Oxford Histological Index (OHI). Preliminary results suggest that the main factor affecting the levels of bioerosion at these sites is the presence of environmental conditions that interfere with putrefaction. In the absence of these conditions, distributions of OHI scores appear to reflect the contrast between consistent Christian graveyard inhumation and variable prehistoric processing of the dead. These findings support the hypothesis that signatures of bioerosion reflect funerary processes and that histological inspection of archaeological bone can contribute towards the identification of mortuary ritual as part of a holistic analysis of the taphonomic evidence.

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**Forest meat consumption in rural northeastern Madagascar: Its extent, incentives, and impact on local lemur and human populations.**

CORTNI BORGERSON and LAURIE R. GODFREY. Department of Anthropology, University of Massachusetts, Amherst.

Wildlife resource use has the potential to threaten Madagascar's ecological integrity and the health of the local people who rely on it for sustenance. Conservationists acknowledge the importance of understanding human behavior in designing effective conservation initiatives, but rarely combine quantitative analyses of lemur ecology and human behavior. This study investigates mammal hunting and consumption in rural northeastern Madagascar within their broader cultural and ecological contexts. Over a period of 12 months, I surveyed lemurs and analyzed habitats at two sites, one near a village and another distant from human habitation. I directly observed trapping behavior through 12 months of trapper shadowing and interviewed 100% of households in the village. Whereas 97% of households consumed some forest meat, marked household and seasonal variation was recorded. Forest animals were caught largely for individual consumption, and were not intended for sale or economic gain. Increased involvement in ecotourism and increased ecological knowledge did not reduce wild meat consumption; other variables, including economic stability, food security, familial relations, and involvement in human-wildlife conflicts strongly affected the likelihood of partaking in snare trapping. This study investigates the sustainability of lemur hunting practices, the importance of forest meats in the local diet, their impact on household health and well-being, and the effectiveness of alternative conservation strategies.

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**The meaning of weaning in wild Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*).**

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In primates, weaning is often considered to be a long lasting process characterized by a very gradual shift toward energetic independence from the mother. Although there is agreement about the importance of the age at nutritional independence, it remains difficult to determine. Some emphasize the moment when mothers resumed cycling as the best measure while others use the cessation of nipple contact which often occurs much later. A recent study on captive Francois' langurs supports the latter by confirming nursing effects via stable isotope ratios in the feces of an infant assumed to be close to independence. Here we investigate these two measures of weaning age in 51 wild Phayre's leaf monkey infants at Phu Khieo Wildlife Sanctuary (Thailand). Infants averaged 15.5 months (range 8-25) when their mothers' resumed mating and 18.9 months (range 12-28) at last nipple contact. If nipple contact lasted less than 16 months, infants did not survive to three years, emphasizing that the end of the nursing period might still be energetically important. For most infants nursing stopped only after their mother had re-conceived, usually during her last trimester. We found little support for the importance of weaning food in the timing of independence because, relative to the annual peak in food availability, the resumption of mating occurred too early and the cessation of nipple contact too late. Instead, there appears to be a compromise between maternal investment in the subsequent infant and a maximum length of investment in the current infant via nipple contact.

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**Tangible or intangible frontiers: qualifying interactions between humans and chimpanzees in fragmented landscapes.**

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Sebitoli, North of Kibale National Park (Uganda) experiences one of the highest chimpanzee density known in the world while many human activities occur along the park border. Villagers enter the park for illegal activities (poaching, charcoal burning) and primates are raiding crops outside the forest. Even if the frontier between anthropogenic and natural areas is geographically and legally clearly defined, nature and intensity of the relationships between chimpanzees and humans remain vague.

We suggest that, in the context of primates living in human modified habitats, resource uses might dictate interactions between the two species over time, emphasizing avoidance of direct contacts.

We classified Sebitoli landscape using satellite images. Combining observation datasheets and GPS coordinates, we created a georeferenced database on chimpanzee repartition. To evaluate food diversity and availability, we censused seventy plots located inside and outside the park. We conducted interviews in local communities to understand uses and practices of people living around.

Analyses show that chimpanzees do not avoid forest edges and occupy more frequently high relief areas or lower sites by river banks. We counted 26155 stems of 348 species, of which 81 items have been so far observed to be consumed by chimpanzees. We assess that interactions between humans and chimpanzees are tempered by filters (food resources, risks) and we determine their dynamics and intensities in humans-chimpanzees interactions.

Using various methods of different disciplines, this study is an overview of social, spatial and environmental factors influencing chimpanzees repartition in a conservation area facing demographic pressure.

#### The evolutionary history of *Yersinia pestis*.

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*Yersinia pestis* is one of the most deadly pathogens to infect human populations. The demonstration that *Y. pestis* DNA can be successfully retrieved from ancient tissues to the extent that whole genome reconstructions are possible reveals that opportunities to gain additional insight into its evolutionary history are within reach. This paper will summarise current knowledge on the estimates for when it arose as a human pathogen, its level of genetic diversity, and its associations with both historical and contemporary human populations. The methods for how we can acquire additional historical information about the bacterium will be explained, and important outstanding research questions regarding its relationship with human groups will be discussed.

#### Medieval monastic mortality: hazard analysis of mortality differences between monastic and non-monastic cemeteries in England .

JESSICA C. BOULWARE and SHARON N. DEWITTE. Anthropology, University of South Carolina.

Scholarship on life in medieval European monasteries has revealed a variety of health and dietary patterns that potentially affected mortality in these communities. These findings include temporal improvements in diet, such that the quality of monastic diets approached that of elites, and, contradictorily, evidence that standards of living within monasteries did not differ greatly from those of peasants. Further, some researchers have hypothesized that there were elevated risks of morbidity among monastery inhabitants resulting from their duties ministering to the sick and thus potentially heightened risk of exposure to infectious diseases. Missing from the literature is an explicit examination of the risks of mortality within medieval monastic settings and how those risks differed from those within contemporaneous lay populations. This study examines differences in mortality between monastic cemeteries (n = 528) and non-monastic cemeteries (n= 204) from London, all of which date to between AD 1050 – 1540. Given the relatively small number of children and females present in the monastic cemeteries, analysis is restricted to adult males. Age-at-death data from all cemeteries are pooled to estimate the Gompertz-Makeham hazard of mortality, and “monastic” (i.e. buried in a monastic cemetery) is modeled as a covariate affecting this baseline hazard. The estimated effect of the monastic covariate is negative, suggesting that individuals in the monastic communities faced reduced risks of dying compared to their peers in the lay communities. These results might indicate better diets within the monastic setting or recruitment of monks from wealthier and thus potentially healthier subpopulations.

#### Ancient tuberculosis DNA revealed by Next Generation Sequencing.

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*Mycobacterium tuberculosis* complex bacteria were the first pathogens targeted in ancient DNA studies, and throughout the period that ancient bacterial DNA has been studied, has had a very constant presence. As the field of aDNA has progressed and more technologies have become available, the research into the causative agent of tuberculosis has been able to become more in-depth. A project was undertaken by the Universities of Manchester and Durham to investigate tuberculosis from the Neolithic until the 19th Century CE across the whole of Europe. This project screened over 500 samples from nearly 100 sites for the presence of

*Mycobacterium tuberculosis* complex DNA before sending 101 samples for targeted next generation sequencing. Here we present the background of ancient tuberculosis research, from the beginnings to today, before detailing the results of the study in the study in comparison to the modern data. One individual from 19<sup>th</sup> Century Leeds was typed with 218 SNPs, eight in/dels and two insertion sequences using SOLiD sequencing and was found to be closely related, but not identical, to the H37Rv strain isolated in 1905. Please note, AB is now at the University of Zurich, but all work was undertaken at the University of Manchester. *Work Funded by NERC.*

#### Assessing damages: Testing the assumptions of a non-destructive protocol for DNA extraction from modern human teeth.

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For skeletal biologists, the use of destructive DNA extraction methods on teeth result in the loss of information on morphology, wear patterns and age. Similarly, these methods affect molecular anthropologists, who may be denied research requests when samples are limited. As an alternative, we are testing a recently published “non-destructive” method (Bolnick et al. 2011) for use in modern DNA, and especially forensic, contexts. Here, we report on our investigations into chemical alterations of the tooth surface and the effects of multiple tooth “soaking” steps. As tooth enamel is composed primarily of hydroxyapatite, our concern is with the use of EDTA, a strong chelating agent that may bond with calcium. Five pigs’ teeth were soaked first to test the effects of the soaking solution (with controlled repeat-soaking) on the enamel of different teeth. Six dry human molars were subsequently soaked, two of which were treated with lower concentrations of EDTA. For all samples, damage was quantified in terms of the change in mass and calcium. Preliminary findings indicate that all teeth were damaged. The effect was much greater on the pig teeth. Cracking and surface erosion were observed for the human teeth, but these effects may be exacerbated by preexisting defects. Further, the human teeth subjected to lower concentrations of EDTA were largely undamaged. These results suggest the possibility of fine-tuning the protocol to be less destructive and to accommodate forensic casework, when pristine samples are not recoverable. Recommendations will be provided on method improvement for contemporary sample analysis.

### Microevolutionary change in the human mandible.

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Previous research on craniometric secular change has documented a pattern of increasing cranial vault height, base length, and narrowing of the cranial vault and face in American White and Black crania over the past 150 years. This has been attributed to environmental variables relating to improved nutrition, leading to an extended period for subadult basicranial growth. Concomitant microevolutionary change in American White and Black mandibles has not been fully investigated. This paper compares both linear (n=14) and coordinate (involving 45 landmarks) dimensions from male and female mandibles representing three temporal groups: 1) 19<sup>th</sup> century Blacks from a combination of several antebellum sites from the mid-Atlantic region; 2) Terry collection Blacks (1828-1924); and 3) a modern sample of Blacks from the Bass Collection. Males and females were separated as to sex. Linear measurements were analyzed via MANOVA (Multiple Analysis of Variance), while the geometric morphometric data underwent standard Procrustes, Thin-Plate Spline, and Principal Coordinate analyses. Results indicate a significant increase in both chin height and ascending ramus height from the 19<sup>th</sup> to the 20<sup>th</sup> century samples, while mandibular angle significantly decreases across this transition. Overall, there is a documented increase in mandibular height which appears to parallel that seen in American Black crania. Mandibular secular changes as indicated by the landmark coordinate data analysis (reflecting changes in mandibular shape rather than size) are more complex and are discussed in terms of slavery and other environmental changes affecting American Blacks across this transition.

### Allometry of calcaneal elongation in euprimate origins.

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Acrobatic leaping is often associated with the origin and subsequent radiation of Euprimates based on its observed frequency in extant primates and inferred frequency in fossils. Hypothesized skeletal correlates include elongated hind limb segments, particularly the calcaneus that may aid leaping by allowing for increased rates and durations of propulsive acceleration at takeoff. Testing this relationship is complicated by body size differences and associated allometric affects. Alternatively, moderate calcaneal elongation of many euprimates may primarily relate to grasping

specializations that necessitate a tarsifulcrumating foot.

We re-assess allometric constraints on, and functional significance of, calcaneal elongation using Phylogenetic Generalized Least Squares for regression and ancestral state reconstruction (ASR). Results show that among all primates, logged ratios of distal- to total-calcaneal length are inversely correlated with logged calcaneal body mass proxies. A line with similar coefficients is independently defined by early Eocene *Teilhardina*, *Cantius*, and *Notharctus* together. If calcaneal elongation is interpreted in the context of this allometric relationship, then relatively elongate calcanea in omomyids could be explained by small body size relative to that of adapids, rather than by differences in leaping proclivity. In contrast, galagids, tarsiers, and most lemuriforms deviate from the line defined by Eocene forms with large positive residuals, meaning another factor besides body size (possibly leaping proclivity) may be invoked. Small residuals of extant *Cheirogaleous* reflect a good match with Eocene taxa. ASR shows non-allometric increases in elongation near the origin of Euprimates, possibly associated with the development of hallucal-grasping or a combination of grasping and leaping.

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### Rethinking lifetime reproductive effort in humans: does early weaning provide the fuel to extend the human lifespan?

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Large brains, prolonged development, and other derived traits that characterize *Homo sapiens* entail a significant increase in energetic demands. This may be especially true for human females, who are confronted with a substantial portion of the metabolic costs of our lineages' intensive reproductive strategy. While previous work has suggested that allocate provided by a wide array of kin and non-kin may help to ameliorate the burden of increased costs of reproduction for females, it is less clear whether this subsidy is so great as to enable surplus allocation to other domains of the life history, such as increased longevity. One approach to clarifying this question is calculating female lifetime reproductive effort (LRE), which reflects the metabolic energy devoted to reproduction over the lifecycle. A recent estimate of LRE among women from a sample of small scale societies (Burger et al. 2010 *Proc R Soc B*) finds an average LRE close to the predicted value for all mammals. That analysis, however, does not consider the substantial energy savings owing to the provisioning of human infants specially-prepared foods, which reduces the costs of lactation to human mothers. Adjusting for this "complementary feeding," we find that the average LRE of human females in these societies is well below the invariant value

predicted by theory. We conclude that early weaning may have contributed not only to our species' characteristically high fertility rate, but may have also freed up excess energy, allowing increased allocation to somatic maintenance and thereby contributing to our unusually lengthy lifespan.

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### Hair plucking in Bonobos (*Pan paniscus*): A consequence of captivity?

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Both wild and captive studies of grooming in non-human primates emphasize the adaptive role of this behavior. Indeed, social grooming is frequently characterized as "social glue" in the life of primates. In captivity, grooming behavior is studied to reveal dominance, kin relations, and social networks. Unfortunately, many captive primates, including apes, are observed to over-groom which may result in denuding of individuals. This study focused on a discrete pattern of grooming, specifically plucking - a rapid jerking away of the hand or mouth to remove the hair follicle, often accompanied by inspection and consumption. This pattern has never been reported for wild bonobos but is routinely observed in many individuals in captive colonies. Subjects were 17 bonobos (4 wild-born and 13 captive-born) housed at the Columbus Zoo. Data were collected using focal behavior sampling, all-occurrence. Results of time-budget analyses show that approximately 21% of self-directed and dyadic-grooming bouts involved hair plucking. The four wild-born individuals were never observed to hair pluck. Age class strongly influenced the percent of grooming bouts that involved plucking - for adolescents the mean percent of grooming bouts involving plucking was 38.5%, whereas in adults it was 20%. Self-directed plucking appears to be influenced by dominance in that the dominant male and female showed the highest percent of self-directed plucking behavior, 54% and 57% respectively. This is the first study to document the significance of plucking in bonobo grooming behavior and contributes to discussions of visitors' perception of ape well being.

Rebecca Jeanne Andrew Memorial Award, Miami University.

### Daily caloric intake in relation to food abundance and female reproductive state in wild Bornean orangutans (*Pongo pygmaeus wurmbii*) in a peat-swamp habitat.

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Due their low productivity, the peat-swamp forests of Central Kalimantan are

challenging environments for large, arboreal frugivores like the orangutan. For adult female orangutans with dependent offspring, obtaining enough energy to support lactation is expected to be difficult, particularly during periods of low fruit availability. However, little is known about how female primates modify their caloric intake to support dependent offspring. We examined variation in Bornean orangutan daily caloric intake in relation to fruit availability and reproductive state at the Tuanan Field Station, an alluvial, peat-swamp habitat. We predicted that caloric intake would increase with fruit availability and that adult females with dependent offspring would have higher caloric intake compared to solitary adult females. We examined 1,707 nest-to-nest focal follows collected from 2003 to 2008 using Generalized Linear Mixed Models. We found a positive relationship between fruit abundance and daily caloric intake ( $p < 0.0001$ ). Adult females with dependent offspring and immature independent females consumed significantly more calories compared to adult females without dependent offspring during periods of high and middle fruit availability, but not when fruit availability was low. During periods of low caloric intake, individuals appear to have less flexibility in the amount of calories consumed. Our results suggest that females with dependent offspring increase their daily intake to account for extra calories lost to lactation, but this strategy is not possible when fruit availability is low. Instead, we suggest that during these periods, lactating females rely on body fat stores and tissues to support their offspring.

#### **A craniometric approach to the question of postmarital residence in European Mesolithic and Upper Palaeolithic populations.**

CIARÁN P. BREWSTER. Department of Archaeology, University College Cork.

An important aspect of social organisation is postmarital residence, as it informs us about how outsiders are incorporated into an already existent residential network. Integration contributes to the maintenance of the group within the larger regional network by promoting stability between neighbouring groups. It also provides a framework for establishing and maintaining alliances and trade networks. While patrilocality is the predominant form of postmarital residence in recent foraging societies, it is not known whether this was also the case for modern hunter-gathering in Europe prior to the Neolithic.

This is the first study to explicitly examine postmarital residence in European Upper Palaeolithic and Mesolithic populations using craniometric data. Data were collected on a total of 100 skulls with a 3D digitiser and examined using geometric morphometrics and multivariate statistics. The predominant form of postmarital residence was examined in the entire dataset, as well as a subset consisting of Mesolithic specimens from the Portuguese Muge Valley sites.

In both analyses males were more variable than females. Additionally, females

showed a greater correlation with geography, suggesting that they were moving less than males. This is a pattern consistent with matrilocality. These results suggest that the predominant form of postmarital residence in these populations was inclined towards matrilocality. This pattern was observed in both the complete and Mesolithic datasets. The exact pattern of residence is undoubtedly much more complex than what can be derived from the present data. Limitations of this study and suggestions for future research are also discussed.

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#### **Growth and development in the genus *Pan*: a life history approach.**

CONRAD S. BRIMACOMBE. Department of Archaeology, University of Sheffield.

The current study applies a holistic approach to understanding both chimpanzee and bonobo skeletal development by means of integrating data on dental development, epiphyseal union, and long-bone dimensions in a cross-sectional sample of sub-adults from museum collections. These data build upon prior research where there has been study of specific regions but a lack of integration of all three types of data in a single sample of significant size.

Included in this sample are 37 *Pan paniscus* and 177 *Pan troglodytes*, the majority of which were wild shot. Epiphyseal fusion state was evaluated using an ordinal classification system based on McKern and Stewart. The dentition was scored by the Demirjian method using radiographs. Diaphyseal length was measured for all long-bones. It was found that the overall epiphyseal fusion pattern was largely similar for both species. Comparisons to humans suggest that the pattern is similar with some exceptions such as the earlier fusion of the ischium of the pelvis in *Pan*. However, despite the similarities in fusion patterning, analysis of timing of epiphyseal events relative to dental development and long-bone growth suggests notable deviations when compared to the human pattern. Full dental maturity is completed significantly before skeletal maturity whereas in humans this is not usually the case. These results will have implications for our understanding of the evolution of positional behaviour adaptations and will contribute to our understanding of life-history patterns in these species.

#### **Impact of tool use on brain development of non-human primates.**

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Correlations between brain evolution and behavior in non-human primates may offer a glimpse into the evolutionary forces pertaining to Hominin brain evolution. To the extent that

endocranial size and shape reflects features of the underlying brain, associations between behavioral variables and endocranial morphology might give clues to the behavior of fossil species. Tool-use is one behavioral variable that has been suggested as a possible driving factor in human evolution. Research on how tool-use might influence site-specific endocranial morphology has yet to be conducted. Open Research Scan Archive CT scans from twelve non-human primate species were used to assess localized correlations between endocranial morphology and incidence of tool use reported in the literature. Morphology was assessed using non-rigid deformation methods, in which endocasts were morphed into one common atlas (*Pan troglodytes*), rendering voxel-based differences across the entire endocranial surface. These voxel differences were then correlated with instances of tool use. Preliminary results show areas of higher correlation in the prefrontal cortex – areas which are associated with language, social interactions and behavioral planning. An additional area of higher association included the cerebellum, possibly indicating increased ability in muscle movement, locomotion and timing. These data suggest that endocranial morphology might be useful for making inferences about hominin tool-use.

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#### **Microbial adaptations facilitate non-ruminant *Theropithecus gelada* grazing behavior in northern Ethiopia.**

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Microbiomes refer to microbial genomes, including their environmental contexts and associations. Among catarrhines, intestinal microbiomes evolve in conjunction with their hosts, indicating phylogenetic conservatism, while diet clearly influences these communities. Such findings suggest that gut microbial communities are shaped by dynamic tensions between inheritance and diet, although roles of

microbiomes in dietary adaptations remain unclear.

We examine effects of phylogeny and diet on the gut microbial communities, studying gut microbial communities of three baboon populations—*Papio hamadryas*, *P. anubis*, *P. hamadryas* x *anubis*—in Awash, Ethiopia, and a population of *Theropithecus gelada* (Guassa, Ethiopia). We hypothesize that the graminivorous diet of geladas is associated with a distinctive microbiome.

Using DNA extracted from fecal samples collected from individuals of each taxon, we employed bacterial 16S rDNA pyrosequencing to analyze gut microbial communities of each host. Phylogenies of microbial taxa and Bray-Curtis distance analyses of microbial taxa were used to identify similarities among baboon taxa.

Gelada microbiomes separate unambiguously from *Papio* microbiomes. While all baboons share similar microbial taxa, proportions of microbial phyla differ. Firmicutes and Bacteroidetes occur in high abundances in geladas, together forming a larger proportion of the microbiome than in other baboons. Microbiomes among other baboons vary, and distinctions among taxa are evident, particularly between olive and hamadryas baboons. Hybrid baboon microbiomes are “intermediate.” The gut microbiome complements distinctive aspects of anatomy and behavior, and is apparently tightly interwoven with aspects of gelada anatomical adaptations, perhaps more so than in other baboons.

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#### Season and aging affect the expression of a hormonal biomarker of life history in lemurs.

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The synthesis of the androgens DHEA and its sulfate DHEA-S in the adrenal is unique to primates. Age-related declines in circulating DHEA/DHEA-S observed in humans and some primates suggest that these androgens are biomarkers/regulators of life history, the rate of decline being proportional to variation in lifespan.

This study tested the generality of primate life history by comparing the age-specific patterning of sDHEA in diurnal lemurs. We predicted that longer lifespans and later reproduction would be associated with higher and more gradually declining sDHEA whereas seasonal breeding would magnify sDHEA. These predictions were tested in lemurs differing in reproductive onset and lifespan: *Lemur catta*, *Eulemur mongoz*, *Propithecus coquereli*, and *Varecia variegata* using serum samples obtained from the Duke Lemur Center. Forty-four samples from males 1-29 years of age were selected to match age and season (breeding [BS],

nonbreeding [NBS]) of sampling in each species. Serum samples were analyzed for DHEA by radioimmunoassay.

MWW/ANOVA showed significant effects of season and species on sDHEA, with 3-fold higher sDHEA in the BS vs. NBS. DHEA levels gradually increased with age in *Varecia*, peaking in the oldest age-class, while those in *Lemur* and *Propithecus* rose markedly until peak fertility at age 12-15 years and then declined in a stepwise pattern thereafter. *Eulemur* exhibited variable age-related patterns of DHEA secretion.

The pattern of age-sDHEA interactions in lemurs is distinct from that observed in other primates and humans. These findings are important for the new contextual insights they provide into human life history and its architecture.

#### The development of the dentition as a complex adaptive system.

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Complexity and Diversity affect biological systems and societies. General characteristics of Complex Adaptive Systems include self adaptation and organisation, emergence, multitasking, robustness, critical phases, diversity and compatibility with such statistical models as Thresholds and Scale Free Networks.

Objectives: Investigate whether dental development shows the general and statistical characteristics of a Complex Adaptive System. Methods: Examine data on normal and abnormal dental development for these characteristics.

Results: Self adaptation and organisation occur as interactions between genes, epigenetic and environmental factors lead to the emergence of cells, germs and mineralised teeth. Multitasking is seen as signalling pathways act simultaneously and reiteratively during initiation and morphogenesis. Tooth germs that do not attain a critical stage during development may undergo apoptosis. Diversity is evident in the variations of tooth number, size, shape and mineralisation. Statistical investigation of these variations in humans has shown that males have significantly larger teeth and higher prevalences of megadontia and supernumerary teeth ( $p < 0.05$ ), supporting the published Threshold Model. Image Analysis of tooth dimensions showed they followed the Power Law distribution of a Scale Free Network, with the first 8 of 34 factors in upper lateral incisors accounting for 94.4% of the total variation.

Discussion: Complexity and Diversity in dental development enables adaptation to different environments and change during evolution.

Conclusion: The development of the dentition shows the general and statistical characteristics of a Complex Adaptive System.

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#### Analysis of bovid remains from Malapa, South Africa and implications for the paleoenvironment of *Australopithecus sediba*.

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*Australopithecus sediba* from Malapa, South Africa, holds important implications for understanding the origin of the genus *Homo*. Accordingly, analysis of the fauna associated with *A. sediba* provides information on the paleoenvironment inhabited by the hominins, and this study presents an examination of the bovid fauna recovered from Malapa. The number of recovered individuals is presently small, since the majority of specimens are represented by articulated, partial skeletons. The bovids were identified using modern and fossil comparative collections and a standardized morphometric approach involving Elliptical Fourier Function Analysis. Partially complete skeletons allow us to obtain age, sex, and body mass estimates for several of the individuals. The taxonomic composition of bovids at the site suggests a mosaic of grasslands as reflected in *C4* grazers such as *Megalotragus* and *Connochaetes*, alongside woodlands as seen in *C3* browsers such as *Tragelaphus strepsiceros* and *T. scriptus*. The presence of a nearby permanent water source is also indicated. This reconstruction corresponds with other lines of evidence in suggesting that Malapa was similar to other hominin-bearing caves in the presence of substantial grasslands, but also reveals a more wooded and better watered component than is typically recorded elsewhere in the area. The bovid remains exhibit breakage patterns indicative of dry fractures, but do not exhibit marks particular to a bone accumulating agent. This taphonomy suggests that the remains were buried and fossilized relatively quickly in a manner similar to the hominins, supporting a common origin for the hominin and non-hominin fauna ca. 1.977 million years ago.

#### George Armelagos and four-field Anthropology: A force against future fission of the discipline.

PETER J. BROWN. Anthropology, Emory University.

In 1992, the School of American Research (SAR) in Santa Fe held a mini-conference entitled “Is Fission the Future of Anthropology?” The event was a response to a prediction by Clifford Geertz that in the 21<sup>st</sup> century four-field Anthropology would be a dead discipline, like Philology.

This poster describes how the remarkable career of George Armelagos – as both scholar and mentor – has represented a powerful force against the fission and death Anthropology. Armelagos proved Geertz wrong. Over the last half-century, he has exemplified four-field approach through contributions in the study of: bioarchaeology, paleopathology, race and

racism, the (pre)history of human health, emerging infection, biocultural theory in medical anthropology, ethnography of St Catherine's island. He has also used his expertise to conserve the sociolinguistics of humor.

Four conclusions from the SAR discussions are salient today: (1) the four fields have historically benefitted from their associations and interaction – the subfields are stronger together than they would be separately; (2) cultural anthropologists benefit administratively within Universities from the “cover” of more scientifically-oriented colleagues; (3) biological anthropologists and archaeologists benefit from their intellectual interaction with cultural anthropologists which encourages them to ask broader biocultural questions about human nature and history – making the American approaches distinctive; and (4) the relevance of an integrated four-field approach was clearly exemplified in the work of some model modern anthropologists like George Armelagos.

#### **Locomotor ontogeny and limb bone length and strength proportions in mountain and lowland gorillas.**

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Inter- and intra-limb bone length and strength proportions are indicative of adult locomotor behavior. However, locomotor behavior often changes through ontogeny in association with changes in body size and proportions. As prior work has shown, infant mountain gorillas (*Gorilla beringei beringei*) experience a phase of increased arboreality before shifting into adult-like, terrestrial knuckle walking; as adults, they are less arboreal than lowland gorillas (*Gorilla gorilla gorilla*).

In this study we examined inter- and intra-limb bone length and strength proportions of an ontogenetic series of mountain gorillas (n = 34) and adult lowland gorillas (n = 13). Bone strength (polar section modulus) was determined using peripheral quantitative CT, and bone lengths via linear measurements. Infant mountain gorillas reach adult-like femoral/humeral length proportions before the onset of independent locomotion. Strength proportions, however, vary with locomotor behavior: arboreal infants (under 2 years of age) have relatively stronger humeri compared to femora than juvenile or adult mountain gorillas (p < .001), but are not different from adult lowland gorillas (p = 0.97). Additionally, the ulna becomes relatively stronger than the radius with age in mountain gorillas, which may be related to ontogenetic changes in hand posture during the transition to knuckle walking.

These results agree with the suggestion that length proportions reflect longer-term (genetic) adaptation to particular behaviors, while strengths reflect the immediate mechanical

environment. Studying ontogeny of skeletal properties and locomotion conjointly allows for a better understanding of the determination of adult skeletal differences, as well as the relationship between morphology and behavior.

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#### **Co-occurrence of tuberculosis and an unusual rheumatoid-like arthritis in prehistoric Central California.**

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Assessment of skeletons from the Hotchkiss Mound (CCo-138) has produced the first evidence of prehistoric tuberculosis on the West Coast. It has also revealed an unusually high incidence of severe, symmetrical, polyarticular arthritis. Tuberculosis infection directly impacts bones and joints. In addition, genetic conditions that result in bone-joint pathology can be accentuated by the introduction of *Mycobacterium tuberculosis*. We hypothesize that a causal link exists between these two conditions and provide a preliminary assessment of our findings.

We examined skeletal remains and compiled observations from a pathology database for the California collection, Phoebe Hearst Museum of Anthropology, UC Berkeley (n=2570). A paleoepidemiological profile was established for the CCo-138 population (n=793). We identified three cases of tuberculosis, all deriving from the CCo-138 locality. Pathologies were identified in 52% of adults and 13% of subadults. Of the adults assignable to a time phase, the frequency of arthritis ranges from 73-100% for adults. Tuberculosis lesions have been identified only in the final two phases.

Joint pathology in the CCo-138 population resembles rheumatoid arthritis, but there is extensive spinal involvement similar to that in advanced cases of osteoarthritis. The incidence and degree of joint destruction is unmatched in any other California locality. We suggest that a genetic condition underlies the observed joint disease and that this destructive condition was accentuated by a cell-mediated response to the bacterium, as occurs in Poncet's disease. Further work on this population may clarify issues related to the pre-European occurrence of rheumatoid arthritis in Native Americans.

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#### **Edge effects on body mass and habitat use in two sympatric species of mouse lemurs in a Madagascan tropical dry forest.**

RYAN J. BURKE and SHAWN M. LEHMAN. Anthropology, University of Toronto.

Edge effects are an inevitable and important consequence of forest loss and fragmentation. These effects include changes in species biology and biogeography. Here we examine variations in body mass for two sympatric species of mouse lemurs (*Microcebus murinus* and *M. ravelobensis*) between edge and interior habitats in the dry deciduous forest at Ankarafantsika National Park. We anticipated that competitive exclusion would result in differing capture rates between species in edge and interior habitats. We predicted that the prevalence of Homopteran insects and their secretions, which represent a key food resource for local mouse lemurs, in edge habitats would result in higher body mass of mouse lemurs in these habitats. Between May and August 2012, we conducted mark-recapture experiments on mouse lemurs trapped along edge and interior forest transects within continuous forest adjacent to a large savanna near the Ampijoroa field station. Of the 37 *M. murinus* captured during our study, 78% (N=29) were trapped in interior habitats. Conversely, 75% (N=60) of *M. ravelobensis* were captured in edge habitats. We found that mean body mass of *M. murinus* and *M. ravelobensis* did not differ between edge and interior habitats. However, female *M. ravelobensis* weighed significantly more in edge habitats (56.6 ±10.4 g) than in interior habitats (48.1 ±11.7 g). We suggest that local resource competition combined with female dominance may have led to higher body mass in dominant animals in edge habitats. Our study provides some of the first evidence of sex differences in edge responses for a primate species.

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#### **Zygomaxillary suture morphology in Pleistocene and Holocene *Homo*.**

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Recent experimental research has demonstrated that restricted growth along the zygomaxillary suture results in profound alteration of both the course of the zygomaxillary suture and overall facial morphology (especially facial projection and infraorbital surface topography). Given the potential evolutionary implications of a relationship between the zygomaxillary suture and overall facial morphology, it is currently necessary to more rigorously evaluate zygomaxillary suture morphology in both recent and fossil *Homo*. In this study, nine semilandmarks derived from a

ridge-curve traced along the external surface of zygomaxillary suture were employed as a proxy for the course of the sutural plane. These semilandmarks were collected on a large sample of fossil ( $n = 58$ ) and recent humans ( $n = 335$ ). A subsequent principal components analysis reveals that the first three principal components account for 71% of the total sample variation. Cumulatively, these three components reveal that among the modern human sample, the greatest degree of variation exists between individuals from the Arctic Circle (straighter and more orthogonal sutures) and individuals from Africa and aboriginal Australia (more curved and parasagittally-oriented sutures). Among the fossils, Neandertals exhibit a considerable range of variation, with Early Neandertals (e.g. Saccopastore 2) appearing morphologically similar to Middle Pleistocene specimens such as Bodo and Petralona. Conversely, later Neandertals (e.g. La Chapelle-aux-Saints 1) exhibit markedly shorter, wider and more parasagittally-oriented sutures. These preliminary results further suggest that the zygomaxillary suture may be important for understanding shifts in craniofacial form during human evolution.

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#### **Kinda baboons in phylogenetic and paleogeographic perspective.**

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Kinda baboons display a suite of morphological and behavioral characteristics unique within *Papio*, the significance of which can be better understood in a phylogenetic perspective. To do this, we have collected genetic data, including mitochondrial (mtDNA) and Y-chromosomal (YDNA) sequences and microsatellite allele frequencies. In both mtDNA and YDNA phylogenies, kinds have quite derived haplotypes compared to other baboons. Divergence date estimates suggest a relatively early split ( $> 1$  Ma) from their closest relative, *P. cynocephalus*. For mtDNA, the deepest split within *P. kindae* is between kinda populations east (Mahale Mountains NP) and southwest (Zambia) of Lake Tanganyika, dated to about 1.7 Ma. However, the Mahale kinda males have Y-chromosomal TSPY and SRY haplotypes identical to Zambian kinds. As kinds are male dispersing and female philopatric, this pattern implies that the Mahale population has not been isolated from other kinds for the full 1.7 million years. Zambian Kinda populations show fairly low levels of mitochondrial haplotype diversity, forming one clade that coalesces at  $\sim 0.3$  Ma. Similarly, microsatellite data show low levels of population structure within these kinds ( $F_{ST} =$

0.033,  $p < 0.05$ ). Mahale kinds are larger than those from the main part of the kinda range, and are similar to *P. angusticeps* and small *P. cynocephalus* in size and craniofacial shape. Given this, the ancestor of *P. kindae* may have been like a small *P. cynocephalus*. The very small size (and overall pedomorphism) of most *P. kindae* likely evolved sometime after the split with the Mahale kinds.

#### **Ingestive behavior of the red (*Procolobus badius*) and black and white (*Colobus polykomos*) colobus monkeys in the Tai Forest, Côte d'Ivoire.**

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*Colobus polykomos* and *Procolobus badius* from Tai Forest, Côte d'Ivoire are known to differ in diet, mandibular morphology, and patterns of dental wear; however, little is known about species-specific differences in ingestive behavior that may be correlated with these variables. From July 2010 through March 2011, we used focal animal sampling to record the ingestive behaviors associated with all foods consumed by both taxa. During five-minute scans the number of ingestive actions was recorded to include food species, food part, incisal bites, canine punctures/scrapes, and masticatory cycles. Data from 270 scans of *Procolobus* and 387 scans of *Colobus* were analyzed. We operated under the null hypothesis that once food species and part (young leaves, mature leaves, ripe fruit, unripe fruit) are accounted for, incisor use and masticatory work (cycles per ingestive event) will be similar in the two taxa.

*Colobus* uses its incisors more often per action than *Procolobus*, and this is largely attributable to incisal work performed by the former on two foods (*Bussea occidentalis* fruit and *Pentaclethera macrophylla* seed pods) in which the average incisal bites per action is  $>20$ . Overall, masticatory work is greater in *Colobus*, averaging 18 chewing cycles per action compared to 15 in *Procolobus*. This is attributable to the greater reliance on young leaves by *Procolobus*. Another factor is the intensive chewing of *Pentaclethera* by *Colobus*. Few foods account for a majority of ingestive effort in *Colobus*, whereas in *Procolobus* this effort is more evenly distributed among food species and plant parts.

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#### **Dietary reconstruction of the Fishergate House juveniles using a new method of dentine microsampling for stable isotope analysis.**

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This study reconstructs diet from the late medieval Fishergate House cemetery site (York,

UK) using nitrogen and carbon stable isotope analysis. The Fishergate House site is composed primarily of the urban poor. Rib collagen of 51 juveniles (fetal to 5 - 6 years of age) and 11 adult females (of reproductive age) were analyzed using traditional methods. A new microsampling method for deciduous tooth dentine was also tested on the sample to reconstruct the pattern of early childhood diet and individuals patterns of diet. This new method allows the reconstruction of diet from samples with very small sample size (.3 mg). Deciduous teeth from 42 subadults individuals, most of whom also contributed rib samples, were also used. The goal of this study was to determine the weaning age for this population and provide a reconstruction of childhood diet for Fishergate House. The results of both methods showed that weaning at the site was complete by around 2 years of age, agreeing with previous studies of Britain during the late medieval period. The weaned diet was different from the diet reconstructed for the adult females. This diet appears to be enriched in high trophic level protein, likely marine fish, when compared to the normal female diet.

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#### **Long bone growth trajectories in Late Pleistocene *Homo*.**

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The evolution of the human ontogenetic pattern continues to be a compelling research topic in paleoanthropology. Here, we have examined long bone growth in a series of Late Pleistocene subadults and compared their growth trajectories to those of subadults from three diverse recent modern human populations. We hypothesized that growth trajectories in the Late Pleistocene subadults would be accelerated compared to those of the recent modern human subadults. The diaphyseal lengths of the humerus, radius, femur and tibia were recorded in 80 subadults (age 0-6) from the Spitalfields (Western/Northern European), Luís Lopes (Southern European), and Hamann-Todd Collections (African-American and European-American). Measurements from six Late Pleistocene individuals (Neanderthals Dederiyeh 1 and Roc de Marsal, and anatomically modern Lagar Velho, Skhul 1, Grotte des Enfants 1 and 2) were collected from the literature. These individuals were selected because of the preservation of the postcrania as well as dentition that could reliably age the subadults. Preliminary analysis of the long bones studied indicates that the Late Pleistocene subadults exhibit differing growth trajectories relative to the recent comparative samples, though rates of growth differ slightly between the recent groups as well. Interestingly, the upper and lower limbs also show differences in growth rates. These preliminary results indicate that further testing of subadult postcranial remains in Late Pleistocene

fossils and recent modern human subadults would be beneficial to the greater field of evolutionary growth and development.

**Ecogeographic patterning in maxillary sinus form among modern humans.**

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While patterns of modern human craniofacial diversity are widely documented for external structures, considerably less is known about internal morphology. Maxillary sinus (MS) form is often thought to vary as a function of the nasal cavity (NC), whose size and shape is climatically driven. However, preliminary studies have provided conflicting results, likely due to geographically-limited samples and a focus on MS volume. This study addresses these issues by evaluating ecogeographic patterns of various MS dimensions in a large sample of modern humans (n=202) spanning 11 climatically-diverse regions. All MS dimensions, except length, were significantly correlated with latitude. Although most MS dimensions were inversely correlated with NC distances, the MS surface-area-to-volume ratio exhibited a positive allometric relationship with NC breadth among groups. While differences in allometric slopes were evident between populations, a MANOVA failed to find significant differences in MS dimensions among the 11 samples. However, when grouped by broad climatically-based categories, t-tests indicated that hot-adapted individuals had significantly longer, narrower, lower, and less-volumetric sinuses compared to cold-adapted individuals. Hot-adapted individuals also had higher-surface-area-to-volume ratios, indicating more cylindrically-shaped sinuses. Overall, these results suggest that while differences in MS form are only evident among broad climatically-based categories, significant differences in the *relative* relationships between the MS and NC are apparent among more precise geographic regions. Following previous studies, these results highlight the importance of examining the interaction between the MS and NC to understand how these structures vary among modern humans in relation to diverse environments.

**Isotopic variation of geographic origin and diet in Upper and Lower Nubia during the Bronze Age: An examination of the sociopolitical effects on population composition and life ways.**

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The Bronze Age in Nubia (~3100-1100BC) was an era of tremendous development and change in the region. During this time,

polities expanded in Upper and Lower Nubia and these cultures interacted with each other as well as their Egyptian neighbors to the north. Strontium (<sup>87</sup>Sr/<sup>86</sup>Sr) and carbon ( $\delta^{13}\text{C}$ ) isotopic analysis of dental enamel carbonate provides important information regarding how geographic origins and diet were affected by the dynamic sociopolitical activities of people living in Nubia. With few baseline data published, this study provides an essential understanding of the isotopic variability in Nubia and the larger Nile Valley region through analysis of human and faunal samples from six sites in Nubia and two sites in Egypt. <sup>87</sup>Sr/<sup>86</sup>Sr human values generally decrease from north to south in the Nile Valley with statistically significant differences between the Egyptian sites studied and most of the Nubian sites. These data suggest that it may be possible to distinguish immigrant Egyptians from local Nubians through strontium isotope analysis and indicate that some Egyptians may have relocated to Upper Nubia during Egyptian New Kingdom period imperial activities, corroborating ideas based on previous craniometric and artifactual studies.  $\delta^{13}\text{C}$  data reveal that, while both Egyptians and Nubians have a mixed C<sub>3</sub>/C<sub>4</sub> diet, C<sub>4</sub> foods contributed more to the diet in Nubia but became less important over time. Geological and environmental factors as well as sociopolitical and cultural changes have a considerable effect on both the methodology and interpretation of these isotopic analyses.

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**Biological variability of the first forager-farmers in the Sonoran Desert.**

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The first cultigens, irrigation canals, and ceramics characterize Early Agricultural period (2100 B.C.-A.D. 200) sites in the Sonoran Desert of southern Arizona and northern Sonora, Mexico. Regional similarities in material culture suggest frequent social interaction where small communities likely exchanged kin to maintain size and stability. This study tests the hypothesis that Early Agricultural period human biological variability reflects patterns of differential migration frequencies between the sexes potentially linked to exchange network organization. Craniometrics were collected from both curated skeletal remains and archived data then were analyzed with multivariate and R-matrix statistical procedures. Results suggest Early Agricultural period males are more variable than expected and most related to males from other site complexes. Females are less variable than expected and more distinct relative to females from other site complexes. Inferences regarding higher male exogamy and female matrilocality is proposed which has also been supported by previous studies done on Early Agricultural period ceramic figurines, long bone cross-sectional morphology, sex-based activity patterns, and mtDNA.

**Individual and group level factors shape the social sphere of individual mountain gorillas (*Gorilla b. beringei*).**

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Research on primate sociality has emphasized important variations in social relationships between primate populations or taxa, but the proximate mechanisms responsible for these variations operate at a finer scale: the individual level. Using data collected by the Karisoke Research Center between 2003-2012, we generated social networks and individual measures of social centrality using agonistic and affiliative behavior data for nine mountain gorilla groups (group size: 2-64). We then examined how individual traits (e.g., sex, age) and group composition shape the social sphere of individual gorillas. Although mountain gorilla society is generally considered to be egalitarian, we found that the degree of sociality varies considerably across individual gorillas. The number of individuals a gorilla regularly interacts with, or social centrality, was mainly explained by the individual's age and sex, the number of adult males and females in its group and the number of related individuals in its group. Over their life spans, we found that gorillas experience sharp changes in social centrality at approximately a year after weaning and again around the age of ten. The maximum number of group members an individual gorilla interacts with does not increase linearly with group size, but reaches an asymptotic value of around 10 individuals, which causes the largest groups to exhibit a modular network structure. Our analyses also revealed the importance of social inertia in female gorillas, which maintain their social centrality for extended periods of time. We discuss these findings in the context of the evolution of social systems in long-lived species.

**The use of musculoskeletal stress markers in determining the effects of workload in a Roman Imperial Necropolis (I-III centuries AD).**

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Muscle stresses could leave marks on the bones. Micro-trauma that may occur in activities usually related to workload, can produce alterations that represent the bone reaction to the performance of daily activities. The location and the different types of these alterations may therefore be a parameter for the reconstruction of the life style of a population, contributing to the

identification of work load patterns and its division based on sex and / or social status. In the present study 240 individuals were examined. They pertain to the necropolis of Castel Malnome (I-III century AD.), in the extreme western Suburbs of Rome. Joints and muscle-tendon insertions alterations were detected by standardized methods such as those proposed by Mariotti and Hawkey. Schmorl's hernia, osteophytes, fractures and fusions of vertebral bodies were also observed. The data analysis allowed to highlight different incidence directions on the upper part of the body with respect to the lower one and even on the preponderance in the use of certain muscle groups linked to specific movements. Notwithstanding, the reconstruction of work activities through the observation of muscle injuries might be conditioned by methodological difficulties and interpretation. The muscles origins and insertions are usually complex to detect and rarely have a morphology associated with a specific activity; moreover a muscle group is often involved in several movements. Nevertheless, all of these data, especially when considered in population analysis, could be a valuable tool in anthropological research for the reconstruction of the socio-economic development of ancient communities.

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**Regional variation in the cross-sectional geometric properties of southern African Later Stone Age foragers: An examination of humeri from three distinct ecoregions.**

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Diaphyseal cross-sectional geometry can be used to infer volitional activity patterns in archaeological populations. This study re-examines the cross-sectional geometric properties of Later Stone Age (LSA) African Cape coast forager humeri from the forest and fynbos ecoregions, previously assessed by Stock and Pfeiffer (2004). The sample size was increased (n=35m,30f), and specimens from the inland succulent karoo ecoregion were added to the analysis (n=4m,13f). Diaphyseal robusticity (J) and circularity ( $I_x/I_y$  and  $I_{max}/I_{min}$ ) were quantified at the mid-distal (35%) location of humeri using the periosteal mould technique.

The majority of Stock and Pfeiffer's (2004) results were replicated. Forest and fynbos females display relative symmetry in J, and increased antero-posterior (AP) relative to medio-lateral (ML) strengthening. Males have higher J values than females, and the fynbos population has higher J values than the forest population. Females likely participated in low intensity activities that create AP loading while males participated in high intensity activities with relatively equivalent AP and ML loading. Unlike the original study, forest and fynbos male bilateral asymmetry values are similar, indicating that males in both ecoregions experienced similar activity regimes, and forest females display increased bilateral symmetry, suggesting

that they participated in more bilaterally symmetrical activities than fynbos females. The succulent karoo population has J values similar to the fynbos population, however both sexes display increased AP strengthening, indicating similar loading patterns and activity types in both sexes. These results suggest that regional variation in cross-sectional geometry may be related to the ecological and cultural factors affecting forager populations.

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**Comparison of the rate of bone degeneration between superior and inferior demifaces of the iliac auricular surface in known-age Portuguese individuals.**

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Usually age at death estimation in adults is unreliable, probably due to genetic and environmental factors that influence rates of bone degeneration. However, little is known regarding the concrete influence of those factors on bone metamorphosis. The trabecular system is distinct between superior and inferior demifaces of the iliac auricular surface, and possibly contributes to a different rate of bone degeneration on both demifaces.

In the present work the rate of bone degeneration was compared between superior and inferior demifaces from 272 left iliac auricular surfaces (119 female and 153 male individuals aged 18 to 84 years old) from the Identified Skeletal Collection at the University of Coimbra, Portugal.

For each demiface, stages of six characteristics associated with age were recorded. The Mann-Whitney U test was used to compare the rate of bone degeneration between superior and inferior demifaces. We also examined the correlations of composite score (sum of the scores for the individual six characteristics) with age.

In the total sample, for both sexes, the U tests show that superior and inferior demifaces from the iliac auricular surface do not present a statistically significant difference ( $p>0.05$ ) in the rate of metamorphosis with age. However, the correlation analysis suggests that in females there are more marked age-related changes in the inferior demiface than in the superior demiface, a pattern that was not found in male individuals.

It is likely that the distinctive morphology of the female auricular region

contributes to this observed difference in the pattern of bone degeneration.

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**Investigating the emergence of tuberculosis in South Africa.**

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Tuberculosis is the leading cause of death in South Africa and while the disease is clearly very relevant socially and medically, little has been done to understand its emergence locally. Indeed, with the exception of Egypt, the archaeological record of this disease on the continent has not been well evaluated. Here we report results of a study aimed at tracing the geographical and temporal emergence of tuberculosis in South Africa through the written and skeletal records, supplemented by aDNA detection and analysis. Descriptions and demographic information (e.g. preservation, age-at-death, sex, burial location, date, skeletal pathology) were collected for the majority of South African Holocene and historical specimens in museum collections (n=2906). Within this extensive sample, only thirteen skeletal specimens showing pathology suggestive of tuberculosis were identified. All of these specimens date to the Colonial period. Most specimens (n=8) were unearthed from the Northern Cape Province. This concentration of specimens supports reports in the literature of an early disease focus associated with the discovery of minerals in this region. One specimen from the North West Province dates to the late 1700s, suggesting an earlier spread of the disease to the region than is acknowledged in the literature, at a time and place of limited contact between indigenous populations and those of European descent. Ancient DNA analysis was performed on nine samples. Human nuclear and mitochondrial DNA were consistently obtained from four of these specimens; however, initial attempts to recover *Mycobacterium tuberculosis* complex DNA were unsuccessful.

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**A survey of the frequency of supernumerary teeth in non-human hominids.**

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Supernumerary teeth have been reported in a wide range of fossil primate taxa including Eocene adapoids, Plio-Pleistocene hominins, and other non-human hominids. In modern humans, a review of the literature shows that polydontia is less common than agensis, more frequent in males than in females, and generally occurs at frequencies of less than 5%. In extant non-human hominids, percent incidence of supernumerary teeth varies, with the overall

pattern usually documented as *Pongo* > *Gorilla* > *Pan*. Within the genus *Pongo*, percent incidence reported generally ranges between 6 to 20%. In a published study on hybridization in a captive baboon population comprised of two closely related species, a high incidence (44%) of supernumerary molars was reported in F<sub>1</sub> hybrids males. Along with similar results documented in a study on hybridization between gorillas, these studies suggest that high frequencies of additional molars within a population may indicate hybridization. For the present study, a survey of specimens held at the Cleveland Museum of Natural History, the American Museum of Natural History, and the Smithsonian National Museum of Natural History, revealed the pattern of incidence of supernumerary molars in non-human hominid skulls examined to be 7.1, 4.7 and 1.2% for *Pongo*, *Gorilla*, and *Pan*, respectively. The high incidence of supernumerary molars as evidence for possible hybridization in *Pongo* is considered here, along with divergence date estimates, population genetics and biogeography. Finally, a method to test if the high incidence of supernumerary molars in *Pongo* is associated with hybrid individuals is proposed.

#### Applying statistical classification methodologies to morphological dental trait data in forensic studies.

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Dental morphological studies have clearly indicated their potential in the analysis of both extant and past populations. However, when dealing with single samples, especially forensic, the potentiality of dental traits is not applied to its full strength since the studies tend to consider only a limited number of the available characteristics and their conclusions are drawn on the basis of the presence or absence of single traits. In the present study we build the database framework that enables the comparison of forensic samples to the worldwide distribution of the traits in their whole.

The initial effort implied the structuring of the reference databank. Available dental traits from autochthonous living and archaeological samples from all continents were scored, using the Arizona State University Dental Anthropology System, and the resulting data pooled into ten regional groups. Statistically relevant traits were thus isolated and used to define standardized individuals for each group that enable the comparison with dental traits from isolated individuals.

At its current level of detail the databank leverages relevant data points for most of the regions considered, sample individuals cluster with the standardized individual of the same area or with those from its wider macro region, and

has thus far provided results that are very encouraging. Initial testing shows that it consistently provides highly discriminating results for individuals from autochthonous populations, confirming its value for genetic classification.

#### A multivariate analysis of the Daka calvaria (BOU-VP-2/66) and implications for *Homo erectus* taxonomy.

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The "Daka" calvaria (BOU-VP-2/66) was recovered, *in situ*, from the Dakanihylo Member of the Bouri Formation, Middle Awash, Ethiopia and dates to approximately 1.0 Myr. Daka plays a critical role in our understanding of *Homo erectus* taxonomy because of its morphological resemblance to fossils from both Africa and Asia, sharing a number of derived traits with Asian *H. erectus*. Most importantly, Daka raises the question of whether African *H. ergaster* and Asian *H. erectus* clades are biologically distinct or represent a wide-spread, morphologically diverse paleodeme. Despite Daka's potentially pivotal role in discussions on the evolution of the genus *Homo*, a multivariate craniometric analysis of the calvaria aimed at examining its morphological similarities with African and Asian *H. erectus sensu lato* is currently lacking.

To address this gap, principal components and discriminant function analyses using linear cranial measurements were performed to investigate the morphological affinities of the Daka calvaria. The comparative sample consisted of *H. erectus* crania recovered from fossil localities spanning broad geographic regions throughout the Old World. Our results indicate that the Daka calvaria exhibits the greatest morphological similarity to Asian *H. erectus* fossils. Additionally, there does not appear to be a clear distinction between African and Asian *H. erectus* crania in terms of linear morphology. These results are in accordance with the conclusions originally proposed in the announcement of the fossil and suggest that the species-level division between African and Asian *H. erectus* may not be taxonomically meaningful.

#### Differentiation of bone functional adaptations in the forelimb and hind limb.

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Documented links between specific locomotor behaviors and bone functional adaptations are rare, but are often assumed when reconstructing activity patterns of extinct primates. Turning, or changing direction, is a major component of locomotor repertoires, and

may ultimately reflect habitat complexity. Here we study bone functional adaptations of forelimb and hind limb diaphyses in response to turning. We ask whether turning elicits a response in both the humerus and femur, whether one bone exhibits a greater response than the other, and whether responses support predictions based on external forces and kinematics associated with turning.

At 4 weeks postnatal, female C57BL/6J mice (n = 35) were introduced to one of three living conditions for a continuous 4 month period: custom-designed cages accentuating either turning (condition 1) or linear locomotion (condition 2), or standard cages permitting normal activity (control group). Instantaneous focal sampling was used to collect daily behavior frequencies throughout this period. After 4 months, mice were euthanized, limb bones extracted, and diaphyseal structure quantified using microfocus CT scanning. Analysis of standard cross-sectional geometric properties was performed, and interpreted with respect to activity profiles.

Both experimental groups exhibited lower activity levels than the control group. Despite their comparatively depressed activity levels, experimental groups exhibited predicted responses (e.g., higher turning frequencies were associated with more mediolaterally elliptical cross sections). Linear and control mice differed less often in many properties, while turning mice were often most distinctive. These data suggest terrestrial habitat complexity may not be trivial in importance compared to arboreal habitat complexity.

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#### Food processing reduces thermogenesis following meat or tuber meals in a model omnivorous mammal.

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Research into the energetic consequences of food processing has focused largely on its role in increasing the proportion of food nutrients absorbed within the gastrointestinal tract. However, by disrupting the structural integrity of food, processing by thermal and non-thermal methods can also be expected to reduce diet-induced thermogenesis (DIT), the cumulative energy expended on food ingestion, digestion, absorption and assimilation. DIT responses to unprocessed versus processed diets have not previously been assessed in humans or relevant animal models. Here we use open-flow respirometry to quantify DIT in adult rats fed standardized meals of lean meat or starch-rich tubers that were unprocessed, pounded, cooked, or pounded plus cooked. In meat, DIT in relation to meal energy was reduced by ~40% due to pounding or cooking and 57% due to pounding plus cooking, with the savings occurring primarily through decreases in the duration of the

DIT response. In tubers, DIT was reduced by 35% due to pounding, 40% due to cooking, and 51% due to pounding plus cooking, with the savings driven by decreases in duration and the activity associated with food ingestion. Assuming that meat and tubers were major caloric resources for ancestral hominins, energetic savings of this magnitude imply that habitual food processing could have increased dietary net energy gain by up to 8% due to DIT-related mechanisms alone. Our results support the conclusion that reductions in DIT contribute meaningfully to energy gains associated with processed diets, providing new insights into the evolution and maintenance of human energy budgets.

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#### **The relationship between thumb reduction and relative carpal volume in African colobines.**

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The African colobus monkeys are unique among catarrhine primates in having a reduced, almost vestigial pollex, with pollical metacarpals that are relatively shorter and more gracile than those of Asian colobines and cercopithecines. The developmental mechanisms for pollical reduction have been indirectly linked with differential *Hox* gene expression patterns in the distal part of the autopod (i.e., digits). Whether similar developmental mechanisms, and corresponding phenotypes (e.g., carpal size), are present in the proximal part of the autopod (i.e., carpals) remains unclear. This is due in part to the limited data available on carpal size and proportions for most primates. Because the pollex is functionally 'linked' with the trapezium and other radial-side carpals, it is reasonable to hypothesize that these bones might be similarly reduced in overall size and robusticity. That is, the radial-side carpals should constitute a smaller proportion of the overall wrist volume in these monkeys with vestigial thumbs. To test this hypothesis, carpal volumes (derived from microCT scans) of African colobines were compared to those of Asian colobines and cercopithecines (n>50). Results show that the trapezia of African colobines are smaller when scaled to total carpal volume compared with those of the outgroup taxa. However, other radial-side carpals do not show this effect. These results indicate probable developmental integration between digital and trapezial size and morphology, and may hint at some degree of modularity in the hand-wrist complex or other functional constraints that limit the downstream

effects of pollical reduction on the rest of the wrist.

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#### **The evolution of third molar agenesis in humans.**

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Humans are one of the few mammalian species showing polymorphism in permanent molar number. The underlying source of this variation, however, remains unclear. Recently developmental biologists have suggested the inhibitory cascade (IHC) model as a paradigm for rodent tooth development, which they also claim generalizes across mammals. Using the Swindler primate dental metric database supplemented with measurements from photographs and histological data, we assess the fit of the IHC model to molar proportions of hominins, extant primates and other large-bodied mammals (n=68 species). Results from analyses of molar morphospace occupation and from the patterns of temporal overlap between first and second molars are incompatible with the patterning mechanism proposed for rodents. Notably, the evolution of low-crowned teeth (irrespective of frugivory) appears tightly linked with the evolution of large second molars and small third molars. Humans, the only species of primate to fit both the morphological and developmental predictions of the IHC model, still differ markedly from the model's prediction of strong covariation between second and third molars. Third molar modularity first appears at the base of the hominin lineage. Surprisingly, the shift to this pattern of covariation occurred substantially before reduction in mandibular corpus length, indicating a non-functional explanation for the origin of third molar agenesis.

#### **Detection of sickle hemoglobin in febrile patients in Leogane, Haiti.**

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Sickle cell disease and trait are common erythrocyte disorders that are caused by a mutation in the hemoglobin beta gene. Sickle cell trait (i.e. heterozygous for the sickle cell allele) is selectively advantageous against severe malaria. Haiti is a malaria-endemic country, yet little is known about the prevalence of sickle cell disease and trait in this country. The purpose of

our study was to detect the presence of sickle cell disease and trait in Haiti, as part of a larger epidemiological study on malaria in Haiti. Sixty individuals at Hospital St. Croix were first screened for sickle hemoglobin using a solubility-based rapid diagnostic test (RDT), SickLeHeme (Michlone Associates, INC). RDT solution turbidity, as an indicator of sickle hemoglobin, was assessed visually and with spectrophotometry. Samples were also genotyped for sickle cell mutations. Of the 62 individuals screened for hemoglobin S using the RDT kit, 11 (17.6%) were positive. Of the 11 RDT positive samples, only six actually carried the sickle cell mutation, and as a heterozygote only. All other samples carried the wildtype genotype. Additionally, we observed "clumping" behavior in some RDT assays after sitting for 8 hours, but only in sickle hemoglobin samples that were confirmed by genotyping. We conclude that that genotyping is the most accurate method to estimate sickle hemoglobin. However, genotyping is expensive and requires specialized equipment. Thus, the "clumping" observation in the RDT assays may be the best option for detecting sickle hemoglobin in Haiti and similar resource-limited regions.

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#### **The relative effects of locomotion and posture on vertebral scaling.**

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Among diprotodont marsupials, koalas (*Phascolarctos*) and wombats (*Vombatus*, *Lasiorhinus*) are sister groups within a clade that has kangaroos and phalangers as its phyletic sister. Both koalas and wombats are quadrupedal, but koalas are slower-moving — and unlike wombats, they spend long periods of time sitting upright while feeding and resting. Preliminary data nevertheless show that the size disparity between the bodies of the cervical vertebrae and the (larger) lumbar vertebrae is less marked in koalas than in wombats. By contrast, kangaroos show a much more marked caudal increase in vertebral body size than either koalas or wombats. This marked increase is seen in kangaroos that are both larger and smaller than koalas, and is therefore not due to allometry.

We suggest that these facts support our earlier inference from similar data on bovinds—that locomotion, especially running, is a more important influence on the scaling of vertebral body size than posture is. This conclusion may have implications for our understanding of the surprisingly small lumbar vertebrae of early hominins.

### Cervicometrics and intra-Iberomaursian phenotypic variability.

CHARISSE L. CARVER and CHRISTOPHER M. STOJANOWSKI. School of Human Evolution and Social Change, Arizona State University.

Taforalt (16,750 BP) and Afalou-bou-Rhumel (ca.12,500-10,500 BP) remain two of the most important sites for understanding the Late Pleistocene Iberomaursian period in northwest Africa. Analyses of the human skeletal remains from both locations have been applied to questions of Iberomaursian population origins, population transitions and continuity, and population affinities. Here, we explore the question of Iberomaursian intra-population homogeneity using cervicometrics collected from permanent observable dentition from Taforalt (n=66) and Afalou (n=61). This approach maximizes sample size, while minimizing the effects of attrition, craniofacial dysmorphia, and ontogenetic plasticity.

Initial results based on standard deviations and F-tests are mixed. For mesiodistal dimensions, Afalou shows greater variability of the posterior maxillary dentition than Taforalt. However, Taforalt shows greater variability of the posterior mandibular dentition than Afalou. In contrast, Taforalt has greater variability in bucco-lingual dimensions than Afalou for both posterior maxillary and mandibular dentition. These differences were statistically significant (p=0.05). No significant differences were detected for the anterior dentition, regardless of dimension. Such results appear to mirror those based on dental morphology (Irish 2000). Therefore, we conclude that caution must be exercised when combining these two sites for larger studies of biodistance, and that further studies of intra-sample variability should be performed in order to better understand population structure for this region and time period.

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### Quantifying sexual dimorphism in the cranium: a preliminary analysis of a novel method.

ANA M. CASADO. Anthropology, The Ohio State University.

Forensic anthropologists and bioarchaeologists must estimate the sex of an individual using only skeletal elements. Several features of the human cranium are useful in estimating sex; these are generally visually assessed and scored using an ordinal scale. This study attempts to quantify six cranial features using three-dimensional coordinate measurements, originally proposed here by the author, to reduce inter- and intra-observer error and to provide a more accurate method for estimating sex.

The features of the cranium used in this study include the supraorbital ridges, glabella, external occipital protuberance, nuchal

protuberances, mastoid processes, and frontal bosses. Measurements were taken blindly from 265 male and female crania of known sex representing both White European and African ancestry from the Documented Skeletal Collection at the University of New Mexico's Maxwell Museum and the Bass Documented Collection at the University of Tennessee. Coordinate calipers and digital sliding calipers were used.

A discriminant function analysis correctly classified males 91% of the time and females 92% of the time, indicating that these measurements are useful for estimating sex in the modern U.S. population. This research is valuable for bioarchaeologists, as well as to forensic anthropologists who must increasingly rely on highly accurate, quantifiable methods for greater courtroom admissibility. Future research will revisit 60 crania to account for intra-observer error, as well as explore the strength of each trait and combinations of traits in estimating sex.

### Differences in owl monkeys (*Aotus* spp.): An examination of nesting site preference and behavioral budgets in three species of captive *Aotus*.

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Nesting behavior is uncommon in primates. Thus, for research facilities that house species requiring nesting sites, providing appropriate nesting materials as part of an environmental enrichment program is crucial to their psychological well-being. We recorded time budgets and examined differences in use of nesting sites between three owl monkey species: Azara's owl monkey (*Aotus azarai*), Nancy Ma's owl monkey (*A. nancyma*) and Spix's owl monkey (*A. vociferans*), housed at University of Texas MD Anderson: Keeling Center for Comparative Medicine and Research Core and Animal Resources, Bastrop, TX. We observed five family groups from each species ranging from 2-5 individuals. The facility provides four different types of nest boxes: [1] a mesh box, [2] a covered box of the same size, [3] a horizontal bucket, and [4] an opaque white box. As a nocturnal species, the owl monkeys are kept on a partial reverse light cycle and the rooms are equipped with louvers, allowing them to experience a "dusk" period in the lighting. We recorded their behavior before, during and after dusk to understand species' differences. During daylight, most of their time is spent huddled together resting (*A. nancyma* 44.8%, *A. azarai* 44%, *A. vociferans* 43.9%) and *A. nancyma* (34.7%) and *A. azarai* (43.1%) spent most of their huddled on a perch while *A. vociferans* rested on the floor (35.7%). However, when a nesting box was employed, all species preferred the covered box (22.3%, 32.5% and 27.1%). We discuss differences in time budgets and the complexities of cage usage.

### A paleopathology case study from the Midwestern Archaic.

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The Meyer site is a Middle Archaic mortuary from southern Indiana consisting of at least 19 people. Burial 54 is a young adult female with significant pathological conditions located primarily on the skull, although a few aspects of the postcranium are affected. The right mandibular body presents a lytic lesion measuring 39 mm in length; the ramus has thinned, twisted medially, and formed a psuedarthrosis between itself and the body. The anterior alveolar margin leans forward, with the front teeth held in a horizontal position. Osteoblastic activity is present along the margins of the nasal aperture, which is slightly reduced in size. On the maxilla, the anterior alveolar margin is completely reabsorbed, resulting the antemortem loss of all of the incisors. The maxillary sinuses have small patches of reactive bony spicules, as well as micro-lesions that have coalesced. Thoracic vertebrae six through ten have pitting on their anterior bodies and the eighth thoracic vertebra has collapsed resulting in inflammatory scoliosis. The right patella has a depressed lesion with osteophytic activity, as well as osteophytes along the patella's inferior border. A differential diagnosis fails to rule out the following: tuberculosis, a soft-tissue oral tumor, and fungal infections. No single disease adequately explains the degree and forms of skeletal involvement. This case serves as a reminder that examples of significant pathology are not limited to large, agricultural populations.

### Serengeti micromammals: testing the predictive ability of owl pellet assemblages for reconstructing paleohabitats.

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Human ancestors have faced changing environments through time, and these changes have had a direct impact on human evolution. Therefore, reconstructing paleoenvironments is an important aspect of paleoanthropological research.

This study tests the power of one approach toward paleoenvironmental reconstruction: the use of micromammal taxonomic relative abundance as an ecological indicator. Micromammals offer a unique, fine-scale spatial resolution suitable for reconstructing localized habitats (100-1,000m). Owls are one of the primary accumulators of micromammals, and, because of their roosting habits, reliably deposit remains in predictable locations. Previous studies indicate that these assemblages are a relatively accurate representation of the micromammals within a 1km radius. Many sites preserve

micromammalian assemblages from crucial periods in human evolutionary and archaeological history. Despite the great promise of micromammal assemblages for reconstructing paleoenvironments, there has been no blind test of this methodology on a known habitat.

This study provides a blind test of a single micromammalian assemblage (HA1) collected approximately 250km from the comparative base of 12 owl roosts across the Serengeti ecosystem. Two researchers, both unaware of the origin of HA1, made independent analyses and habitat reconstructions. These interpretations were then compared to each other and the site's actual location and habitat type. There was no disagreement between observers, and the provided environmental information for HA1 fit well within the predicted habitat description. Though there was some anthropogenic disturbance at HA1, the habitat type was accurately predicted. This blind test validates the use of micromammal taxonomic abundances for reconstructing past environments.

#### **A comprehensive bioarchaeological analysis of a Copper Age society from Rome, Italy.**

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Recent archaeological surveys performed in Rome (Italy), have brought to light a small necropolis which use is dated to Eneolithic. The Eneolithic is a key transitional period, between the Neolithic and the Bronze Age, often identified as the Copper Age. In Italy it is dated from 3600 to 2300 BC, mostly characterized by the increase of agriculture activity. The 14 people buried in the area have been anthropologically analyzed to assess the demographic profile of the community and to identify the morphological and/or pathological conditions. Health status, unspecific stress markers and an overall skeletal strength associated with the presence of marked muscle insertions, have been evaluated according to classical morphological analysis. The finding of two children in a single burial led to perform ancient DNA analysis to investigate the relationships between them. Stable isotope analysis of human remains offers a potential solution to analyze the basic subsistence level, since the isotopic ratios of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) in preserved human bone tissue reflects the isotopic ratios of food consumed during the individual's lifetime. The results

underlined an overall satisfactory health condition that might be ascribed to a not lacking dietary uptake. This trend is supported by regional archaeological evidences for the advent of technological innovations linked to intensive terrestrial plant processing. The results show how the integration of different kind of data is important to outline a complete biological profile of ancient populations.

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#### **Developmental perspectives on feeding in wild tufted capuchins (*Cebus libidinosus*).**

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Tufted capuchins employ complex processing behaviors coupled with physical strength to access mechanically-protected foods. It has been argued that tufted capuchins require an extended juvenile period to gain the strength and skill necessary to achieve adult competence when extracting foods embedded in tough or hard tissues. While several behavioral studies have demonstrated that extractive-feeding proficiency improves with age in capuchins, this research has relied on a subjective assessment of dietary mechanical demand. Here we compare the mechanical properties of foods eaten at various stages during tufted capuchin development and examine the relationship between age, feeding behaviors, and food mechanical properties. Our sample included adults ( $n = 17$ ) and juveniles ( $n = 11$ ) from two groups of wild tufted capuchins (*Cebus libidinosus*) at Boa Vista, Brazil. We used continuous focal animal sampling methods to collect data on food processing behaviors. Food mechanical properties were measured using a HKU Darvell universal mechanical tester. Juveniles and adults exploited foods of comparable toughness and Young's modulus ( $p > 0.05$ ). Despite this overlap in food mechanical properties, processing behaviors differed between adults and juveniles when eating certain foods. These results indicate that age-related differences in feeding proficiency are specific to food type and reflect a combination of food mechanics, food geometry, and skill level. These findings emphasize the importance of integrating behavioral and food mechanical property data to better understand the factors influencing the ontogeny of primate feeding.

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#### **“Short people got no reason to live”: Long bone length and selective mortality of children in medieval Denmark.**

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Children often make up half of the individuals found in pre-industrial cemeteries. Their ages, identified by dental development and by long bone length, are used to build demographic models for the populations. Given selective mortality among children, however, the long bone growth of dead children may lag behind that of those who survive to adulthood, underestimating their ages and skewing the demographic estimates. In this study, we hypothesize that the long bone lengths (femur, tibia, radius, ulna, and humerus) of the children found in Tirup cemetery will be shorter than expected given their dental development. Tirup, a medieval Danish cemetery, contained 464 graves with preserved human remains. Of those, 138 were adults having at least one measurable long bone with fused epiphyses, and 78 were children with at least one measurable diaphysis and preserved dentition. We use the length of the Tirup adult long bones, and known models of bone growth, to construct expected growth curves for each bone. Plotted dental age versus observed diaphyseal lengths are compared to the growth curves. Preliminary work finds that the children's limbs are short for age, leading to the conclusion that the children found in the cemetery were not a representative sample of the total child population at each age. These findings might be applicable to other collections with large proportions of children, and should caution osteologists about making direct inferences about the living children from the deceased.

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#### **First known tarsals of the earliest primate *Purgatorius*.**

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Earliest Paleocene *Purgatorius* has traditionally been considered the most primitive known primate based on its age, dental morphology, and plesiomorphic lower dental formula (3.1.4.3). However, its primate (or even placental) affinities have been questioned based on results from recent phylogenetic analyses that suggest a relationship with primitive condylarths including contemporary *Protungulatum*. The fossil record of *Purgatorius* has been limited to isolated teeth and fragmentary dentitions, with little data relevant to hypotheses of relationships or primitive primate ecology. Isolated tarsals found in the same deposits as hundreds of dental

specimens of *Purgatorius* from the earliest Paleocene (~65MYA) of the Garbani Channel fauna localities, Garfield County, Montana, are referred to *Purgatorius* based on size, abundance, diagnostic similarities to dentally-associated tarsals of eurchontans (generally) and plesiadapiforms (specifically). *Purgatorius* differs from *Protungulatum* in having astragali with a longer, narrower trochlea that extends distally onto the neck, confluent sustentacular and navicular facets, and a more pronounced medial side of the head; and calcanea with a more proximodistally aligned ectal facet, a helical sustentacular facet that extends distally onto the body, a circular and concave cuboid facet, and no fibular facet. These characteristics are consistent with a mobile ankle capable of pedal inversion to adjust to an uneven substrate in *Purgatorius*, whereas *Protungulatum* is better suited for a more level substrate. We suggest that tarsals of *Purgatorius* are most similar to those of micromomyid plesiadapiforms, reconstructed as arboreal based on fairly complete skeletons, and that *Purgatorius* lies near the ancestry of all primates within Eurchonta.

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#### **Osteoarthritis and resource intensification in prehistoric Central California.**

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Zooarchaeological and archaeobotanical data from Central California document a shift from the use of lower-cost, higher-ranked resources toward the greater use of higher-cost, lower-ranked resources during the late Holocene. Archaeological evidence suggests an increased reliance on acorns through time, concomitant with a more sedentary lifeway. These changing subsistence patterns likely influenced sexual division of labor practices, including intensive plant processing activities and greater logistical mobility to acquire key game resources away from village sites. Framed within the context of resource intensification models, these trends correspond to declines in human health documented in previous bioarchaeological research.

Bioarchaeologists study osteoarthritis to infer changes in physical activity and functional stress in past societies. This study investigates the prevalence of osteoarthritis in the appendicular skeleton during three periods of Central California prehistory: the Early (4500-2800 BP), Middle (2800-1200 BP), and Late (1200-200 BP) Periods. Adult individuals (n=284) were examined from seven sites in the prehistoric Sacramento-San Joaquin Delta region. Preliminary results indicate that the prevalence of osteoarthritis in the upper limb did not change through time, but increased in the hip joint of both sexes during the Late Period.

Additionally, no significant differences between males and females were identified for all three time periods, suggesting relatively equal stress levels between the sexes. The temporal increase in lower limb osteoarthritis supports the hypothesis of increased logistical mobility over time to procure key resources away from the village sites. Changes in the patterning, but not activity levels, may explain why sex differences were not observed.

#### **A pilot description and categorization of Kinda baboon vocalizations.**

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Kinda baboons (*Papio kindae*) differ from other baboons in both body size and body size dimorphism, and exhibit a number of social and behavioral peculiarities. These physical and behavioral differences are expected to result in differences in structure, frequency, and context of Kinda baboon vocalizations relative to other baboons. In summer 2012, I recorded 658 calls or call bouts opportunistically over a one-month period at Kafue National Park, Zambia. Whenever possible, vocalizations were supplemented with *ad lib* behavioral observations.

The most commonly encountered calls (>50 recordings each) were: grunts, screams, threat barks, and "fear" gecks. In contrast to other baboons, copulation calls were absent and the prevalence of barks/wahoos was low. While the rarity of barks/wahoos may reflect variation in ranging behaviors, group demographic histories, and environmental features, the absence of copulation calls (after 69 documented copulations) appears to be a distinctive characteristic of this taxon and is consistent with observations of Kinda baboons at Kasanka National Park, Zambia. At Kafue National Park, observed copulations were more commonly followed by agonistic behaviors among males, accompanied by screams and threat barks, or grunting by the male partner. Taken together, the vocal behaviors associated with copulations in Kinda baboons shed important light on the meaning and function of female copulation calls. The absence of copulation calls in Kinda baboons stands in contrast to existing reports from all other baboon taxa and provides support for the female choice hypothesis.

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#### **Testing the source of the non-embedded projectile point: inflicted point or pit fill?**

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Previous research on Late Woodland period (AD 900-1200) intergroup violence in the

Hamilton Mortuary Complex (HMC) of East Tennessee revealed a prevalence approaching 10%. As no trophy taking was observed, the frequency was based on inflicted points, ectocranial trauma and mass interments where at least one burial displayed with an inflicted point. However, the mortuary context in several HMC sites included individuals with projectiles either recovered in the thoracic cavity or touching a long bone. The field notes concluded that the body cavity points were also inflicted. However, without evidence of infliction, the stray points are at best suggestive evidence of violent trauma. The projectiles involved are small (circa 20-25 mm) and finely serrated arrow points. If such a point glanced bone, the sawing action would theoretically leave nicks. This was tested in the HMC Hiwassee Island site adult sample (N=82). Skeletons with embedded points, non-embedded body cavity points, cached points (occurring at the neck or upper chest), or no points were examined with a hand lens for evidence of nicked bone. No cuts or nicks were found in individuals in any context, even the inflicted cases. Given the possibility of sampling error, further forensic assessment of HMC contexts is warranted. However, the veracity of the test relative to the field report is the results of a mortuary assessment of the cached points: these are (exclusively) male grave inclusions of a quiver of arrows (and presumptive bow) as all interments cross an arm over the chest.

#### **To commit or play the field? Costs and benefits of male mating strategies in hamadryas versus chacma baboons.**

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Male hamadryas baboons are unusual among primates in focusing their reproductive effort on a small set of females in a one-male unit (OMU) rather than queuing for all estrous females as do other baboon males. Hamadryas males thus experience opportunity costs by failing to pursue additional females. Additional costs may derive from the presence in OMUs of follower males, who may gain sexual access to females. Here we explore the costs and benefits of this strategy in comparison to that of a closely related polygynandrous primate, the chacma baboon. Our data include seven years of observations of wild hamadryas baboons in Ethiopia and three years of chacma baboons in South Africa. Hamadryas leader tenure length averaged 44 months (N=69; an underestimate as most observations were censored), and leader males obtained 1-14 (mean 3.4) females overall and 1-8 sexually mature females (mean 2.8) during their tenure. We will compare the success of this exclusion strategy with that of chacma baboons, in which males compete for dominance rank and queue for estrous females. To further assess the costs and benefits of the hamadryas

strategy, we will discuss the impact of follower males and size of OMUs on leader male tenure, the time interval between acquisition of successive females, and the number of infants born into their OMUs during their tenure as well as the survival of those infants. Via this comparison, we hope to elucidate the relative costs and benefits of multi-male queuing versus reproductive exclusion among male baboons.

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#### **Ethics of field site management and oversight.**

KATHRYN B. H. CLANCY. Anthropology, University of Illinois, Urbana-Champaign.

There is never an instance in which our research agenda should be privileged over supporting junior scientists, providing them the resources to flourish, and protecting them from mental, physical and emotional harm. This mentorship from faculty and their institutions, and the student labor derived from it, provides the foundation upon which our research rests. This foundation is cracked: undergraduates, graduate students, postdocs, and faculty report sexual harassment and assault not only by their peers, but by their bosses and mentors in the field. I suggest that the first step to counteract this damaging culture is to raise awareness by creating safe spaces for victims to speak out. Once we raise this awareness we can understand the scope of the problem, and begin to devise plans to end sexual harassment and violence in the field. I will describe existing ally work and suggested directions for future action that include preventive measures such as sensitivity training and contracts for appropriate field behavior, as well as how to foster a meritocratic atmosphere that is intolerant of oppression.

#### **Sexual dimorphism and health in prehistoric Thailand.**

ANGELA L. CLARK, NANCY TAYLES and SIÂN E. HALCROW. Department of Anatomy, University of Otago.

Sexual dimorphism, the difference between male and female body size, varies between populations and is influenced by environmental factors. The level of skeletal sexual dimorphism in a population is often used as an indicator of health. It is expected that in adverse conditions, males would not reach their genetic potential for size, resulting in low levels of sexual dimorphism.

This paper aimed to test the relationship between sexual dimorphism in skeletal size and general health in an adult sample ( $N = 190$ ) from Ban Non Wat, Northeast Thailand (1750 – 420 B.C). Previous research suggests that health in Southeast Asia did not deteriorate during agricultural intensification as severely as in some Western populations. Therefore, this research tests three hypotheses: 1) health would be static over time; 2) population sexual dimorphism will

positively correlate with general health; 3) males will be more sensitive to environmental changes than females. These hypotheses are tested by examining childhood stress reflected in the prevalence of linear enamel hypoplasia, terminal adult skeletal size, and stress during later life reflected in periosteal reactions.

The results indicated that general health improved over time, sexual dimorphism and health were negatively correlated, and females demonstrated greater variation in skeletal dimensions, whereas there was stability in male body size over time, and there are no sex-specific differences in either indicator of non-specific systemic stress. This research shows that the assumptions about the relationship between changes in health and sexual dimorphism with agricultural intensification in mainland Southeast Asia are complex.

*This research was funded by a University of Otago Doctoral Scholarship awarded to AC.*

#### **Macro tooth wear patterns amongst the early hominins of South Africa.**

ANNA F. CLEMENT and SIMON W. HILLSON. Institute of Archaeology, University College London.

Research into the diet of early hominins has focused on data from craniodental morphology, palaeoecology, dental microwear and stable isotopes. While each of these lines of evidence has provided important insights into past diets, they often produce conflicting results. Microwear studies of early hominins from South Africa suggest they were largely fruit and leaf eaters, but that *Australopithecus africanus* consumed tougher, more elastic foods than *Paranthropus robustus*, which consumed harder and more brittle foods. Results from stable carbon isotope analysis, however, suggest greater similarities between their diets. This study presents an alternative source of evidence, examining the macro tooth wear patterns in *A. africanus* and *P. robustus* specimens from the South African sites of Sterkfontein, Swartkrans, Kromdraai and Makapansgat. Macro tooth wear was measured from digital photographs of the permanent dentition of original specimens. A dentine proportion was calculated for each tooth by dividing the area of exposed dentine by the area of the occlusal surface. Wear patterns were compared independent of age; this was achieved by dividing the dentine proportions of each tooth by that of the first molar. The results not only show differences in the wear patterns between *A. africanus* and *P. robustus* specimens, but also between the different sites. These results are discussed in relation to differences in dental growth and development, tooth morphology and diet. *This study funded by the Leverhulme Trust.*

#### **Cross-comparison of the use of ketones and urinary C-Peptide of insulin as a means of assessing energetic status in wild bonobos (*Pan paniscus*); Iyema Forest, DR Congo.**

AMY K. COBDEN. Anthropology Department, Emory University.

Assessment of energetic status in wild primates is a challenging, but useful endeavor

when investigating behavioral and reproductive ecology. Urinary “chemstrips” are a relatively cheap means of ascertaining basic and broad health indicators within minutes of urine collection. In particular, the ability to measure urinary ketones is of interest since the presence of ketones is an indication of energetic stress. However, the efficacy of these strips in detecting ketones has been called to question in the absence of positive results across time and multiple studies and species.

Here, I compare the results of urinary ketones with levels of urinary C-peptide of insulin collected from wild bonobos (*Pan paniscus*) as a means of cross-methodological validation. Ketones reflect energetic stress, while urinary C-peptide of insulin reflects the recent presence of insulin in the blood stream, suggesting energetic surplus. Fresh urine samples were collected between August 2010 and June 2011 from a semi-habituated community of wild bonobos at the Iyema study site, DRCongo. Samples were tested the day of collection for ketones and other biomarkers, and remaining urine was preserved on filter paper (Whatman 903 Protein Saver Cards) for analysis at Emory University. Results are compared against phenological data taken during corresponding months, representing seasonal patterns of 1805 individuals from 45 species of trees and lianes.

The results from this study reflect the significance of using multiple measures in the process of assessing health status in complex, free-ranging (and in this case, endangered) primates.

*This project was funded by the Leakey Foundation, USFWS Great Ape Conservation Fund, and Emory University Anthropology Department.*

#### **Early postnatal brain growth in *Homo erectus*: Incorporating uncertainties.**

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Different studies focusing on the Mojokerto calvaria have variously concluded that *Homo erectus* brain growth was either similar to chimpanzees, within the human range of variation, or overlapping with both species' patterns. However, these inferences have relied on comparing subadults with adults, due to the absence of fossil neonates. The purpose of this study is to examine early postnatal brain growth in early *H. erectus*, utilizing recent estimates of cranial capacity and chronological age for the Mojokerto calvaria, and estimates of *H. erectus* neonatal brain size. Randomization methods, taking into account the ranges of these estimates, are employed to compare *H. erectus* brain growth with cross-sectional samples of recent humans and chimpanzees between birth and 1.25 years of age.

In the first 1.25 years of life, brain size increases by a median factor of 2.0 and 2.6 in chimpanzees and humans, respectively, with great overlap between species; *H. erectus* is

intermediate, with a median size increase of 2.3 times (resampled) neonatal values. Median absolute size increase is 206 and 558 cm<sup>3</sup>, in chimpanzees and humans, respectively. Resampled *H. erectus* values overlap the upper half of the chimpanzee range and are subsumed entirely within the human range, albeit mostly in the lower half. The 'intermediate' rate of *H. erectus* brain growth would have entailed high energy requirements and great parental investment. We discuss implications for *H. erectus* social behavior and cognition, and suggest applications of the present analytical techniques to questions of australopithecine brain development.

#### Feeding behavior and trabecular architecture of the mandibular condyle in extant primates.

SUSAN COINER-COLLIER, ERIN R. VOGEL and ROBERT S. SCOTT. Department of Anthropology, Rutgers, The State University of New Jersey.

The relationship between jaw form and diet has long been of interest to anthropologists, but little is known about the factors that influence trabecular bone morphology in the mandibular condyles. The temporomandibular joint experiences loading during mastication, and it is thus reasonable to expect that its form and bone density may vary with diet and feeding parameters. We tested the hypothesis that the internal morphology of the mandibular condyle is driven by dietary ecology. The architecture of the mandibular condyle was examined using a sample (N=12) of extant primate mandibles. Mandibles were scanned using high-resolution X-ray computed tomography (HRXCT) and a 50-pixel cubic volume of interest from the center of the mandibular condyle was analyzed with ImageJ and Quant3D. Degree of anisotropy (DA) and trabecular bone volume fraction (BV/TV) were measured.

Daily percentage of time spent feeding was regressed against mean body mass for each species, and the ordinary least square residuals were calculated as a measure of feeding time relative to body mass. The relationship between DA and feeding time was not significant, but the correlation between BV/TV and feeding time was highly significant ( $p < 0.001$ ,  $R^2 = 0.619$ ). Primates that spend more time feeding than expected based on body size appear to have denser trabecular bone within the mandibular condyles. These data are important to further our understanding of the factors driving jaw form, and may enable us to predict the proportion of a daily activity budget spent on feeding for early hominins based on BV/TV in the mandibular condyles.

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#### Cementochronology: A test of accuracy by age groups on a reference population.

THOMAS COLARD<sup>1,4</sup>, BENOIT BERTRAND<sup>2</sup>, STEPHAN NAJJI<sup>3</sup>, AMÉLIE

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The main goal of this poster is to demonstrate how tooth cementum annulations (TCA) method improves the field of age assessment, through a distinct physiological phenomenon. Acellular cementum begins its regular growth with tooth eruption and then continues to be produced throughout life as incremental layers of alternating dark and light bands. Cementochronology involves the counting of these incremental lines using light and polarized microscopy.

Since the first study of Stott *et al.* (1982), many researchers have published correlation rates above  $r = 0.9$  effectively making cementochronology the most precise technique for individual skeletal age estimation. In our study, 350 recent teeth from known-age individuals, divided in six age categories of ten years range, were collected at the Lille Dental Surgery Department. All teeth were embedded in a two components epoxy resin and dried in a vacuum chamber. Six sequential 100-130 mm undecalcified cross sections were prepared for each tooth, from the middle third of the root, with a precision saw. Three observers were involved in each counting process. We have focused our study on two main issues in order to improve this method: Correlation by age groups between estimated and calendar ages. Comparison of cementochronology with others dental methods for age estimation (Lamendin, Bang and Ramm, Prince and Ubelaker).

Our results showed a statistically significant strong correlation between estimated and calendar ages for all age groups, with a small decrease of accuracy in old age individuals. In addition, cementochronology was always more accurate than others dental methods.

#### Exploratory multivariate analysis of shape in commingled fossil assemblages.

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Fossil assemblages are often small, fragmentary, and commingled, posing considerable challenges to the multivariate study of size and shape. In this context, we must find or develop new methods appropriate to the nature of the data. We focus here on exploratory methods, searching for interesting patterns in shape variation. We use a novel method where complete observations ("composites") are simulated by randomly combining isolated fragments. We scale the data by defining logshapes, which are ln-transformed ratios of a

composite's measurements to their geometric mean. Principal components analysis summarizes logshape variation in relatively fewer dimensions. We use interactive graphics methods, including scatterplot matrices and parallel coordinates plots, to search the PCA scores for patterns. These are linked together and patterns are sought by interactively highlighting specific composites with distinctive colors and symbols.

To illustrate, we study dental shape variation in *Homo erectus sensu lato* from China, Indonesia, Africa, and Europe. Mesiodistal and buccolingual diameters of permanent teeth were analyzed in 1000 random composite dentitions. The first ten principal components of logshape were explored using the *ggobi* software package. Most components describe contrasts between the relative sizes of incisors and molars and between different molars. In comparison, there appears to be relatively less variation in the shapes of individual teeth. When the distribution is explored graphically, the distinctiveness of European specimens from Dmanisi is effectively highlighted. We conclude that these methods show promise for detecting patterns in fossil assemblages that could reflect possible variations in sex, time, geography, or taxonomy.

#### What do primate auditory ossicles tell us about hearing patterns in living and extinct taxa?

MARK N. COLEMAN and KEVIN R. MANFREDI. Anatomy, Midwestern University.

The auditory ossicles have been used for functional and phylogenetic comparisons in various groups of mammals including primates. However, the implications of variation in ossicular morphology remains poorly understood and few studies have looked at the influence of different measurement protocols. In this study we examined a sample of primate earbones and took measurements on both isolated and articulated mallei and incudes. Our sample consisted of over 1000 ossicles representing 61 genera of primates. The measurements we took included the functional lengths (lever arms) of the malleus and incus, the angles of the manubrium and long process relative to the axis of rotation, and various other measures capturing shape characteristics of each bone. Measurements were made on scaled digital photographs of the ossicles taken under low magnification.

Many of the measurements differed depending on whether they were taken on isolated or articulated specimens. For example, although the two sets of measurements were correlated, the lever arm lengths for both the malleus and incus could differ by up to 18%. Similarly, the angles of the lever arms could show more than 20 degrees of difference depending on whether the measurements were taken on articulated pairs or on isolated bones. This is likely related to differences in interpreting the axis of rotation. However, regardless of which approach was used, strepsirhines demonstrated a lower angle of the manubrium when compared with haplorhines.

This pattern may be related to the increased high frequency sensitivity characteristic of most strepsirhine taxa.

*Funding for this project was provided by Midwestern University.*

**Let your fingers do the walking: A simple spectral signature model for “remote” fossil prospecting.**

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Paleoanthropological explorations are time-consuming, expensive, logistically challenging, and often hit or miss. Success can be serendipitous. Therefore, any technique that might increase the odds of locating fossil localities, particularly those in remote and extensive badland areas, would be a major contribution to the field. Here we describe, and test, a technique that has great potential for increasing the probability of finding fossiliferous sediments - a relatively simple spectral signature model using the spatial analysis and image classification functions of ArcGIS<sup>®</sup>10. We demonstrate how these tools can create interactive thematic land cover maps that can be used for “remote” fossil prospecting. Our test case is the extensive Eocene sediments of the Uinta Basin, Utah, a fossil prospecting area encompassing ~1200 square kilometers. Using Landsat 7 ETM+ satellite imagery, we first “trained” the spatial analysis and image classification algorithms using the spectral signatures of known fossil localities discovered in the Uinta Basin *prior* to 2005. We then created interactive probability models of the Uinta Basin which highlighted other regions in the Basin predicted to be fossiliferous based on the similarities of their spectral signatures to the fossiliferous “training” sites. A fortuitous “post-hoc” validation of our model presented itself. Our model identified several potential paleontological “hotspots”, regions that had not produced any fossil localities *prior* to 2005, but had high probabilities of being fossiliferous based on the similarities of their spectral signatures to those of previously known fossil localities. Subsequent fieldwork found fossils in all the regions predicted by the model.

**Hominin hard object feeding as inferred from dental chipping analysis.**

PAUL J. CONSTANTINO and ALEX EDELMANN. Department of Biology, Marshall University.

Ever since Philip Tobias dubbed OH 5 “nutcracker man,” the derived masticatory morphology of the robust australopiths has been associated with hard food consumption. However, recent evidence from the analysis of dental microwear and stable isotopes has cast

considerable doubt on this dietary interpretation. These new studies suggest that *Paranthropus boisei* (as well as *Australopithecus afarensis* and *Au. anamensis*) were not consuming hard foods in any significant quantity. We recently introduced a method called dental chipping analysis that can detect the presence of hard foods in the diets of fossil taxa. Because it detects the consumption of large hard objects that are potentially outside the size range of foods that can be detected by dental microwear analysis, we argue that it can sometimes detect the presence of hard foods in the diet even when dental microwear does not. Therefore, we assessed the number and size of chips on the teeth of fossil hominins in order to estimate the frequency with which these hominins ate hard foods. We then compared these frequencies with those obtained from dental microwear. Species examined include *P. aethiopicus*, *P. boisei*, *Au. afarensis*, *Au. anamensis*, and early *Homo* from East Africa, and *P. robustus*, *Au. africanus*, *Au. sediba*, and early *Homo* from South Africa. The results reveal a high degree of tooth chipping in the South African specimens, particularly *P. robustus*, but noticeably less in the East African specimens, which is in broad agreement with results from dental microwear analysis.

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**Apples, oranges, and incremental lines: A fresh look at enamel formation and long bone growth in prehistoric Illinois.**

DELLA C. COOK. Anthropology, Indiana University.

The Schild Cemetery in west-central Illinois provides a large, well-preserved Middle Mississippian skeletal series from the rural hinterlands of Cahokia, the largest prehistoric community in North America. Prior studies have documented stress markers, growth and stature during the transition to maize agriculture in the theoretical context of processual archaeology, quantified maize consumption using stable isotopes and explored specific nutritional deficiencies. Gendered activity patterns are reflected in cross-sectional geometry, arthritis and enthesiopathies. Many young adults in this series suffered chronic orthopedic conditions that would have compromised their participation in some activities.

This paper examines Harris Lines in the tibiae and pronounced Striae of Retzius in the molar enamel of Schild adults 20 to 35 years in the context of this prior research. These stress markers are not correlated with one another or with adult stature, a finding that replicates other research and points to differing mechanism of growth disruption. More surprising is the failure of these two stress markers to demonstrate history of elevated stress during childhood and adolescence in persons with chronic orthopedic conditions who died as young adults. This finding is examined in two theoretical contexts. The frailty hypothesis is a poor fit for this result, perhaps because both the underlying causes of

orthopedic conditions and of these two stress markers are heterogeneous. In contrast, the emerging interdisciplinary focus on disability studies provides a context in which Mississippian society can be viewed as well-integrated and supportive of disabled persons.

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**GIS analysis of the ranging behaviors of red-capped mangabeys (*Cercocebus torquatus*) from Sette Cama, Gabon.**

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Several factors influence the ranging of primate populations including group size, predation pressure, and the spatio-temporal availability of foods. *Cercocebus torquatus*, the red-capped mangabey, in Sette Cama, Gabon, has a large group size (~70 individuals) but a smaller home range (250 hectares) than other mangabeys of similar group sizes. We hypothesized that *C. torquatus* would show minimal seasonal variation in its habitat use because of the nature of their habitat. Group members should also exhibit a high degree of vertical group spread. GIS analysis is a useful tool for studying primate ranging patterns as it offers a means to compare movements to multiple variables. A total of 635 GPS points were collected during 2008-2009 and analyzed using ArcGIS 10. The vertical distribution of the group members in the forest was also recorded. *C. torquatus* movements were spatially correlated (Moran's index: 0.596,  $p < 0.001$ ) indicating that they repeatedly return to the same areas within their habitat. The ranging patterns of the group were only slightly related to the seasonality of resources (ordinary least squares, wet season:  $F = 664$ ,  $p = 0.05$ ; dry season:  $F = 0.019$ ,  $p = 0.05$ ) which differs from other populations of *C. torquatus*. The group had a mean diversity index of vertical distribution of 0.47. We suggest that *C. torquatus* maintains its large population in a small home range in part by intensively using its habitat and concurrently occupying different levels of the forest. The importance of subgrouping for the maintenance of this large population is also discussed.

**Form and function in a sample of platyrrhine primates: A three-dimensional analysis of dental and TMJ morphology.**

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Cranial and temporomandibular joint (TMJ) form have been shown to reflect masticatory forces and mandibular range of motion, which vary in relation to feeding strategy. Similarly, the dentition, as the portion of the masticatory apparatus most directly involved in triturating food items, strongly

reflects dietary profile. Fine control over condylar and mandibular movements guides the teeth into occlusion, while the topography and position of the dental arcade mediate mandibular movements. Thus, we hypothesize that masticatory, and particularly TMJ, morphology and dental form covary in predictable ways with primate diet. We employed three-dimensional geometric morphometric techniques to examine both intra- and inter-specific variation in ten platyrrhine species. Landmarks were collected on six separate datasets describing the upper and lower molars, the cranium, glenoid fossa, mandible, and mandibular condyle; 2B-PLS analyses were performed to assess co-variation between cranial morphology and the dentition. Significant relationships were identified between the upper and lower molars and the mandible, and between the upper and lower molars and the glenoid fossa. Some of these shape complexes reflect feeding strategy; for example, higher crowned/cusped dentitions, as found in primates consuming larger quantities of structural carbohydrates (e.g., *Alouatta* and *Saimiri*), correspond to deeper glenoid fossae and larger post-glenoid processes. These results indicate strong covariance between dental and TMJ form, aspects of which are related to feeding behavior. However, other aspects of morphological variation display a strong phylogenetic signal; we must therefore examine further ways in which to control for phylogeny when examining covariation of interspecific masticatory form.

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#### **Hormonal contributions to sex differences in baboon skeletal robusticity.**

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Slender bones (narrow relative to length) are generally assumed to be weaker than robust bones (wide relative to length). However, slender bones compensate for the natural variation in bone shape by adjusting bone quality traits such as tissue mineral density (TMD) to support the loads incurred during daily activities (achieve mechanical functionality) – a consideration of great import given the ubiquitous use of skeletal shape in the fossil record to predict activity patterns and population affinity. Using microCT scans of bones from adult captive baboons (*Papio anubis*), we tested the hypothesis that the correlation between bone shape and quality would be higher in weight-bearing relative to non-weight bearing bones (N=35). We also investigated patterns of hormones involved in osteogenesis as potential mediators of these relationships. Osteocalcin, adiponectin, and osteoprotegerin concentrations were assayed in serial blood samples collected from a group of juvenile baboons (N=25) and were expected to

reveal sex-specific differences around the time of sexual maturation.

The expected inverse relationship between TMD and slenderness existed in the humerus and tibia but not in the femur, ulna, radius, or clavicle. Females invariably exhibited the lower values of shape variables and higher quality measures in these elements. Our analyses revealed significant sex differences in absolute hormone concentration and patterns with age, with notable associations with puberty. These results indicate that the relationship between bone shape and tissue quality are site- and sex-specific and that hormones play a vital role in the development of this subtle interplay.

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#### **3D analysis of the jaw-basiscranium-cervical skeleton in fetal and infant humans and chimpanzees. Implications for shaping the mandibular symphysis.**

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In chimpanzees and modern humans, symphyseal growth includes a forward shift of the mental region leading to a vertical symphysis in chimpanzee fetuses, but a mental prominence in human infants. It is suggested that this displacement may be associated with spatial changes in the back of the vocal tract delimited by the cranial base, the upper mid-face, the cervical column and the hyoid bone. Our study aims to examine this hypothesis.

The sample consists of 3D reconstructed jaw-basiscranium-cervical skeletons based on CT-scans of 8 chimpanzee fetuses and 36 human infants, from birth to 5.5 years. On each specimen, we digitized 668 semi-landmarks and converted these to shape-variables by Procrustes superimposition to compare chimpanzee and human ontogenetic shape changes.

Our results show that in chimpanzees and humans, the forward positioning of the mental region is associated with the space restriction at the back of the vocal tract due to upper mid-face retraction, resulting from cranial base flexion. In humans the space restriction is associated with the development of the upright body posture and the descent of the hyoid bone, whereas in chimpanzees it is associated with flexion of the head towards the throat, related to the fetal position, and the ascent of the hyoid bone.

These findings suggest that the development of a vertical symphysis in chimpanzees and a prominent mental region in humans may provide space for the tongue and the suprahyoid muscles in order to preserve the functionality of the laryngopharynx.

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#### **Male dominance rank, access to females, and mating success in mantled howlers (*Alouatta palliata*): Testing the priority-of-access model.**

LISA C. COREWYN. Department of Anthropology, University of Texas at San Antonio.

The priority-of-access (PoA) model posits that high dominance rank increases male mating success by increasing access to fertile females. However, the relationship between rank, access to females, and subsequent mating success is unclear in many primate taxa. The purpose of this study is to test the relationship between these variables in an asynchronously breeding Neotropical primate species, *Alouatta palliata*, in order to contribute to our understanding of the function of dominance that will inform sexual selection theory and future models of reproductive skew. From January to December 2010, I collected 1741 H of focal data on adult males within 2 study groups (N=4 males in each group) at La Pacifica, Costa Rica. Male rank was determined based on agonistic interactions. Females were classified as potentially fertile (PF) or non-fertile (NF) based on behavioral and birth data. Access to mates was measured based on total time in 3 m proximity to PF females, and mating success was measured based on copulation frequency with PF females. Results from pooled data revealed that beta males obtained greater proportions of time in proximity to PF females than alpha and other males ( $\chi^2=11.74$ ,  $p=0.008$ ). However, copulation frequency for beta males was significantly lower compared to alpha and other males ( $\chi^2=11.22$ ,  $p=0.011$ ). These results suggest that access to potential mates does not necessarily increase mating success, and do not support predictions of the PoA model. Instead, 'queue-jumping' by lower-ranking males, as well as the reproductive strategies of females, may be operating to influence differential mating success.

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#### **Ranging patterns of solitary floater owl monkeys.**

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Azara's owl monkeys (*Aotus azarae*) are small territorial primates that typically live in socially-monogamous groups of 2 to 6 individuals. In an owl monkey population inhabiting the gallery forest of the Gran Chaco in Formosa, Argentina both male and female offspring disperse from their natal groups and become solitary floaters for a period that ranges

from a few days to months. Since solitary floaters often gain reproductive status by displacing reproductive adults in existing groups, examining their ranging patterns is essential for understanding dispersal, territoriality, and adult replacement, which, thus far have only been studied from the perspective of the groups. To this end, we collected daytime ranging data every 20 minutes between dawn and dusk from 11 solitary floaters and we estimated nighttime ranging distance from the locations of floaters at dusk and the following dawn. Floaters ranged farther during full moon nights than during new moon nights, while the reverse pattern was observed for daytime ranging. The activity patterns of floaters were similar to patterns previously described for groups, suggesting that solitary individuals do not significantly alter their activity patterns after dispersing from groups. Although the areas used by solitary floaters overlapped with group territories, the locations of floaters were concentrated on the peripheries of territories, suggesting that floaters alter their ranging behavior, possibly to avoid competition or confrontation with groups.

#### Resource use by yellow-tailed woolly monkeys in disturbed and undisturbed forests.

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Endemic of Peru's northeastern cloud forests and classified as critically endangered by the IUCN, the yellow-tailed woolly monkey (*Lagothrix flavicauda*) subsists on a thin and fragmented band along the eastern slope of the Andes, between 1500 and 2700m asl. In order to investigate the effects of human disturbance, here we compare the use of space and diet of two groups in two different sites in Peru; an undisturbed forest in the Private Area of Conservation Abra Patricia - Alto Nieva, and a disturbed and fragmented forest in the district of Corosha. In the disturbed site, hunting for monkeys stopped 5 years ago, but pastures and crops still dominate the landscape. Groups of 11 and 14 individuals were followed all day for 7-20 days per month during 5 and 12 months respectively. Vegetation data was gathered through vegetation plots and transects. In both forests, trees with a DBH between 10-19.9 cm were the most predominant (47.6 and 52.4%), and the canopy height averaged 11.66±2.11m and 10.23±3.21m. In the undisturbed site, the group used a total of 69 ha, and in the disturbed site they used a total of 87 ha. Daily ranges averaged 818 and 1067 m, respectively. In the disturbed site, the group consumed 23 plant species, and in the undisturbed site 18 species, sharing 76% of the consumed items. Despite differences in disturbance, results for both sites were similar. Preliminarily, this suggests that yellow-tailed woolly monkeys may be less affected by human disturbance provided that it does not increase.

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#### Markers of corporate identity: variation in postmortem treatment and burial deposition in the Wisconsin Late Woodland effigy mound tradition.

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The purpose of this presentation is to report on how corporate identity may have been reinforced through juxtaposition of postmortem manipulation and deposition of the dead in the mortuary program of the Late Woodland Effigy Mound Tradition of southern Wisconsin.

The Late Woodland Effigy Mound Tradition has conventionally been characterized as a regional cultural tradition with shared material and ritual traits, including mound construction, with little variability between Effigy Mound groups. When Effigy Mound features are examined closely it becomes apparent that few Effigy Mound sites conform to the type site.

First, this study focuses on variability between eight Effigy Mound sites and across three regions of Wisconsin in the postmortem treatment of burials. Second, although there is homogeneity for the horizontal deposition of the dead in Effigy Mounds, each mound building community tended to have certain preferences for the vertical deposition of remains in: a subfloor pit, on the mound floor, or in the mound fill. Finally, there is marked differences between Effigy Mound groups for whether mounds were used for burial purposes and, for mounds containing burials, the number of burials occurring in each burial mound (N=1-4 burials).

Although there may have been an overarching precept for how and what rituals were practiced, there is variability in how the local group embodied the ritual materially. This variation was likely due to local differences in construction and management of the effigy mound groups which may have functioned as high visibility territory markers in a kinship based land tenure system.

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#### Use of geometric data in human factors and ergonomic applications.

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Human factors and ergonomics (HFE) studies seek to match capabilities of people to products and task. Typically, emphasis is on product or task design, but understanding user population form is also important. The application of geometric methods in HFE differs from usual explorations in physical anthropology. In HFE, both size and shape differences matter. Analysis seeks to characterize variation *within* a population rather than quantifying differences *between* populations. We used 3D scans from the CAESAR dataset to examine female anterior torso form (size and shape) for a personal protection application. For a human modeling application, seated torso scans were used to generate models for virtual fitting trials of an office chair. In both examples, scan data were sampled to reduce the number of mesh vertices and to establish correspondence between vertices and anatomy.

Principal component analysis (PCA) was performed on the mesh data. Analysis of anterior torso form found differences along PC1 to be largely in girth, PC2 contrasted girth and torso height, and PC3 found differences mostly in chest/abdomen form. For the seated torso models, PCA scores were regressed against stature and BMI. Stature and BMI were then used to generate synthetic torso models for office chair evaluation.

The use of geometric-based analysis is relatively new in HFE and has the potential to greatly influence the analysis of body form. In the future, we will be investigating differences in body size and shape in more realistic dynamic postures.

*Approved for public release by the US Army Natick Soldier Research, Development and Engineering Center, U12-429.*

#### Association between gonial angle and mandibular torus.

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The mandibular torus, variably present in humans, is thought to be a threshold trait caused by variation in the LPR5 gene associated with bone density; however, those with the trait may only develop one or more tori after a threshold of masticatory stress has been reached. Whereas some mutations in this gene are known to cause an increased or decreased gonial angle, there is little to no information about the relationship between the gonial angle and mandibular torus. Findings on the rate of mandibular torus occurrence in similar populations are somewhat inconsistent. For instance, different studies of present-day Thai populations have reported rates of mandibular torus at 9.2% and 29.9%. Such results have led to significant skepticism as to the reliability of the trait in biodistance analysis and whether mandibular torus presence can indicate anything about a population's lifestyle. We examined the relationship between the mandibular torus and gonial angle in modern skeletal collections in the United States, also recording variables such as: wear on the temporomandibular joint, attrition, approximate

age of the individual, edentulism and other exostoses. Angle measurements in this study were taken using a goniometer. Although preliminary, our results support that factors other than heredity may reliably correlate with the mandibular torus. If establishing other correlates can increase the reliability with which this trait can be predicted, it could provide sound behavioral and biological insight.

**Estimating age at death from the femur using histological methods: Problems and prospects.**

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There is a need in forensic anthropology and bioarchaeology for accurate and easily replicable age estimation methods that produce reliable and timely results. The goals of this study were to quantify the amount of variation explained by age in two variables: proportion of intact osteons comprising osteon population density (OPD) and total number of osteon fragments, and to explore the extent to which these variables may improve existing age estimation methods. The anterior, posterior, medial, and lateral regions of 200 femoral cross-sections from known-age individuals from the Ericksen sample were examined histologically (100x magnification) using a three-columned checkerboard pattern read from the periosteal border to the endosteal border. Univariate simple linear regression analysis was used to assess the relationships between these two variables and known age. As the aim of this study was to predict an individual's age when a particular value of a variable is observed, inverse prediction was employed. The resulting  $r^2$ -values for the proportion of intact osteons comprising OPD for each region and for the total cross section fell below 0.50, indicating that less than 50% of the variation observed is explained by age. Conversely, the  $r^2$ -values for osteon fragments were greater than 0.50, indicating that more than 50% of the variation observed is explained by age. These results suggest that the proportion of intact osteons comprising OPD is not likely to increase the reliability of histological age estimation methods and that more accurate age estimations can be achieved using the total number of osteon fragments.

**A unique constellation of pathological features in a 13<sup>th</sup> century adolescent male from Illinois: Treponematoses with destructive lesion of the palate, orthopedic complications, and other anomalies.**

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Gentleman Farms (11LS27) is an Upper Mississippian Langford Tradition site from LaSalle County in northeastern Illinois. The village and burial mound were excavated in

1940. The site was later dated to the 13<sup>th</sup> century. Individual LS2-40 is an adolescent male from a pre-mound interment. The fragmentary skull is thin and a destructive lesion of the right orbit suggests a lacrimal gland lesion or cyst. A large circular defect of the palate has reactive margins. There is dense reactive bone in the maxillary sinus and the nasal cavity. The mandible is atrophied: second molars were lost early in life and third molars are carious. The right humerus displays a depressed surface in the area of the deltoid with a very wide radial groove and very poorly developed deltoid insertion. The left humerus was not recovered but both forearms are unremarkable.

Cortical bone in the right femur and tibia is thin. The right distal femur is reactive and the epiphysis is fused, unlike the left. Both fibulae show osteitis, surface distortion, and dense medullary bone. The midshafts are irregular and roughly doubled in diameter. There are destructive lesions of the heads of the right first phalanx and fifth metatarsal. The left foot has a coalition of the third tarsometatarsal joint.

LS2-40 suffered from multiple conditions. Differential diagnosis includes treponematoses, non-specific osteomyelitis, developmental anomalies, trauma, and feeding difficulties secondary to the oral lesions. "A dog may have both ticks and fleas."

**Changes in selection on height and BMI during the demographic transition: the case of rural Gambia.**

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Height and body mass index (BMI) are two anthropometric traits of importance in humans. They are related to survival and fecundity, and are heritable. Therefore, these traits are subject to selective pressures and evolve accordingly. This was true in our evolutionary past and still is today. However, our selective landscape has recently been profoundly affected by major demographic and environmental changes. In particular, the demographic transition (i.e. the universal trends in increasing survival and decreasing fecundity rate) results in a decrease in variance in relative fitness and so in the opportunity for selection to act on any traits. It also changes the composition of the variance in fitness from acting via variation in early survival to acting via variation in fecundity.

Here, we study how selection on height and BMI changed throughout a period of rapid demographic transition in rural Gambia 1956-2004. Our study relies on the longitudinal follow

up of 3374 women resulting in 76,913 person-years observations derived from UK Medical Research Council data. We found that tallness was initially associated with increased early survival and decreased fertility, but these antagonistic effects on directional selection reduced with time, and stabilizing selection on height emerged. Directional selection for BMI initially favored high values but progressively switched to favor low values. These differences resulted from changes in fitness variance, together with direct changes in selective pressures triggered by environmental changes. Our results demonstrate how demographic and environmental trends encountered by current human populations worldwide can influence selection on anthropometric traits.

**Distribution of the Indochinese Silvered langurs in the Mekong Delta Region of Vietnam.**

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In Vietnam the globally endangered Indochinese silvered langur (*Trachypitecus germaini*) is reported to occur to the west of Mekong River but the population is poorly known. Here we report on the status of the species based on archival studies and fieldwork conducted during the past four years covering most of the suitable habitat for this species in the Mekong Delta region of Vietnam. Our surveys confirmed the occurrence of silvered langurs in two previously identified sites and also in two additional locations. We have found the langurs in evergreen and semi-deciduous forests on granite and karst hills and in mangrove forests. The estimated total population is less than 300 individuals, of which 230 are distributed on four small and isolated karst hills and about 45 on Phu Quoc Island of Kien Giang Province. Two other small sub-populations have been confirmed, one in a mangrove plantation in Ca Mau Province and one on a small mountain in An Giang Province. Only the sub-population on Phu Quoc Island is in a protected area. Habitat lost, especially karst quarrying, habitat fragmentation, and hunting are the most serious threats to the langur. At least 108 individuals living on two karst hills that have been allocated to cement companies for quarrying will need to be translocated to safe areas in the next few years. The Indochinese silvered langur in Vietnam is facing extinction in the near future if appropriate management action is not taken.

Margot Marsh Biodiversity Foundation, IUCN Vietnam, the Wenner-Gren Foundation

**Investigating paleoclimate in the Levant: carbon and nitrogen isotope analysis of gazelles and rodents.**

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The Younger Dryas (YD) stadial is often linked to the adoption of agriculture in the Levant. However, the local impacts of the YD are unclear. Because plant and mammal  $\delta^{13}\text{C}$  values reflect water availability, we are able to directly address these issues. Unlike plant remains, mammal remains are prevalent within the archaeological record. Thus, gazelles and rodents can serve as climate proxies. Herbivore tissues ( $\delta^{15}\text{N}$ ) reflect the  $\delta^{15}\text{N}$  values of their plant diets, and plants in turn reflect climate variables. Because of the general relationships between climate and mammalian tissues, we further develop these proxies through an actualistic study of modern gazelles and rodents, under different climatic conditions in the Levant. Here we use carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotopic composition of hair keratin to determine how environmental changes (aridity and temperature) are expressed in the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of gazelles (*Gazella gazella*, *Gazella dorcas*; n=125) and rodents (*Microtus guentheri*; n=36). The incorporation of multiple species of mammals when investigating relationships between precipitation and climate is useful because it more thoroughly completes the archaeological record in the Levant. Ultimately, these modern data may be used to predict the climatic impact of the Younger Dryas (YD).

Wenner Gren Foundation; The Irene Levy Sala Care foundation for MB; The land vertebrate collection of the Tel Aviv University Zoological Museum (TAUM); and Curator Dr. Shai Meiri.

**Human predation of *Pachylemur*: Evidence of butchery of extinct lemurs in south central Madagascar.**

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Modern-day butchery of endemic mammals (bushmeat) in Madagascar leaves tell-tale signs in the form of chop marks, cutmarks, and spiral fractures on bones of prey. Machetes carried to trap sites are used to disarticulate limbs at joints, chop bodies into pot-sized chunks, or remove flesh. Cutmarks can be recognized because the process is deliberate and the cuts strategically placed; cuts produced by sharp implements also have characteristic shapes.

Subfossil lemur collections in Antananarivo, Madagascar, include bones of now-extinct lemurs (*Palaeopropithecus*, *Archaeolemur*, *Pachylemur*, *Megaladapis*, and

*Hadropithecus*) with definitive signs of butchery. We have begun to analyze the prevalence and geographic distribution of these marks by surveying 220 *Pachylemur* femora in this collection with known provenance. For this pilot study, we document cutmarks only, which are present on 6.4% of femora examined. Locations and orientations of marks were recorded, and each was photographed and measured using a Dino-Lite Premier 5MP AD7013MZT 10x-240x polarizing microscope. Vinyl polysiloxane impressions were made using a low viscosity impression material, providing accurate reproductions of cuts that could be subjected to thin-sectioning and microscopic analysis. There is clear site bias, with 13 of the 14 cut-marked bones coming from Tsirave (south central Madagascar). While none of these were sampled for radiocarbon dating, 30 other bones from this site, including 6 *Pachylemur*, were dated (range 1065-3800 Cal yr BP). The youngest *Pachylemur* was 1165 Cal yr BP, and *Pachylemur*'s median age was 1660 Cal yr BP. Human predation of *Pachylemur* evidently occurred prior to 1000 years ago at Tsirave.

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**Illness, identity and the Mesoamerican infant: A regional perspective.**

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Bioarchaeologists have increasingly advocated placing health data in both cultural and regional contexts in order to more fully interpret the broader social experience of disease. One way to achieve this is to use a life-course approach. This methodology uses mortuary and skeletal data to examine the ways that illnesses accumulate on individuals, by age, in order to explore how persons of different ages and health states were perceived and treated in the past. Moreover, research may also focus on variation in health/treatment of individuals within a particular age category. For example, are infants variably treated after death? Here we apply a life course approach to sites in Mesoamerica where a regional comparison of infant burial practices has yet to be synthesized.

Mortuary treatment and paleopathology data are used to test the recent argument, based on archaeological evidence, that the ill and young (<1 year of age) were viewed as liminal persons across ancient Mesoamerica. Our results appear to support this hypothesis. For example, data from Postclassic/historic Maya and Loma San Gabriel Tepahuan, sites demonstrate high rates of scurvy (58% and 42% respectively) and other bony indicators of ill-health such as periosteal reactions and endocranial lesions, in infants buried in special contexts. Supporting data from other sites in this region will also be discussed. This research highlights the social

consequences disease had for particular age groups (such as infants) and provides a more nuanced perspective of the social roles the ill played in prehistory.

**Changes in orangutan brain ontogeny indicate parallel evolution.**

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Different elements of human ontogeny have been described by various heterochronic modes, such as neoteny and sequential hypermorphosis. The evolution of brain ontogeny has received a great deal of attention, owing to the complex and sophisticated nature of our brains. Previous works have determined that a growth phase appears in chimpanzees and humans at around birth and continues on until nine months and one year, respectively. Given the similarities of brain cytoarchitecture in these species, and the dissimilar structures in the more distantly related monkey species, there was an important cytoarchitectural remodeling event sometime during the last 18-20 million years after the divergence of the ape clade from the Old World monkeys. To increase our resolution of ape brain evolution, and by extension, human brain evolution, this study investigates the evolution of orangutan brain ontogeny. Comparing the growth trajectories of humans, chimpanzees, squirrel monkeys, macaques, and orangutans, we discovered that orangutans do not follow the expected growth pattern of humans and chimpanzees. Instead, the orangutan growth trajectory much more closely resembles that of the squirrel monkey and thus indicates parallel evolution of brain growth strategies in these two species.

**Dental pathology at Shabona, a Khartoum Mesolithic site.**

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Dental pathology recorded in human skeletal remains from archaeological contexts informs the relationship between diet and health in past populations. Prehistoric African foragers, however, remain a poorly documented group despite our knowledge of their diverse subsistence behaviors. Using standard macroscopic data collection protocols for pathological assessment, this study examines the evidence for dental disease and enamel defects from the Khartoum Mesolithic (>7000-5000 BC) site of Shabona (n=7; six adults, one subadult) to provide valuable health and subsistence information about prehistoric hunter-fisher-gatherers of central Sudan.

Atypical for African Mesolithic skeletal samples, the Shabona remains exhibit a relatively high frequency of dental caries (26/89 teeth, 29%; n=5 individuals). Excluding the most complete individual (#11049) from the overall rate due to exceptionally severe oral pathology, however, yields a low frequency of carious teeth (2/61 teeth, 3%; n=4 individuals). Linear enamel hypoplasia (LEH), a marker of childhood physiological or nutritional stress, was identified in the maxillary incisors and canines of two individuals, but was otherwise absent in the collection. Evidence for possible dental ablation of the central maxillary incisors was also documented (#11044) and is consistent with the pattern of cultural modification found at the Khartoum Mesolithic site of 'Khartoum Hospital.'

The small number of individuals at Shabona limits the ability to generalize about the relationship between oral health and hunter-fisher-gatherers of the Khartoum Mesolithic. When combined with evidence for dental disease and enamel growth disturbances in contemporaneous skeletal samples and subsequent Neolithic groups in the region, however, a broader perspective is achieved.

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#### **Stable isotopes indicate forest fragmentation affects cheirogaleid lemurs.**

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We use stable carbon and nitrogen isotopes to investigate how forest fragmentation affects niche partitioning among sympatric dwarf and mouse lemur species inhabiting three eastern Malagasy rainforests with varying levels of disturbance (Tsinjoarivo continuous forest, Tsinjoarivo fragmented forest, and Ranomafana selectively-logged forest). Overall, carbon isotope values in lemurs roughly correlate with those in plants, and nitrogen isotope values are similar for plants and lemurs at Ranomafana and Tsinjoarivo continuous forest. These results suggest that cheirogaleid foraging is not affected by the historical logging activity at Ranomafana. However, nitrogen isotope values for lemurs and plants diverge at Tsinjoarivo fragmented forest. Whereas plant nitrogen isotope values are lowest at this locality, those for lemurs are elevated. This pattern strongly suggests that lemurs behave differently in the fragmented forest. Carbon data indicate that mouse lemurs may feed at lower canopy heights than dwarf lemurs at all three localities. They also suggest that sympatric *Cheirogaleus crossleyi* and *C. sibreei* might feed at different canopy heights in the forest fragment. Mouse lemurs have significantly higher nitrogen isotope values than dwarf lemurs

at all three localities, indicating that they are more faunivorous than the dwarf lemurs. Slightly elevated nitrogen values for dwarf lemurs in the fragmented forest may reflect increased consumption of arthropods at this locality. Alternatively, higher nitrogen isotope values for fragment individuals may indicate chronic nutritional stress. Future research will investigate these alternative options in depth.

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#### **Craniofacial changes between children with otitis media with effusion and control.**

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To determine if there are changes in craniofacial form during childhood growth that are different between children with no history of otitis media (control) and children with otitis media with effusion (OME). Eight children, 4 control and 4 OME, had standard lateral and AP cephalometric x-rays using accepted clinical procedures at 3.5 and 5.5 years of age. Ten anatomical landmarks were identified and used to construct angular and linear measures for 6 anatomical regions of the craniofacial complex. The change in angular and linear measures from 3.5 years of age to 5.5 years of age in an individual was calculated. The net change was used to compare craniofacial growth between control and OME groups. The means for the two groups were compared using a Student's t test for significance at  $P \leq 0.05$ . Five constructed measures were significantly different between the groups. The measures of change in nasopharyngeal (NP) width, NP height, the magnitude of the tensor veli palatine muscle-membrano-cartilaginous ET (mcET) vector, the height of the NP Eustachian tube orifice relative to the hard palate and the directional component of the mcET inferio-medial vector relative to the cranial base were less in the OME group. In conclusion, the results reveal that the measures of changes in craniofacial morphology from 3.5 to 5.5 years of age are different between control and OME groups. These differences may be reflected in the anatomy and function of the Eustachian tube system.

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#### **Visualizing artiodactyl ecomorphology with geometric morphometrics.**

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Ecomorphological methods are becoming increasingly common for reconstructing paleoenvironmental parameters of hominin sites.

These methods, which examine the fit between the form and function of a given species and its environment, rely strongly on functional morphology. An individual's morphology places limits on the types of behaviors it can perform and the environments in which those behaviors can take place. This study examines artiodactyl (Cervidae, Bovidae, and Tragulidae) functional morphology as it relates to locomotion in different habitats, with the goal of applying these data to the reconstruction of fossil hominin sites.

Three-dimensional outlines of rearlimb joint surfaces were analyzed using geometric morphometrics, principal components analysis, and canonical variates analysis. Visualizations of morphologies associated with different habitat types allowed for the synthesis of a series of functional hypotheses for the rearlimb as a whole, wherein the morphology of open-adapted artiodactyls enhances speed and joint stability whereas saltatorial artiodactyls emphasize joint mobility. Results demonstrate that extant artiodactyls can be reclassified into their known habitat types with up to 66.3% (cross-validation) and 74.7% (resubstitution) accuracy, and thus are a useful proxy for paleohabitat. Applying these methods to three sites in Europe, it was found that early Pleistocene cervids were adapted to mostly open habitats. This reconstruction demonstrates that conditions in France and Romania were broadly similar to those for other penecontemporaneous Eurasian and Africa sites in which *Homo erectus* has been found, supporting the hypothesis that habitat type did not preclude hominins from occupying Europe during the early Pleistocene.

#### **Interpersonal violence in the Paleoamericans of Lagoa Santa, Brazil.**

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The Lagoa Santa region in Brazil is unique archaeologically in the Americas, in part owing to the large number of human skeletons dated to the Early Holocene (n= 195; ca. 10,000-7,000 yBP). Few studies have approached the study of Paleoamerican patterns of violence from a population perspective. In this study, 63 crania from Lagoa Santa are analyzed for traumatic lesions. We test the hypothesis that prevalence of violence in Lagoa Santa is more similar to hunter-gatherers than to agriculturalists. For comparison, we use the Western Hemisphere Project (WHP) database composed by 6,733 prehistoric skeletons from 36 series across the Americas. Nasal trauma (1/30; 3.33%) and cranial vault trauma (6/63; 9.52%) were observed in Lagoa Santa series. These values are not significantly different (chi-square;  $p > 0.05$ ) from injuries involving the nasal bone (8/591; 1.35%) and the skull vault (108/966; 11.52%) of the hunter-gatherers of the WHP database. Both values from Lagoa Santa are higher than the prevalence of trauma for agriculturalists (1.20% and 3.03%, respectively), but the differences do not reach statistical significance. Males (2/22; 9.09%) and females (2/11; 18.18%) show similar

prevalence of traumas. Only one case of adult vault is perimortem (1/5; 20.00%). These results suggest that interpersonal violence was an element of daily life in Lagoa Santa, although not in a different level than in other hunter-gatherer populations. These results suggest that violence in Lagoa Santa occurred in a domestic context and the majority of the injuries were not intended to have a lethal outcome.

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**Mechanical properties of *Pentaclethera macrophylla* seed pods and ingestive strategies of the western pied colobus monkey (*Colobus polykomos*).**

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*Colobus polykomos* from Taï Forest, Côte d'Ivoire seasonally specializes on *Pentaclethera* seeds, the access to which requires substantial ingestive effort to broach the surrounding woody pod. *Pentaclethera* pods are large, stiff (up to 700 MPa, comparable to pine woods), and moderately tough by primate food standards (~800 J/m<sup>2</sup>). The pods are highly anisotropic in stiffness but essentially isotropic in toughness.

*Colobus polykomos* is sympatric with the Upper Guinea red colobus (*Procolobus badius*), an eclectic frugivore-folivore, and the sooty mangabey (*Cercocebus atys*), a dedicated hard-object feeder. Data on food-specific ingestive behaviors were collected for all three taxa to determine how feeding strategies are influenced by the size, shape and mechanical properties of selected foods. We tested a prediction that both *Cercocebus atys* and *Colobus polykomos* would engage in greater incisal and masticatory work than *P. badius* by virtue of the former's reliance on large, stress-limited foods.

Masticatory cycles per ingestive event are generally higher in the colobines than in *Cercocebus*, which is potentially explicable by both the use of cheek pouches in mangabeys and the more displacement-limited diet of the colobines. Incision frequency per ingestive event is similar overall across taxa, although relative to averages for other foods this frequency increases over ten-fold when *Colobus* processes *Pentaclethera*. Both feeding and morphological data suggest that *Colobus* has compromised masticatory efficiency for maintenance of sufficient gape, resulting in a gnathodontal complex characterized by low canine dimorphism (i.e., females possess large canines), and which facilitates exploitation of large, tough foods such as *Pentaclethera*.

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**The Relationship between dental crowding and cephalometric measurements in contemporary New Mexicans.**

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Dental crowding is extremely common, with 70 to 80% prevalence in contemporary populations. Crowding was less frequent in the past although some population specific studies have shown high rates. Researchers have variously associated the increase in dental crowding and malocclusions with diet, mutation, and selection. Using small sample sizes, relationships between crowding and cephalometric (head x-ray) measurements have been studied. Results range from no relationship to significant correlations for multiple length and angle variables.

We analyzed data from a sample of 1,975 patients (968 with and 1,007 without crowding) from the Economides Orthodontic Collection of the Maxwell Museum of Anthropology, University of New Mexico. The material spans 1972-1999 in Albuquerque, NM, and represents African, Asian, European, Hispanic, and Native Americans. Each subject had cephalometric measurements and a diagnosis of crowding made by a single treating orthodontist. There was no difference in crowding frequency between the sexes (p=0.306) but multiple measurements were significantly different (p<0.05). Significant differences between individuals with and without crowding were detected for four measurements in males and 11 measurements in females, with only one measure seen in both. A logistic regression was performed; for both sexes only one variable was significant in predicting crowding. Anterior cranial length (as defined by Ricketts) was significant (p<0.0001) for males, and the angle describing Sella-Nasion-Pogonion (p<0.0001) for females. Discriminant logistic analysis determined that these single measurements correctly predicted individuals having crowded teeth 62-69%. The significant variables suggest that crowding is related to maxillary length in males and mandibular length in females.

**"Following" in olive baboons (*Papio hamadryas anubis*) results in deviation from the Priority of Access Model: Consortship behavior and genetic paternity.**

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Recent studies have suggested that alternative mating strategies may explain deviation from the Priority of Access Model of male reproductive success. "Following" of consortships has been proposed as an alternative mating strategy of subordinate male olive baboons, although the impact of this strategy on the ability of high ranking males to monopolize

mating and paternity remains little studied. Data were collected from August 2009-July 2010 on followed consortships in one habituated group of olive baboons in Kenya. Genetic paternity was determined for 9 of 11 surviving infants conceived during the same period using noninvasively collected fecal samples. The proportion of time a male spent consorting during a female's fertile phase was predicted by male dominance rank (GLMM,  $z=-3.472$ ,  $p<0.001$ ) but not by any of three measures of female cycle synchrony. Notably, consorting time differed considerably from that predicted by the Priority of Access Model. Additionally, the proportion of infants sired was not correlated to dominance rank (Spearman Rank Correlation,  $r=-0.32$ ,  $p=0.18$ ). The maximum proportion of infants sired by a single male was 0.22, and the alpha male sired no infants. Following allowed males of all dominance rank to achieve consort turnovers, with 75% of turnovers instigated by followers. All genetically-determined sires were observed as followers in cycles resulting in conception (N=6 conceptions with sufficient consortship data). These findings suggest that following can reduce mating skew in olive baboons, indicating the evolutionary significance of this alternative strategy.

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**Ossification of the posterior longitudinal ligament: Reassessing the disease in non-Asian populations.**

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Ossification of the posterior longitudinal ligament (OPLL) of the cervical spine has been a disease of interest throughout Asia for over 50 years; however, the literature on the prevalence and presentation of this disease in other populations is sporadic. When studies do appear, the results are often marred by small sample sizes and conclusions that turn out to be anecdotal at best. OPLL is historically accepted to reach its highest prevalence among the Japanese population at 4.3%, while Caucasians have been shown to present with frequencies between 0.05% and 1.7%. Diagnosis of this disease is based on radiographic analysis of clinical patients complaining of spinal and/or neurological symptoms. As a result, diagnosis often occurs only in symptomatic individuals, and only after the disease has reached an extreme state.

In order to better understand the prevalence and presentation of OPLL in non-Asian populations and to consider the potential differences between methods of diagnosis, I analyzed a sample of White and Black males and females from The Terry Collection (n=1051). The results challenge previous assumptions concerning the prevalence of OPLL in non-Asian populations: the sample populations ranged in prevalence from 32% in White females to 67% in Black males, with all males showing a significantly higher prevalence than all females (p<0.00001). Males also presented with a

significantly larger maximum area of ossification than females ( $p=0.00587$ ). While the differences in radiographic and skeletal diagnosis will be discussed as a factor, this new data should provoke a reassessment of how we understand this disease.

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#### **The bicondylar angle in modern humans and its relationship to joint stresses and locomotor economy.**

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The bicondylar angle (or “carrying angle”) evident in the distal femur of humans and fossil hominins has been suggested to increase the efficiency of bipedal walking by placing the foot closer to midline, below the body’s center of mass, during stance phase. In this study we analyzed coronal-plane hind limb joint moments and metabolic cost during walking to determine whether knee-joint stress or economy is correlated with carrying angle. We assessed moments at the knee in the coronal plane by using a combined modeling and experimental approach. Ten subjects (4 males, 6 females) walked along a trackway with an embedded force plate while kinematics and kinetics were recorded; inverse dynamics were used to calculate joint moments. During Control trials, kinematic markers were placed directly on the skin over skeletal landmarks. In Low-Angle trials, the right knee marker was modified to simulate a reduction in bicondylar angle. Analyses confirmed that simulated coronal-plane knee moments, and thus knee-joint stresses, were greater in the Low-Angle condition, indicating that the normal bicondylar angle reduces knee joint stresses. In a separate study of  $n=26$  subjects, we compared bicondylar angle, determined via magnetic resonance imaging, and walking cost, measured via respirometry. Bicondylar angle was not significantly correlated with mass-specific walking cost in these subjects. The implications of these results for interpreting lower limb skeletal adaptations in the hominin skeletal record are also discussed.

#### **Identifying hominin hybridity in light of taxonomy: testing a *Papio* model using craniometrics.**

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Baboons (*Papio sp.*) have been recommended as a primate model for

investigating hybridity in hominid species, and especially for studies of craniofacial variability. Several species within the *Papio* genus are known to hybridize in the wild, and this behavior makes them ideal candidates for questions of species identification, when presence or degree of hybridity is unknown.

To develop a primate model for examining hybridity, finite mixture and discriminant analyses were applied to craniometric data ( $n=222$ ) from four species: *Papio hamadryas*, *Papio anubis*, *Theropithecus gelada* and *Mandrillus leucophaeus*. Both cluster and classification results indicate that baboons are not appropriate for the effective quantification of hybridity. These findings bring the taxonomic classification of *P. hamadryas* and *P. anubis* into question, as these two groups were consistently classified together. Moreover, hybrid offspring of *P. hamadryas* and *P. anubis* present mid-parental values for all measurements, which is a signature expected for admixed groups rather than hybridizing species. Analyses examining scaled, pooled male and female data consistently group sexes together regardless of species, suggesting that sexual dimorphism overrides between-species distinctions. This pattern further implies that *P. hamadryas* and *P. anubis* are subspecies rather than separate species. Genetic evidence also supports this conclusion. New research has identified recent divergence between *Papio* groups in eastern Africa and has noted that mtDNA evidence conflicts with traditional baboon taxonomy. As morphogenetic data do not support species distinctions between *P. hamadryas* and *P. anubis*, these groups are not ideal species for developing useful models of hybridity.

#### **The origin of two Ethiopian communities according to HLA genes: admixture with Asian and Sub-Saharan people.**

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Human Leukocyte Antigens (HLA) are crucial proteins in adaptive immunity processes. Class II HLA DQ molecules are found on specific antigen-presenting cells to present exogenous epitopes. They are heterodimers encoded by DQA1 and DQB1 genes. HLA molecules have come under recent inquiry because of their extreme polymorphic nature. This study explores the allele composition of DQ genes in apparently healthy people. The sample pertains to 107 unrelated individuals: 46 belong to Ethiopian Amhara community and 61 belonging to Oromo population. Both HLA DQA1 and DQB1 genes have been high-resolution molecularly typed (Sequence Based Typing, SBT) by direct sequencing of exons 2 and 3. The allele distribution at each locus encompasses 9 DQA1 and 7 DQB1 variants in Amhara, while 8 DQA1 and 9 DQB1 alleles pertain to Oromo. The frequencies for DQA1\*0102 allele, for DQA1\*0201 and for DQA1\*0501 allele in Amhara are respectively

28,2%; 26% and 23,8%. These alleles are significantly present also in Oromo, where the frequencies are very close each other (22,9%; 26,2 and 20,4 respectively). Among DQB1 alleles, in both human groups the \*0201, \*0301, \*0402 and \*0501 are the leading variants. The allele compositions of Amhara and Oromo communities were compared to other worldwide populations through genetic distance analysis that highlighted how their variability might be compliant with African populations, although Ethiopian samples place themselves near the Asian cluster: it suggests the influence of Asian gene pool on the African background of these Ethiopian populations, improving the genetic information about these human groups.

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#### **Impact of periodontal disease on cementochronology.**

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Estimating an individual’s age-at-death is important regarding post-mortem identification as well as paleodemography. With substantial development in the past ten years of cementochronology analyses, a certain number of questions have arisen regarding the impact of oral pathologies which may artificially reduce or increase cementum apposition.

The objective of this study is to observe the impact of the periodontal disease on cementum and on the method reliability in order to improve the accuracy for determining individual age-at-death. The study concerns 41 teeth presenting different degrees of bone destruction, from 18 individuals affected by an untreated periodontal disease.

No correlation between cementum thickness and civil age ( $p>0.05$ ,  $r<0.5$ ) throughout the root was observed. Since several other studies (Solheim 1990, Stein and Corcoran, 1994) observed a correlation between cementum thickness and civil age on healthy individual, it would seem that periodontal pathologies do have a direct influence on cementum thickness. Regarding the degree of alveolysis, periodontal disease have only limited effects on cementum annulations count in the middle third of the root ( $r=0,92$ ,  $p=5,1.10^{-14}$  between estimated and civil age) whereas in the lower third, the number of increments is considerably increased. This hypercementosis would compensate bone destruction and loss of attachment apparatus. These data suggest that cementum could continue its growth at a lower rate despite bone destruction due to periodontal disease.

Cementochronology can be thus applied to teeth presenting a damaged periodontium, by observing the middle third of the root.

**Dental microwear: A window into dietary texture during the Late Bronze Age and Early Iron Age in East Lokris Greece.**

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The assessment of dietary indicators is a key component of a thorough bioarchaeological analysis. Dental microwear has been examined for the last 40 years to investigate diet in humans and primates. This study uses dental microwear texture analysis as well as traditional dental microwear methods to document the dental microwear signature of two skeletal collections from the sites of Mitrou and Tragana Agia Triada, located in East Lokris, Greece. Mitrou, located in the Bay of Atalanti, has recently been the focus of archaeological excavations. The second site, Agia Triada, was excavated in the 1990s and consists of nine Late Helladic chamber tombs located 3 km from Mitrou. Burials recovered from these two sites are demographically diverse. The combined skeletal collections offer a unique opportunity to examine the diet of Bronze and Iron Age populations from central Greece.

The two samples complement each other temporally, with the Agia Triada tombs representing Late Helladic periods and the burials at Mitrou representing Middle to early Late Helladic and Protogeometric period burials. This research represents an expansion of preliminary studies conducted by the authors examining geographic and temporal variation in dental microwear during the Bronze to Iron Age transition at these two sites. The results from the present analysis indicate no significant difference between the samples when they are grouped by time or site. While there is no apparent statistical difference in microwear signature between the various groups, the results from each method indicate the same general dietary trends.

**Oral health and dietary change during the Epipalaeolithic-Neolithic transition in Northwest Africa.**

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This study evaluates changes in oral pathologies and dental attrition between the Epipalaeolithic and Neolithic in Northwest Africa, to test the prediction that the transition from a hunter-gatherer to an agricultural lifestyle would result in a decline in overall oral health. Dento-alveolar pathologies were analysed in 111 individuals (2039 tooth sites) from the Iberomaurusian (20,000BP-8,000BP), 20 individuals (410 tooth sites) from the Capsian (10,000BP – 7,000BP), 18 individuals from the Neolithic and a historic sample from Algeria of 31 individuals (811 tooth sites). Each sample was subdivided by age category (young adult, middle adult, old adult).

The Neolithic sample shows a prevalence and pattern of oral pathology similar to that reported for other early agricultural populations. Contrary to predictions, the Iberomaurusian and Capsian hunter-gatherers show an extremely high prevalence of oral pathologies. Post-canine antemortem tooth loss, abscess and caries prevalence for the hunter-gatherers was greater than that of the Neolithic sample. High caries prevalence in the hunter-gatherers may be partly attributable to high attrition rates. Young adult and middle aged adult exhibited higher rates of attrition during the Iberomaurusian and Capsian times than in subsequent groups.

Tooth morphology and fluoride levels in ground water are relatively constant across the region and time period and would have contributed little to the prevalence of pathologies. The high prevalence of caries in non-agricultural groups could be caused by a high cariogenicity of oral bacteria and/or a diet rich in fermentable carbohydrates. Analyses of recently excavated Iberomaurusians from Taforalta are used to clarify this issue.

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**Race, disease, disability, and medical ideologies tied to the American anatomical collections.**

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The United States has a controversial history of medical ideologies tied to disease and race. Nineteenth-century physicians, especially those in the South, were proponents of polygenism, which placed African Americans in a separate, and inferior, race to Euro-Americans. This resulted in differential medical diagnoses and disease ideologies tied to African American health which persisted into the 20th-century. Despite these beliefs, Euro-American doctors utilized the bodies of African Americans to teach medical students human anatomy and disease progression. This poster will explore the relationship between race, disease ideologies, disability, and dissection in 651 males and 256 females from the Terry, Hamann-Todd, and Cobb anatomical collections. Findings will discuss how these collections are a reflection of beliefs about race, disease, disability, and medical dissection subjects during this time period. This is especially true for the Terry and Hamann-Todd collections, both of which, despite their Midwestern origins, are skewed towards African American remains. As many of these individuals received medical treatment in municipal hospitals or died in mental institutions, this implies a continued preference for the use of Black bodies in medical experimentation and dissection in the late 19th and early 20th-century.

**Revisiting incisor allometry and diet (again): New 2D and 3D approaches to an old question.**

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Among anthropoids, and hominoids in particular, incisors function in the pre-processing of food prior to ingestion. Given the unique selective pressures imposed by the mechanical loading associated with individual dietary resources, it is not surprising that incisor allometry and shape are strongly correlated with anthropoid diets. Although it has been commonly accepted that incisor row width discriminates between frugivorous and folivorous anthropoids, this conclusion has recently been questioned on the basis that dietary discrimination is likely a composite function involving several variables unrelated to incisor width (i.e. procumbency, spacing, orientation) and that, in isolation, incisor width is a relatively poor discriminator among dietary groupings.

The present study addresses methodological differences among prior analyses of incisor allometry and contrasts their results with those from a similar analysis quantifying the 'true' length of the parabolic incisor row for a taxonomically and ecologically diverse anthropoid sample (n=120). In addition, a supplemental analysis of the relative hominoid I<sup>1</sup> crown surface area was completed to examine the potential for individual incisors to reliably predict diet. Results indicate that the 'true' length of the parabolic incisor row is a more accurate predictor of anthropoid diet relative to the summed widths of individual incisors or the maximum distance between the distal margins of the left and right I<sup>2</sup>. Likewise, relative hominoid I<sup>1</sup> crown surface area accurately discriminates among soft and hard object frugivores, seasonal folivores and dedicated folivores. These results pose significant implications for future dietary analyses of extant and fossil anthropoids based on incisor allometry.

**Beyond stress: "Biological sensitivity to context" as an evolutionary construct and its implications for psychosocial markers in field research.**

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Adrenocortical and autonomic markers (e.g., cortisol, heart rate variability) reflect an evolved, ontogenetically plastic, contextually sensitive state regulation system. Yet temptation remains to treat them simply as stress markers. Except for the early origins literature (e.g., Worthman and Kuzara 2005), evolutionary modeling of individual differences remains thin.

Children's responses evolved to maximize survival across social contexts, including variable caretaker capability and investment (Chisholm 1996, Flinn 2006). To account for individual variation in adaptive flexibility, Boyce and Ellis (2005) suggested reframing "stress reactivity" as "biological sensitivity to context," (BSC) an individual index of how physical and social contexts evoke changes in physiological state. Since BSC reflects internalization of context, high BSC children experience greater beneficial and detrimental developmental effects of caretaking environment. Yet BSC itself is developmentally plastic, so Boyce and Ellis proposed evolutionary models regarding "optimal" programming of stress responsiveness under varying long-term childhood conditions. We assessed 60 children in a pre-kindergarten U.S. Head Start program for cortisol and autonomic reactivity before and after an intervention designed to improve classroom and home environments. Highly sensitive children (higher HPA reactivity to mild experimental challenges) had poorer behavioral outcomes ( $p < .01$ ), yet benefited more from the changes in context yielded by the intervention ( $p < .10$ ). We interpret this within the BSC evolutionary framework. Then, through comparison with & reinterpretation of serial cortisol measures from an earlier field study involving 35 U.S. pre-kindergarten children, we discuss implications for field research of treating variation as indicative of "sensitivity" as well as distress.

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**From piles of bones to coffin-boxes: Making sense of commingled and fragmented human remains from the Middle/Late Bronze Age Tomb VII, Qatna (Tell Mishrife, Syria).**

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In 2009, an undisturbed double-chambered tomb (Tomb VII) of approximately 32m<sup>2</sup> ground area was discovered underneath the west wing of the Middle Bronze Age royal palace of Qatna, Syria. The assemblage was dominated by human skeletal remains that were intermingled with various grave goods, a few animal bones, and soil. The entire floor was covered with scattered bones and bone fragments, up to a height of 44cm. Thus far, 7100 human bones and bone fragments from an estimated MNI of 78 are documented. Bone concentrations and remnants of wooden structures suggest that the remains had originally been stored in wooden coffin-boxes.

Recording both the archeological and anthropological findings of such a complex assemblage in a limited time required the development of a new protocol to document and

recover the remains. We present the results of the investigations for the content of one of the assumed coffin-box (installation 3248) based on the new protocol.

The coffin-box was located in the southern chamber of the tomb. Distinct layers could not be distinguished. Bones in the uppermost portion of the deposition were highly fragmented and commingled, whereas underneath the degree of fragmentation decreased and joining elements were exposed. On the bottom of the installation two complete skeletons in anatomically correct position could be recorded. In total, an MNI of ten was estimated for this installation. It is assumed that the coffin-box was first used for regular burials and later for secondary burials of disarticulated parts of bodies.

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**Monkey tourism in Japan: How travel health knowledge, attitudes and practices may influence pathogen transmission.**

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The relative contribution of tourists to the spread of pathogens to wildlife is unknown, but the number of tourists visiting wildlife sanctuaries worldwide is increasing dramatically. To understand better the potential roles of tourist behaviors on pathogen transmission to wild primates, 686 tourist surveys were conducted at the Takasakyama Monkey Park in Kyushu, Japan, home to over 1000 wild Japanese macaques (*Macaca fuscata*). Almost 93% of survey participants were Japanese. Only 1.5% were carrying their immunization record, many did not know what they were currently vaccinated for, and less than 30% reported ever being vaccinated for measles. 16.5% reported at least one symptom of current infection, with 12.8% reporting at least one current symptom of respiratory tract infection. Surprisingly, only 53.2% believed that humans can give diseases to wild primates. Lack of knowledge about zoonoses and anthrozooses may contribute to why 61.2% of participants still expressed desire to feed monkeys at the park, and 22.8% would own one as a pet. The primary reasons for desired or realized animal contact reported by both the park staff and the tourists, are that these animals are 'cute,' the thrill of adventure, because their behaviors are often similar to humans, and because they saw others (including professional primatologists) touching primates in various media sources. The majority of tourists that visit wildlife sanctuaries arguably underestimate their own risk of infection as well as their potential contribution to the spread of diseases themselves. Education of travelers about wildlife health is necessary for future sustainable tourism.

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**Diet composition of savanna chimpanzees at Toro-Semliki Wildlife Reserve, Uganda.**

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The mosaic of forest, wood- and grassland in dry chimpanzee (*Pan troglodytes*) habitats has been proposed as a good extant model for hominin paleoenvironments. The habitat of "savanna" chimpanzees is open, seasonally dry and often described as "marginal" because suitable fruits are purportedly scarce and widely distributed. Understanding the diet of savanna chimpanzees is therefore the basis for understanding the evolution of morphological and behavioral niche adaptations in early hominins.

Thus far, the only two detailed studies on savanna chimpanzee feeding ecology are from West Africa. Both sites are proposed to differ from East African sites in their composition of woodland and other habitats used by chimpanzees. This is the first systematic study of chimpanzee diet composition at Toro-Semliki Wildlife Reserve, Uganda. The Mugiri community is the only habituated savanna chimpanzee community experiencing a bimodal rainfall pattern. Over one year (2009-2010), diet composition of this community was assessed through fecal samples (n=311) and observations.

Semliki chimpanzees relied on 1-2 food species in their monthly diet, and most food items were harvested in the gallery forest, rarely from the bush- and grassland. After the unusually short first dry season in 2010, normally preferred species failed to produce an abundant crop. Chimpanzees consumed figs, *Phoenix* palm fruits and fruits from shrubs (*Securinega virosa*, *Dovyalis macrocalyx*). When these were depleted, chimpanzees fed heavily on the cambium/bark of trees and *Aframomum* fruits. This study supports the notion that savanna chimpanzees must cope with great spatio-temporal variability in food resources.

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**Anterior dental microwear in sympatric *Callicebus brunneus* and *Ateles marginatus*.**

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Titi monkeys (*Callicebus*) have short, incisiform canines compared with most other anthropoid species. They are reported to use these teeth more in ingestive behaviors than do sympatric primates such as *Ateles*, which have longer, dimorphic canines. Here we compare dental microwear textures of the anterior teeth of *Callicebus brunneus* (n = 10 C's, 10 I's) and *Ateles marginatus* (n = 11 C's, 9 I's) to determine whether differences in dental form and

function are reflected in microwear texture patterning.

We predicted that *Callicebus* canine microwear should more closely resemble that on their incisors given their greater role in ingestive behavior compared with *Ateles*. We expected more complex microwear with less anisotropy and more variability of canine microwear for *Callicebus* than *Ateles*, with fewer differences between species for the incisors.

White-light confocal profilometry and scale-sensitive fractal analysis were used to characterize microwear on the labial surfaces of I's and C's. Results are generally consistent with predictions. No interspecific differences were found for incisor microwear textures. *Ateles* canines have significantly lower complexity and variance in textural fill volume than those of *Callicebus*. *Callicebus* canines evince higher anisotropy and scale of maximum complexity, but not complexity than their incisors. *Ateles* canines have significantly lower complexity, higher anisotropy, and lower variance for complexity and scale of maximum complexity than their incisors. In sum, results appear to reflect greater use of canines in ingestive behavior for *Callicebus* than *Ateles*. This demonstrates the potential of anterior dental microwear textures for inferring tooth use in fossil primates.

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#### Human dietary reconstruction from stable carbon and nitrogen isotope analysis in Anglo-Saxon England.

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This study reconstructed ancient human diet from stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope analyses of bone collagen recovered from Anglo-Saxon Rookery Hill ( $n=20$ ) in Sussex, England. Following this, Rookery Hill was compared to previously reported values from other Anglo-Saxon sites around England, to search for regional variation, and dietary differences between coastal and inland sites.

Mean isotope values from Rookery Hill were lower compared to all other Anglo-Saxon sites in England, which suggested a dietary focus towards terrestrial plant foods and herbivore animal proteins. Even though archaeological evidence recovered from Rookery Hill included fish and other marine resources, isotope values indicate this was not an important dietary component.

When Anglo Saxon sites in England were grouped by region, mean  $\delta^{15}\text{N}$  values were relatively high in York and low in Kent. Mean  $\delta^{13}\text{C}$  values were also more positive in Kent, and the least positive in Suffolk. There were some differences in isotopic values between coastal and inland sites, however these were not consistent. No significant variation occurred when the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values were compared between the sexes, the age at death groups, or against the presence of grave goods.

#### Lesula: A remarkable new species of Cercopithecus monkey from Congo's Central Basin.

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In September 2012 we published a full description and diagnosis of the new guenon species *Cercopithecus lomamiensis*, only the second species of African monkey to be described in the past 28 years. Our study integrated a diversity of data to document concordant patterns of genetic, morphological, and phenotypic (pelage) divergence between *C. lomamiensis* and its sister species *C. hamlyni*. Furthermore, the two species are separated by two major rivers and interfluvial forest region. Here we recount the discovery of *C. lomamiensis* in the forests of the Lomami Basin in central Democratic Republic of Congo (DRC), and review the evidence used to confirm its species recognition. We present new information on the species, including use of camera traps to document the behavior and ecology of this cryptic species, and update its conservation status.

The discovery of *C. lomamiensis* adds a new species to the previously monotypic and poorly known *hamlyni* species group. Several traits within the *C. hamlyni*-*C. lomamiensis* lineage are unique within the arboreal *Cercopithecus* radiation, including a distinctive dawn loud call chorus, adult males with blue perineal, buttocks, and scrotal, and semi-terrestriality. The discovery confirms the biogeographical significance and importance for conservation of the eastern interfluvial region of the Congo River's central basin, known as TL2, from the upper Tshuapa through the Lomami River Basin to the Congo (Lualaba) River. This previously little surveyed forest region is shown to have high taxonomic richness and endemism of primates, and represents an important area for conservation of Central African forest faunas.

The research was supported by Arcus Foundation, US Fish and Wildlife Service, a grant from Edith McBean, Abraham Foundation, Margot Marsh Biodiversity Foundation Grant, Gaylord Donnelley

Environmental Postdoctoral Fellowship from the Yale Institute for Biospheric Studies.

#### Eagle syndrome in two forensic anthropological cases.

TATIANA DEVIA, JESSICA CARTIER and HEATHER WALSH-HANEY. Department of Justice Studies, Florida Gulf Coast University.

We present two forensic anthropology cases to shed light upon the etiology of Eagle Syndrome. Specifically, we provide detailed gross and radiographic skeletal analyses of two adult African American males evincing elongated ( $\geq 25\text{mm}$ ) styloid processes to highlight how our contemporary cases break with current clinical findings; yet, align with bioarchaeological cemetery studies.

Our clinical literature review indicated that the pathogenesis of Eagle syndrome involves three (3) etiologies: post-traumatic ossification; developmental anatomic defect; and age related tendinosis of the stylohyoid ligament. Furthermore, computed-tomographic studies of symptomatic individuals showed that the condition was neither sex nor age related—a finding in contrast to several historic cemetery studies.

Our forensic anthropology cases revealed that in both instances, the manifestation of the elongated temporal styloid processes presented with antemortem trauma (i.e., healed unilateral styloid process fractures; healed cranial, clavicular, rib and fibular fractures); developmental defects of the axial skeleton; and age-related change. While the manifestation of the condition in our sample fit all three etiologies, the sex and age-related influence on the condition was supported; thereby lending support to the bioarchaeological cemetery studies while refuting clinical findings.

#### Severely impaired skeletal acquisition in a mouse model of adolescent Type 2 diabetes.

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The rise in adolescent onset type 2 diabetes (T2D) is of concern for bone health since diabetes is known to impair skeletal acquisition and increase fracture risk. Here we test the hypothesis that adolescent T2D impairs peak bone mass acquisition using the TALLYHO/JngJ mouse, a model of early onset polygenic T2D. We compared skeletal acquisition in male TALLYHO/JngJ and SWR/J controls (N=8-10/grp) starting at 4 wks of age. Outcomes at 8 and 17 wks of age included body mass, %body fat, glucose tolerance, whole body bone mineral densitometry by pDXA, cortical and trabecular microarchitecture by  $\mu\text{CT}$ , femoral strength by three-point bending, and cortical bone tissue material properties by microindentation. Tallyho were obese and

glucose intolerant, developing T2D (fasting glucose >250 mg/dl) by 8 wks of age. Tallyho had ~2-fold higher leptin and %body fat, with severe deficits in distal femur trabecular bone volume fraction (-54%), trabecular number (-27%) and connectivity density (-82%) vs. SWR ( $p < 0.03$  for all). Tallyho had higher midshaft femur cortical bone area fraction, cortical thickness, total cross-sectional area, and polar moment of inertia vs. SWR ( $p < 0.05$  for all), reflecting their higher body mass. Three-point bending of the diaphysis showed Tallyho had lower post-yield displacement than SWR, indicating brittleness ( $p < 0.01$  for both). Microindentation showed higher indentation distances in Tallyho ( $p < 0.05$ ), signifying impaired cortical bone tissue properties. The Tallyho mouse has pronounced deficits in bone mineral content, trabecular microarchitecture, cortical bone material properties, and bone brittleness, suggesting adolescent T2D may be deleterious to bone health in humans.

*Funding for this project was provided by NIH R01AR058389 and F32HD060419.*

#### **Health in post-Black Death London (1350-1538): Age patterns of periosteal new bone formation in a post-epidemic population.**

SHARON DEWITTE. Anthropology, University of South Carolina.

Previous research has shown that the Black Death targeted older adults and individuals who were already in poor health. This project investigates whether this selectivity of the Black Death, combined with post-epidemic rising standards of living, led to significant improvements in health among survivors and their descendants. Patterns of periosteal lesions (which have been previously shown, using hazards analysis, to be associated with elevated risks of mortality in medieval London) are compared between samples from pre-Black Death (c. 1000-1200,  $n = 262$ ) and post-Black Death (c. 1350-1538,  $n = 133$ ) London cemeteries. To avoid the assumptions that stress markers provide a direct measure of health and that a change in frequencies of the stress marker by itself indicates changes in health, this study assesses the joint distribution of age and stress marker to obtain a more nuanced understanding of the population-level effects of an epidemic disease. Age-at-death in these samples is estimated using transition analysis, which provides point estimates of age even for the oldest adults in these samples and thus allows for an examination of physiological stress across the lifespan. The frequency of lesions is significantly higher in the post-Black Death sample ( $p = 0.05$ ), which, at face value, might suggest a decline in health. However, a significant positive association between age and periosteal lesions ( $p = 0.004$ ), as well as a significantly higher number of older adults ( $p = 0.001$ ) in the post-Black Death sample actually suggests improvements in health following the epidemic.

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*School for Advanced Research, and the Ethel-Jane Westfeldt Bunting Foundation.*

#### **Evaluating the utility of GPS collars for studies of ranging by large-bodied, arboreal, forest-dwelling primates.**

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Studies of animal movement have benefitted in recent years from the development of GPS collars that can be deployed on wild individuals. Previously, concerns about size, weight, and GPS accuracy have limited the use of these technologies with arboreal primates, but the development of smaller, more efficient components means that lighter collars with longer lifespans can now be made to perhaps warrant their further use. Here, we report preliminary data on our use of GPS collars with two species of large-bodied, arboreal primates living in a closed-canopy rainforest in Amazonian Ecuador.

We fitted one woolly and three spider monkeys with ~145 gram collars (Telemetry Solutions), each equipped with a high-sensitivity GPS antenna, a VHF transmitter, and hardware to support bi-directional UHF data transmission, allowing users to upload customized GPS schedules and download recorded locations remotely. All four collars collected positional data successfully over periods of up to 11 months, although two failed within ~25% of their projected lifespans, and the best-performing collar reached only ~80% of its estimated life. Combined, the collars recorded fixes on 3096/4939 attempts (79%), with a mean "time-to-fix" of  $57 \pm 20$  sec. Kernel range sizes estimated from the set of GPS fixes for each individual were comparable to those based on locations recorded during focal follows over the same time periods. Overall, the collars provided valuable and accurate data, but their high cost (~\$3200/unit) and disappointing early failures suggest that technological improvements are needed before these become a reliable tool for long-term use with arboreal, forest-dwelling primates.

*This research was supported in part by the Harry Frank Guggenheim Foundation, the National Science Foundation, the New York Consortium in Evolutionary Primatology, and New York University.*

#### **Anthropogenic impacts on primate distribution and matrix-edge dynamics in a Bolivian forest.**

ILEANA I. DIAZ. Department of Anthropology, University of Victoria.

Human activities cause changes in the vegetation structure and plant species composition of habitats. Loss of forested land increases fragmentation and the amount of habitat edge. These edges are characterized by the penetration of abiotic factors such as wind, temperature, humidity, and solar radiation.

Consequently, changes in microclimate and food resources occur. This study investigates the relationship between a primate community and its distribution between the edge and matrix of a forest in northwestern Bolivia (11°23'S, 69°06'W). In total, 10 primate species were surveyed in 6 habitat types along 8 km transects walked at 1 km/hr. In addition, 80 quadrats were sampled at 100 m intervals. Traditional terrestrial census technique was combined with satellite imagery to assess absence, presence, and proximity of species to the edge. For all sightings ( $n = 121$ ), location, group size, group composition, height, and habitats occupied were recorded. These data show that *Saguinus labiatus* was found on average closer to forest edges (322 m), while *Callimico goeldii* was found the farthest from forest edges (650 m). Most primates avoided the forest edge, and *Saguinus labiatus* and *Saguinus fuscicollis* seem to be most frequent at these areas. Lastly, satellite images from 1969 and 2012 were examined. Results suggest that the rate of deforestation has more than doubled over the last forty years. Several primate species are exploiting the forest edge more often than before. These results are important for understanding the effects of degraded habitats and anthropogenic impacts on primates in the Amazon.

*This study was funded by the Fresno Chaffee Zoo and Northern Illinois University.*

#### **Evidence of non-bone cellular and microstructure preservation in skeletonized remains from Middle Bronze Age Italy.**

SUSAN K. DIBBLEY, TEDDI J. SETZER and BIRGITTA I. SUNDELL-RANBY. Anthropology, Wayne State University.

Histological methods were used to examine the health of three individuals from a Middle Bronze Age (ca. 1600-1300 BC) tomb in Sardinia, Italy. The intention of this research was to identify the nature of the high rates of porotic hyperostosis and cribra orbitalia observed in this population through an examination of the hard tissue. Although these skeletal remains were described as highly fragmented and of poor quality, preservation of microstructures consistent with mummified marrow, including probable blood cells and evidence of diagenetic processes, were detected. Bone tissue was decalcified using an EDTA treatment and embedded in paraffin blocks. Five  $\mu$ m sections were prepared with hematoxylin-eosin and Giemsa stains. In a second study performed in a separate laboratory with different technicians, additional compact bone sections were demineralized and samples from the medullary cavity were embedded in cryo-OCT compound. These were prepared with a hematoxylin-eosin stain. The results of the second analysis supported the initial findings. This study indicates that bone marrow and blood cells may be better preserved in skeletonized remains than previously thought, even when the remains are highly degraded and considered to be of poor quality from a macroscopic perspective. Methods such as these can provide an additional line of

evidence when addressing health and evolutionary questions through the analysis of human and non-human skeletonized remains.

**A review of undescribed human skeletal remains from archaeological sites in Venezuela: Indicators of health, nutrition, and social practices.**

MOLLIE A. DIBRELL and GARY P. ARONSEN. Department of Anthropology, Yale University.

While there is a rich archaeological record for Venezuela, few human remains have been recovered or described. Here, we provide an inventory and description of unpublished human skeletal material curated by the Yale Peabody Museum of Natural History. Based on museum records, these remains were recovered from Venezuelan archaeological sites dating to the Regional Development Period, between 500BC & 500AD. We review seven catalogued sets of remains comprising at least twelve individuals from multiple archaeological sites. Both sexes and a variety of ages are represented. While preservation is poor for the majority of the remains, there are indicators of cranial reshaping, caries and periodontal disease associated with subsistence agriculture, indicators of nutritional stress, and blunt force trauma evidence on an adult male's cranium, suggesting interpersonal violence. Our results are compared to previously reported data on Latin American skeletal material, and together they provide further insights into the life histories of prehistoric Venezuelan people. We suggest additional isotopic and genetic analyses to further enhance our knowledge of these and other human skeletal remains from this region and time period.

*This work was supported by the Yale Peabody Museum of Natural History and by the Yale University Department of Anthropology.*

**Training and empowerment in Forensic Anthropology on an international level: How the life's work of Dr. Karen Ramey Burns has inspired training in Colombia.**

ELIZABETH A. DIGANGI. International Criminal Investigative Training Assistance Program (ICITAP)-Colombia.

While Dr. Karen Ramey Burns' body of work was extensive, ranging from testifying as an expert witness in court to mass disaster victim identification to bioarchaeological histories of notable figures, perhaps she undertook her most challenging project towards the end of her life: working as a Fulbright Scholar for the Universidad de los Andes in Bogotá, Colombia. As part of this position, she taught courses, mentored students, and served a key role in the development of the non-governmental organization, EQUITAS, a group dedicated to helping the victims of Colombia's ongoing internal conflict via ensuring that forensic anthropological methods used by government agencies are correct. Colombia has innumerable problems with regards to the practice of forensic anthropology: anthropologists are often ill-

trained (many have a bachelor's degree in cultural anthropology alone) and grossly underpaid; field conditions are dangerous, as many graves are located in areas where illegal groups still operate; and the proper resources necessary for field and lab work are often not available or somehow fall through the cracks when most needed. Dr. Burns had been in Colombia for just over a year when this author moved to that country to serve as an anthropology advisor to provide training. Her impact on the field was immediately apparent, as all the anthropologists knew who she was and those who were fortunate enough to have had a class with her were the most technically knowledgeable. Her lasting influence will be discussed as to how current training provided by this author has been impacted.

**Evidence for behavioral change between the Middle and Late/Final Jomon period using long bone diaphyseal robusticity.**

DAVID T. DILLON and DANIEL H. TEMPLE. Department of Anthropology, University of North Carolina Wilmington.

This study documents long bone diaphyseal robusticity in Middle (5000 to 4000 BP) and Late/Final (4000 to 2300 BP) Jomon period skeletal remains from southwestern and eastern Honshu. Results are interpreted within the context of a climatic cooling episode documented around 4000 BP. Micro CT scans of humeri and femora were collected at 33% and 50% of biomechanical length for each bone respectively. Cross-sectional geometric properties including total subperiosteal area (TA), cortical area (CA), medullary area (MA), and polar second moment of area (J) were calculated using the Moment Macro program for Image J software. All measurements were standardized using appropriate parameters: TA, CA, and MA by body mass, J by long bone length<sup>2</sup> · body mass. Comparisons between Middle and Late/Final Jomon period long bone diaphyses were performed separately for males and females. Differences in cross-sectional properties were evaluated between time periods using MANOVA methods. Significantly greater femoral CA ( $P < 0.025$ ) and J ( $P < 0.079$ ) as well as reduced MA ( $P < 0.001$ ) were found in the Late/Final compared to Middle Jomon period males, while no differences were found in humeral diaphyseal robusticity between time periods for males or females. These results suggest increasing femoral diaphyseal robusticity among male members of the Late/Final Jomon community, specifically greater amounts of cortical bone and reductions of medullary area. This increase may reflect an increase in foraging distances, exposure to more rugged terrain during subsistence forays, or migration between sites. Recent strontium isotope analysis supports the latter assertion.

**Social flexibility in the classically monogamous Titi monkey: A response to increased population pressure.**

KIMBERLY A. DINGESS. Anthropology, Indiana University, Bloomington.

Titi monkeys typically reside in small groups consisting of a breeding pair and dependent offspring. Traditionally they are believed to be the only primates strictly conforming to the classic monogamous profile being monomorphic, forming tightly bonded pairs maintained by coordinated displays, and territorial with a high level of paternal investment. Observations from a long-term field study of *Calliticebus donacophilus* in Santa Cruz, Bolivia, however, reveal a much more flexible social system. In October of 2009, we observed a two-adult male, resident male plus male from adjacent territory, and one female grouping. Both males resided in the group providing infant care until the resident male was ousted in January 2010. A two breeding female, resident female plus female from nearby group, and one male grouping was first observed in September 2011. The male simultaneously cared for both infants born to the group that season, although displaying a social preference for the resident female. Fecal samples have been collected from both groups for genetic paternity testing. The observed social arrangements can likely be attributed to increased population pressure as a result of population growth and further degradation of their fragmented habitat. Territories overlap considerably at Yvaga Guazu and there appears little opportunity for new territory formation, thus resulting in novel social behavior.

**A tooth atlas for the developing dentition of *Hylobates lar* based on radiography and histology.**

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Developmental atlases of the great ape and human dentitions have proved invaluable in ontogenetic studies of both cranial and postcranial traits because they allow specimens to be individually aged rather than aggregated into discrete categories. The creation of a similar atlas for the hylobatid dentition allows for extending these comparative ontogenetic studies across the hominoid clade. The goal of our preliminary study is to document and provide a chronological time scale for the developing dentition of *Hylobates lar* using a combination of cross-sectional radiographic data of 18 juvenile gibbon mandibles and histological sections of three lower molars (M1, M2 and M3) from individuals with histologically derived ages at death (AS1627, NYU008 and NYU029). An atlas of dental formation was created using the radiographic images, with 10 separate stages of tooth mineralization being identifiable across all individuals (based on Dean and Wood's atlas

method). Growth increments in the crown and root of histological sections of each molar were used to determine the age for each of the 10 stages. These provided a time-scale of postnatal dental development spanning from 0.22 years (M1 1/4 complete) to 5.8 years (M3 root 1/2 complete). In combination, these data allowed for assigning approximate relative dental ages (ARDA) to each individual gibbon specimen in a way that is comparable to Dean and Wood's great ape atlas. Future work will include histological data for the remaining mandibular dentition (I1, I2, C, P3 and P4), thus increasing the resolution of the method. Funded by NSF (SBR-9700822) and the Royal Society.

**Dental bioindicators of health: at the intersection of bioarchaeology and contemporary human biomonitoring programs.**

ALEXIS E. DOLPHIN. Anthropology, The University of Western Ontario.

Bioarchaeologists are familiar with the notion of using teeth to assess the degree of stress of past populations, or the quality of their health. Markers of growth arrest, such as linear enamel hypoplasia or accentuated striae of Retzius, are used to determine the frequency and timing of stress episodes. The chemical compositions of teeth are often used to comment not only upon aspects of diet, but extended to the building of explanatory models regarding the health of past peoples. In fact, bioarchaeologists have been viewing teeth as retrospective indicators of childhood stress, and linking this stress to long-term consequences for individuals and populations, for decades.

Bioarchaeologists are not alone in their use of teeth to explore human health. Dental 'bioindicators' are of growing interest to epidemiologists, environmental scientists, and public health researchers, who aim to biomonitor the health of living populations. Several biobanking initiatives around the world now include deciduous tooth banks. Samples from these biobanks, when combined with longitudinal health data, are used to link variation in early childhood environments to later morbidity and mortality outcomes.

Based upon this bioarchaeologist's experience of working with a tooth bank associated with the Norwegian Mother and Child Cohort Study (MoBa), this paper will explore the fruitful connections and current miscommunications between researchers with diverse understandings of the stress and health relationship(s). A critical evaluation of how these concepts are employed by various researchers will help to maximize the potential contribution of dental bioindicators to the study of health in past populations.

**Geometric morphometric analysis of human footprints.**

JACQUELINE DOMJANIC<sup>1</sup>, MARTIN FIEDER<sup>2</sup>, HORST SEIDLER<sup>2</sup>, SLAVENKA

PETRAK<sup>1</sup>, DARKO UJEVIC<sup>1</sup> and PHILIPP MITTEROECKER<sup>3</sup>. <sup>1</sup>Department of Clothing Technology, University of Zagreb, <sup>2</sup>Department of Anthropology, University of Vienna, <sup>3</sup>Department of Theoretical Biology, University of Vienna.

We used geometric morphometrics for a detailed analysis of footprint shape in a sample of adult women. The outline of the footprint, including the toes, was represented by a comprehensive set of landmarks and semilandmarks. The first four principal components represented the major axes of variation in foot morphology: low-arched versus high-arched feet, long and narrow versus short and wide feet, the relative length of the hallux, and the relative length of the forefoot. These shape features varied relatively continuously across the measured individuals without any distinct clusters or discrete types of footprint shape. We identified and visualized influences of body mass index (BMI), shoe size, and the frequency of wearing high heels on footprint shape. We further assessed average and individual asymmetry in footprint shape.

**Using a hierarchical generalized linear model to predict crop damage by vervet monkeys (*Chlorocebus aethiops*) in St. Kitts, West Indies.**

KERRY M. DORE. Anthropology, University of Wisconsin-Milwaukee.

The invasive African green vervet monkey (*Chlorocebus aethiops*) has pestered the agricultural system of St. Kitts since the monkeys were brought to the island with the slave trade over 300 years ago. This is the first study to systematically monitor monkey crop damage patterns. Crop damage data were collected on one-third of the registered farms in St. Kitts (n = 65, randomly selected) within half-acre grid cells (level 1) and for the entire farm (level 2) for 12 sequential months. I present a model that can predict a farm's probability of incurring crop damage by monkeys. To develop the model, the data were randomly split into a training set (80%) and a testing set (20%). A binomial (damage or no damage) hierarchical generalized linear model (HGLM) was fit to the training data. Variable selection was performed via backward selection and a receiver operating characteristic (ROC) curve was used to determine a cutoff value to make predictions. Crop preference is the greatest predictor of crop damage (b = 0.259, p = 4.91e-10), followed by distance to water (b = -0.0105, p = 0.0026), number of neighbors (b = -0.451, p = 0.00288), distance to forest (b = -0.000549, p = 0.0782), and whether or not it is the mango season (b = -0.654, p = 0.0794). Predictions are made using a cutoff associated with achieving close to 80% for both sensitivity and specificity (0.0351). This model will be used to establish which farms should be slated for protection assistance.

This research was funded in part by the University of Wisconsin-Milwaukee's Golda Meir Library Scholar Award and the University of Wisconsin-Milwaukee's Dissertation Fellowship.

**Best practices for the integration of tablet-based applications into a laboratory course: a case study from the human gross anatomy laboratory.**

ALISON F. DOUBLEDAY. Oral Biology, University of Illinois at Chicago, College of Dentistry.

Common challenges for faculty in any discipline include finding ways to motivate students to stay on task and remain engaged with course content, as well as encouraging students to work collaboratively with their peers. The increased adoption of new technologies into the classroom provides unique opportunities to take advantage of existing applications in order to address these challenges. This presentation provides an example of how tablet (iPad)-based applications were integrated into a human gross anatomy lab at University of Illinois at Chicago, College of Dentistry. Among the specific mobile applications used, one employed a scavenger hunt as a strategy to increase student engagement and collaboration within the laboratory. Student-generated photo and video data were also used for formative assessment of student understanding by course faculty. Details and challenges of logistical planning, as well as implementation of the project are addressed. Additionally, results of student surveys highlighting student impressions and patterns of use demonstrate that careful integration of tablet-based applications into the classroom leads to increased collaborative activity and engagement, as well provides a means of formative assessment. This study illustrates an example of the use of best practices for incorporating technology into a course and is relevant for faculty teaching similar laboratory based courses, such as osteology or paleoanthropology.

**Lives of deprivation or lives of industry: possible cerebral palsy on the *Mary Rose*.**

ROSE DREW. Department of Archaeology, University of Winchester UK.

Contemporary historical and medical writing on impairment in the medieval period claim the congenitally disabled and deformed were blighted evidence of God's disfavor for the sins of their parents. Such opinions are tautologies based on secondary sources, unsupported by 14<sup>th</sup> century primary sources (Piers Plowman, Lollard writings). Vagrancy proclamations (1495), and dissolution of monasteries from 1538 encouraged self-sufficiency. Impairment may not have equalled poverty.

Cerebral palsy (CP) is associated with maternal infections, low birth weight, premature birth, and labor complications. Chronic disorders are considered when examining archaeological remains; anomalies suggesting CP include hip dysplasia; Talipes; flexion contractures; valgus ankle in a Pleistocene hominin. Clinically, affected femora retain infantile valgus and anteversion angles due to muscle imbalance and abnormal loads. Normal neonate anteversion averages 40 degrees, reduced to 19 degrees in adolescence, 8-15 at maturity; neck-shaft angles

similarly decline with age, from 140 to 125 degrees. Other vara or valgus deformities may occur distally, related to 'windswept disorder'.

In this speculative study, 98 femora from the *Mary Rose* are examined for anteversion and valgus: with commingling, elements are best considered in isolation. Six femora have anteversion of 30-45 degrees, one with 140 degree valgus. Four have 27-28 degrees anteversion, with one also having 144 degree valgus. Differentials include idiopathic anteversion; congenital hip dysplasia; activity. *Mary Rose* crew with possible CP were employed at time of death, and thus challenge our assumption that only compassion and charity enabled an impaired person's survival, overlooking the very real probability of productive membership in society.

#### Secular change in pelvic sexual dimorphism: a 3D study.

KATHRYN R.D. DRISCOLL. Anthropology, University of Tennessee.

Research has shown that there is secular change occurring in the shape of the human bony pelvis. The pelvic canal has become more rounded with significant increases in the inlet AP diameter and the outlet transverse diameter. Because these changes are consistent across ancestries and sexes, environmental improvement (such as nutrition) rather than parturition is likely the cause. The question driving this research is whether sexual dimorphism is decreasing with the secular increases in these pelvic diameters.

The rearticulated bony pelvic girdles of individuals born between 1842 and 1981 were digitized for this study. Skeleton from the Hamann-Todd Osteological Collection, the Robert J. Terry Anatomical Skeletal Collection, and the William M. Bass Donated Collection were used. Individuals were placed into five birth cohorts made up of equal numbers of black and white, male and female. 3D coordinates were collected and measurements were calculated.

Geometric morphometry and traditional metrics indicated that the human pelvic shape has changed. The index of pelvic dimorphism revealed that for both blacks and whites, the transverse outlet diameter was the most dimorphic measurement followed by the inlet AP diameter. Whites showed a decreasing trend in sexual dimorphism in the inlet diameters and the AP outlet; however, these differences were not statistically significant. Blacks fluctuated in dimorphism, but this was also statistically insignificant. While secular changes are occurring in the human bony pelvis, there does not appear to be shift toward a uniform morphology. Females continue to maintain a form that is significantly different from males.

#### Exploring hormonal correlates of small body size in the Kinda baboon (*Papio kindae*).

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Kinda baboons (*Papio kindae*) are the smallest and least sexually dimorphic of extant *Papio*, and studies of their cranial morphometrics have suggested a distinctive developmental trajectory. To investigate possible proximate causes, we compared body mass with blood serum levels of testosterone, estradiol, insulin-like growth factor-I (IGF-I), insulin-like growth factor binding protein-3 (IGFBP-3) and insulin C-peptide in 32 female and 44 male Kinda baboons from Kafue National Park, Zambia. Their ages, estimated from dentition, ranged from 1 to 215 months.

IGF-I and testosterone predicted body mass in male Kinda ( $R^2 = 0.54$ ,  $p < 0.01$ ), and IGF-I predicted mass in females ( $R^2 = 0.27$ ,  $p < 0.01$ ). IGF-I and testosterone concentrations were higher in males than females (IGF-I:  $U(1)=301$ ,  $p < 0.01$ ; T:  $U(1)=202.50$ ,  $p < 0.01$ ), and estradiol was higher in females ( $U(1)=212.00$ ,  $p=0.02$ ). In males only, C-peptide concentrations were positively correlated with IGF-I ( $r = 0.52$ ,  $p = 0.01$ ). When compared with other species (*P. anubis* and *P. hamadryas*), Kinda IGF-I concentrations were closest to those of anubis, with hamadryas IGF-I significantly higher than either ( $F(2,373)=8.97$ ,  $MSE=0.19$ ,  $p < 0.01$ ). Intriguingly, in both male and female Kinda, IGFBP-3 was undetectable by our assay. Since IGFBP-3 prolongs the half-life of circulating IGF-I and also facilitates delivery of IGF-I to cellular receptors, this suggests that the bioavailability IGF-I in Kinda may be considerably affected during development. Overall, these results suggest that IGF-I and testosterone influence the developmental trajectory of Kinda baboons, and that their smaller adult body size might be related to unusually low concentrations of IGFBP-3.

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#### Ancient burials from the site of Cardón Mocho, province of Catamarca, Argentina.

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Cardón Mocho is a recently discovered archaeological site found in the vicinities of Azampay, province of Catamarca, in the northwestern region of Argentina. Several archaeological excavations conducted in the area during 2010 and 2011 under the auspices of Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT) have uncovered human burials dating to AD 0-200. The site has yielded until now the skeletal remains of 11 individuals. Standard practice for *in situ* documentation of these burials and skeletal inventory and other

aspects of data collection were conducted following previously published procedures, in order to obtain a population sample for osteological analysis. Age at death and sex were estimated using standard procedures. Lower limb bones were measured to allow calculation of living stature. Dental and skeletal pathologies have also been examined. The 11 skeletons from Cardón Mocho consist of 7 adults, including 4 females and 3 males, and 4 immature individuals. Dental lesions were noted, including alveolar abscesses, caries, and linear enamel hypoplasia. Skeletal lesions probably attributed to osteomyelitis, signs of trauma, vertebral osteophytosis, abnormal periosteal bone apposition and porotic hyperostosis of the parietals were also observed. One individual displays cultural modification of the head. The presence of ornaments on some individuals may suggest social differences in this ancient society. This study is part of a research project that aims to examine long term temporal changes in skeletal samples from this particular region. Additional research will be needed to place these preliminary results in a greater temporal and geographical context.

#### Towards a theoretical framework for understanding the variation in sexually-selected traits among multimale-multifemale anthropoid primates.

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Sexual selection theory explains the evolution of traits that increase reproductive rate. A variety of mechanisms may influence the evolution of sexually-selected traits in males, including contest competition, sperm competition, and female mate choice. However, it remains unclear whether and how such mechanisms interact to shape trait evolution. Anthropoid primates are an ideal model system for investigating these interactions because they display a great array of sexually-selected traits that are typically attributed to different sexual selection mechanisms, even among those subject to the same mating system: polygynandry. Here, we propose a framework aimed at explaining this variation using a socio-ecological approach. We explain the observed pattern based on variability in the degree of synchrony of female mating activity, which has previously been proposed to shape male-male competition for fertile females. In short, we predict that species facing high degree of synchrony exhibit traits associated with contest competition (e.g. sexual dimorphism in weaponry; signals of social status), while those facing low degree of synchrony exhibit traits associated with sperm competition (e.g. large testis size) and female mate choice (e.g. signals of quality). We further propose that the dynamic of male-male competition also shape the evolution of female signals. We predict that presence, precision and/or conspicuousness of signals of the probability of ovulation are more likely to evolve

in context of low degree of synchrony where male dominance rank provides honest cue about their quality. These predictions will be illustrated with examples extracted from the literature.

**Investigating shape changes in American White and Black cranial dimensions: a 3d geometric morphometric approach.**

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A multitude of research investigating microevolutionary processes has been published that has identified combinations of shape and size related changes in the cranial and postcranial dimensions of modern Americans over time. The majority of these studies have utilized two dimensional data to assess metric differences between 19<sup>th</sup> and 20<sup>th</sup> century Americans. However, using geometric morphometrics to examine coordinate data in three dimensions has been shown to aid researchers identify patterns of change within a sample. This study investigates the hypothesis that examining secular change of the cranium in modern American blacks and whites using 3D coordinate data will support previous findings as well as provide better resolution to how variation has changed through time.

This analysis examined coordinate cranial data from American whites and blacks from the University of Tennessee Forensic Databank and the Terry Anatomical collection. Coordinate data was used from 65 landmarks that describe the dimensions of the human cranium. Analyses were carried out using MorphoJ software, which allows for extraction of shape variables to allow for visualization of differences between data sets. Results support the general findings of earlier publications, such as the increase in vault height is mostly due to an inferior lengthening of the cranial base. However, visualization of secular change using 3D coordinates also indicates movement and change of cranial dimensions that have not been previously described, such as anterior movement of the nasomaxillary complex of males and females of the American black samples and inferior displacement in the American white male samples.

**Sinodonty and beyond: reasserting the relevance of dental anthropology for understanding the peopling of the New World.**

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The past ten years have seen a dramatic rise in research on the peopling of the New World by archaeologists, craniometricians, and geneticists but with less input from dental specialists. In this presentation we review the

history of dental anthropology as it relates to peopling of the New World and offer an analysis of Paleoindian dentition that reasserts dental anthropology's relevance and potential to lead future discussion in the debate.

Pioneered by Christy Turner, dental anthropology was one basis for the development of the three wave model of peopling of the New World that reflected separate migrations of populations from Asia. All groups were characterized by what Turner called Sinodonty, a suite of dental traits found in northeast Asian populations. Subsequent work on Paleoindian and Archaic Period dentition focused on the presence or absence of Sundadonty and America's subgroup structure. Although the three migration model remains viable, genetic research documenting alternative, and more complex, migration scenarios dominate recent literature.

Here we provide an interindividual analysis of confirmed Paleoindian dentitions to evaluate competing models of geographically structured New World migration routes (coastal vs. ice-free corridor, bi-coastal migration routes) and different migration processes (South America bottlenecking). Multidimensional scaling of Gower similarity coefficients confirms that there is geographic patterning that may reflect a bi-coastal migration route or a combined bi-coastal migration (north and south coast of Beringia eventually into the Pacific and Atlantic coast of North America) with a later migration through the ice-free corridor (the central North Americans in this analysis).

**Locomotion of Angolan black and white colobus monkeys (*Colobus angolensis palliatus*) in coastal Kenya's Diani Forest.**

NOAH T. DUNHAM and W. SCOTT MCGRAW. Anthropology, The Ohio State University.

Anthropologists interested in understanding constraints on positional behavior focus increasingly on the relationships between locomotion, posture, and details of forest architecture. Recent studies have shown that in several taxa, locomotion and posture are conserved intra-specifically in groups inhabiting structurally distinct habitats; however, several critics note that the habitats under study may not be structurally different enough to warrant significant behavioral adjustments. We address this issue with new locomotor data on a species inhabiting a highly perturbed environment. These data are compared with those of closely related taxa inhabiting a gradient of habitat types to test the null hypothesis of no difference between species and across habitats.

Positional behavior data were collected from June to August 2012 on Peters' Angolan black and white colobus (*Colobus angolensis palliatus*) inhabiting coastal Kenya's heavily degraded and increasingly urbanized Diani Forest. Instantaneous time point sampling was used to generate an overall locomotor profile from three habituated groups. This profile was compared to those of three other colobines from East and West Africa: *Colobus guereza*, *C.*

*polykomos*, and *C. vellerosus*. The Angolan colobus at Diani spent approximately 8.9% of their time moving with an overall locomotor profile of 71.2% quadrupedalism, 13.2% climbing, and 14.5% leaping. Comparisons of overall locomotor profiles using G-tests revealed significant interspecific differences with two of the three colobine species; however, methodological approaches are not uniform. These results underscore the need for standardized protocols in positional sampling.

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**Genotyped undergraduates: Better learners and leaders in the personal genomics era.**

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Personal genomics isn't just high-tech navel-gazing. It's a potentially powerful tool for understanding human evolutionary biology. This begs an important question of educators: Can personal genomics improve undergraduate learning of biological anthropology? To test the hypothesis that it does not, and to find out whether direct-to-consumer genetic testing contributes to learning success, 145 students in introductory and advanced biological anthropology courses at the University of Rhode Island were given the option to have thousands of their SNPs genotyped by 23andMe, with university granted funds. Pre- and post-tests both about evolutionary principles and the fundamentals of personal genotyping were administered at the beginning and end of the courses. Assignments drew upon the experience, and surveys were periodically collected. Guests with relevant expertise visited the classrooms. Of those that opted to participate (which was the vast majority), only one student responded 'yes' to a survey question asking if they wish they had not. Students in both courses demonstrated improved understanding of, and confidence about, fundamental principles of evolution and science in general. However, by the end of the courses, many still struggled with interpreting disease risk and probability, with understanding laboratory methods of genotyping, and with comprehending ancestry reports. Nonetheless, students demonstrated improved understanding of many principles of human genetics as well as many of the ethical and privacy issues to do with personal genomics. All together these results suggest that student participation in personal genomics does not hinder learning success, but, rather, that it enhances undergraduate learning in biological anthropology courses.

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### Is there evidence for assimilation in Australasia?

ARTHUR C. DURBAND. Department of Sociology, Anthropology, and Social Work, Texas Tech University, Department of Archaeology, Flinders University, Department of Anthropology, South Australian Museum.

The study of modern human origins in Australia has a long history. Throughout much of this history, workers interested in the origins of the Australians have often focused on scenarios that invoke multiple founding populations for the modern inhabitants of this continent. These theories have included the Trihybrid model by Birdsell and the Dihybrid model championed by Thorne, with the latter often portrayed as one of the strongest supports for the modern Multiregional hypothesis. "The mark of ancient Java" has long been thought to link populations like the Ngandong fossils to both fossil and modern Australian Aborigines. More recently, genetic evidence has suggested that the Denisovans contributed genes to modern Australian populations, suggesting that at least some admixture did take place in Southeast Asia and Australasia.

Examination of the fossil evidence casts doubt on hypotheses of regional continuity in Australasia. Morphologies seen in the Sangiran/Ngandong fossils from Java are not found in any "robust" early Australians, and this evidence is most supportive of the replacement of these archaic Indonesian populations by later migrations of modern humans. The genetic evidence, however, may indicate some assimilation of an archaic genome in modern Australian populations. This presentation will summarize our current understanding of modern human origins in Australasia and examine a series of hypotheses that could reconcile the potentially conflicting evidence from the fossils and ancient DNA.

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### Reconstructing the ecology of a forest in late Miocene Central Europe using stable isotope and trace element analysis.

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The faunal assemblage at Rudabánya, a Late Miocene (~10 Ma) primate locality in northern central Hungary, preserves an abundance of forest-dwelling taxa, including a hominoid, *Rudapithecus hungaricus*, and pliopithecoid, *Anapithecus hernyaki*. The co-occurrence of these catarrhines at Rudabánya represents one of the very few localities in Eurasia where a hominoid and pliopithecoid coexist. Reconstructing the unique paleoecology of this spatially and temporally rare site is critical to understanding the context of hominoid evolution in Europe. To evaluate forest structure,

climatic regime, and resource partitioning we examine stable carbon ( $\delta^{13}\text{C}$ ) and oxygen ( $\delta^{18}\text{O}$ ) isotope values in correlation with trace element ratios (Sr/Ca) in the dental enamel of ten genera of medium to large bodied herbivores.  $\delta^{13}\text{C}$  and Sr/Ca values suggest a mosaic  $\text{C}_3$  forest environment, ranging from dense closed canopy to more open woodland settings. The observed  $\delta^{18}\text{O}$  values are similar to what is found in modern humid temperate environments. Intra-tooth  $\delta^{18}\text{O}$  values for all sampled taxa reveal a pattern of seasonal enamel growth. Significant differences in stable isotope and trace element values exist between taxa implying competition and partitioning in resource use. *Hippotherium intrans* (Equidae) and *Lucentia* aff. *piensis* (Cervidae), show more positive  $\delta^{13}\text{C}$  values and the highest Sr/Ca ratios, suggesting feeding on irradiated vegetation in open woodland settings. More negative  $\delta^{13}\text{C}$  values and lower Sr/Ca ratios found in *Miotragocerus* sp. (Bovidae), *Tetralopodon longirostris* (Gomphotheriidae), and *Aceratherium incisivum* (Rhinocerotidae), suggest browsing on fruit in more densely forested environments. These results provide insight into the paleoecological context of European hominoid evolution.

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### Weaning in the Virunga mountain gorilla (*Gorilla beringei beringei*): factors causing variation in weaned age.

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Offspring age at the termination of direct nutritional support by the mother, here referred to as 'weaned age', is an important measure of maternal investment. Delayed weaning can reduce the mother's future reproductive success, while premature weaning can reduce the offspring's chances of survival and future reproductive success. Thus, weaned age is crucial in understanding female reproductive strategies. This study aimed to investigate the impact of offspring sex, group size, presence of silverbacks, as well as maternal age, rank, and parity on weaned age variation in the Virunga mountain gorillas. The status of nutritional independence in 69 offspring was monitored using suckling observations from 1973 to 2012. A Cox-regression was used to model weaned age and to examine its relationship with covariates. Preliminary analysis suggests that offspring in one-male groups are weaned at an earlier age than offspring in multi-male groups which may indicate a female strategy to reduce the higher risk of infanticide that is present in one-male groups. Offspring were also weaned earlier the older their mother which may reflect an overall increase in fertility with age. In addition, sons of high-ranking mothers were weaned earlier than

daughters, consistent with previous findings on inter-birth interval and suckling frequency. The bimodal nature of weaned age distribution in mountain gorillas and the need of future studies on the impact of environmental factors on the timing of weaning will be discussed.

### Pathology of LB1 (Flores, Indonesia): Down syndrome considered.

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Reification of a novel hominid taxon for Liang Bua Cave, Flores, skeletons embodies several leitmotifs: 1. descriptions of morphologies that are abnormal (e.g. rotated bilateral upper premolars) or pathological (marked craniofacial asymmetry of the LB1 skull with endocranial volume several standard deviations below relevant reference populations, disproportionate limb segment ratios, etc.); 2. insistence that such features are normative for the hypothetical taxon; 3. contention that clinical signs of abnormality cannot be accepted without diagnosis of some specific disorder.

Logically, documentation of abnormality precedes inferences about causation. Salient for LB1, short stature, microcephaly, plus skull asymmetry occur jointly in 100 to 200 syndromes. Only three were considered before hypothesizing the new species; subsequently, fewer than ten have been evaluated.

Here we explore another possible diagnosis: Down Syndrome (DS), which occurs worldwide 1/<700 births. Signs of DS include reduced brain size, brachycephaly, shortened extremities, hypotonia, etc., all documented in LB1. Notably, abnormally low femur:foot ratios are so common in DS that they are used in prenatal screening. Jungers, et al. (2009 Nature 459) estimated foot:femur ratio of 70.0 (67.5–72.9, 95% prediction interval) are compared here to data on 8 preadolescents (foot:thigh ratio 67.9, 62.6–73.6) and 12 adults (foot:thigh ratio 61.1, 57.0–67.1).

Further testing of the DS hypothesis requires access to the original specimens, denied to us since 2007. Should further work eliminate DS for LB1, observations of abnormality persist.

### Are there 40 kinds of hispanics in New Mexico?

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In New Mexico it is common to hear that there are two groups of Hispanics in the state, those primarily of Spanish descent and more

recent immigrants of Mexican descent. Many New Mexicans say they can distinguish these groups by their appearance, including skin color, face shape, and hair form.

In an open-ended question, we asked 418 New Mexicans of Spanish-speaking descent to describe their sub-ethnic identity. Fifty-three distinct descriptors were used. We took three-dimensional facial photographs of these subjects, removing any data associated with coloration or shape below the mid-neck. Using unsupervised computer learning, we used a piecewise polynomial model of surface patches to represent facial structures with each patch representing a region of the face. We applied a genetic algorithm to select patches, and regularized least-squares to fit patches to face-scans. We use k-means clustering to group subjects in the polynomial coefficients, which represent the clusters of faces found to be similar.

We tested fit at 2-20 spline-plate patches and  $k=2-50$  clusters, and found that 10 patches and 40 clusters best captured the variation among the faces, with only 0.05 mm loss per cluster.

Comparing the results of this unsupervised test to the subject's own assessment of their ethnicity shows various levels of inconsistency among the groups. This may result from a lack of fit between self-identity and appearance, unequal distinctiveness of ethnic labels, or errors in the model. However, even with these caveats, it seems unlikely that two distinct groups can be identified by face shape alone.

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#### **A comparative analysis of hippocampus size and ecological factors in primates.**

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Primates vary in their need to store spatial and temporal information for foraging and distinguishing food quality. The hippocampus plays a role in spatial navigation and episodic memory. This study investigates the effect of environmental factors, such as diet, home range size, activity pattern and habitat, on variation in hippocampal volume among primates. We hypothesized that primates with highly frugivorous diets and larger home ranges would have relatively larger hippocampal volume compared to folivorous/insectivorous primates and primates with smaller home ranges. Furthermore, we expected that arboreal primates would have larger hippocampal volumes than terrestrial primates, resulting from an increased reliance navigating in the complex three-dimensional space of the canopy. We did not expect hippocampal volume to differ between nocturnal and diurnal primates. Using

uncorrected and phylogenetic independent contrast analyses on 42 primate species, body size-adjusted hippocampal volume was significantly increased in primates with a frugivorous diet. Conversely, primarily insectivorous primates demonstrated a negative correlation with hippocampal size, suggesting they have smaller hippocampal volumes. As predicted, hippocampal volume increased in association with home range size and activity patterns had no effect on primate hippocampal volume. Surprisingly, arboreal primates did not differ from terrestrial primates in hippocampus size. These results demonstrate that environmental factors related to diet and home range size may selectively shape an increase or decrease in hippocampal volume in primates due, in part, to its role in spatial memory. This study also adds to a growing body of research in support of the mosaic theory of cognitive evolution.

#### **Does the primate zygomatic arch respond to food material properties?**

HALLIE M. EDMONDS. Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University.

The morphology of the primate craniofacial complex is thought to be influenced by the material properties of food. This relationship is often used to explain facial morphology in fossil taxa, yet a comparative analysis linking the two is lacking. Species that process more mechanically demanding foods (i.e., hard and/or tough diets) are expected to have more robust morphologies to combat higher magnitude forces. This hypothesis was tested using the dimensions of the zygomatic arch, a bony structure important in jaw adduction. Primate taxa that consume more mechanically resistant foods were predicted to possess more robust zygomatic arches than those with less resistant diets. Arch robusticity was represented as cross-sectional area (CSA) and measured from microCT scans on anthropoid and strepsirhine skulls ( $n=163$ ). Taxa were grouped into two mechanical dietary types (hard/tough and soft/brittle) based on their broad dietary categories (e.g., frugivore, folivore). Phylogenetic generalized least squares regression was used to evaluate the relationship between CSA and a size surrogate (palate breadth) for both diet types while also considering the effect of shared ancestry. The results for strepsirhines were not significant. Among anthropoids, the two diet types scale in the same manner with size, indicating no significant difference between diet types. Results indicate that observable arch differences among primates are not due to the physical properties of food alone. Implications for interpreting fossil morphology as well as limitations of using dietary category as a proxy for food material properties are discussed.

#### **Responses to resource bottlenecks in a sympatric hylobatid community.**

ALICE A. ELDER. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

During resource bottlenecks, sympatric ecologically-similar species are expected to reduce feeding competition by diverging in their responses. Individuals should compensate by either increasing feeding and travel time or decreasing travel time. However, when foraging effort exceeds energy intake, dietary switching and increases in dietary breadth may prevent negative energy balance. I compared responses to seasonal changes in fruit availability between sympatric siamangs (*Symphalangus syndactylus*, 4 groups) and agile gibbons (*Hylobates agilis*, 2 groups) at Way Canguk, Sumatra. Although siamangs dominate gibbons, ecological overlap is high, with both species preferring ripe fruits. Data were collected from October 2008 through October 2009 on activity, diet ( $N=169$  siamang and 115 gibbon all-day follows), and monthly fruit abundance across 100 10x50 m phenological plots. During periods of ripe fruit scarcity neither siamangs nor gibbons significantly altered feeding time or dietary breadth. However, both species increased consumption of fallback foods (ANOVAs:  $p<0.05$ ). While siamangs increased fig consumption, slightly increased leaf consumption, and decreased travel time, gibbons decreased fig consumption and greatly increased feeding on young leaves (ANOVAs:  $p<0.05$ ), but did not alter travel time. The dominant siamangs preferentially fed on large, productive fig patches, whereas gibbons used lower quality resources. Despite similar responses, siamangs and gibbons used divergent strategies during resource bottlenecks. Because hylobatid densities are predicted by fig availabilities, gibbon's inability to access these resources during crunch times may contribute to their low density at Way Canguk. Gibbons may coexist as fugitive species by using resources less-preferred or overlooked by siamangs.

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#### **Mechanical and metabolic influences on human cortical bone morphology.**

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Mechanical loading and metabolism concurrently shape human cortical bone morphology and strength at both macroscopic and microscopic levels. As few studies have focused on how these environmental factors interact in humans, researchers continue to investigate mechanical and metabolic influences on bone as if they act independently. Assessing their interaction not only has implications for our understanding of bone biology, but also may

affect behavioral analyses in bioarchaeological samples.

This study is the first large scale study of this potential interaction, using an archaeological human juvenile sample ( $n = 72$ ) recovered from a medieval Lithuanian cemetery (Alytus). Juvenile bone responds strongly to both mechanical and metabolic effects, a dynamic that favors its use over adult bone. Macroscopic and microscopic bone morphology were assessed in three skeletal elements under different levels of biomechanical loading (i.e., femora, humeri, ribs) and compared among individuals under varying amounts of metabolic stress (utilizing skeletal stress markers). Analyses evaluated whether, in the presence of bone loss due to metabolic stress, bone mass and strength were preferentially maintained in skeletal elements under the highest biomechanical demands.

Results indicate that such a preferential maintenance may occur in cortical bone. Ribs exhibit significant reductions in macroscopic and microscopic bone mass with metabolic stress, while femora demonstrate minimal reductions, and humeri are intermediate. However, alterations in femoral and humeral cross-sectional shape may, in fact, compensate for reductions in mass. Nonetheless, the results caution researchers against evoking solely mechanical or metabolic causes for variation in cortical bone morphology.

#### **An osteological analysis of the Manasota Period Yellow Bluffs site (8SO4) from Sarasota, Florida.**

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Osteological analyses of populations in the Southeastern U.S. have generally focused on large inland burial mounds associated with historic and proto-historic farming populations. By contrast, relatively little osteological information has been generated on small coastal pre-Columbian hunter-gatherer populations. Here, we provide information on such a population through the analysis of a salvage collection from the Yellow Bluffs Mound (8SO4) on Sarasota Bay, Florida. The goal of this project is to assess the health and demographics of the small coastal fishing population that interred their dead in the mound during the early middle of the Manasota Period (185-60 cal B.C.). Comparisons are drawn with the limited information available from other pre-Columbian hunter-gatherer populations in southern Florida.

Analysis was aided by Osteoware Software to ascertain the minimum number of individuals (MNI) represented by the highly fragmentary and commingled remains. Preliminary results based on sided temporal bones suggest an MNI of 26 individuals, although additional archaeological information indicates that the probable count may be closer to 33 adults and 12 juveniles. This percentage of juveniles (27%) is comparable to other pre-Columbian sites in southern Florida. Observed

pathological conditions include one incidence of osteomyelitis on the tibia, an isolated incidence of endocranial lytic activity manifested as hematopoietic inflammatory/hemorrhagic response of the meninges in both parietals and the frontal of an adult male, a healed antemortem fracture in the same individual, one dental abscess, and six individuals (13%) with linear enamel hypoplasia. These results also compare well to other contemporaneous sites in southern Florida.

#### **Pace of dental eruption and epiphyseal fusion in captive *Macaca mulatta*.**

ANDREA R. ELLER, SAMANTHA BUCKLEY, TREVOR EDWARDS, STEPHEN R. FROST and FRANCES J. WHITE. Anthropology, University of Oregon.

Data on the timing of developmental markers in non-human primates is rare. This study reports new data on the pace of dental eruption and epiphyseal union in two populations of macaques. Since development and aging are impacted by environmental conditions, we wanted to compare different captive populations. The timing of eruption and epiphyseal fusion in primates can elucidate ecological relationships in ways that sequence alone cannot.

Thirty-nine *M. mulatta* individuals of known age (fetal to adult) from two captive populations are included. Teeth were scored from "0" (unerupted) to "4" (full occlusion) for each tooth, deciduous and permanent, and epiphyses from "0" (no fusion) to "2" (completely fused), for 33 epiphyses including all major long bones, the pelvis, and metapodials. Because we use graded, not dichotomous, scales and younger populations than previous studies, we are able to contribute new data for understanding the pace of development within *Macaca mulatta*, including the first age estimates for metapodial fusion and tooth eruption data prior to dp4 in macaques.

There were significant positive regressions of both fusion ( $F=292.19$ ;  $df$  1,47;  $p < 0.001$ ) and eruption ( $F=291.49$ ;  $df$  1,73;  $p < 0.001$ ). The two measures of development were also highly correlated (Spearman  $r = 0.745$ ,  $p < .001$ ), and therefore either juvenile cranial or postcranial material can be used to predict age. However, Spearman rank correlation between the residuals from the separate dental and epiphyseal regressions yielded no significant correlation ( $r = -0.137$ ,  $p = 0.413$ ), suggesting deviations from the predicted developmental state within individuals were not caused by a single common factor.

#### **Are primate folivores ecologically constrained? A comparative analysis of behavioral indicators of within-group feeding competition.**

KELSEY M. ELLIS. Department of Anthropology, University of Texas at Austin.

Exhibiting an ambiguous relationship between group size and daily path length, folivorous primates are thought to experience

little feeding competition. However, previous studies lacked sufficient control for ecological variation and the phylogenetic relationships among the taxa being compared. Controlling for phylogeny and key ecological variables, I examined how daily path length and relative ranging cost influence group size in 37 primate species, including 18 folivores. I also examined group size effects on group spread, activity budgets, and the ratio of infants:females since these variables have been found to index feeding competition among folivores. Relative ranging cost was not a significant predictor of folivore group size, although larger groups traveled significantly farther per day, showed increased group spread per individual, and had lower infant:female ratios than smaller groups. Larger groups also spent more time feeding and less time resting than smaller groups; however, these trends were not significant. A strong phylogenetic signal was detected among species' mean values for average group size (PGLS,  $\lambda = 0.827$ ). Because primate group size and behavior reflect adaptation to present-day environments and phylogenetic inertia, future analyses of feeding competition should take into account both current ecological conditions and the phylogenetic structure of the taxa being compared. Furthermore, including alternative indicators of feeding competition (e.g., increased group spread, changes in activity budgets, and decreased female fecundity) in comparative analyses may provide a better assessment of such competition in folivores, improving our current interpretations of the 'folivore paradox' and the competitive regime of leaf eating primates.

#### **Professional publishing and professional ethics in biological anthropology.**

PETER T. ELLISON. Human Evolutionary Biology, Harvard University.

There are many ethical issues that arise in academic publishing, most driven by concern for promoting one's individual professional reputation. It is not always easy to distinguish issues of professional ethics from issues of professional courtesy. The line between plagiarism and under-citation is an example. Other issues involve the use of human subjects in research, concern for which does not end with institutional IRB review. Most recently, the open access movement in academic publishing has raised new ethical issues surrounding the right of the public to access the results of publicly funded research, and the right of other researchers to access the data derived from publicly funded research. These issues deserve a fuller discussion within professional societies and will require an adjustment in the way individual scientific impact is assessed.

#### **Context of copulation calls in wild chimpanzees.**

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<sup>2</sup>Department of Human Evolutionary Biology, Harvard University, <sup>3</sup>Department of Biology, Bates College.

Females of many primate species produce distinctive calls in association with copulation. Numerous functional hypotheses have been advanced, many proposing coevolution of copulation calls with promiscuous mating, infanticide avoidance, and sperm competition. In predictive models for primates, chimpanzees produce calls less frequently than expected. However, the dynamic social environment of chimpanzees offers an excellent opportunity to study contextual variation in call production. We studied the incidence of copulation calls in over 10,000 copulations occurring during 14 years of study in wild, unprovisioned chimpanzees at Kanyawara, Kibale National Park, Uganda. We conducted goodness of fit tests and multivariate logistical regressions with repeated measures to control for individual variation in call production. Nulliparous females called most frequently. Calls were elicited most commonly from adult males, particularly middle-ranking males, and during morning copulations. Contrary to the hypothesis that calls serve to promote male aggressive or sperm competition, females were most likely to give calls when few males were present and when pregnant rather than cycling. Calls did not appear to promote mate guarding or in female competition because call rates were independent of the presence of the alpha male or of other estrus females. Call production peaked at the median copulation length and was strongly associated with female darting behavior, suggesting that it may be a signal of ejaculation. Whereas models of copulation calls have focused on positive outcomes of call production, data from chimpanzees suggest that it is important to consider factors, such as sexual coercion, that may promote call suppression.

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#### **Vertebral joint disease and trauma with horse riding among ancient Mongolian pastoralists.**

JACQUELINE T. ENG. Department of Anthropology, Western Michigan University.

The adoption of nomadic pastoralism introduced new physiological stresses to the human spine. Horses can move at fast speeds and riders must contend with unpredictable behaviors of their horse. Spinal injuries have been documented in clinical studies of modern recreational equestrians and a few studies of archaeological collections of horse riders. These samples, while useful for comparative basis, may not be representative of injuries suffered by ancient pastoralists, where whole communities traveled by horse as part of their subsistence activity.

A study of archaeological samples of Mongolian pastoralists offers insight into the patterns of vertebral joint disease and trauma seen among horse riding cultures. Vertebral data from 119 individuals (20 subadults and 99 adults, with 46 males and 53 females) derive from three periods: Bronze Age (2500-500BC) when pastoralism emerged; the Xiongnu Empire (3<sup>rd</sup> c. BC-2<sup>nd</sup> c. AD), whose mounted warriors

threatened neighboring polities; and the later Mongol Empire (13<sup>th</sup>-14<sup>th</sup> c. AD). Observations of osteophytosis, apophyseal joint disease, Schmorl's nodes, and spondylolysis were scored and analyzed with Fisher's exact test. Among the adult samples, intragroup comparisons by time period show no significant differences between male and female rates of trauma and joint disease except in apophyseal joint disease during the Bronze Age (males 44%, females 22%,  $p=0.041$ ). Intergroup comparisons of total sample frequencies across time periods show the highest rate of spondylolysis in the Bronze Age sample (16%), which also has a significantly lower rate (24%) of Schmorl's nodes compared to Xiongnu (52%,  $p=0.040$ ) and Mongol (52%,  $p=0.055$ ) samples.

*This study was supported by funds from the American Association of Physical Anthropologists Professional Development Grant and the Faculty Research and Creative Arts Award from Western Michigan University.*

#### **Population dynamics within graveyards.**

FELIX ENGEL. Biological Anthropology, University of Freiburg.

This study introduces a new approach to detect spatial distribution patterns within graveyards, avoiding the necessity to divide the material into distinct groups, where convincing assumptions that motivate such divisions are missing. The routine, which is based on a moving focus, analyzing a large number of overlapping subsamples, can be applied to any anthropological or archaeological parameter, in this case trauma analysis in the large early medieval graveyard of Lauchheim from the Swabian Alb in Germany. Previous research on effects of armed violence showed that cranial trauma was virtually absent in females. The objective of this study was to detect phases of over- and under-representation of males in the mortality profile and to spot irregular mortality patterns. As burials were placed in sequence, temporal change can be assessed through spatial analysis of the graveyard's layout.

Age at death and hazard rates were analyzed for groups of 50 individuals, centering on each of the 988 adult skeletons that allowed for age estimation. As these groups largely overlap, differences between them can track minute distribution changes. Additionally, a Gompertz-Makeham model was fitted to each subset, in order to study age-related and age-independent parameters. Risk of death varied among age classes and is compared to age-specific prevalences of trauma. For the model, goodness of fit related largely to degrees of material preservation, but revealed some areas of deviation from the expected pattern.

#### **Preferences for male voices and faces among breastfeeding and non-breastfeeding women in Manila.**

MICHELLE J. ESCASA-DORNE. Anthropology, University of Nevada, Las Vegas.

This project investigates the influence of lactation on female preferences for male voices and faces in urban Manila, a population with long-term breastfeeding, low contraceptive use, and quick return to cycling. From an evolutionary perspective, female ancestors were likely spending more time pregnant and lactating rather than ovulating. Moreover, a majority of conceptions in natural fertility societies occurred in lactating, ovulating women. These considerations suggest that lactating women face important life history allocation trade-offs between mating and parenting effort that may be manifested in their preferences for certain traits in a partner. Breastfeeding ( $n=68$ ) and regularly cycling ( $n=66$ ) women were recruited to complete a face and voice preference task to determine preferences for masculinity. All participants also completed a questionnaire that assessed sexual functioning, sociosexuality, and relationship satisfaction, along with demographic variables. Breastfeeding women significantly have a higher preference for high-pitched voices than regularly cycling women ( $t=2.43$ ,  $p=.016$ ). No differences were found between the two groups' preferences for male faces. Further analyses incorporate sociosexuality, sexual functioning, and other variables. Life history strategies will be discussed and will serve as a framework for the findings.

#### **The effect of burden, velocity and gradient on the energetic expenditure of walking in females.**

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Previous research into the effect of gradient or burden transport on energy expenditure has focused on males, with little attention given to understanding the interactions among variables.

To address this deficit, we had eight women walk at three different gradients (0%, +5%, +10%), with and without a 10kg burden, which was carried in a standard backpack. They walked on the level at their slow, normal, and fast walking velocities, which were chosen while unburdened. For the incline trials, they walked at the same velocity as their slow and normal walking velocities on the level. Their volumetric consumption of oxygen (VO<sub>2</sub>) was collected using a Sensormedics Vmax 29c metabolic cart and standard anthropometrics were assessed.

Preliminary results indicate that in addition to mass, velocity, and gradient (all  $p$ -values  $\leq 0.001$ ), energy expenditure is influenced by the interaction of burden and velocity ( $p=0.059$ ), with 57% of the variation in VO<sub>2</sub> explained ( $r^2 = 0.57$ , all coefficients  $> 0$ ). Other potential interactions, such as that between body mass of the subject and burden mass, did not reach significance, but this may be due to the current inadequate sample size. While further data collection is needed, these preliminary results indicate that, similar to the limited data

for men, velocity and burden interact to increase energy expenditure on inclines.

**The role of the hunter: stable isotope evidence of hunting in adult male chimpanzees.**

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Comparisons with our closest living relatives, chimpanzees (*Pan troglodytes*), can potentially shed light on whether hunting, and associated meat eating or plant food consumption played a larger role in shaping hominin evolution. There is variation in diet amongst different chimpanzee communities, and amongst chimpanzees of the same group. Substantial amounts of meat are eaten by adult male chimpanzees at Taï National Park, Côte d'Ivoire compared to their female counterparts, and juveniles. Additionally the nature of group hunting at Taï suggests that meat consumption is linked to an individuals' role in the hunt. Quantification of meat eating through behavioural observations alone is difficult, however stable isotope analysis can further elucidate the role of meat in the chimpanzee diet. This study employed  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of hair keratin to determine if behavioural observations of hunting and meat-eating correlate with protein-associated  $\delta^{15}\text{N}$  values. Significant sex differences were confirmed, with adult males being significantly more enriched in  $\delta^{15}\text{N}$  compared to adult females. Furthermore, irrespective of rank, successful hunters had  $\delta^{15}\text{N}$  values ~1.0‰ higher than their less successful counterparts indicating that meat consumption by male Taï chimpanzees is highly dependent on participation in meat acquisition. These results provide a platform for understanding the initiation of the sexual division of labour, and further assist our interpretation of hunting and meat eating in our early hominin ancestors.

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**Human childbirth: An obstetrical dilemma or a solo act.**

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The obstetrical dilemma posits that through the evolution of bipedalism and encephalization, childbirth became more difficult for hominin females. Due to this increased difficulty, complications are more likely to arise and women may require assistance during childbirth. Indeed, it is theorized that in response to the obstetrical dilemma the genus *Homo* adapted through obligate midwifery. The term obligate indicates that this particular function, midwifery, is required for life in the same way as an obligate aerobic requires oxygen to grow. This

project seeks to contribute to the issue of the obstetrical dilemma through analysis of qualitative data gathered with 'solo' birth mothers. Solo birth is the term being assigned to birth where the mother catches her own baby without the assistance from another person. Through an online survey and follow up emails, women were asked to describe their solo birth process and particularly how their baby presented and was caught. Thirty-four women responded to the survey indicating they had caught their own baby. The women's responses were qualitatively analyzed. The narratives indicate that the majority of women received support, physical or emotional, during labor and prior to catching the baby. However, the narratives also indicate that the occiput anterior presentation was not an obstetrical problem. For example, when probed about the baby's presentation, one woman stated, "The baby naturally does a little turn to face the mama when coming out." These data suggest that obligate midwifery should be refined to better reflect a woman's ability to birth unassisted.

**Resolving missing and unidentified persons cases: Results of multidisciplinary efforts and new data collection technologies.**

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There are an estimated 1000 unidentified bodies in the State of Florida with nearly half of them found in South Florida. The resolution of unidentified decedent cases can be of great importance to the families of missing persons and establishing the identity of the unidentified is vital to the resolution of case status, including judicial activities.

In 2007, Investigator Crane of the Broward Medical Examiner's Office (BME) initiated a resurrection in the interest of unidentified decedents handled by the BME. In her efforts she retrieved over 100 boxes of remains that were not on site at the BME's Office. In October, 2008 while developing the investigatory analysis, the Broward County Sheriff's Office (BSO) and the BME entered into a formal arrangement to examine all missing and unidentified decedent cases within their respective and overlapping jurisdictions. BSO and the BME's Office continued to catalogue the remains to ensure that the proper forensic analysis of all cases be completed and entered into NamUS. To date, over 111 cases with combined efforts have resolved the identity of 11 individuals.

Twenty six unidentified persons were buried by the county prior to the development of contemporary biometric methods, which include STR based typing methods utilizing mini- and Y-STR PCR multiplexes that enables the analysis of inhibited and degraded DNA. The use of these techniques and 3-D GPR technologies will be presented. As Fred Smith has said, the identity is in the anatomy, you just have to look at it properly.

**Carnivore-Primate Interactions across fragmented and contiguous forests in N.E. Madagascar.**

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Studies investigating predator-prey dynamics between primates and carnivores are limited given that carnivores are often rare or highly elusive and predation events are difficult to observe. Understanding how carnivores influence primate density and behavior is fundamental to the study of primate ecology and essential for their conservation. From June 2011 to March 2012 our team collected an average of four GPS points per day on a group of three silky sifakas, top 25 most endangered primates of the world, at the Anjanaharibe study site in the Makira Natural Park, NE Madagascar. In addition, our research team photographically sampled endemic and exotic carnivores, as well as humans using remote sensing cameras for 65 days during the course of this study. Using silky sifaka range and activity patterns, as well as photographically sampled data, we investigated the movement and activity patterns of silky sifakas based on the trap rates, movement, and range of carnivores and humans across the 10km<sup>2</sup> study site. Additionally, we used two species interaction occupancy modeling to investigate the relationship between silky sifakas and their top predators. The findings of this research provide the first direct assessment of carnivore-primate dynamics in Madagascar's eastern rainforest. Moreover, the combination of telemetry and photographically sampled data represents a new approach to understanding the relationship between carnivores and primates throughout a wide range of habitats.

**Application and use of cyclododecane, Part II: En bloc removal of osteological remains.**

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This study contributes to ongoing research of cyclododecane (CDD) as a tool in the recovery and analysis of friable osteological remains. Cyclododecane, in either molten or solvent solution forms, has the unique property of sublimation, making its use completely reversible and thus an ideal tool for work with sensitive materials.

In prior lab experiments, CDD proved successful at stabilizing individual fragments recovered from the field through traditional hand-excavation methods. These excavation methods can unfortunately cause damage to friable remains. This continuation study illustrates the development and testing of field methods to remove sensitive remains en bloc using CDD. The goals were complete removal

and reduced fragmentation of clustered remains with their surrounding matrix, with recommendations for best field practices.

The hypothesis is that CDD-saturated cheesecloth molded around pedestaled remains provides sufficient stabilization for en bloc removal. Hypothesis testing included burial of ten clusters of pig bones (five cremated, five unaltered), pedestaling of the clustered remains, and application of molten-CDD saturated cheesecloth prior to attempts at en bloc removal. Four layers of cheesecloth completely saturated in cyclododecane proved to be the most effective at stabilization. After application of this novel methodology, the samples were successfully excavated en bloc and transported to a laboratory for further observation.

This research demonstrates the potential for stabilization and recovery of friable bone in situ in bioarchaeological and forensic settings. It is shown that application of CDD with this method allows for recovery and transportation of burials that may otherwise be damaged during excavation.

#### **A palaeogenetic investigation into the pre-Columbian population history of Central Andean South America.**

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The population history of Central Andean South America has been largely inferred from the genetic analysis of present-day indigenous populations. However, genetic information about the genetic structure and population dispersals throughout the pre-Columbian period are likely to be obscured by recent historical demographic events, such as admixture and bottlenecks after the arrival of Europeans. Ancient DNA studies can give accurate estimates of pre-Columbian population history in real-time, although to date the number of such studies is low and as a result the temporal and geographic representation remains uneven.

Here, we present a study investigating changes in the patterns of genetic diversity by analyzing mitochondrial and nuclear DNA from human skeletal remains from several archaeological sites in the Central Andean area and contrasting them with episodes of cultural and environmental change. The dates of the sites range from the Archaic Period to the Late Horizon to allow for a diachronic analysis. Data

is compared using a range of population genetics and demographic modeling approaches.

Our analyses show that population discontinuities coincide with episodes of cultural and environmental change in the Central Andean prehistory. Moreover, while populations from different geographic regions seem genetically distinct during early periods, we observe a process of homogenization in the Central Andes starting with the advent of the first Highland Empires in the Middle Horizon.

This study also highlights the limits of PCR-based ancient DNA analyses and the necessity to analyze genomic data employing Next Generation Sequencing technologies to further decipher the population history of South America.

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#### **Sleep site selection of proboscis monkeys (*Nasalis larvatus*) in West Kalimantan, Indonesia.**

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Proboscis monkeys (*Nasalis larvatus*) often sleep along rivers and form bands (aggregations of single male, multiple female units) at sleep site locations. While sleep site selection likely influences both the behavior and socioecology of this species, the factors underlying the choice of sleep sites are not fully understood. We examined how forest structure, weather, and insects influence sleep site selection by proboscis monkeys. We collected data on a wild population of proboscis monkeys living in three forest types in West Kalimantan, Indonesia for twelve months. We recorded the location of, characteristics of, and number of individuals in each tree, monitored changes in weather, and measured the abundance of insects and compared these data to random samples of trees and conditions throughout the forest. We found that proboscis monkeys preferentially chose to sleep in tall emergent trees located within ten meters of the river. The size of the tree positively correlated with the number of proboscis monkeys in sleep trees. Temperature and humidity seem to have little influence on the choice of the sleep tree sites. Proboscis monkeys tended to sleep slightly more inland when there was a high occurrence of sand flies on the rivers; mosquito densities varied in the different habitats, but did not seem to influence the location of sleep sites. These data indicate that grouping behavior of proboscis monkey are influenced by the availability of large sleep trees and that sleep site selection in our study groups is not solely shaped by anti-predator behavior.

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#### **Male chimpanzee aggression toward females: A test of the sexual coercion hypothesis.**

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In sexually reproducing animals, male and female reproductive interests often fail to align, resulting in opposing reproductive strategies. Males of many species employ aggression to overcome female choice, but debate persists over the extent to which male chimpanzees effectively use this strategy. Previous studies of male chimpanzee aggression toward females at Kanyawara (Kibale National Park, Uganda) demonstrated a positive correlation between aggression and copulation frequency, however copulation frequency in primates is not always predictive of reproductive success. We analyzed a 13-year sample of behavioral and genetic data from two chimpanzee communities in Gombe National Park, Tanzania, to test the hypothesis that male aggression toward females is positively correlated with reproductive success. We found that, similar to Kanyawara, male-female aggression over a female's entire estrous cycle was positively correlated with copulation frequency (GLMM,  $p < 0.0001$ , controlling for male dominance rank). Further, the timing of aggression played an important role, as aggression during a female's estrous phase was correlated with copulation frequency ( $p < 0.0001$ ), while aggression during a female's non-estrous phase was not ( $p = 0.48$ ). Preliminary analysis of the genetic data demonstrated that the rate of a male's aggression toward a given female was positively correlated with the probability of siring that female's offspring ( $p < 0.001$ ). Together, our data suggest that male chimpanzees at Gombe successfully employ a strategy of sexual coercion to increase their probability of paternity. Future analyses will incorporate dominance rank and kinship into our analytical model.

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#### **Cranial variation among three regional groups in Mexico.**

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Cranial morphology can be influenced by either genetic and/or environmental factors; therefore it can be used to study the population structure and population history (Relethford 1996). This study examines cranial morphology in a sample of 63 Mexican crania obtained from the Pima County Office of the Medical Examiner and the *Universidad Nacional Autónoma de México* to determine if a regional differentiation (North, Central, South) is evident in cranial morphology. Phenotypic variation and biological distances were assessed using 10 craniofacial measurements following Howells (1973) definitions. A Mahalanobis D<sup>2</sup> and canonical discriminant analysis was performed to compare significant differences between the three regional groups. The distance relationship suggests that the Northern region of Mexico present the greatest biological distance, while the Central and Southern regions show the closest similarities. Canonical coefficients indicate that individuals from the Northern region display a larger overall crania, in particular a longer maximum cranial length, cranial base and frontal cord than individuals from the Central and Southern regions of Mexico. Isolation by distance and migration patterns may be possible factors responsible for the morphological differentiation and diversification of Mexican crania across the Central, Northern and Southern regions of Mexico. These results emphasize the need for understanding the cause of variation within populations in Mexico, as well as the need to incorporate these findings into forensic practice when identifying remains of Hispanic ancestry.

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#### **Ethical challenges for biological anthropologists working in mass fatality contexts.**

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Anthropologists have a long history of involvement in mass fatality incidents, and this involvement has increased substantially in the past two decades as the value of our expertise in archaeology, osteology, and even cultural issues, have been recognized. With a higher level of involvement in events that can be highly publicized and emotionally charged, this paper will present and discuss potential ethical issues that biological anthropologists may face.

Biological anthropologists may be involved in four different aspects of the response to a mass fatality incident: field, morgue, antemortem data collection, and identification operations. Each of these areas will be presented

and the ethical questions that can arise will be discussed. Examples of questions include: Is it appropriate to allow families of the missing/deceased to visit the disaster scene and when should this occur? How should family notification be handled in regards to the identification of fragmented remains over a long period of time? What questions are appropriate to ask during the antemortem data collection process? Case examples will be drawn from personal experience in multiple mass fatality responses from around the world including the World Trade Center, the Boxer Day Tsunami, and Hurricane Katrina.

It is hoped that biological anthropologists who have or may participate in the response to a mass fatality incident will gain some insight into the ethical complexities of these incidents so they may be better equipped to handle them as they arise.

#### **Tooth wear and culture in the Middle Paleolithic humans from Near East.**

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New Electron Spin Resonance age estimates indicate that Neanderthals and anatomically modern humans (AMH) from Near Eastern sites were largely contemporaneous. Different interpretations have been proposed as to whether these two species interact or compete between each other in the Levantine region. In this study tooth wear patterns of Neanderthals and AMH from Middle Paleolithic sites of Israel and Northern Iraq are analyzed, based on the observation of specific occlusal contact areas (para-facets) that have been previously described in the dentition of historic and modern hunter-gatherers. The Occlusal Fingerprint Analysis (OFA) method is applied here to virtually reconstruct the jaw movements responsible for the creation of the occlusal wear areas. The results exclude the possibility that para-facets were created by a normal chewing cycle, suggesting, as seen in a previous study, that the formation of these areas is related to paramasticatory activities. Additionally, the results also indicate strong similarity in tooth wear patterns between Near Eastern Neanderthals and AMH. Because these two groups are geographically close and broadly contemporaneous, and because tooth wear is related to cultural factors, this result is interpreted as evidence of cultural interactions between them. Such a scenario is compatible with the analysis of the Neanderthal genome, where it has been suggested that gene flow occurred between Neanderthals and AMH, probably in the Middle East, before 100,000 years ago.

#### **The role of exotic and ornamental plants in the feeding ecology of mouse lemurs (*Microcebus murinus*) at Berenty Private Reserve, Madagascar.**

KRISTA FISH. Department of Anthropology, Colorado College.

Vegetation within and surrounding Berenty Private Reserve in southern Madagascar exhibits human influences such as the introduction of exotic plants and the use of ornamentals. Animals such as fruit bats (*Pteropus rufus*) and ring-tailed lemurs (*Lemur catta*) exploit these plants with consequences for their health and conservation, but the use of ornamental or exotic plants by nocturnal primates remains unexamined. During a six-month study spanning the rainy season/ dry season transition, the feeding ecology of mouse lemurs (*Microcebus murinus*) was investigated, including their use of non-native and ornamental vegetation. Continuous focal sampling of mouse lemur behaviors occurred in both the gallery forest and the forest-tourist lodge interface. The time, location, and type of food item consumed by mouse lemurs were recorded. Habitat structure, tree phenology and insect abundance were assessed along forest transects.

During the study period, mouse lemurs foraged primarily on insects. However, in the late rainy season, *Cordia sinensis* fruits comprised the majority of their diet. Although native to Madagascar, *C. sinensis* was not sampled within Berenty's gallery forests. Instead, it was most abundant along roads and near tourist lodges where it was used as ornamental vegetation. Mouse lemurs also consumed exudates from the introduced prickly pear (*Opuntia* sp.). Another exotic, *Cissus quadrangularis* strangled 23% of the sampled trees within the gallery forest with implications for fruit, leaf, and folivorous insect abundance. Comparisons to mouse lemurs in other habitats suggest a lowering of dietary diversity for Berenty's mouse lemurs due to the prevalence of *C. sinensis*.

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#### **Is sickle-cell trait as benign as is usually assumed?**

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The assumption that sickle-cell trait (SCT) is benign is challenged, particularly by health-care providers working with athletes. Since 2000 sixteen SCT athletes died during exertion. Why these individuals died while other SCT athletes can train and play normally has not been determined. In this paper we present data from a study which determined the frequency of SCT as a causal factor for death in the US general population and use a GIS approach to understanding the distribution of these deaths. The number of deaths linked to SCT as a cause of death since 2000 is 74. This number is an

underestimate, since fourteen states do not record SCT as a cause of death. A GIS-constructed map showed that high frequencies of SCT deaths were clustered in few states. Mortality rates were computed by dividing the number of SCT deaths by population size and multiplying by 1,000. The states with the highest SCT mortality rates are: Colorado (0.005), Alaska (0.0014), and Mississippi (0.001). Possible factors may include elevation, climate, SCT prevalence, etc. Our study shows that more data are desperately in need. It would be informative to compute the mortality rate per state by dividing the number of deaths by the number of SCT individuals rather than by the total population. Factors which cause death in some SCT individuals remain largely unexplored. From an evolutionary perspective, an understanding of such factors will allow us to predict changes in the frequency of the sickle cell allele with greater precision.

Supported by a NCAA 2012 Graduate Student Research Grant.

**Reconstructing a multiple infant burial from the commingled bone assemblage of Tomb VII underneath the Bronze Age palace of Qatna (Tell Mishrif, Syria).**

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In 2009, an undisturbed rock-cut tomb (Tomb VII) was discovered underneath the Middle Bronze Age royal palace of Qatna, Syria. Human skeletal remains dominated the assemblage, intermingled with precious grave goods and animal bones. The entire floor was covered with scattered bones and bone fragments that were partly embedded in sediments and reached a height of up to 44cm. Bone concentrations surrounded by remnants of wooden structures suggest that the remains had been located in wooden coffin boxes.

An area of presumably major significance was located close to the entrance. Compared to other locations within the tomb this area was characterized by a high concentration of precious pottery and a conspicuous accumulation of sediment. This sediment package contained a high number of infant bones scattered within a volume of c. 100 × 30 × 25cm as well as jewelry and remnants of wood. We present the results of the investigation of this burial based on a specifically developed documentation and recovery protocol for this excavation.

In total, 65 skeletal elements could be assigned to three individuals, (i) a perinatal, (ii) a neonatal to 1 year old, and (iii) a 1.0 to 1.5 year old individual. It is assumed that the bodies of the infants were originally deposited above each other in opposing orientations in a coffin located among the pottery. The origin of the sediment in this installation remains unclear, probably a mixture of rotten organic materials and sediment

originating from the floor and the walls of the tomb.

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**Seasonal intake of polyphenols and cellulose in two wild lemur populations (*Lemur catta* and *Propithecus verreauxi*).**

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Many plants contain toxic secondary compounds, such as polyphenols, and structural carbohydrates, like cellulose, to deter herbivores. Herbivores can alter their behavior to reduce their ingestion of these plant defenses. By consuming plant parts containing smaller amounts of these compounds, selective herbivores can maximize the digestibility of their food.

We studied the dietary polyphenol and cellulose of two sympatric lemurs, the ring-tailed lemur (*Lemur catta*), a generalist herbivore, and the folivorous Verreaux's sifaka (*Propithecus verreauxi*) in Beza Mahafaly special reserve, Madagascar. Both species' diets shift seasonally between the wet and dry seasons. We hypothesized that the polyphenol and cellulose content of *P. verreauxi*'s diet would remain stable across seasons, while these would decrease from the dry to the wet season in *L. catta* from the fluctuating availability of fruit. We also predicted that these levels would be higher in *P. verreauxi* than *L. catta* year-round due to their folivorous diet.

We observed the lemurs and recorded the contribution of each food to their diet. By measuring the polyphenols and cellulose in each food, we were able to calculate their total intake of these compounds. Contrary to expectations, we found an increased intake of polyphenols in both species in the wet season, due to the increased availability of a few key foods. Each lemur species preferred different polyphenol-rich foods, leading to a timing gap between their peak polyphenol consumption due to the availability of these foods. These results can help us understand how plant chemical defenses influence diet choice in herbivores.

This study was funded by the National Scientific Foundation.

**Dental sexual dimorphism in Eocene euprimates.**

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The evolution of Eocene euprimates in North America produced a diverse array of species that filled many ecological niches, however, due to poor preservation, little is known about their life history. Based on a few existing complete skulls, adapids have been suggested to be sexually size dimorphic, while omomyids are said to be monomorphic like the

closely related tarsiers. The degree of sexual dimorphism in other early primates, like microsyopids, is unknown. The pattern of sexual dimorphism across primates may be indicative of both social organization as well as phylogenetic relatedness. The goal of this study was to measure the degree of sexual size dimorphism across a wider taxonomic range of Eocene euprimates than has previously been reported. I measured a single tooth type of representative species of adapid (*Notharctus numenius*, *N. venticolus*, *Cantius ralstoni*), omomyid (*Omomys carteri*) and microsyopid (*Microsypops elegans*), then used cluster analysis to determine if each sample could be grouped into two distinct size-based clusters with significantly different means. I mapped the proportion of sexual size dimorphism onto a phylogenetic tree and used independent contrasts to test for the effect of phylogeny. The results confirm that some notharctid adapids were dentally sexually size dimorphic, while omomyids and microsyopids are monomorphic with respect to dental size. These results have implications for the pattern of evolution of sexual dimorphism in primates – sexual size dimorphism appears to be a plastic trait that evolves repeatedly in distantly related lineages, and likely does not carry a strong phylogenetic signal.

This project was funded the Department of Anthropology at Iowa State University.

**Hair cortisol concentrations in wild saddle back tamarins (*Saguinus fuscicollis weddelli*).**

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Tamarins live in small multimale-multifemale social groups in which subordinate adult females are reproductively suppressed. In order to better understand the physiological consequences of female and male reproductive competition, we measured cortisol in hair samples (time-averaged index of hypothalamic-pituitary-adrenal axis activation) collected from 7 groups of wild saddle back tamarins (N=22 males and N= 16 females) trapped, marked, and released during June 2012, in northern Bolivia (11° 23' S, 69° 06' W). This research is part of an ongoing study examining tamarin reproductive ecology. We explored whether group size, number of adult males/females in a group, and female reproductive category (nulliparous or multiparous) contributed to variation in hair cortisol.

We validated and used commercially available kits designed for salivary cortisol analysis, and employed dilutions suggested by previous analysis of captive marmoset hair cortisol. Our results suggest that while the number of adult males in a group or reproductive category are not significant predictors of hair cortisol, the number of adult females in a group

is – specifically, groups with three adult females had significantly higher hair cortisol than groups with two adult females (t-test,  $t=-2.521$ ,  $df=9.541$ ,  $p=0.031$ ). This effect is tied to group size, where females in larger groups (7+) have significantly higher hair cortisol than individuals in smaller groups ( $\leq 5$ ) (t-test,  $t=-2.466$ ,  $df=14$ ,  $p=0.027$ ). Although the effects of these differences on reproductive outcome or social grouping remain unclear, it is possible that larger group size creates more stress for subordinate females, and may contribute to their emigration.

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**Population variation of Level 2 detail in dermatoglyphics: A study of heritability and environmental influence.**

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Dermatoglyphics have been studied extensively in physical anthropology to examine the heritability of friction skin traits and between population variation. The majority of the previous studies have tested these relationships on level 1 detail (e.g. pattern type, total ridge count). Therefore, the results are largely irrelevant in the field of forensic science, where identifications are made based on level 2 and 3 details (e.g. minutiae and pores, respectively). The present study applies the methodologies developed in physical anthropology for quantifying fingerprint traits of level 1 features, which have been found to be strongly heritable, to level 2 details and tests whether population variation will be upheld at the minutia level, where environmental factors in the womb influence development. Five types of minutia, or Galton Details, were analyzed and include bifurcations, ending ridges, short ridges, dots, and enclosures. The right index finger of a total of 120 individuals (30 African American females; 30 African American males; 30 European American females; 30 European American males) was examined using Spex PrintQuest, divided into four quadrants and each type of minutia was visually counted. The ANOVA results show that the total number of bifurcations on each individual differs significantly ( $p\text{-value} = 0.030$ ) between sex and ancestry. No other minutia type was significantly different. Results of each minutia type in each of the four quadrants will be presented. By using level 2 detail, the results of this study will be relevant to both anthropological and forensic contexts.

**Neandertal lumbopelvic anatomy and the biomechanical effects of a reduced lumbar lordosis.**

MARIA C. FOX and KATHERINE K. WHITCOME. Anthropology, University of Cincinnati.

A fundamental change associated with bipedalism was the evolution of a lumbar lordosis. Recent research suggests that unlike early hominins and modern humans, Neandertals were hypolordotic. Absence of a lordosis in Neandertals is surprising given both the evolutionary and biomechanical relevance of the lumbar curve in bipedal locomotion. To better understand the function of the reduced lumbar lordosis in Neandertals, I kinematically assessed movements of the lumbopelvic complex in human subjects walking with an experimentally reduced lordosis. Subjects posteriorly tilted the pelvis to achieve a reduced lordotic curve, simulating the Neandertal hypolordosis. Segment angles of the lower back, pelvis, and hind limb were calculated from 3D motion capture data. Kruskal-Wallis tests were performed to identify significant differences between conditions in static posture and dynamic gait.

Subjects achieved a posterior pelvic tilt (normal mean  $12.1^\circ$ , experimental mean  $-0.58^\circ$ ,  $p < .05$ ) and a reduced lordosis (normal mean  $27.9^\circ$ , experimental mean  $19.5^\circ$ ,  $p = .275$ ) in quiet stance. Overall, posterior tilt increased the mean lordosis during walking ( $+6.6^\circ$ ,  $p < .0001$ ). It appears that a reduction in lordosis is difficult to sustain during locomotion, hinting at the fundamental need for the lumbar lordosis. Hypolordotic strides were reduced in length and associated with a less extended knee ( $p < .0001$ ). The gait kinematics of experimentally induced hypolordosis in modern bipeds, combined with the relatively short legs of Neandertals, suggest that Neandertals were less efficient bipeds than modern humans and thus likely expended greater energy in their foraging and hunting efforts. University of Cincinnati and The Charles Phelps Taft Research Center at the University of Cincinnati

**Foot for thought? Contextualization of *os tibiale externum* from two Roman period mass graves at Oymaağaç Höyük, Turkey.**

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The most common foot ossicle is an accessory navicular bone known as *os tibiale externum* (OTE). Today radiographic estimates for OTE incidence range from 4-21%, with ~5% reported for Turkey. At the archaeological site of Oymaağaç Höyük, Turkey, 5/33 (15%) adults from two mass graves, dating to the Roman period (3rd century AD), present evidence of OTE. Its frequency from one of the graves (#7384) is 29%. In the other (#7484), 1 of 19 (5%) individuals shows the condition. Among those with OTE, at least one displays bilateral expression. Only adults presented the condition, with the sex ratio presently unknown. Given that OTE is congenital, we hypothesize that individuals from grave #7384 were genetically related. Although the sample size is small, this high frequency of OTE suggests that at least four family members were buried together in a Roman period mass grave from Turkey.

**Anatomically modern humans as a ‘self-domesticated’ species: insights from ancestral wolves and descendant dogs.**

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Anatomically modern humans are recognized in the fossil record principally by a retraction and diminution of the facial skeleton, and other derived metric or discrete craniofacial features. There are several mechanistic models for this important morphological shift, but no consensus on which explanation, if any, is most accurate. A promising model for this shift argues that anatomically modern humans represent a ‘self-domesticated’ species where selection for behavioral modifications in the social environment led to developmental timing alterations, which then produced a cascade of diagnostic morphological shifts. Dog domestication from ancestral wolves provides a particularly useful comparative framework for this model. We used a 3D digitizer to collect 84 landmarks on associated crania and mandibles from 21 wolves (*C. lupus*: subspecies *lupus*, *lycaon*, and *rufus*) and 19 recent dogs (*C. familiaris*) from the Field Museum, Chicago, and 19 prehistoric dogs (ca. 5,000 years BP) from the Kentucky Green River sites (U. Kentucky). For each canid specimen we also collected up to 23 postcranial measures reflecting overall body size and proportions. We subsequently compared these canid data to homologous landmarks and measurements collected on genus *Homo* fossils using a variety of geometric morphometric, multivariate and univariate procedures. Our results document an array of apparently parallel craniofacial changes occurring during both the archaic-to-modern human and wolf-to-dog evolutionary transitions. These results, considered in light of previous experimental work in other animal models (especially domesticated foxes), provide strong support for the ‘self-domestication’ model in anatomically modern humans.

**Primate habitat selection near humans in northern Madagascar: the edge of a primary forest vs. forest fragments.**

BENJAMIN Z. FREED. Anthropology, Sociology, and Social Work, Eastern Kentucky University.

In forests that were subjected to low-level logging, Ganzhorn (1995) found that increased sun exposure of the tree crown related directly to fruit production, and may help raise the carrying capacity of frugivorous primates. In this study, I compared populations of two frugivorous species, crowned lemurs (*Eulemur coronatus*) and Sanford’s lemurs (*Eulemur sanfordi*), in two kinds of forest in which low-level tree removal has occurred: in four edges of primary forest in Mt. d’Ambre, and in four forest fragments near humans west of Mt. d’Ambre. Broad surveys

were conducted in 1989-1991, 2004, and 2009-2010. Conservation threats were assessed through examination of remote-sensing images, and by observing evidence of human use of local forests. Although I surveyed more than twenty forest fragments, all but four experienced extensive logging during the last thirty years. I found few differences in the numbers of lemur groups encountered in low-level logging fragments and in the four primary forest edges of Mt. d'Ambre. Several factors may explain the large numbers of lemur groups in both types of habitat: 1) compared with non-edge primary regions of Mt. d'Ambre, both fragments and primary forest edges have more light gaps, and may have increased fruit production; 2) foresters and neighboring humans have introduced fruit species (*Lantana camara*, *Musa*, *Tamarindus*, and *Carica*); and 3) local humans, perhaps resulting from the adherence to local traditions, have largely resisted hunting, forest encroachment, and large-scale logging.

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#### **Ethological study of manual laterality in sanctuary chimpanzees (*Pan troglodytes*).**

AMANDA N. FRIEND, JACOB D. NEGREY and LINDA F. MARCHANT. Anthropology, Miami University.

The study of manual laterality in nonhuman primates figures in some models that seek to explain the evolution of cerebral lateralization in *Homo sapiens* (e.g., MacNeilage, 1987). The nature of laterality in chimpanzees (*Pan troglodytes*) is debated with much of the disparity derived from methodological concerns and contrasting results from field and captive studies. This study used ethological methods to observe chimpanzees in a semi-natural environment. Given the results of wild laterality studies, excluding tool-use, we hypothesized that few behavioral patterns would be biased, when individuals had hand preferences these biases would not generalize across patterns, and no group-level bias would emerge.

Data were collected from 22 individuals (15 females and 7 males) in Enclosure 2 of the Chimfunshi Wildlife Orphanage, Zambia, in July 2012 using McGrew and Marchant's 2001 ethogram of 35 patterns of hand use. Data were collected using continuous focal animal sampling. A total of 1258 observations of hand use were recorded. Binomial tests were subsequently performed on the 9 most frequent behaviors.

Of the 55 analyses performed, 6 analyses of 4 behaviors and 5 individuals yielded statistical significance. An adolescent male exhibited biases in 2 behaviors, though with opposite hands. Additionally, for 2 other patterns, *Nose Wipe* and *Pick Up*, more than 1

individual exhibited a bias, though not with the same hand. Based on these results, we conclude that naturalistically housed chimpanzees exhibit no greater manual biases (in non-tool related behaviors) than wild chimpanzees.

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#### **Cranial shape variation in extant and fossil *Papio* and its implications for the evolution of the Kinda baboon.**

STEPHEN R. FROST. Department of Anthropology, University of Oregon.

To evaluate cranial variation in Kinda baboons relative to that of the genus *Papio*, forty-five three dimensional landmarks were digitized on 527 extant and fossil specimens of *Papio*, representing both sexes. Bilateral asymmetry was mitigated by superimposing each specimen with its mirror image and taking their average, which also replaced missing bilateral landmarks with their contralateral counterpart where present. These were analyzed using generalized Procrustes analysis, Procrustes distances, principal components analysis, multivariate regression, and partial least squares analysis. Results were visualized using Landmark editor software by warping an exemplar surface.

Static allometry and sexual dimorphism together accounted for nearly half of the total variance. Adjusting for these two factors, extant baboons fall into two major geographic clusters: northern (anubis, hamadryas, and Guinea) and southern (chacma, yellow, and Kinda), and within the latter Kinda baboons are most similar to yellows. In fact, this relationship holds even when the relatively small fossil forms *P. h. angusticeps* and *P. izodi* are included. The geographic locations of specimens accounted for the majority (64%) of variance after size and sex adjustment, with differences among the various *Papio* forms in turn representing a small component of the residual variation. Taking this clinal pattern into account, significant differences in cranial shape remain between all extant forms of *Papio* except between *P. h. kindae* and *P. h. cynocephalus*. This overall pattern of relationships for the Kinda baboon is broadly consistent molecular studies and suggests a significant amount of gene flow among baboon populations.

This research was supported by the Wenner-Gren and Leakey Foundations, as well as the University of Oregon.

#### **Primate socioecology: Where are we, what are we doing here, and where are we going?**

AGUSTIN FUENTES. Anthropology, University of Notre Dame.

Examining the core hypotheses and theories in the context of results of the last 40 years of primate research suggests that we require a new paradigm, a multi-nodal and

dynamic systems approach, when asking about primate social organization. There is an ongoing discussion about the utility, structure and content of the underlying theoretical framework used by most primatologists. Diet, foraging, females, predation, and social structure have been the central themes with competition, friendship, infanticide, cooperation, and many other patterns having their moments in the spotlight. In 1994 Karen Strier challenged us to move beyond the "myth of the typical primate" and in 2008 Bernard Thierry called on us to recognize that most data do not conform to the expectations of basic socioecological predictions and suggested we drop the model. This elicited a stridently negative response from some primatologists/biological anthropologists and a hearty round of approval from others. In 2012 the publication of yet another overview (by Clutton-Brock and Janson) concluded that we do indeed need to explore a diversity of explanations for primate social organization, but that holding on to the central themes of socioecological theory might be a good idea. It is time to move to a more comprehensive and less reductive suite of assumptions about primate societies. Here I present a structural overview, a roadmap of sorts, to the past, present, and future of theory and practice in primatology.

#### **News from the Northern New France: A pathological assessment from the 18<sup>th</sup> Century French military and trading post Fort Michilimackinac.**

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This presentation examines the health experiences of individuals recovered from Fort Michilimackinac, an 18<sup>th</sup> century French military and trading post in northern Michigan. The remains of twenty adults, a combination of Metis, European, and Native American individuals, were exhumed from underneath the fort's church, Sainte Anne. Ages range from approximately 20 – 50 years; however most are younger and middle adults. Sex determinations for the group were primarily male. Most in the population enjoyed relatively healthy childhoods. Hypoplasias were infrequent and of slight severity with ages at formation ranging broadly between two and five. A slight case of porotic hyperostosis was observed in only one of sixteen individuals. Frequencies for caries and antemortem tooth loss are relatively low, and periosteal lesions suggestive of infectious disease are rare. Arthritis in a mild form was extremely common, and in moderate or severe manifestations affected a third of the group. Trauma was also common with over half exhibiting some type of injury, and three of the seven experiencing trauma on multiple elements. One individual displays perimortem blunt force trauma and sharp trauma in conjunction with scalping. Another had severe osteomyelitis apparently associated with musket ball wound. These findings correlate with expectations for life on the frontier of New France. Food,

especially protein, was plentiful, and population densities were low. Adult health, however, indicates that life at the fort was incredibly hard on the people there shown by high rates of both trauma and arthritis on a population of primarily younger and middle adults.

#### **Postnatal growth of the long bones in the African apes.**

ANDREW GALLAGHER. School of Anatomical Sciences, University of the Witwatersrand.

The in-utero emergence of distinctive limb-to-trunk and intra-limb proportions of *Gorilla*, *Pan*, and *Homo*, were detailed by A.H. Schultz in a series of contributions in the 1920's. On the basis of Schultz's data, it is probable that the observed differences in proportions in human and ape foetuses are established during initial chondrogenesis and emergence of the hyaline cartilage template, primarily ossified in the region of the diaphyseal centre. By birth, the elongation of the upper limb in *Gorilla*/*Pan* and lower limb in humans is apparent, yet it remains unclear the extent to which allometric growth of the osseous elements of the limbs is accelerated during early postnatal ontogeny. Published data (Fazekas and Kosa, 1978) and additional specimens yield an allometric baseline for the assessment of comparative post-natal ontogenetic growth in humans and extant African apes. Linear regression models were developed for the proportional growth in-utero of dependent skeletal dimensions against a valid proxy of general size, the mean of five log-transformed variates. In humans, foetal growth of the humerus and radius is isometric, whereas the lower limb attests significant positive allometry. Surprising consistency exists in the post-natal ontogenetic trajectories of the appendicular skeleton in humans and the derived foetal allometric functions, with the exception of the femur and tibia, which depart from the foetal trajectory in early postnatal life. Postnatal growth of the zeugopoda evidence positive allometry in *Gorilla* and *Pan*, whereas sylopoda are approximately isometric, and this explains observed discrepancies in brachial indices of adult *Gorilla* and *Pan*.

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#### **Country roots: Non-urban environments and the impact of socio-economic status on growth in a British cemetery assemblage.**

EVAN M. GAROFALO and CHRISTOPHER B. RUFF. Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

In combination with intrinsic genetic factors, extrinsic or environmental factors such as nutritional status, disease, and socio-economic

status are important for the regulation of endochondral and appositional bone growth trajectories. High socio-economic status is often cited as a buffer against detrimental environmental conditions and non-urban settings may foster better growth environments. However, few intra-population studies address the effects of status on growth in non-urban settings.

Growth in body size (femoral length, stature, body mass), appositional growth (percent cortical area, %CA), and femoral polar section modulus (overall bone strength,  $Z_p$ ) was evaluated in a large British church cemetery assemblage, Barton-upon-Humber (950 AD-1849 AD). The sample (perinatal to young adult;  $n=279$ ) was subdivided into age cohorts and the effect of socio-economic status on ontogenetic trajectories was compared between interments Inside ( $n=46$ ) and Outside ( $n=233$ ) the church building. It was expected that Outside Church infant and early childhood body size and the environmentally sensitive %CA would suggest less adequate living conditions, and bone strength would indicate greater activity.

Contrary to expectations, results show no statistical effect of status (burial location) on growth in body size from birth to adulthood. However, statistical differences emerge with higher Inside Church bone strength ( $Z_p$ ) after 14 years of age ( $p<0.01$ ). Percent cortical areas exhibit no significant differences during growth but lower Inside Church values (birth to 5 years) imply infant feeding practices differed with socio-economic status. This suggests non-urban environments may buffer negative effects of socio-economic disparities on growth and high-status loading activity shifts with advancing age. *Research supported by The Wenner-Gren Foundation (EMG).*

#### **Morphological variation of modern human browridges.**

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The browridge, or supraorbital torus, is a distinct craniofacial feature which is found throughout the human lineage in a variety of forms. The browridge remains evident in modern humans and is one of the primary discrete cranial traits used in sex estimation methods. Descriptions of browridge morphology and sexual dimorphism in modern humans are commonly limited to discussions and scoring methods based on degree of projection. In this study, 3D surface scans were collected from 669 crania from geographically and temporally diverse populations, and shape analyses were performed on the isolated browridge regions. The diverse browridge forms observed across six populations and thirteen samples are presented and discussed in terms of geographic patterns and sexual differences.

Although browridge projection remained the most sexually dimorphic feature, geometric morphometric analyses (GPA, PCA) revealed a number of other morphological variations not traditionally discussed in the anthropological

literature. These variations include the degree of lateral extension of the browridge, the relative projection of the browridge at the midline in comparison to the supraorbital region (i.e., continuity/discontinuity of browridge projection at glabella), the degree to which the browridge arches over and diverges from the supraorbital margin, the relative angle of brow projection and the radius of browridge curvature. Knowledge of such morphological diversity in the browridge has important implications, especially with regard to ancestry and sex estimation methods. In addition, a better understanding of variations in browridge form may provide insight into the adaptive functions of this trait.

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#### **New calculation of habitable land area during glacial periods and its implications for Pleistocene hominin population size.**

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The estimation of population size in the distant past is a difficult endeavor. Previously, researchers have estimated prehistoric population size by comparing the total area of human habitation (as determined from archaeological data) with observed population densities of hunter-gatherers. This method ignores largely archaeologically invisible areas of land currently submerged by oceans, and areas in which archaeological materials are unlikely to be recovered. We present a new method of estimating habitable area that includes areas now below sea level, but exposed during glacial maxima. We couple these data with population density data for widespread large carnivores and foragers to estimate Pleistocene population size.

First, we estimated the areas of Eurasia and Africa when sea level was 120 meters lower today using the polygon creation function in Google Earth, which calculates the area within the polygon. The land area Africa is estimated at 30,493,900.3 km<sup>2</sup> and Eurasia at 62,280,164.2 km<sup>2</sup>, for a combined total area of 92,774,064.5 km<sup>2</sup>. Subtracting areas covered by glaciers, Siberia north of 65° N, the Sahara and Arabian deserts, and elevations higher than 3000 m, we arrive at a potentially habitable area of 66,637,563.4 km<sup>2</sup>.

Using hunter-gatherer data, we then estimate Pleistocene human population size at between 4.2 - 10.2 million. Wide-ranging large carnivore data suggest a Pleistocene human population size of 1.8 - 2.5 million. These estimates should be viewed as population ceilings, since they assume that all lands suitable for human occupation were in fact occupied, which was certainly not the case.

**Exploring phylogenetic beta diversity in neotropical primate assemblages: Historical, ecological and neutral processes underlying patterns of nestedness and turnover.**

MARIA M. GAVILANEZ and RICHARD D. STEVENS. Biological Sciences, Louisiana State University.

The relative importance of processes such as environmental filtering, historical events and neutral dynamics driving observed patterns of change in community composition across space (beta diversity), remains uncertain. In the case of Neotropical primate communities, many potential drivers of large-scale beta diversity have been proposed, including climate, dispersal limitation and historical/biogeographic events. However, most of these studies have investigated only the taxonomic dimension of biodiversity. Here I assess the relative importance of multiple drivers of community structure in the phylogenetic component of biodiversity, which takes into consideration species evolutionary histories. I deconstruct phylogenetic beta diversity of Neotropical primate communities (> 100 species) into its turnover (change in species composition because of species replacements) and nestedness components (change in species composition because of species richness differences), and assess the relative influence of multiple mechanisms proposed to cause this variation. Preliminary results suggest Platyrrhine phylogenetic beta diversity is mainly caused by spatial turnover, with nestedness contributing with a small fraction. Highly nested communities were located in areas with high environmental variation, while those represented by higher levels of spatial turnover were found in areas that have experimented greater climatic stability. Furthermore, compositional variation accounted for "purely by space" was greater than the "unique environmental" contributions for both components of phylogenetic beta diversity. These results suggest that primate phylogenetic beta diversity reflects a complex interaction of spatial turnover and, to a lesser extent, nestedness, which may be driven by dispersal and environmental dynamics of the region.

**Dental microwear analysis of *Cercopithecoidea williamsi* from the Pliocene caves of South Africa.**

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*Cercopithecoidea williamsi* from the Pliocene karstic caves of South Africa, including Sterkfontein Member 4, Sterkfontein West Pit, Bolt's Farm and Makapansgat, has been previously described as a terrestrial colobine monkey. This characterization differs from other Plio-Pleistocene cercopithecoid monkeys which are allocated to the Papionini. In order to infer the dietary proclivities of *Cercopithecoidea williamsi* ( $n = 17$ ) we utilize low-magnification stereomicroscopy at 35x using an ocular reticle and an external light source to manifest small, large and puncture pits as well as fine, coarse and hypercoarse scratches. Although additional

specimens were examined, not all individuals showed evidence of dental microwear due to postmortem taphonomy. The comparative sample includes *Colobus* spp. ( $n = 8$ ), *Gorilla gorilla* ( $n = 5$ ), *Papio ursinus* ( $n = 35$ ), *Theropithecus gelada* ( $n = 5$ ). Analysis of Variance shows that the taxa can be distinguished on the basis of fine scratches ( $p = 0.012$ ) and hypercoarse scratches ( $p = 0.031$ ). When all scratches are compared to all pits, the 95% confidence ellipse around group centroids nearly separates *Papio ursinus* and *Cercopithecoidea williamsi* while the confidence ellipse for *Colobus* spp. overlaps both taxa. Multivariate analyses show that *Papio ursinus* and *Colobus* spp. are distinct from *Cercopithecoidea williamsi* due to the predominance of fine scratches in the former two and small pits and lack of fine scratches in the fossil taxon. Given its attribution to the Colobinae, we expected *Cercopithecoidea williamsi* to align with *Colobus* spp. However, its inferred terrestriality may explain its distinction from extant arboreal *Colobus* spp. *This research was supported by a Research Professional Enhancement Grant from the Vice President for Research at Georgia State University.*

**Using ancient DNA to investigate genetic adaptation to high altitude stressors in Andean populations.**

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The evolution of Andean highland cultures is highly dependent on the populations' ability to adapt to physical stressors of high-elevation environments. The genetic basis of adaptation to high altitudes is still poorly understood. By now, several associated genes but only few directly associated SNPs have been identified. An additional problem is that the possibility to infer processes of selection using DNA from modern indigenous South American populations might be obscured by admixture events due to the European colonisation or pre-Columbian gene flow.

To test if adaptation to high altitudes has led to selective change of allele frequencies we analyze pre-Columbian highland and coastal populations from southern Peru. We analyze a total of three SNPs, one of which is located in the *NOS3* gene and has been associated with AMS susceptibility. For the other two SNPs, located in the *EGLN1* gene, a strong selective pressure has been detected in Andean populations. SNPs are genotyped via multiplex SBE assay, allowing for the simultaneous determination of the three SNPs.

It was possible to reproducibly determine the genotypes of  $n = 37$  high-altitude individuals and  $n = 26$  low-altitude individuals. The comparison of the allele frequencies revealed a significant difference between highland and coastal populations for the *NOS3* SNP (rs1799983) and one of the *EGLN1* SNPs

(rs1769813). The results suggest a selective effect on the allele frequencies due to the permanent settling above 2500 masl. However, it cannot be fully excluded that the observed differences result from differential population histories.

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**Physiological costs of dominance and mating effort in male chimpanzees.**

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Costs of reproductive competition may be important limiters for fitness in primates. In seasonal breeders, males suffer elevated mortality during the mating season. Similar effects have not been documented in non-seasonal breeders, where they may be predicted to be more subtle yet more persistent over time. We studied wild chimpanzees (*Pan troglodytes*) at Kanyawara, Kibale National Park, Uganda to assess whether adult males experience short-term costs associated with mating competition. We compared feeding time, aggression, urinary cortisol, and urinary C-peptide (UCP) levels on days of high mating competition (with at least one parous, estrous female present) to days of low competition. Our 12 study males spent less time feeding on days of high mating competition, with individual feeding time being negatively associated with both rate of aggression and mating success. Males had lower levels of UCP, a measure of energy balance, on these days. High-ranking males were more aggressive and had lower UCP levels overall, though the reduction in male feeding time and UCP on high competition days was unrelated to rank. Finally, high-ranking males experienced greater increases in cortisol production, relative to baseline, on days of high mating competition. Thus, mating effort in chimpanzees had measurable costs in terms of both reduced energy intake and increased physiological stress. While experienced over the short-term, these energetic costs of mating effort could in theory accumulate to constrain survival and/or limit the attainment and maintenance of high dominance rank.

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**Cultural replacement and diet in Peru's prehispanic Central Coast.**

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This study focuses on the diet, environment and geographical origin of two populations buried in the Tablada de Lurín necropolis (2nd cent. BC - 2nd cent. AD; Lima, Peru) and seeks to test archaeological hypotheses based on material culture by contrasting the cultural evidence with biological data. Tablada is characterized by two distinct phases of occupation which evidence a clear rupture in burial patterns. Moreover, based on ceramic evidence and the lack of habitation sites in immediate proximity to the cemetery, it appears that both burial populations stem from a certain distance of the site (ca. 20 km) and that they were turned toward land rather than marine resources despite Tablada's close proximity to the ocean. Forty-seven human individuals and eleven faunal remains from both occupational phases were sampled for isotopic analysis (carbon, nitrogen, sulphur and oxygen) of bone and dental collagen and apatite. Modern samples of autochthonous food staples were also tested in order to provide a baseline for comparison. Preliminary results show a clear preservation state difference between the remains of the two phases. The first phase individuals provide the best isotopic dataset and would show consumption of protein from marine resources. On the other hand, oxygen and carbon stable isotope results from the both phases highlight possible outsiders. Together with archaeological, anthropological and palaeoenvironmental data, this study seeks to understand both population's dietary habits and geographic origins and evaluate whether these shed any light on the cultural rupture revealed by the change in burial practices.

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#### An evaluation of three sternal rib end age estimation techniques.

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The estimation of age is essential in the fields of physical and forensic anthropology; therefore the accuracy of these methods needs to be evaluated. Currently, there are multiple methods available for age estimation, including sternal rib end aging, which was specifically evaluated in this research.

Three sternal rib aging techniques, İşcan et al. (1984, 1985), Hartnett-Fulginiti (2007, 2010), and Oettlé and Steyn (2000), were the focus of this study. The main objective was to determine the overall accuracy of each method, as well as examine differences in rates of accuracy between European-Americans and African-Americans. The primary research questions addressed were: 1. Does the Oettlé and Steyn method more accurately assess the age of African-American individuals, and 2. Does the Hartnett-Fulginiti method more accurately assess the age of all individuals. It was hypothesized that there would be statistically significant

differences in the rates of accuracy between European-Americans and African-Americans.

Data was collected from the Hamann-Todd and WM Bass collections. The sample consisted of 414 male and female right fourth sternal rib ends from individuals of both European and African ancestry, ranging in age from 14 to 97 years.

Results indicate that although the Oettlé and Steyn method was designed specifically on individuals of African ancestry from South Africa, it proved to not be as effective in the United States. Conversely, the Hartnett-Fulginiti method proved to be the most accurate method for all individuals, demonstrating that the Hartnett-Fulginiti method is a valuable age estimation technique in the field of physical anthropology.

#### Testosterone, immune function, and life history transitions in the Philippines.

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Fathers have lower testosterone than non-fathers in many cultural settings, and it was recently shown that the transition to first-time fatherhood caused testosterone to decline in a sample from the Philippines. There is also evidence that testosterone may have immunosuppressive effects. Thus, one plausible health benefit of reduced paternal testosterone could be enhanced immunity. Drawing on a large, ongoing study in Cebu City, Philippines, we test whether men transitioning to fatherhood show increases in salivary secretory immunoglobulin A (SIgA) compared to men who do not become fathers and assess whether testosterone impacts these relationships (n = 319). Higher SIgA helps protect the body against infectious agents at mucosal surfaces. Using data collected at two time points (2005 & 2009) 4.5 years apart, we found that new fathers did not differ in changes in SIgA compared to non-fathers. However, regardless of parenthood or marital status, men with greater testosterone declines over the 4.5-year period had larger increases in SIgA (p = 0.0001). Although seemingly unrelated to potential trade-offs between mating and parenting in this sample, we did find evidence indicating that multi-year declines in testosterone predict enhanced SIgA profiles. These data are consistent with the idea that testosterone suppresses some aspects of immunity.

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#### Appearance of the modern baboon, *Papio hamadryas*, in the Plio-Pleistocene fossil record: Evidence from South Africa.

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Savannah baboons, *Papio hamadryas*, are among the most successful extant primates, with a minimum of six recognizable populations/subspecies spread throughout Sub-Saharan Africa. Their presence in the fossil record, however, remains unclear. There are three early fossil forms in South Africa that have been argued to be members of the genus *Papio*. *P. izodi*, from Taung and Sterkfontein, retains many primitive features and is distinct from modern *P. hamadryas*. Both *P. h. robinsoni* and *P. h. angusticeps*, however, have at times been considered as subspecies of the extant species. Because of their derived appearance, *P. h. angusticeps* and *P. h. robinsoni* have often been used as important biochronological markers for the Plio-Pleistocene sites at which they are found. The two species have even been suggested to co-occur at Kromdraai and Coopers.

Here, we reexamined *P. h. robinsoni* and *P. h. angusticeps* with emphasis on their distinguishing features and distribution. We find that *P. h. robinsoni* and *P. h. angusticeps* are distinct in a number of cranial features (needed for definitive identification) but overlap in dental size. No diagnostic crania suggest that the species co-occur. Dental variation at each site is comparable to that in extant *P. h. ursinus*, also suggesting that only one form of *Papio* is present at each. *Papio h. robinsoni* appears distinct from modern *P. hamadryas* subspecies in its combination of features while *P. h. angusticeps* might be included within one of the modern *P. hamadryas* varieties. These results have implications for South African Plio-Pleistocene biochronology.

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#### Functional impairment and physical stress in the past: How physiotherapy ideologies can contribute to bioarchaeological interpretations.

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Evidence of 'disability' in the past is a topic widely discussed in bioarchaeology, but little attention has been paid to the complexities associated with retrospective identification of physical impairment using skeletal evidence.

Interpreting how individuals and groups experience injury requires a more detailed understanding of the factors leading to the development of physical dysfunction than are currently available in bioarchaeological literature. Incorporation of contemporary physiotherapy ideologies, concerned primarily with the management of physical impairment through optimization of function and mobility, will greatly inform bioarchaeological interpretations of the long-term effects of musculoskeletal trauma. Physiotherapy practitioners often look beyond physiology and stress the importance of socio-cultural and subjective perceptions of injury as mediating factors in developing coping strategies. Coping strategies, frequently influenced by pain perception and reaction, are important in predicting the development and sustenance of physical impairment, especially as the subjective nature of pain and coping indicates that response to injury/stress is not universal (i.e., individuals with similar physiological trauma may differ greatly in their perceptions of injury severity, coping strategies, pain, and consequent impairment). As both culture and individual cognition influence the development and expression of dysfunction, these concepts should be considered in bioarchaeological interpretations to build a more comprehensive approach for assessing function associated with musculoskeletal trauma. The integration of physiotherapy functional concepts in bioarchaeological assessments of physical impairment will permit more informed interpretations regarding cultural behaviors and individual lived-experiences, ultimately improving our understanding of the reality of physical stresses in the past.

#### **A preliminary assessment of the primates of Burkina Faso, West Africa.**

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The West African country of Burkina Faso is home to at least seven species of primates, yet very little is known about their distribution, abundance, and potential for sustainability. We conducted a preliminary survey of five different forest reserves in southern Burkina Faso, utilizing 250 km of reconnaissance walks and semi-structured interviews, to assess the relative abundance of and potential threats to the following species: *Cercocebus lunulatus*, *Chlorocebus aethiops*, *Colobus vellerosus*, *Erythrocebus patas*, *Galago senegalensis*, *Pan troglodytes verus*, and *Papio anubis*. We were able to confirm the presence of *G. senegalensis*; interviews suggest *C. vellerosus* and *C. lunulatus* remain in only small, isolated, and highly threatened groups in the southwest. We found zero signs of chimpanzee presence, and interviews suggest they may not have been present for ten years. *C. aethiops*, *E. patas*, and *P. anubis* were observed at average encounter rates of .06 groups/km, .03 groups/km, and .09 groups/km, respectively. Encounter rates for *P. anubis* and signs of poaching were significantly

negatively correlated. *P. anubis* and *E. patas* were considered to be heavy crop-raiders, rivaled only by elephants, and local farmers reported guarding as the most effective mitigation tool, although trapping and killing were also reported. We discuss the need for future research in this region, the potential extirpation of three species from Burkina Faso, and the immediate and long-term threats to the remaining species, as well as outline recommendations for increasing international collaboration to effectively reduce poaching in this region.

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#### **The energetics of mate-guarding in wild male long-tailed macaques (*Macaca fascicularis*).**

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The factors shaping the evolution of male reproductive strategies in primates can be fully understood only by investigating both costs and benefits of such strategies. While mate-guarding has been proven to increase mating and reproductive success of male primates in multi-male groups, little is known about the energetic costs of such behavior. The aim of the study was therefore to quantify these costs using long-tailed macaques as a model. This species is of particular interest in this respect because alpha males mate-guard females to a lesser extent than predicted by the priority of access model. The study was carried out during two reproductive seasons on three groups of wild long-tailed macaques living in the Gunung Leuser National Park, Indonesia. We combined behavioral observations and non-invasive measurements of c-peptides, as an indicator of male energetic status. Males decreased feeding time and fruit consumption during mate-guarding and concurrently decreased vertical locomotion. These results suggest that male long-tailed macaques balanced lowered energy intake by reducing energetic expenditure. Accordingly, we did not find any effect of mate-guarding activity on energetic status. The incomplete monopolization of females by alpha males might thus be a form of an energy management strategy. These management strategies might strongly differ between non-strictly seasonal species, such as long-tailed macaques, and strictly seasonal ones and further studies on both ends of the spectrum are needed. Finally, our results also emphasize the importance of measuring both components of energy balance,

i.e. energy intake and expenditure, when investigating energetic costs of reproduction.

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#### **The influence of body mass on humeral strength: An ontogenetic perspective.**

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Analyses in cross-sectional geometry (CSG) have emphasized the upper limb as a possible window into habitual activity patterns that is not complicated by a primarily weight-bearing role. In contrast, while lower limb robusticity has implications for mobility, much of the variation in lower limb strength is related to body mass. However, Ruff (2000) found that CSG properties of the humerus scale with body mass in much the same way as femoral CSG properties. Given this, it may be that there are other processes, either systemic or genetic, that contribute to long bone ultimate shape and structure. This study, which uses immature individuals from seven Holocene samples (n=516), was undertaken to examine the relationship between body mass and CSG properties of both the upper and lower limbs and the implications of that relationship for the interpretation of activity patterns. Correlation coefficients and 95% confidence intervals were used to evaluate differences in the strength of the relationship between body mass and the upper and lower limbs in six age categories. The results of this study confirm the high degree of correlation between body mass and humeral CSG properties, and found no significant difference in the strength of the correlation between body mass and the upper limb and body mass and the lower limb. In addition, these correlations remained high during growth, indicating a possible systemic factor contributing to the shape of the humerus. Further research is necessary to isolate the specific factors that result in humeral form and robusticity.

#### **New interpretations of the positional behaviors of the Dominican subfossil, *Antillothrix bernensis*, from the pectoral and pelvic girdles.**

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Subfossil platyrrhine postcranial remains from the Dominican Republic include a partial sacrum, several os coxae, and the first scapulae from the Caribbean. These remains, attributed to *Antillothrix bernensis*, exhibit a unique mosaic of morphology not found in modern platyrrhines, potentially expanding the diversity of platyrrhine

positional behaviors and adding to the novel behaviors interpreted for other Caribbean fossil taxa (i.e., *Xenothrix* and *Paralouatta*). Based on absolute size and published mass regressions, *Antillothrix* was larger than a male *Cebus*, but smaller than most atelids (~3.5-6kg). Although the new specimen may approach the size range dominated by prehensile-tailed platyrrhines, the fragmentary sacrum does not appear to indicate such adaptations based on its low sacral canal height index (<0.80). The os coxae have expanded iliac and deeply excavated gluteal planes, a morphology found in atelids that might indicate powerful hindlimb-assisted climbing or anti-pronograde behaviors. However, the ratio of the ventral to dorsal acetabulum walls (<0.65) is unlike the roughly equal walls in atelids, possibly indicating more pronograde positional behaviors for *Antillothrix*. The blade of the scapula strongly resembles quadrupedal primates, with its greater length across the spine than between the superior and inferior angles. The morphology of the shoulder joint, especially in the robust acromion and short coracoid with an expanded attachment for the coracoclavicular ligament, is unlike any modern platyrrhine and shares similarities with slow-climbing lorises. Behaviorally, these new fossils are best reconstructed as of a moderately large platyrrhine practicing arboreal quadrupedalism, possibly with specialized climbing adaptations not found amongst modern platyrrhines.

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#### Molar wear in a wild population of known-age mountain gorillas from Volcanoes National Park, Rwanda.

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Teeth are at the interface between an animal and its environment. Consequently, aspects of dental size, shape, development, and wear inform research on the ecology, life history, and dietary demands of extinct and extant primates. Teasing apart influences on tooth wear (unworn morphology, food/tooth material properties, etc.) can be difficult even in living primates, and to date has relied on samples lacking critical chronological and ecological data. The mountain gorilla skeletal collection from Volcanoes National Park, Rwanda provides

an excellent case study for relating dental ecology to dental wear as this sample represents a breeding population, with known ages, life histories, diets, and ranging patterns.

An emerging view is that as teeth wear, their occlusal surfaces alter in a way that maintains or enhances their complex topography. We tested this by employing dental topographic analyses of occlusal slope, angularity, and relief index (RFI) on a cross-sectional sample (n=17; ~4-43 yrs.) of wild *G. beringei beringei* for M<sup>1-2</sup>. Slope (r=-0.76, -0.81) and angularity (r=-0.72, -0.75) are negatively correlated with age (for M<sup>1</sup> and M<sup>2</sup>, respectively; p<0.05). RFI and age are not linearly related, but sample size prohibited alternative curve fitting. It was observed that M<sup>1</sup> RFI initially decreases with age, but rises at >20 yrs., with the opposite pattern for M<sup>2</sup>s. This complex relationship between RFI and age suggests that selection may shape tooth anatomy to maintain occlusal relief. This may be advantageous for the lifelong mastication of tough fibrous foods. Results are discussed within the context of population life history.

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#### FTO (rs9939609) and INSIG2 (rs7566605) allele distributions in human populations.

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It is known the influence of the genetic background in obesity. Double homozygotes AA at *FTO* gene (rs9939609) and CC at *INSIG2* gene (rs7566605) (Chu *et al.*, 2008) have a higher probability to develop morbid obesity than general population. Given their clinical significance, it is of interest to know the distribution of these genetic variants associated with obesity in populations from different continents.

A total of 533 unrelated individuals, from Africa, Asia, America and Europe were typed for rs7566605 (*INSIG2*) and rs9939609 (*FTO*) using RT-PCR. The study was approved by the Ethics Committee of the University of Rome "Tor Vergata".

Double homozygotes individuals AA/CC were found only in the Amhara of Ethiopia, the Libyan Tuaregs, and in the African-Ecuadorian population of Rio Cayapas. The results obtained confirm that the obesity associated genes present a degree of differentiation among populations of distinct continents. They also highlight the usefulness of this kind of research in identifying individuals at higher risk for the development of obesity in view of the current change of lifestyles. A general approach for an integrated analysis of human nutrition, within an anthropological and evolutionary perspective

will be unavoidable in order to unravel the complexity of human eating behavior and nutritional disorders.

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#### New estimates for ages in historic Italian populations derived from Bayesian analysis: Pubic symphyses.

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Age estimation is experiencing intensified interest as anthropologists recognize the advantage provided by statistical modeling of skeletal indicators. Thus, visual examination and phase assessment have been improved upon by implementation of Bayesian analysis. In our prior work, we presented both a forensic and Rostockian approach to Bayesian age estimation from pubic symphyses. The purely methodological focus of our Rostockian analysis prevented us from presenting lookup tables with revised age estimates for historic Italian populations. The age estimates reported here are derived from the Rostockian analysis, with demonstrated accuracy at 50%, 75%, 90%, and 95% confidence levels.

The test sample in our Rostockian analysis is comprised of turn of the 20<sup>th</sup> Century blue-collar workers excavated from a cemetery in Sardinia, Italy. Individuals from the Terry Collection were the best fit for transition analysis. Another historic Italian sample (Torino), which is contemporary to both Terry and Sardinia, functioned as the prior. Transition analysis parameters from the Terry Collection were obtained from published sources and a Gompertz hazard model best described the Torino prior. The hazard and transition analysis parameters were input into Bayes' Theorem to calculate probability density functions (PDF), and subsequently, highest posterior density regions (HPDR). In our previous research, we tested the accuracy of the HPDRs from Terry and Torino on the target sample (Sardinia), finding 50%, 75%, 90%, and 95% accuracy, depending on the desired coverage. Here, the HPDR values are tabulated to provide an easy reference for estimating age from pubic symphysis phase in modern historic Italian populations.

The data collection was facilitated by a grant for Samantha M. Hens from the Office of Research and Sponsored Projects, California State University, Sacramento.

#### What did *Hadropithecus* eat? And why should paleoanthropologists care?

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Despite its bearing robust facial features and dental proportional convergences with robust australopithecids, *Hadropithecus* was likely not a hard-object feeder. Stable isotopes ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) show a match for CAM plants such as *Alluaudia* but not for hard-seeded C3 plants or C4 grasses. Heavy predation on *Alluaudia* leaves might help explain this plant's own spiny defenses and other craniodental features of *Hadropithecus* (small gape, low relative enamel thickness, high molar occlusal surface complexity). Finite element analysis shows that *Hadropithecus*' skull was not as strong as that of the closely related hard-object feeder, *Archaeolemur*, but that *Hadropithecus* could (1) transfer muscle to bite force at P4 and especially M2 with greater mechanical advantage, and (2) produce absolutely higher bite forces. However, bite force divided by tooth occlusal area is 10-30% higher in *Archaeolemur*. Thus, despite the high mechanical advantage of its feeding apparatus, *Hadropithecus* produced lower bite force per unit occlusal area than did *Archaeolemur* and was structurally weaker. The hominin likenesses of *Hadropithecus* may be related to increased mechanical efficiency of its hypertrophied cheek teeth (P4-M3), possibly signaling high-bulk feeding on low "quality" foods.

Our point, that hominin craniodental likenesses do not necessarily translate into high bite forces per unit occlusal area, is not meant to imply that *Paranthropus* did not consume hard objects, or indeed that *Paranthropus* and *Hadropithecus* had similar diets. Rather, we suggest that their craniodental likenesses may reflect the ability of both to process high-bulk, low-quality foods.

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#### Genomic copy number variation within and between species is a major driver of primate evolution.

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Copy number variants (CNVs, defined as polymorphic losses and gains of segments of genomic DNA) constitute a greater portion of human genomic variation as compared to single nucleotide variants, and play an important role in human disease and evolution. However, little is

known about the impact of CNVs on nonhuman primate genomes and evolution. Therefore, we examined both within species CNVs and copy number differences (CNDs, changes in copy number of genomic segments between species) across the genomes of multiple human, chimpanzee, and rhesus macaque samples. In doing so, we delineated mechanisms in which such copy number changes can affect eventual phenotypes. Specifically, we present more than 2,000 polymorphic human CNVs that overlap with orthologous chimpanzee or rhesus macaque CNVs, confirming the presence of CNV formation hotspots in primates. Many of these hotspots are functionally relevant, with a bias toward genes involved in immune function. The genes in these primate CNV formation hotspots have significant differential expression levels between species ( $p < 0.001$ ) and show evidence for positive selection. We also identified 964 CNDs of conserved sequences across these primate species and demonstrated that samples with copy number different genes had significantly different expression than samples with neutral copy number ( $p < 0.001$ ). We postulate that cross-species CNV hotspots harbor signatures of ongoing, recent evolutionary pressures, such as response to pathogens, whereas CNDs reflect fine-tuning of developmental pathways by altering the levels of RNA. Overall, our results establish genomic copy number variation within and between species as a major driver of primate evolution.

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#### Differences in food availability may guide the foraging decisions of captive marmosets (*Callithrix* spp.).

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The ability to discriminate among varying amounts of food resources plays an important role in the process of patch choice. By increasing foraging efficiency this ability may also reduce feeding competition among social animals. We tested whether 11 captive marmoset (*Callithrix jacchus*, *C. penicillata*, and *C. penicillata* vs. *C. kuhlii* hybrids; 2-4 individuals) groups would respond to differences in food availability in making foraging decisions. Five white plexiglass boxes (11 x 25 x 20 cm) were placed in each group's cage. Each box had a cup in its back where food rewards (1 cm banana slices) were hidden. During 20 consecutive days the same box contained three available slices (richest box), another contained a single available slice and two unavailable slices within a wire-mesh cage (poorest box), whereas the remaining three boxes contained three unavailable slices (non-reward boxes). Unavailable slices aimed at equalizing odor cues. Each study group was tested once a day early in the morning just after its release from the nest box. Marmosets from seven groups inspected the

richest box as their first choice above a 20% chance level (1 out of 5 boxes) and two groups selected it above a 50% chance level (1 out of 2 reward boxes). Also, there is evidence that marmosets were learning to differentiate the boxes based on food availability as the number of groups going directly to the richest box in each session increased along the experiment. The influence of hunger, stress, and competition on these results is discussed.

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#### Characterization of the gastrointestinal bacterial communities of western lowland gorillas (*Gorilla gorilla gorilla*).

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The gastrointestinal microbiome (GIM) is an important force behind mammalian dietary adaptations, influencing immunity and the ability to harvest otherwise inaccessible nutrients. In western lowland gorillas (*G. g. gorilla*), shifts in the availability of resources, e.g., fruit-based vs. high fiber content diets impact nutritional efficiency. We predict that the GIM contributes significantly to foraging plasticity and efficiency, particularly when animals focus on high fiber items.

Here, we characterized the GIM of gorilla groups from the Dzanga Sangha protected area in the Central African Republic using high-throughput sequencing of bacterial 16S rDNA from fecal samples. We evaluated annual, group, and individual variability in GIM ecosystems from 1.2M high-quality pyrotag sequence reads, enabling identification of bacterial content with an average sampling depth of ~12,400 reads per individual.

Analysis of dry season samples (Nov-Dec/2009 and 2010) reflect high abundances of *Leuconostoc* sp., a lactic acid producing bacteria, associated with fermented foods. The presence of *Bellilinea* sp., a member the phylum Chloroflexi and rarely a constituent of the mammalian GIM, suggests uniqueness of gorilla microbiomes. Other genera detected reflect significant metabolism of soluble and recalcitrant

polysaccharides, phenolics and the synthesis of short chain fatty acids. We also report interannual and intergroup GIM variation.

Our findings support the hypothesis that the GIM contributes significantly to the physiology, adaptability, and health of gorillas in a changing, potentially threatened niche. The relative role of the GIM in meeting the nutritional needs of gorillas in tandem with morphology and behavior is discussed.

This study was funded by the University of Illinois and NSF grant 0935347. Field research was conducted with permission from the authorities of the Central African Republic.

**Grébouo 1 forest grove in southwestern Côte d'Ivoire is the final refuge for *Colobus vellerosus* in the Sassandra-Bandama inter-fluvial region.**

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Two species of black-and-white colobus occur in West Africa: *Colobus vellerosus* is found east of the Bandama River and ranges discontinuously as far as western Nigeria while *C. polykomos* has a disjunct distribution beginning at the Sassandra River and extending west to Guinea-Bissau. A possible third black-and-white colobus occupies portions of the Bandama-Sassandra inter-fluvial region and has a disputed taxonomy: some claim it represents a remnant population of *C. p. dollmanii* (Schwarz 1927), while others argue for polykomos-*vellerosus* hybrid status. In order to clarify the monkey's distribution between the Sassandra and Bandama rivers and provide additional descriptive information on the taxon, we conducted surveys within all forest fragments capable of supporting monkeys. During 2011 and 2012, we carried out foot surveys in nine forest blocks in south central Côte d'Ivoire. We spent an average of 7.4 days in each forest walking line transects averaging 105 km in length. Based on these surveys, the only locality containing black-and-white colobus is a forest grove near the village of Grébouo I in the southwestern portion of the country. The Grébouo I grove is highly degraded, but contains two monkey groups of 8 and 6 individuals, respectively. Adult pelage is similar to that of *Colobus vellerosus* (Oates & McGraw 2009) and we are now collecting vocal and genetic data to confirm the population's taxonomic affinities. We conclude the colobus between the Sassandra and Bandama Rivers is *C. vellerosus* and that unless immediate conservation measures are implemented, this small population will be extirpated.

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**Semicircular canal morphology as a predictor of platyrrhine locomotor behavior.**

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Rotations of the head are detected by the semicircular canals, and it is understood that canal morphology is functionally related to animal movement. A study of 210 mammals has shown a significant correlation between "agility rank," a qualitative surrogate for head rotation, and the paired variables mean canal radius of curvature (R) and body mass. Recent measurement of head rotations in strepsirrhines, however, indicates that mean angular head velocity (AVM) is significantly correlated with canal orthogonality, not with R and body mass. One possible explanation for this discrepancy is that agility ranks do not adequately describe the head rotations that serve as the stimulus to the semicircular canals.

To explore variation in canal orthogonality and its implications for head movements outside of strepsirrhines, we measured canal orthogonality in 11 extant platyrrhine species. Values of canal orthogonality in platyrrhines fall within the observed strepsirrhine range. Using the strepsirrhine equation to estimate platyrrhine AVM, we predict *Callicebus* and *Pithecia* experience the fastest average head rotations, similar to that of the bush baby *Galago moholi*. At the opposite extreme, the woolly monkey *Lagothrix* is predicted to exhibit the slowest head rotations — most closely resembling *Eulemur*. These findings suggest a lack of correspondence between the kinematic variable AVM and behaviorist's perceptions of agility or locomotor categories—woolly monkeys climb and suspend below branches whereas *Eulemur* is an above-branch arboreal quadruped. Moreover, the apparently slow-moving howler *Alouatta* has highly orthogonal canals. These inconsistencies highlight the need for *in vivo* head movement data from platyrrhines.

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**Functional morphology of the primate hallucal metatarsal (Mt1) and implications for inferring hallucal grasping capability in fossil primates.**

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Primates are unusual in having a highly abducted, opposable hallux. It has been suggested that 'powerful' hallucal grasping evolved along the primate stem lineage, facilitating locomotion on vertical substrates and access to terminal branch resources in early primates and extant strepsirrhines. A reduction in hallucal grasping capability is believed to characterize anthropoids and may be related to use of relatively larger, horizontal substrates. Researchers have asserted that variation in hallucal grasping capability, as it relates to substrate size and orientation, is reflected in hallucal metatarsal (Mt1) morphology. This study examined the relationship between Mt1 morphology (torsion, relative peroneal process length and thickness, abduction angle, and proximal articular surface curvatures) and substrate data taken from the literature across 80 taxa (78 primates, one tupaiid, one dermopteran). Phylogenetic ANOVAs were used to examine differences in Mt1 morphology among six substrate categories and PGLS regressions were used to assess the relationship between Mt1 morphology and proportion of time spent on 'relatively small' branches (defined as a function of body mass). Vertical clingers and leapers have significantly longer peroneal processes and more curved articular surfaces than all other groups. Mt1 torsion in non-graspers is significantly lower than in all grasping groups, and higher Mt1 torsion is associated with relatively more time spent on small branches. These results indicate that a more detailed reconstruction of the sequence of behavioral changes leading from stem-primates to the euprimate ancestor should be possible using the Mt1 when fossils and extant taxa are considered in an explicit phylogenetic framework.

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**George Armelagos and changing ideas about the realities of race, human variation, and racism.**

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George Armelagos holds a pivotal position in changing conceptions about race, human variation and racism over the last half decade. In this paper we sketch out key individuals, events, and trends in Armelagos' research, writing and mentorship on race, human variation and racism.

As an undergraduate at Michigan and as a graduate students at Colorado in the 1960s, Armelagos was influenced by mentors C. Loring Brace and Jack Kelso, as well as Frank Livingstone, and Alice Brues, exposing him to new and often conflicting ideas about race and human variation. Early on, he took a position close to Brace, who followed his own mentor,

Ashley Montagu. For Montagu and Brace, race was a myth.

Armelagos also saw quickly the limitations of the position that race is a mere myth, not least because this position failed to consider how powerful ideologies of race and racism remained all too real and become biological. Since the 1970s, Armelagos has tirelessly and passionately encouraged his students and colleagues to explore how race is both unreal as a way to describe genetic variation and yet very real as lived experience. He has encouraged us to explore the history and continued impact of racism in anthropology and beyond the academy. Armelagos continues to provide his students and colleagues wide intellectual freedom to explore their own ideas and theories. Moreover, are encouraged to explore and speak out by his clear sense of outrage at the "shoddy sciences of race" and continued racism in the academy and beyond.

#### **Post-traumatic bone loss in Civil War soldiers.**

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The relationship between bone density and physical activity is important to biological anthropologists interested in reconstructing past life ways. This study compares femur density of modern American white males to their 19<sup>th</sup> century counterparts, and evaluates the effects of immobilization on bone density in traumatically injured Civil War soldiers. Dual-energy X-ray absorptiometry was used to measure femoral neck densities in contemporary males aged 18 to 40 years (n=58), 19<sup>th</sup>-century male civilians (n=11), Civil War soldiers who lived less than 15 days after receiving mortal injuries (n=30), and Civil War soldiers who lived longer than 15 days after injury (n=54). The greatest time interval between injury and death was 575 days. The samples come from reference collections maintained by the University of Tennessee, the National Museum of Health and Medicine, and the Smithsonian Institution.

Our results show that bone densities of 19<sup>th</sup> century civilians, 19<sup>th</sup>-century soldiers who lived less than 15 days after injury, and modern males are not significantly different. Linear regression analysis shows a significant inverse relationship between length of immobilizing injury and bone density ( $r = -0.37$ ). The negative correlation reflects decreasing femur density over time with loss of weight-bearing activity and declining health. This evaluation of the rate of bone loss leading to osteopenia presents a sample-based comparison that measures the effect of severe trauma and immobility on bone density.

#### **Functional correlates of cochlear shape.**

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Previous research on the functional morphology of the primate cochlea has demonstrated that hearing abilities are correlated with cochlear volume and basilar membrane length. Here we assess the functional utility of cochlear shape for estimating high frequency limit, low frequency limit, and best frequency of hearing in a sample of 12 primate species. Two cochlear shape indices (CSI) were developed to measure the height of the cochlea relative to its width and were measured from high resolution CT scans of the bony labyrinth. Phylogenetic generalized least squares regressions were calculated in R to determine associations between both shape indices, hearing parameters, and body mass. CSI 1 is positively correlated with best frequency ( $n = 12$ ;  $R^2 = 0.455$ ;  $p > 0.05$ ) and CSI 2 is positively correlated with high frequency limit ( $n = 12$ ;  $R^2 = 0.453$ ;  $p < 0.05$ ). CSI 1 and CSI 2 are not associated with either low frequency limit or body mass. These results suggest that the gross shape provides another metric for estimating hearing ability in primates in addition to cochlear volume and basilar membrane length. However, preliminary observations also suggest that lorisiforms and lemuriforms differ systematically in cochlear shape, although differences in hearing ability have not been suggested for these two clades. Future analyses will address whether these patterns hold with greater sampling and the utility of cochlear shape as a tool for recognizing phylogenetic groups.

#### **Complex patterns of selection and constraint explain the evolution of the hominin hip bone.**

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Human and fossil hominin pelves are strikingly different from those of other apes, with numerous large-scale changes in bony morphology hypothesized to play major roles in bipedal behavior. But playing a functional role in a behavior does not mean that a trait has evolved as the result of selection for that behavior, or even that a trait was under directional selection at all. If the same genes influence multiple traits - pleiotropy - selection on one trait can lead to correlated responses in other traits, and thus morphological differences between species may not be a reliable indicator of past selective forces. This study uses evolutionary quantitative methods based around patterns of integration (POI) to reconstruct the selection pressures that led from the hypothesized hip morphology of the last common ancestor (LCA) of chimpanzees

and modern humans, to a sample of fossil hominins, and up to modern humans. We demonstrate that though a small number of traits hypothesized to play a major functional role in bipedalism have actually evolved due to correlated evolution, the selective hypotheses of past researchers were fairly accurate overall. We also show that individual traits were under contrasting selection pressures during the non-human hominid to hominin evolutionary transition, though a human-like POI significantly reduces constraints on evolution. Finally, a human-like POI facilitates evolution along the LCA - fossil hominin - modern human trajectory. Overall, our results suggest a complex pattern of selection and constraint during hominin hip evolution.

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#### **The relationship between age, sex and severity of arthritis in a turn of the century African American burial ground in Savannah, Georgia.**

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New South Associates, Inc. conducted two cemetery relocations at Hunter Army Air Field in Savannah, Georgia from 2006 to 2008. The cemetery population consisted of emancipated slaves from the late 19th to early 20th century. The cemetery at Area 1 (8CH1168) contained 40 individuals, while Area 2 (8CH875) contained 306 individuals for a combined total of 346 individuals. These remains were sexed and aged according to standard osteological methods. The severities of arthritic skeletal changes were scored using the Chicago Standards. The age intervals were converted to single numbers to identify potential relationships between sex and severity of skeletal degeneration and remodeling. A t-test between severity and sex revealed no significant relationship. However a general linear model which used sex as a categorical variable, and covariate of severity when compared to age, demonstrated a significant relationship ( $p < 0.001$ ) and strong between-group differences ( $F = 17.189$ ). A partial correlation between age and severity, controlling for the effects of sex, yielded a significant relationship ( $p < 0.001$ ). Results suggest that when sex is held constant, age has a strong effect on severity of arthritis, but there is no significant relationship between females and males in severity of skeletal degradation. The laborious activities that the cemetery population likely participated in during life to cause such skeletal responses were examined through historical evidence in order to contextualize the data.

**Gait mechanics of inverted walking: Implications for the evolution of suspensory locomotion.**

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A shift from above-branch quadrupedalism to suspensory locomotion is viewed as a critical transition in primate locomotor evolution, particularly as larger primates moved to suspensory postures as a means to mitigate the problems associated with balance on relatively thin arboreal supports. While such a strategy reduces problems associated with balance, it may change the mechanical stresses on the limbs and obviate energy saving mechanisms used during above-branch quadrupedalism. Currently, little is known about the basic mechanics and requirements of this unusual form of locomotion and the changes in anatomy required to successfully adopt effective inverted quadrupedalism. This study examined the mechanics of inverted quadrupedalism in three adult *Varecia variegata* walking above and below an instrumented raised pole. During upside-down quadrupedalism animals had a significantly shorter stride duration and swing phase, and a longer stride frequency and forelimb duty factor compared to above-branch walking. Kinetic analyses shows that during inverted walking compared to above-branch walking the normal pattern of peak vertical forces was reversed (FL/HL Vpk ratio = 0.730 vs. 1.338) and the braking and propulsive roles of the forelimb and hindlimb are reversed (FL is net propulsive). The shift between above-branch to below-branch quadrupedalism appears to involve significant alterations to the rate, direction, and magnitude at which the limbs are loaded that reflect a change in the functional role of the forelimb and hindlimb. Habitual inverted quadrupedalism in certain primate lineages may have played a key role in the reduction of hindlimb loading and the evolution of suspensory locomotion.

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**Bioarchaeological analysis of Oak View Landing (40DR1): An archaic population in the Kentucky Lake Reservoir.**

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Bioarchaeological research in the Southeastern United States has largely been focused on the Mississippian period due to the decline in health as a result of increased sedentism and intensified agriculture. The literature, however, has been less concerned with Archaic populations – with exception to large groups such as Indian Knoll. Biocultural examinations of small Archaic groups, when compared to larger samples, may prove to be beneficial to the ongoing research in understanding the lifeways and adaptations of

prehistoric people as they reflect sociopolitical and subsistence strategies.

For this study, a comprehensive bioarchaeological analysis was conducted on an Archaic population excavated from Oak View Landing (40DR1), a multiple occupation site located along the Tennessee River in Decatur County, Tennessee, and the sample consists of 50 adults (18 males, 16 females, 16 of unknown sex). Skeletal indicators used to understand biocultural phenomena (e.g., dietary reconstruction, infection, activity markers) were assessed macroscopically on cranial and postcranial elements.

Results from this study indicate a low prevalence of metabolic disease within this population; none of the 43 crania observed displayed anemic lesions. Of the 50 individuals examined, two were especially noteworthy for systemic infection (including osteomyelitis). Rates of arthritis were also high (21/50), as were cases of individuals with trauma, especially to cranial and forearm bones (10/50). Archaic populations have been shown to be highly active; thus the high prevalence of arthritis and trauma is not unexpected. These findings will be compared with larger Archaic groups to determine correlations between health patterns and population size.

**Life and death in 19<sup>th</sup> century Peoria, Illinois: Taking a biocultural approach towards understanding the past.**

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The excavation of a 19<sup>th</sup> century city cemetery in Peoria, Illinois provides an opportunity to understand aspects of life and death in complex socio-economic contexts. Using census and mortality records, along with other historical documents, this project seeks to explore whether the 86 individuals excavated from the Peoria Public Library Cemetery (ca. 1839-1886) reflect the demography and morbidity recorded in 19<sup>th</sup> century documents. Results of the skeletal analysis indicate that juveniles between the ages of 0-2.9 years old constitute the highest proportion of the population (n=32, 37%), while fetal and neonatal skeletons contribute the next highest percentage (n= 12, 14%). Hence, of the cemetery sample excavated, 51% of the individuals recovered were below the age of 3 years old. The high percentage of individuals displaying periosteal reaction (n>30), enamel hypoplasia (n>40), and pathological conditions associated with physical labor (os acromiale and spondylolysis), suggest that in spite of the economic prosperity of the city, a substantial segment of the population lived arduous lives. While these findings are reflected in the census and mortality records, combining skeletal analyses with historical documents provides a more nuanced snapshot of life in the past.

**What kind of anthropologist am I? Boundary crossings and the new one-drop rule.**

CLARENCE C. GRAVLEE. Department of Anthropology, University of Florida.

Washburn's (1951) vision for a new physical anthropology required active collaboration between subdisciplines to elucidate the biocultural processes shaping human evolution and variation. Sixty years later, the need for such collaboration remains, but new barriers have emerged. Here I consider one neglected barrier—a new one-drop rule in anthropology—and argue for the continuing promise of a biocultural synthesis.

The one-drop rule usually refers to an aspect of racial classification in the United States: the automatic assignment of people with any detectable trace of African ancestry to the category *black*. Anthropologists are justifiably critical of this rule, yet an analogous principle operates within the discipline. To wit, cultural anthropologists who exhibit any trace of another subfield are automatically reclassified to that subfield. One consequence is that biocultural approaches are generally defined as outside the scope of cultural anthropology, and interactions between human biology and culture become the purview of biological anthropology alone. This pattern impoverishes anthropology as a whole but constitutes the unique contribution of biological anthropology to science.

I illustrate this argument using examples from research on race, racism, and health. Racial inequalities in health are a major focus of interdisciplinary debate, but the debate often founders on the lack of a biocultural perspective. My work with colleagues in Puerto Rico and the mainland United States shows that integrating methods and theory from cultural and biological anthropology reframes the research questions and results in more specific tests of competing hypotheses for the causes of human variation.

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**Microtomographic assessment of mineralization patterns to inform isotope paleoenvironment reconstruction.**

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Seasonal climatic patterns may have influenced the evolution of human foraging behaviors and tool use during the Plio-Pleistocene. One means of reconstructing climatic parameters is through sequentially sampling stable light isotopes from fossil dentitions. However this method requires knowledge of the pattern of mineral deposition within developing teeth, which is poorly understood. Here we use micro-computed tomography (uCT) to assess temporal and spatial patterns of mineral deposition in 25 developing molar crowns of domesticated sheep (*Ovis aries*) aged 0-32 weeks. Mineral densities are

quantitatively measured using hydroxyapatite standards manufactured for this study. Comparisons of successive age classes reveals that the rates of cellular activation (extension) and maturation phases of mineral deposition are distinct, with maturation at first lagging behind but ultimately advancing more rapidly than activation. Extension rates are comparable to published rates determined from histological study. Importantly, the geometry of maturation is found to be different than that of activation and secretion. Controlled 3-dimensional planes reveal how different sequential sampling strategies integrate different periods of time during tooth formation. Furthermore, we show how optimization of anode choice and beam power, flux, and filtering improves quantification of density. While synchrotron microtomography holds greater potential for quantitative reconstruction of densities, both uCT and synchrotron imaging are powerful tools for revealing mineralization processes. Ultimately, an improved understanding of mineralization will inform sampling procedures for reconstructing seasonal processes, and contribute to our understanding of the climatic context of human origins and evolution.

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#### **Geometric morphometrics of hominoid infraspinous fossa shape.**

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<sup>1</sup>Department of Anatomy, Midwestern University, <sup>2</sup>Department of Human Evolution, Max Planck Institute.

Recent discoveries of early hominid scapulae from Ethiopia (Dikika, Woranso-Mille) and South Africa (Malapa) have motivated new examinations of the relationship between scapular morphology and locomotor function. In particular, infraspinous fossa shape has been shown to significantly differ among hominoids, but this region presents relatively few homologous landmarks, such that traditional distance and angle-based methods may oversimplify this complex, three-dimensional structure. To more thoroughly assess infraspinous fossa shape variation as it relates to function among adult representatives of *Homo*, *Pan*, *Pongo*, *Gorilla*, and *Hylobates*, we considered two Procrustes superimposition methods – one employing five homologous landmarks and another with sliding semilandmarks along the entire border of the infraspinous fossa.

The landmark-based method identified general differences in the sample that largely agree with more traditional assessments: *Homo* infraspinous fossae are superiorly broad with transversely oriented scapular spines, which distinguish them from *Hylobates* and *Pan*. However, *Pongo* approaches *Homo* in relative infraspinous breadth. In comparison, the semilandmark method offers a more complete assessment of three-dimensional fossa shape: all nonhuman hominoids possess obliquely oriented scapular spines, and the *Pongo* spine is relatively

shorter than the axillary border, effectively elongating the medial portion of the infraspinous fossa. This, in part, explains the aforementioned convergence with *Homo*, while also highlighting the fact that, like other suspensory hominoids, *Pongo* infraspinous fossae are relatively longer and narrower throughout, and obliquely oriented with respect to the vertebral border. We hypothesize that this configuration allows the infraspinatus muscle to better stabilize the glenohumeral joint during suspensory activities and postures.

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#### **Comparing forelimb skeletal anatomy in gray squirrels and primates.**

STEPHANIE A. GREEN and HERMAN PONTZER. Anthropology, Hunter College.

Studies of primate locomotor anatomy and kinematics have demonstrated that arboreal primates have highly mobile shoulder joints and use greater forelimb protraction during quadrupedal locomotion compared to terrestrial mammals; these traits are argued to reflect adaptations for terminal branch foraging and locomotion. Eastern grey squirrels (*Sciurus carolinensis*) have recently been shown to engage in terminal branch foraging similar to arboreal primates, despite a lack of orbital convergence, opposable first rays, and other primate traits. Here, we examine the skeletal morphology of the gray squirrel forelimb to test for functional convergence with arboreal primates. Morphological characteristics of the scapula, humerus, and ulna, including the size of the humeral head, the size of the supraspinatus and subscapularis facets on the humerus, the length of forelimb bones, width and angle of the bicipital groove, the spinglenoid angle and the supraspinatus facet angle, were examined in small-bodied arboreal primates and gray squirrels. Results suggest that the squirrel shoulder is similar in some ways to that of other small bodied primates, but reveal possible functional differences in the elbow.

#### **Geographic origins and diet during the Bronze Age in the Oman Peninsula.**

LESLEY A. GREGORICKA. Department of Sociology, Anthropology, & Social Work, University of South Alabama.

Stable oxygen and carbon isotope analyses represent an effective means of assessing residential mobility and diet in past populations. Dental enamel from individuals (n=120) interred in six Umm an-Nar (2500-2000 BC) and seven Wadi Suq (2000-1300 BC) tombs in the UAE was utilized to test two hypotheses: (a) southeastern Arabia's growing involvement in interregional Gulf trade during the Umm an-Nar would correspond with a more isotopically variable population, but with a purported

collapse in exchange networks during the Wadi Suq, this variability would decrease considerably, and (b) a significant shift in diet would take place over time as Umm an-Nar agro-pastoral communities became increasingly mobile coastal gatherers in the Wadi Suq.

Mean  $\delta^{18}\text{O}_c$  ratios between the Umm an-Nar ( $-2.5 \pm 0.8\text{‰}$ ,  $1\sigma$ ) and Wadi Suq ( $-2.4 \pm 0.7\text{‰}$ ,  $1\sigma$ ) were not significantly different (Monte Carlo,  $p=0.36$ ), with most individuals possessing homogeneous values indicative of predominantly local population that acquired water from isotopically similar sources. A corresponding lack of variance (Levene's,  $p=0.36$ ) implies that mobility did not change significantly over time, despite concurrent changes in social organization and trade relations. Mean Umm an-Nar  $\delta^{13}\text{C}_{ap}$  ratios ( $-8.4 \pm 2.9\text{‰}$ ,  $1\sigma$ ) suggest a broad, varied diet consisting of  $\text{C}_3$  cultivars as well as marine resources. Unexpectedly, while archaeological evidence points to increased exploitation of littoral environments in the Wadi Suq period, few contributions from maritime sources are apparent ( $-11.1 \pm 0.7\text{‰}$ ,  $1\sigma$ ), and dietary variability much more restricted, signifying an increasing reliance on  $\text{C}_3$ -based plants, possibly associated with oasis agriculture.

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#### **Complications in cross-species comparisons of joint kinematics: An example from the primate foot.**

THOMAS M. GREINER. Department of Health Professions, University of Wisconsin-La Crosse.

Kinematic analyses are often complicated by the casual creation of the reference planes used to describe the orientation of joint rotational axes. The human "anatomical position" is most often chosen as the standard referent. However, the identification of the anatomical position becomes complicated when it is based upon skeletal landmarks. Skeletal landmarks are subject to individual variation and the basis of their variation rarely coincides with the biology of joint mechanics. Therefore, comparisons of joint kinematics are confounded by variations in the reference frame. Complications are magnified when the comparisons are made between species, each of which may have different skeletal growth trajectories and natural postures that diverge from the human based standard. This presentation will illustrate this problem by comparing the orientations of rotational axes for intrinsic foot joints of three different primates.

Data are derived from a kinematic investigation of cadaveric feet in six humans, five chimpanzees and six baboons. The orientations of the rotational axes for selected joints are then described using different

reference frame constructions. Comparisons show that there is higher variation, both within and between species, when reference frames are constructed from skeletal landmarks. Undue emphasis on skeletal landmarks may therefore complicate posited interpretations of cross species biomechanical functions. These results suggest that some interpretations of the evolution of biomechanical functions may be similarly misguided.

**Oral hygiene and patterns of use in teeth of individuals of six sites in northern Caucasus dating from Eneolithic Period to Bronze Age.**

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During the last years many new burials of the Eneolithic and Bronze Age period were excavated in the piedmont area of the Northern Caucasus. There exist very few paleopathological investigations regarding the life conditions of the almost unknown North Caucasian Culture. By investigating these people's teeth information about diet, oral hygiene and use of teeth as tools in geographical and chronological diverse sites can be received.

Morphological and paleopathological examination was carried out. For differential diagnosis microphotography and scanning electron microscope were used.

Teeth were investigated in six different burial sites dating from 4200-2100 BC: Marinskaya 5-1 (34 individuals), Marinskaya 3-1 (17 individuals), Sharachalsun 6-2 (19 individuals), Rasshevatskiy 1-21 (18 individuals), Progress 2-1 and 4 (7 individuals) and Vonjuchka 1-1 (7 individuals).

So far, out of 41 adults with well preserved teeth 29 (70.7%) showed interproximal grooving. The extensive activity leads to opening of the root canals in several cases. Signs of pronounced use are the extended abrasion especially of the frontal teeth and dental chipping. Caries was not very frequent. Enamel hypoplasia was found in 63% of the individuals. Calculus occurred very frequently and in high value.

More samples especially of the Eneolithic period have to be examined, but so far no significant differences e.g. in the frequency of interproximal grooving and enamel hypoplasia are visible between Eneolithic and Bronze Age people of the same region. However, the most western located population, living in the steppe region, show less frequently interproximal grooving but more enamel hypoplasia.

**Atlantooccipital joint orientation and posture in catarrhines.**

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of Physical Medicine and Rehabilitation, Michigan State University.

The biomechanics of the atlantooccipital joint is poorly understood in non-human primates. Previous research suggests the atlantooccipital joint reaction force is directed anterosuperiorly in primates with orthograde and posterosuperiorly in primates with pronograde. Because joint morphology responds to the direction of the forces passing through it, postural differences should result in atlantooccipital joint morphologies that provide the necessary mechanical advantage to maintain joint stability.

The goal of this study was to explore the relationship between the orientation of the C1 superior articular facets and neck position in catarrhines. The morphology of the atlantooccipital joint was quantified using three-dimensional coordinate data collected manually with a three-dimensional digitizer while neck inclination data was taken from the literature. Though previous research used categorical classifications of posture, we used neck inclination to quantitatively represent neck posture because it more accurately characterizes habitually assumed positions. We hypothesized that the orientation of the posterior aspect of the facet would correlate strongly with neck inclination due to the theorized direction of joint reaction forces. The relationships were analyzed using phylogenetic comparative methods. Results do not support a relationship between the orientation of the superior articular facet and neck inclination. However, there is a moderate correlation between the anteroposterior curvature of the facet and neck posture. This relationship can be used to reconstruct posture in fossil species.

**Strepsirrhine cranial shape: A multivariate approach.**

ERIC E. GRIFFITH and LAURIE R. GODFREY. Anthropology, University of Massachusetts, Amherst.

A prior study of primate cranial diversity has suggested that strepsirrhines show less variation in cranial morphology than catarrhines or platyrrhines, and that strepsirrhine and haplorhine skulls differ fundamentally in morphology. This research did not consider the large-bodied extinct lemurs of Madagascar and thus may not have captured the full range of variation in strepsirrhine crania. To determine whether the implied unparalleled cranial diversity of haplorhines is an artifact of incomplete sampling of strepsirrhines or a real product of the different evolutionary histories of these two clades, we replicated the earlier study, but with an expanded sample for extant species, and the inclusion of extinct lemurs. The extinct lemurs included in our study are *Palaeopropithecus kelyus*, *P. maximus*, *Megaladapis edwardsi*, *Hadropithecus stenognathus* and *Archaeolemur* sp. cf. *edwardsi*.

The cranial morphology of 185 primate taxa was recorded using 3D geometric morphometric techniques. The data were scaled using a Generalized Procrustes Analysis and

described via principal components analysis. As in the prior study, the first principal component axis (PCA1) captured the differences between strepsirrhines and haplorhines, but their separation was not nearly as clean. It is the archaeolemurids (*Archaeolemur* and *Hadropithecus*), who approach the haplorhines in cranial shape and thus blur the distinctions between the two clades. Inclusion of the extinct lemurs also challenges the second main conclusion of the prior study, i.e., that strepsirrhines and haplorhines differ significantly in their degree of variation. PCA2 captures some of the within-strepsirrhine variation, which does not differ significantly from that of platyrrhines or catarrhines.

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**High incidence of supernumerary and ectopic teeth from Nuvakwewaqa (Chavez Pass), AZ.**

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Supernumerary and ectopic teeth are seldom reported in clinical contexts and described less frequently from archaeological settings. The etiology of these abnormalities is not well understood. Ongoing gross and radiographic examination of the looted and commingled skeletal remains from the Nuvakwewaqa (Chavez Pass) site (1250-1400AD) in northern central Arizona has revealed multiple dental arcades (n=9) with nonmolar supernumerary and/or ectopic teeth. This poster presents these cases and considers contextual factors that potentially contributed to the observed incidence of dental anomalies from this site.

We have only analyzed only relatively complete maxillary (n=69) and mandibular (n=92) arcades. All supernumerary maxillary teeth (n=5) are mesiodens, while all mandibular supernumerary teeth are accessory premolars (n=2). All observed ectopic teeth involve a mesiodens (n=2) or maxillary canine (n=2). While normally erupted supernumerary teeth are generally asymptomatic clinically, ectopic teeth are sometimes associated with chronic conditions (e.g. head and sinus aches) that may affect quality of life but are infrequently associated with mortality. Interestingly, all observed arcades with ectopic teeth lack fully developed third molars; thus, we consider possible evidence of pathology associated with ectopic teeth.

A limited effective population size could explain the high occurrence of the dental anomalies. However, naturally occurring environmental toxins (e.g. high arsenic content in the nearby Verde River) along with cultural practices (e.g. presence of lead in Gallina pigment) could have caused developmental perturbations that produced the abnormal traits. This study contributes new data relevant to

understanding the etiology of rare morphological variations of clinical and anthropological interest.

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**Primate paleocommunities in the early Miocene of Africa: Why are apes and monkeys so rarely found together?**

ARI GROSSMAN. Department of Anatomy, Midwestern University - Glendale, School of Human Evolution and Social Change, Arizona State University.

Monkeys dominate modern African primate communities while apes are species poor. However, in the early Miocene when modern catarrhine apes and monkeys first appear apes were very diverse while monkeys were not speciose. New fossil discoveries and recent changes in our understanding of ape and monkey systematics allow for more critical examination of early Miocene diversity. Comparisons among localities provide information about the factors that lead to this pattern. This project summarizes the primate communities of early Miocene localities and examines the taxonomic breakdown of each group at each site. Comparisons among the major localities are used to examine taxonomic diversity, habitat distributions and regional biogeography. Our data indicate changes throughout the early Miocene. In the earliest part of the early Miocene apes are diverse while monkeys are very rare and cannot be confidently assigned to any genus. Later in the early Miocene monkeys are more taxonomically diverse (*Noropithecus*, *Prohylobates*, *Zaltanpithecus*) and are found in woodland and more open habitat localities from the Turkana region and into North Africa, where they are unassociated with apes. Apes are found from Turkana and farther south in woodland and forest habitats but slightly decline in diversity. By the middle Miocene, apes continue to decline in diversity while monkeys (*Victoriapithecus*) appear farther south together with apes. Thus, it appears that monkeys and apes occupied different habitats and possibly evolved in slightly different regions of Africa. Southbound dispersion of monkeys appears associated with the opening of habitats further south and the decline of forest-adapted apes.

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**Are pygmy tarsiers phyletic dwarves? An allometric analysis of tarsier limb proportions.**

NANDA B. GROW. Department of Anthropology, Texas A&M University.

Phyletic dwarfism is a density-dependent adaptive process where lineages experience size reduction in response to resource limitations. Dwarfed lineages may exhibit allometric patterns

that are opposite from interspecific trends. This study examines whether morphometrics can clarify if the highland pygmy tarsier (*Tarsius pumilus*) is truly a phyletic dwarf. I conducted an allometric analysis of pygmy tarsier limb proportions based on standard external measurements of live tarsiers (n=61). Linear characters were standardized by log transformation or scaling the variable by the cube root of body mass. To test the hypothesis that pygmy tarsiers have distinct body proportions from other species, I used canonical discriminant analysis on scaled linear characters to generate functions that predict group membership according to "pygmy" status, species, and geographic location. Pygmy tarsiers were significantly different from other (non-pygmy) tarsier species. A stepwise variable-selection procedure selected hindlimb, upper leg, and hindfoot lengths as good candidates for discrimination, where 100% classified correctly. Further, linear regression of log-transformed mass and forelimb lengths revealed that while non-pygmy species exhibit a negative slope, pygmy tarsiers exhibit a positive slope. Canonical functions additionally discriminate between species, as well as geographic regions. These results suggest that a) tarsier species can be accurately distinguished based on limb proportions, regardless of body weights and b) pygmy tarsier limb proportions cannot be explained solely by an allometric decrease in size. Therefore, pygmy tarsier body proportions may indicate that the species has undergone an evolutionary size reduction, possibly in relation to decreased resource availability at higher altitudes.

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**Functional morphology of the human dentition and its probable influence on tooth cementum thickness and incremental line count.**

GISELA GRUPE and ANNE LIPPITSCH. Faculty of Biology, Anthropology, Ludwig-Maximilian-University Munich.

A systematical investigation of 17 premolars from the lower jaw of 13 adult human skeletons from early medieval times was performed. Focus of this study was the variability of cementum thickness and incremental line number and the relationship to their location on the cross section of the tooth root. The number of 2,280 cementum thickness measurements and 4,726 incremental line counts permitted for a statistical evaluation. Cementum thickness and line count increased significantly from the cervix to the apex of the tooth root. With regard to the quadrants of the cross section, a likewise significant increase from buccal < lingual < mesial < distal was observed.

These results are compatible with and can be explained by the functional demands and physical loads acting on the human dentition, in particular the chewing cycle, the occlusal and mesial drift. A phenomenon previously described as "cementum exuberation" was observed in the majority of investigated teeth and is hypothetically interpreted as areas of minimized physical loading.

We conclude that the functional morphology of the human dentition should largely be responsible for the observed variability in the tooth cementum. Therefore, choice of area on the cross section for the incremental line count should not be at random.

**Human rights in Colombia and the creation of EQUITAS, an independent organization for the support of victims.**

ANA CAROLINA GUATAME-GARCIA. Forensic, Colombian Interdisciplinary Team on Forensic Work and Psychosocial Assistance.

Throughout her professional career, Dr. Karen Ramey Burns was deeply committed to science and human rights. This approach to her work as a physical and forensic anthropologist, took her to several countries all over the world where she helped to strengthen the skills of local researchers for improved and more responsible scientific work.

In early 2000, two Colombian forensic anthropologists interested in forming an independent forensic organization in Colombia (South America) contacted Dr. Burns to be part of the project. The goal of the project was to provide forensic expertise to victims resulted of a serious internal armed conflict. Many regions of the country have experienced blatant human rights violations such as torture, mass killings, forced disappearances, and extrajudicial executions.

Dr. Burns accepted the invitation to be part of the project. Through her expertise, she emphasized the importance of a scientific system of review and repeatability in the context of judicial investigations. She additionally stressed the need for a victim-centered scientific approach, especially in cases involving crimes related to human rights abuses.

Dr. Burns became a founding member of the Colombian Interdisciplinary Team on Forensic Work and Psychosocial Assistance, a non-governmental forensic team that provides independent scientific contributions and psychosocial assistance to families of victims of crimes committed in the context of serious, mass or systematic human rights violations and violations to international humanitarian law.

**A glimpse of the fossil *Theropithecus* wrist.**

EMILY H. GUTHRIE. Office of Research, University of Washington, Anthropology, University of Oregon.

The hand of fossil *Theropithecus* has been relatively widely studied, however, the carpal elements are often undescribed or unidentified (Jolly, 1972; Krentz, 1993b;

Jablonski, 2002b). While carpal elements are rare in the fossil record, KNM-WT 39368, a partial skeleton of *Theropithecus brumpti*, preserves the full suite of carpal bones. For this study, the carpals were first identified and then noteworthy or functionally relevant measurements taken. The *T. brumpti* carpals were visually compared with *Papio* (*Papio anubis* and *Theropithecus gelada*). Differences, when found, were noted. Overall, carpal bones are remarkably similar within cercopithecines. However, in the *T. brumpti* carpal suite there are several features that suggest terrestriality: 1) slight medial expansion of head of the capitate, 2) beaking on the distal portion of the triquetrum face of the hamate (thereby limiting range of motion) and 3) relatively long hamate facet on the triquetrum. Whitehead (1993) described carpal features that may signal digitigrade locomotion, some of these are present in *T. brumpti*: a lack of distinction between the MCIV facet and MCV facet on the distal hamate and large and hooked hamate hamulus. Among the extant primates, only the relatively terrestrial species adopt digitigrady. These data, taken together with recent re-analyses of the *T. brumpti* postcrania further refute previous hypotheses about arboreality in *T. brumpti* and confirm probability of terrestrial locomotion.

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**Poorhouse portrait: Analysis of the burial population in a New York poorhouse and tuberculosis ward cemetery.**

ERIN GUTHRIE<sup>1</sup>, GIOVANNA VIDOLI<sup>1</sup>, DANIEL SEIB<sup>2</sup> and NINA VERSAGGI<sup>2</sup>. <sup>1</sup>Department of Anthropology, Binghamton University, <sup>2</sup>Public Archaeology Facility, Binghamton University.

The former site of the Onondaga County Poorhouse in Onondaga County, NY, was excavated as part of a salvage project, revealing an extensive early 20<sup>th</sup> century cemetery. This paper examines results from the skeletal analysis of 71 discrete burials. Placing them in a regional context with poorhouses from the same historic time period sheds light on a people whose history is often neglected due to their position in life and the circumstances of their death and burial.

Nearly one-third of the burial population are sub-adults, and the large number of children under the age of five (n=15) is consistent with pre-industrial, urban populations with poor sanitation. Sex of adult individuals is heavily skewed towards males, with seven times as many males. These proportional values are consistent with contemporaneous poorhouse cemeteries from the region. 63% of individuals in the Onondaga County Poorhouse cemetery sample displayed some form of trauma or skeletal pathology, with differential diagnoses ranging from the very common osteoarthritis to the rarer Legg-Calve-Perthes disorder. Additionally, 56% exhibited one or more dental pathologies.

The comparison of trauma and pathology incidence among the burial population at the Onondaga County site with other poorhouse cemeteries from turn-of-the-century New York state contributes to the body of bioarchaeological data for evaluating health and mortality in a particular subset of individuals. This growing portrait of their lifeways, as reflected in the skeletal remains, describes a people facing the hardship of disease, nutritional deficiency, and personal injury in life, and anonymity in death.

**Determination of ancestry in historical skeletal populations: Two case studies from French colonial sites in the U.S.**

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With its ability to address ancestry in past populations, bioarchaeology is singularly well placed to help reconstruct the multiethnic interactions characteristic of colonial settings. This project compares ancestry determinations based on skeletal morphology and mtDNA analysis at two 18<sup>th</sup> century French Colonial skeletal series: Ft Michilimackinac (20EM52), a fur trading post in northern Michigan where Europeans, Native Americans and Metis resided; and Moran (22HR511), an immigration staging site in Biloxi, Mississippi, with a predominantly European population.

Approximately 27 individuals from Moran and 33 individuals from Ft Michilimackinac were examined for a variety of standard cranial, dental, and femoral indicators of ancestry. mtDNA haplogroups were obtained for a subset in each series. Surprisingly, only one of 15 tested at Ft Michilimackinac had a Native American haplogroup. The population, however, showed highly variable expressions of most skeletal traits, including suggestions of African ancestry, with multiple indicators for an individual often in conflict. Even traits such as incisor form and zygomatic projection failed to show expected correlations. At Moran, genetic results supported a homogeneous population, but morphological traits again showed a broad range of expression, with many individuals displaying broad noses and brachycranic vaults generally unassociated with European ancestry.

Possible explanations for results include high levels of intrapopulation variation for most traits, difficulty in assessing admixture, effects of secular change on standards employed, and variable quality in markers used due to preservation issues. This suggests that ancestry assignments in past populations should be considered tentative, especially if strong corroborating evidence is not present.

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**Are socioethnic groups biologically meaningful entities? A tooth size allocation analysis of the Baltis of northern Pakistan.**

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The inhabitants of Gilgit-Baltistan, northern Pakistan self-identify as members of specific ethnic groups. However, it remains unknown whether these social constructs encompass biologically meaningful populations. In this study, we examine whether the ethnic group known as the "Baltis" represents a biologically meaningful population by testing two geographically distinct samples. Logically, if the Baltis encompass a biologically meaningful population, then these two geographically separated samples of Baltis ought to exhibit closer phenetic affinities to one another.

The biological meaningfulness of the "Baltis" was investigated through an analysis of permanent tooth size allocation among 194 Balti individuals from Partuk and 217 Balti individuals from Khaplu, the tehsil seat located 35 km northwest of Partuk. These samples were compared to 24 other samples from Pakistan, peninsular India, and prehistoric Central Asia. Maximum mesiodistal and buccolingual measurements were obtained for all permanent teeth, except third molars. Measurements were size-corrected against the geometric mean to control for sex dimorphism and evolutionary tooth size reduction. Squared Euclidian distances were calculated to access inter-sample differences in tooth size allocation. Neighbor-joining cluster analysis, principal co-ordinates analysis, and multidimensional scaling were employed to analyze patterning of phenetic affinities among samples.

Results indicate that when compared to other samples, the two Balti samples exhibit closest biological affinities to one another. Such results indicate that the ethnic identification "Baltis" represents not only a social construct, but also a biologically meaningful population. Thus, the socially defined ethnic entity, Baltis, is legitimate for reconstructing population histories of ethnic groups of northern Pakistan.

**Analysis of multi-locus sequence data indicates complex speciation in the evolutionary history of the Papionina.**

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The Papionina is a well-studied subtribe of African monkeys whose evolutionary history is of particular interest because of its geographic and temporal parallels to hominin evolution. Nevertheless, relationships among several of its constituent genera (*Lophocebus*, *Papio*, and *Theropithecus*) remain unresolved. To address

the different phylogenetic hypotheses for this group, we compiled a large (~56 kb) multilocus DNA sequence dataset that we phylogenetically analyzed using several methods including the multispecies coalescent and Bayesian concordance. These latter methods have been proposed to accurately estimate species trees in the presence of conflicting phylogenetic signal. Analyses of concatenated alignments recovered a *Lophochebus-Papio* clade with strong statistical support. However, Bayesian and parsimony analyses of individual genes revealed extremely high levels of gene tree discordance. The species tree generated by a Bayesian multispecies coalescent method supported a *Lophochebus-Theropithecus* clade, but with extremely low support values. Bayesian concordance analysis supported a *Lophochebus-Papio* clade, as in the concatenated analysis, but with low concordance factors indicating that only around a third of the genome is estimated to support this clade. This widespread incongruence—in spite of broad genomic sampling—has a number of potential causes including pervasive incomplete lineage sorting produced by rapid successive divergences and/or hybridization. We suggest that a fully-resolved, bifurcating species tree does not most appropriately reflect the evolutionary history of the Papionina. These results support the growing evidence cautioning against reliance on concatenation methods in phylogenetic analyses, as they may obscure our understanding of a group's historical phylogenetic complexity.

#### Neolithic human mitochondrial haplogroup H genomes and the genetic origins of Europeans.

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Haplogroup (hg) H dominates present-day Western European mitochondrial (mt) DNA

variability (>40%), yet was less prevalent amongst early Neolithic farmers (~19%) and virtually absent in Mesolithic hunter-gatherers. To investigate this haplogroup's significance in the maternal population history of Europeans we employed novel techniques such as DNA immortalization and hybridization-enrichment to sequence 39 hg H mt genomes from ancient human remains across a transect through time in Neolithic Central Europe.

The results of our population genetic analyses reveal that the current patterns of diversity and distribution of hg H were largely established during the Mid-Neolithic, but with substantial genetic contributions from subsequent pan-European cultures such as the Bell Beakers, which expanded out of Iberia in the Late Neolithic (~2800 BC). Using a strict diachronic approach allowed us to reconcile 'real-time' genetic data from the most common European mtDNA hg with cultural changes that took place between the Early Neolithic (~5450 BC) and Bronze Age (~2200 BC) in Central Europe. This revealed the Late Neolithic (2800-2200 BC) as a dynamic period that profoundly shaped the genetic landscape of modern-day Europeans.

Furthermore, linking ancient hg H genome sequences to specific points in time by using radiocarbon dates as tip calibrations allowed us to reconstruct a precise lineage history of hg H and to calculate a mutation rate 45% higher than traditional estimates based on the human/chimp split.

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#### Dental morphological analysis of Roman-Era burials from the Dakhleh Oasis, Egypt.

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Kellis 2 is a cemetery in the Dakhleh Oasis, Egypt, dating to the Roman period. Previous studies of skeletal material from Kellis and other oasis sites suggest that the ancient population of the Dakhleh Oasis was homogenous and inbred as a result of geographic isolation. Archaeological and textual evidence, however, indicate a record of contact with the Nile Valley since the Neolithic. Descriptive and multivariate statistical methods are employed in an analysis of heritable dental morphological variants in 186 individuals from Kellis using the ASU Dental Anthropology System. The study has two components: 1) an intra-cemetery assessment of inter-sex and inter-group morphological variation in order to identify related individuals within the Kellis 2 cemetery and provide evidence for post-marital residence patterns; and 2) an inter-regional comparison

between the Kellis assemblage and groups from Egypt, Nubia, North and Sub-Saharan Africa in order to place the oasis population within a regional context. The results of the intra-cemetery analysis indicate low levels of inter-sex phenetic variation consistent with an isolated and possibly interbred population. Spatial analysis within the Kellis 2 cemetery has tentatively identified one area containing individuals with distinctive dental trait frequencies. The results of the inter-regional comparison of trait frequencies demonstrate an overall affinity with North African populations, especially with several early Upper Egyptian and contemporary Lower Nubian groups. Despite these similarities, however, the Kellis assemblage remains relatively distinct in relation to the comparative groups. This is consistent with a geographically isolated population experiencing limited gene-flow.

#### Botanical medicines for diuresis: Cross-cultural comparisons.

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Throughout history and cross-culturally, healers have employed procedures and medicinal substances to expel toxins, poisons, evil spirits, etc. from a sick patient's body. Purging, blood-letting, sweat induction and the use of natural laxatives, expectorants, and diuretics are all prominently featured in traditional medical systems. Diuretic herbs have been frequently prescribed to rid the body of excess fluids through increased urine production, as well as for detoxification and dehydration for such conditions as high blood pressure, kidney infections, obesity, and the edema associated with premenstrual syndrome (PMS) or traumatic injuries. A survey of 92 medicinal plant shops ("botanicas") in Miami, Florida discovered 13 botanical species sold specifically for their diuretic effects. An additional 394 species used for this purpose worldwide were catalogued in the literature for a total of 407. These plants contain a number of phytochemical compounds that induce diuresis, including saponin (C<sub>27</sub>H<sub>42</sub>O<sub>3</sub>) and arbutin (C<sub>12</sub>H<sub>16</sub>O<sub>7</sub>). Research suggests that saponin ingestion is associated with reduced incidence of kidney stones, and arbutin has an anti-bacterial effect on the urinary tract. Many of the plants contain a number of flavonoids and polyphenols which also may impart therapeutic benefits for the renal system. The two main preparation methods of herbal medicines—decoction and infusion—permit the extraction and concentration of their curative bioactive constituents while simultaneously eliminating or neutralizing toxins, irritants and impurities. The most commonly utilized plant parts to produce traditional diuretic medications are leaves, stems, seeds, roots, berries, barks, saps, resins, pollens, and fruit juices.

**Investigating the relationship between endocranial volume and cranial shape in *Alouatta*.**

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Cranial shape in *Alouatta* is unique among platyrrhines and is assumed to be derived for atelids due to selective pressures from their folivorous diet, enlarged hyoid, and low encephalization, all of which are part of their energy-minimizing lifestyle. *Protopithecus*, *Paralouatta*, and *Antillothrix* have been linked to *Alouatta* based on shared small brain size and shape of the basi-occipital region, despite distinct morphology in other aspects of the skull and dentition. Tests of the "spatial packing" hypothesis suggest that relative brain size impacts cranial base angle as well as facial size. We test two hypotheses: (1) there are other aspects of cranial shape related to encephalization; and (2) it is these cranial traits that unite the "*Alouatta*-like" fossils.

To test these hypotheses, 3D landmarks were collected on laser scans of over 50 individuals representing six species of *Alouatta*. Endocranial and hyoid volumes were measured for the same individuals. Regressions were performed on the landmark data against size, sex, endocranial volume, encephalization quotient, hyoid volume, latitude/longitude, and shearing index in order to correlate aspects of cranial shape with other biological factors. Results indicate that encephalization quotient represents a relatively small proportion of the shape variability in *Alouatta*, but there are aspects of cranial variability that are uniquely correlated with this index, particularly: outline and width of the nuchal plane, posterior and lateral shape of the neurocranium, and bi-zygomatic breadth. Thus, the similarities amongst *Alouatta* and the fossils, many of which are in these regions, are potentially a product of low encephalization.

**Activity pattern can only be predicted from eye morphology for haplorhine primates among mammals.**

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As in many vertebrate groups, eye shape in haplorhine primates varies predictably with activity pattern. *Tarsius* and *Aotus*, the single nocturnal anthropoid, have large corneas relative to eye size as an adaptation for increased visual sensitivity. Conversely, diurnal anthropoids generally demonstrate smaller corneas relative to eye size as an adaptation for increased visual acuity. In this sense haplorhines are unique among mammals as several studies have concluded that most non-haplorhine mammals

exhibit eye shapes typical of nocturnal haplorhines and other nocturnal vertebrates, regardless of activity pattern. However, a recent study has argued that new statistical methods allow eye shape to accurately predict mammal activity patterns, including catemeral species. Here, we conduct a rigorous test examining primate and non-primate mammalian eye shape and activity pattern using a broad sample of species. We find that haplorhine primates is the only mammalian clade where activity pattern is clearly differentiated by eye morphology. We find that the eye shapes of catemeral non-haplorhine primates and other mammals completely overlap with nocturnal and diurnal species. Additionally, most diurnal and catemeral mammals, including strepsirrhine primates, have eye shapes that are most similar to those of nocturnal birds and lizards.

**Living on the edge: Interdisciplinarity and the future of Biological Anthropology.**

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Biological anthropology is not the only field in either the biological or social sciences that is facing an existential crisis. To a large degree this crisis, real as I believe it is, is a consequence of the growing trend towards interdisciplinarity in both of these broader spheres within which our field exists. On the one hand, this trend is healthy and will likely lead academia to greater innovation. For biological anthropology, however, this trend represents a threat because of the possibility of marginalization and the loss of the unique perspectives of biological anthropology as we integrate with larger fields. It is also a challenge, it the need broaden and intensify our training so that biological anthropologists can see and exploit productive avenues for interdisciplinary collaboration. It is critical that that leaders in biological recognize this trend for towards interdisciplinarity and realize its implications for the field. Failing to do so will see the field struggle for a shrinking share of the research funding pie in most countries and grapple marginalization within the broader academic community. Seizing the opportunities that this trend presents, however, will lead biological anthropologists to conduct more impactful and relevant research. This is also the only way to preserve a place for the unique perspective of biological anthropology in Academia.

**Acoustic determination on the dialects of wild chimpanzee (*Pan troglodytes verus*) Calls in Sierra Leone.**

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In an attempt to determine the effects of acoustic parameters on the group-specific vocalizations of chimpanzees, we undertook a project whereby we recorded and analyzed the calls of four groups of wild chimpanzees (*P.t. verus*) in four acoustically distinct areas in Sierra Leone. Concurrently, we measured the acoustic parameters of barometric pressure, average sound level, humidity, and the geometry of the habitat. Each vocalization was measured using Fourier analysis for spectral peak energy and frequency; as well as for form and duration. Preliminary data suggests that chimpanzees in areas of substantially more acoustic attenuation are accommodating these obstacles by utilizing longer vocalizations at a lower frequency. This foundational difference may be the catalyst for dialects in chimpanzee vocal communication. The implications of this data shed light on our understanding on how dialect differences may begin as a simple accommodation to acoustic pressures.

**Pattern differences in the resorption and exfoliation of deciduous teeth between captive and wild *Pan troglodytes*.**

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The degree to which captive and wild chimpanzees differ in various aspects of growth, particularly within the context of construction of growth norms for interpretation of fossil hominin life history, is a contentious issue. Past research has reported growth differences between the two; however more recent work demonstrates a substantial degree of overlap in at least dental growth. Previous studies on tooth growth largely focus on the permanent dentition of *Pan troglodytes*. This project examines the growth pattern of the mixed deciduous and permanent dentition in juvenile *P. troglodytes* in order to capture the potentially unique interactions between the two sets of teeth.

Dental x-rays were obtained from total of 110 wild-caught and 66 laboratory-reared juvenile *P. troglodytes*. All permanent and deciduous teeth were scored according to 10 point scale after Demirjian (1973), Kuykendall (1996), and Fanning (1961) that accounts for deciduous tooth root resorption and exfoliation in addition to growth of all teeth. Results obtained from data on development patterns indicates that in addition to exhibiting greater variability and increased occurrences of sequence polymorphisms overall, wild-caught *P. troglodytes* differ from their laboratory-reared counterparts in at least three ways: 1) they complete deciduous tooth growth later 2) they initiate deciduous tooth root resorption later and 3) exfoliation of deciduous teeth occurs later in the overall sequence than in their laboratory-reared counterparts. These results indicate the usefulness of methodologies that incorporate information on the mixed dentition as a whole in teasing out the finer differences of dental development between populations.

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***In vivo*-validated digital models of hip joint range of motion applied to fossil hominoids.**

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Specialization for below-branch locomotion represents a key transition, or transitions, in the evolution of the Hominidae. Suspensory locomotion has been hypothesized to require substantial hip joint mobility in order to enable abducted limb postures, necessary to negotiate the arboreal canopy. If joint mobility is tied to suspensory adaptations, and if hip joint mobility can be reconstructed for fossil taxa, hip joint range of motion estimates would provide a new tool to evaluate locomotor adaptations in fossil apes.

Here we present results of *in vivo* and *in silico* measures of hip joint abduction ability in suspensory (*Symphalangus*, *Hylobates*, *Pongo*, *Gorilla*, *Pan*, *Ateles*) and non-suspensory (cercopithecids, *Cebus*) taxa. Angular abduction at the hip was measured on anesthetized living primates using a goniometer. Pelvis and femora of the same taxa were laser scanned and 3D polygonal models were digitally articulated. Maximum hip abduction was modeled using PolyWorks software using strictly-defined morphological criteria for joint movement. These methods were then applied to fossil hominoids *Proconsul nyanzae* and *Rudapithecus hungaricus*.

*In vivo* results demonstrate that suspensory taxa have greater ranges of hip abduction than non-suspensory ones. Estimates based on the *in silico* models are strongly correlated with the *in vivo* data, validating the digital models. The early basal hominoid *Proconsul* had limited hip abduction capabilities similar to non-suspensory quadrupeds, whereas the late Miocene crown hominoid *Rudapithecus* displays a higher hip abduction capacity. This analysis suggests that there was directional selection for increased hip joint mobility in *Rudapithecus*.

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**Deciduous enamel defects: Perinatal health at Non Nok Tha, Thailand.**

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Non Nok Tha is a cemetery site in Northeast Thailand (c 3000 - 200BC) excavated in the late 1960s. The presence of pottery, rice, cattle, dogs, and a variety of wild game, suggests that a mixed subsistence regime of foraging and

rice cultivation was maintained. While it is clear that the agricultural revolution had a significant, negative impact on population health, there is also evidence that even at the transition to agriculture, when populations were still practicing a more mixed subsistence strategy, that health was compromised. To assess the impact of this mixed subsistence strategy on maternal health, as well as that of the developing fetus and infants, a reanalysis of the deciduous dentition from the 1968 Non Nok Tha skeletal series was undertaken. Enamel defects on all teeth were scored and measured using standard methods. Six of twenty individuals with observable deciduous dentition exhibited enamel defects (30%) and eleven of 134 teeth (8%). Analysis revealed that 56% of defects occurred between the 9th month of gestation and the 2nd month of infancy and that 66% of individuals exhibiting enamel defects experienced initial onset during this period of time. Additionally, 83% of affected individuals presented at least one defect within this three-month period. These data contrast with published work on agricultural groups who experienced initial onset of hypoplasia earlier in pregnancy. Our results suggest that, for those pursuing a mixed subsistence economy at Non Nok Tha, the perinatal period was a time of vulnerability for mothers and their offspring.

**Addressing the unresolved phylogeny of *Leishmania*: A next-gen and ancient DNA approach.**

KELLY M. HARKINS. School of Human Evolution and Social Change, Arizona State University.

*Leishmania*, a genus of parasites transmitted to human hosts and mammalian/reptilian reservoirs by a sandfly vector, is the causative agent of the human disease complex leishmaniasis. Despite the increasing availability of genome sequence data, evolutionary relationships within the genus *Leishmania* and its origins are the source of ongoing debate, reflected in unresolved phylogenetic and biogeographic reconstructions. Given recent epidemics and the global increase in disease incidence, sequence projects often focus on human pathogenic taxa. While invaluable for clinical research, this biased sampling strategy limits comprehensive examination on the genus level, creating obstacles for well-supported phylogenetic analyses. This project addresses the sampling bias by sequencing (Illumina HiSeq 2x100bp) thirteen new genomes, broadly representing poorly/unclassified taxa, those only found to infect reptiles and mammals, and new human pathogenic species. De-novo assembly (SOAPdenovo) is performed for four species too divergent from reference data. Coupled with previously available genomes, these new data are used in phylogenomic analyses to infer evolutionary relationships and test hypotheses about the origins and dispersal of leishmaniasis. Preliminary reconstructions using maximum likelihood and Bayesian methods with publicly available sequences indicate that missing data (species with few gene sequences) and an

improper outgroup when inferring a genus-wide phylogeny contribute to poor tree resolution. Including loci on a genomic scale with a more representative sample creates higher support of the phylogenetic inferences. The observable genetic diversity also informs the design of a *Leishmania*-specific enrichment array, currently being used to target the parasite in archaeological remains from northern Chile.

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**Environmental and dietary variation during the Dallas Phase in East Tennessee.**

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East Tennessee River Valley environmental data suggests appreciable variation in the quality and quantity of arable land and average rainfall and temperature that may have affected prehistoric maize based agricultural practices during the Mississippian Period. Dental health offers an excellent proxy for reconstructing paleodiet to examine if observed environmental differences influenced subsistence behavior during this period. Dental data was collected from skeletal samples for four East Tennessee Late Mississippian/Dallas Phase (AD 1300-1600) archaeological sites. These sites are located in different reservoirs in East Tennessee representing the greatest regional environmental variation.

Adult dentition (N=9,084 teeth) was macroscopically examined for carious lesions, dental calculus, and linear enamel hypoplasia. Results suggest regional differences in diet and morbidity among Dallas phase samples in which environmental differences may have played a significant factor. Statistical analysis indicate significant differences (chi-square,  $p > 0.05$ ) in caries rates, number of anterior teeth affected, and calculus rates that may indicate differences in carbohydrate (i.e., maize) consumption among these groups. The results of the analysis indicate a significant correlation between less arable land and average rainfall and lower caries and calculus rates. Greater frequencies of linear enamel hypoplasia recorded among the samples representing areas with the least amount of arable land and average rainfall may be suggestive of greater susceptibility to environmental perturbations and dietary stress. While most investigations dental health focus on major subsistence shifts or large scale inter-regional differences, this study demonstrates the importance of examining smaller scale intra-regional differences in diet and morbidity.

**Secular change in the knee joint and the effects of obesity.**

KATHERINE I. HARRINGTON and DANIEL J. WESCOTT. Department of Anthropology, Texas State University.

In America, there have been well-documented trends of rising obesity in the past

30 years and a steady increase in stature during the 20<sup>th</sup> century. Proposed explanations for these increases in body weight and stature include improvements in nutrition, healthcare, sanitation, and socioeconomic status, as well as reduced incidence of infectious disease during early growth. Of interest to anthropologists is how excessive body weight affects the skeletal system. The purpose of this study is to: (1) determine if there is a secular change in the articular surfaces of the knee joint, and (2) examine if secular changes in body weight are reflected in the size and shape of the articular surfaces of the knee joint. Twenty-one measurements from the femur and tibia were collected and analyzed from 174 skeletons from the Terry Collection, Bass Collection, and the Texas State Collection. Body Mass Index (BMI) was calculated for each individual. The data was then subjected to statistical analyses to determine whether there has been secular change in the size and shape of the knee and to determine if obesity is a significant causal factor. The results of these analyses indicate a secular trend in several of the dimensions, and that increases in BMI are contributing to changes in diaphyseal size ( $p = 0.000$  to  $0.009$ ) and tibia lateral condyle shape ( $p = 0.040$ ). The results of this study support a growing body of literature that indicates obesity has a significant effect on skeletal morphology.

#### **Analysis of fauna in Post-Meroitic tumuli at the Ginefab School Site, Sudan.**

JACOB A. HARRIS and BRENDA J. BAKER. School of Human Evolution and Social Change, Arizona State University.

Analysis of faunal remains from human habitation sites has long been used as a source of inference concerning the role of animals in past societies. Inclusion of faunal material is common in mortuary contexts, but it is surprisingly under-analyzed in bioarchaeological investigations. In Sudan, cemeteries have included remains from both domestic and wild animals since the Neolithic period.

To investigate how animals were used in Post-Meroitic (c. A.D. 350-550) mortuary rites, a multivariable faunal analysis ( $N=467$ ) was conducted on six tumuli from the Ginefab School site in northern Sudan. Tumuli consist of three parts—a superstructure, grave shaft, and burial chamber. The spatial distribution of faunal material differs between grave shafts and burial chambers. Grave shafts possessed 24 of 30 (80%) identifiable canid specimens, whereas 98 of 158 (62%) identifiable bovid specimens were found in burial chambers, in proximity to the human remains. This disproportionate distribution of taxa suggests different species played preferential roles in mortuary rites. In addition, skeletal element abundance and bone surface modification were analyzed macroscopically and microscopically with a Nikon SMZ1000 microscope. In burial chambers, skeletal elements with the highest meat utility index (i.e., femora and humeri) were most frequent. Of the 70 cut-marked specimens, 64 (91%) showed concentrations around epiphyseal ends, implying disarticulation rather

than defleshing. Thus, the choicest cuts of meat were intentionally interred with human remains. This study shows that faunal material can be used to investigate social dynamics, particularly concerning burial rites, and should be an integral part of bioarchaeological research.

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#### **New ways of understanding hand stencils in French and Spanish cave art.**

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Hand stencils form an enigmatic category of Upper Palaeolithic cave art. Created between approximately 27, 000 and 22, 000 years ago they can be found on the walls of deep caves in the foothills of the French Pyrenees and northern Spain. While these have been studied generally, the physical context of the stencils has rarely been discussed. We have carried out an extensive study of the stencils, recording positioning, angle and context, as well as morphometrics of each hand. We combined this with a series of experimental studies investigating the application of the pigment and the ease of placement at particular heights and angles.

Our findings demonstrate the possibility that the stencils were created by a very limited number of artists, perhaps just two individuals in some sites. Further to this, an analysis of the ratio between the second and fourth digits suggests that the artists may have for the most part been females or adolescents. Many of the stencils are found in 'association' with fissures or other features; some of the hands are positioned on bosses in the wall in such a manner that they appear to be 'gripping' the wall. In addition stencils were located deep into the caves in areas which were difficult and often treacherous to access.

We argue that the production of Upper Palaeolithic hand stencils was part of a complex, communal activity, and understanding why these stencils were made helps us to uncover the origins of ritual and symbolism in our remote past.

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#### **Cranial depression fractures of the frontal bones from a Bronze Age arabian commingled tomb.**

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Lethal violence and perimortem trauma have been a recent focus of studies, but less reporting of nonlethal (healed or healing) trauma has occurred, especially for the Bronze Age Arabian Peninsula. This research examines the presence and frequency of cranial depression fractures (CDFs) within the United Arab Emirates site of Tell Abraq. The assemblage consists of at least 286 individuals of all age groups and both sexes, from a Late Bronze Age (c. 2100 BCE) Umm an-Nar style tomb (communal chambered mortuary context). The repeated use of the tomb presents analytical challenges, as the assemblage is highly commingled and fragmentary. For example, the MNI based on cranial features (i.e. 76 glabella) are significantly lower than other elements such as the right talus ( $n=286$ ). Also, the cranial sex ratio (54.5% male 45.5% female) differs from that of post-cranial elements (65% male 35% female), suggesting differential disposal of male crania.

Analysis of frontal fragments revealed that there were 11 CDFs identified on a total of 8 individuals. Where sex could be estimated, females show 13.3% (4/30) and males show 8.3% (3/36). One unusual case of a female with 5 CDFs is highlighted. Mostly, these are small, relatively spherical CDFs (less than 35 mm<sup>2</sup> in area). One male and two females, however exhibited larger, elliptical CDFs with areas greater than 110 mm<sup>2</sup>. While CDFs can result from accidents, recent forensic research has shown that trauma to the head above the hat brim line are more likely to be the result of interpersonal conflict.

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#### **Effect of opponent distance on post-conflict behavior in wild chimpanzees, Kanyawara, Kibale National Park, Uganda.**

JESSICA A. HARTEL and CRAIG B. STANFORD. Department of Biological Sciences, University of Southern California.

Post-conflict behavior has been extensively studied in captive populations, but field data are limited. I argue that wild chimpanzee fission-fusion social structure complicates applications of captive data to naturalistic populations. In particular, distancing strategies following aggression may play a key role in wild post-conflict behavior. I hypothesized that opponent distance affects wild chimpanzees' post-conflict decisions. Specifically, I predicted that increased distance would decrease reconciliation and vice versa. This research investigated the reconciliation behavior of adult wild chimpanzees at

Kanyawara over a one-year period. I analyzed post-conflict interactions from 636 aggressive observations between 181 adult dyads. Reconciliation occurred 122 times between 56 adult dyads. Overall, the Kanyawara chimpanzees had a corrected conciliatory tendency (14%) similar to other wild populations (Mahale-15%, Tai-16%, Budongo-19%), but notably lower than their captive counterparts (ranging 22-48%). Male-male dyads had the highest conciliatory tendency (23%), followed by male-female (14%) and female-female (3%) dyads. Generalized linear mixed models determined opponent distance was the best predictor of reconciliation. Opponents within 10 meters after the conflict were more likely to reconcile than those beyond 10 meters, indicating distancing strategies influence reconciliation. Higher reconciliation rates in captivity may be a byproduct of enforced proximity. However, close proximity following aggression presented a tradeoff at Kanyawara. Data showed that opponents within 10 meters also had a higher risk of renewed aggression, but this risk greatly decreased if/after opponents reconciled. This study demonstrates the importance of space in post-conflict decisions and explains how differences might emerge between wild and captive populations.

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#### **Informed consent and building a skeletal sample.**

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From January 11, 2005, through June 30, 2006, skeletal specimens were collected from decedents of known age, sex, and race during examination at the Maricopa County Forensic Science Center (FSC) in Phoenix, Arizona. The specimens were collected for research on the estimation of age at death from the pubic bone and sternal end of the fourth rib. Consent from next of kin was obtained in compliance with the protocol approved by the Arizona State University Human Subjects' Institutional Review Board. The collection consists of pubic bones and fourth rib ends from 419 males and 211 females, ranging in age from 18 to 99 years of age at death, and remains available for future study.

While past abuses of human subjects in the name of science cannot be taken back, those atrocities have led to legislation designed to protect the rights and privacy of individuals involved in biomedical studies. Currently, these laws and regulations only cover human subjects research on living individuals; there are no federal statutes regulating research on cadavers or human tissue from deceased individuals. State laws, however, do regulate some aspects of cadaveric, autopsy, and human tissue research on the deceased, but these laws vary from state to state. This paper discusses the present laws regulating human subjects research on deceased

individuals, the concept of the Institutional Review Board, the processes of informed consent and creating a skeletal specimen collection, the state laws of Arizona regarding research on the deceased, and ethical considerations for this type of research.

#### **Scaling of forearm muscle architecture in primates.**

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The bony morphology of the distal humerus has been demonstrated to correlate with locomotor behavior. These osteological differences are thought to reflect variation in the force production capabilities of the forearm musculature, necessitated by differences in substrate interaction between locomotor groups. Muscle strength may be affected by muscle mass, muscle fiber architecture, and mechanical advantage. Previously, we demonstrated that primate forearm muscle mass scales isometrically with body mass. Here, we examine the potential relationship between locomotion and muscle fiber architecture, including physiological crosssectional area (PCSA) and fascicle length (FL), of the forearm musculature.

The sample includes six strepsirrhines, six platyrrhines and seven catarrhines. We measured wet mass (MM), linear dimensions, and FL for each antibrachial muscle following dissection. PCSA was calculated for each muscle and studied across muscles groups (flexors, extensors, and "others") using RMA regression ( $\alpha = 0.05$ ). Total forearm (TFor) PCSA is tightly correlated with TFor MM across the whole sample and within each suborder and is slightly positively allometric across the whole sample and within strepsirrhines and catarrhines (but not platyrrhines). Similar correlations and allometry between MM and PCSA are found within the flexor and extensor compartments. FL is not highly correlated with total MM variables and appears instead to relate to locomotor patterns. Thus primate forearm muscles have relatively consistent (though slightly positively allometric) crosssections, but vary according to FL, suggesting locomotor adaptations in stretch and flexibility, but not force production. Therefore variation in epicondylar anatomy instead likely relates to adaptations for mechanical advantage.

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#### **New Neanderthal remains from Kalamakia cave, Mani peninsula, Southern Greece.**

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The Kalamakia Middle Paleolithic site, a karstic cave on the western Mani peninsula, Greece, was excavated from 1993 until 2006 by an interdisciplinary team from the Ephoreia of Paleoanthropology and Speleology (Greek Ministry of Culture) and the Musée National d'Histoire Naturelle (Paris). The site is dated to between ca. 100,000 (U / Th) and >39,000 (AMS <sup>14</sup>C) kya and has yielded Mousterian lithics and rich faunal remains, including several carnivores, small vertebrates and shellfish. The site has also yielded fourteen human specimens from several layers. These include 10 isolated teeth, a cranial fragment and three postcranial elements. The Kalamakia human remains represent at least eight individuals, including two subadults. One specimen shows clear carnivore modification marks, suggesting that some of the remains were brought into the cave by carnivores. Additional, anthropogenic, modifications in the form of interproximal grooves, are present on two of the isolated teeth. The Kalamakia remains from all stratigraphic levels can be identified as Neanderthal on the basis of diagnostic morphology. A mixed habitat is suggested by our analysis of dental wear (Occlusal Fingerprint Analysis) and microwear (Occlusal Texture Microwear Analysis), in agreement with the faunal and palynological analyses of the site. These new fossils significantly expand the Neanderthal sample known from Greece. Together with the human fossils from Lakonis and Apidima, the Kalamakia human remains add to the growing evidence of a strong Neanderthal presence in the Mani region during the late Pleistocene.

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#### **Variation in running foot strike patterns in two habitually unshod Kenyan populations.**

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Endurance running probably has a long evolutionary history within the genus *Homo*, and it was not until very recently that humans ran wearing shoes. Whereas most shod runners today strike the ground with their heels first, generating a large and rapid impact force peak, recent research has found that modern unshod runners most commonly use a forefoot strike in order to avoid generating impact peaks. This finding suggests that habitually unshod human ancestors may have run in a similar way, but variation in barefoot running kinematics has been poorly studied. Here, we present the results of studies of foot strike patterns during running among adolescents and adults from two habitually unshod groups, the Daasanach (n=38) and Kalenjin (n=49) of northern and western Kenya. Subjects ran at speeds ranging from 2.15 to 6.63 m/s. Daasanach subjects used a rearfoot strike in 67% of the trials, but their percentage of mid- and forefoot strikes increased significantly with speed. In contrast, only 15% of Kalenjin subjects preferred a rearfoot strike, and in this sample, speed had no significant effect on foot strike types or angles, but soft (versus hard) substrates significantly increased rearfoot strike frequency. Analyses of variation among subjects and between groups suggest that strike patterns are influenced by multiple factors, including substrate mechanical properties, speed, training level, and running distance and frequency. These differences highlight the need for further research into the factors underlying variation among unshod populations in order to refine hypotheses about the biomechanics and evolution of endurance running.

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#### **Investigating sexual dimorphism of the mandible using 3D geometric morphometrics.**

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Numerous studies of the human cranium have indicated that the skull is not always a reliable indicator of sexual dimorphism, yet far fewer publications have utilized the mandible to examine sex differences within modern

populations. Available research of the modern human mandible shows that differences exist between sexes and ancestral groups (Berg, 2011 and Humphrey et al., 1999). This study examines the hypothesis that differing patterns of sexual dimorphism between modern American White, American Black and Thai samples can be identified by quantifying size and shape variables of the mandible using a geometric morphometric approach.

This paper examined mandibular data from American Whites and American Blacks from the William M. Bass Donated and Forensic Skeletal Collection at the University of Tennessee, Knoxville. In addition, mandibular data from the Khon Kaen University Anatomical Collection, Thailand was also included. Twenty three landmarks were digitized and recorded by both authors using a MicroScribe GT according to the methods outlined by Mckeown and Ousley (1999). Coordinate data was extracted and analyzed using MorphoJ software. All landmark data was scaled and rotated using Generalized Procrustes Analysis, and Principal Coordinate Analysis was performed on the extracted shape variables. Results indicate that patterns of sexual dimorphism based on mandibular dimensions differ between the sample populations utilized. The quantification of shape differences between males and females using geometric morphometrics indicates benefits for practitioners, in that a better understanding of patterns of variation is identified. Thus, results provide utility for anthropologists working within archaeological and forensic contexts.

#### **Sense and sensitivity in Neandertals and Denisovans.**

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Human cultural, dietary and foraging behaviors rely upon information from the senses. Primates vary in auditory sensitivities across a range of frequencies, in the number and types of olfactory receptors, in color sensitivity, and in the types of chemicals they can taste, all reflective of ecological or social requirements. Likewise, some sensory traits differ between humans and chimpanzees, or vary within and among human populations. Here I focus on the genetic aspects of sensory variation in humans and the known sensory innovations in human evolution. These include recurrent positive selection on genes related to inner ear function, losses and duplications of olfactory receptors, and allelic variants responsible for taste polymorphisms. Most nucleotide sites that differ between humans and other hominoids, or that vary among humans, are represented in ancient DNA evidence from the Vindija Neandertals and from Denisova Cave. Neandertals and Denisovans show a substantial number of olfactory receptor losses relative to humans, but comparable in scale to those found among human populations. Of those genes related to hearing that show evidence of positive selection in humans relative to the great apes, nearly all known human-specific changes are also found in the Neandertal and Denisova genomes. These

genetic observations related to the inner ear are consistent with morphological evidence from the middle ear that Middle Pleistocene people had adapted toward the humanlike condition, although not identical to the present human state. These comparisons may contribute to our understanding of the Umwelt of these ancient people.

#### **The comparative and functional anatomy of the forelimb musculature of Humboldt's woolly monkey (*Lagothrix lagotricha*).**

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Humboldt's woolly monkey (*Lagothrix lagotricha*) is a 'tail-assisted' brachiator similar to other members of the subfamily Atelinae, however that taxon more frequently engages in non-suspensory forms of locomotion (i.e. quadrupedal climbing). As a group the atelines share a suite of derived forelimb skeletal characters that are specialized for brachiation and that are convergent with 'true' brachiators (*Hylobates*, *Symphalangus*). The forelimb skeletal anatomy of *lagotricha* is similar to more suspensory atelines (*Ateles*, *Brachyteles*) and 'true' brachiators, but is typically less derived and many skeletal characters are intermediate between those forms and non-suspensory anthropoids. Although the functional morphology of the ateline skeletal forelimb is well documented, relatively little is known about the comparative and functional morphology of the forelimb musculature. Specifically, can locomotor differences between *Lagothrix* and more suspensory atelines and hylobatids be explained, in part, as a result of differences in muscle-tendon architecture?

This study provides quantitative anatomical data on the muscle-tendon architecture (muscle mass, physiological cross-sectional area, fascicle length) of the forelimbs of *Lagothrix*, *Symphalangus* and *Macaca* (n=9). Despite less frequent brachiation, the distribution of *Lagothrix* forelimb muscle mass and force is identical to similar results obtained for *Symphalangus* and with published data for *Hylobates*. Specifically, *Lagothrix* resembles hylobatids in the concentration of muscle mass and force in the flexor compartments of the arm and forearm. This suggests that despite a reduced reliance on suspensory postures and brachiation, *Lagothrix* forelimb muscle-tendon architecture may be, at least in part, a response to the minimum functional demands of brachiation.

**Morphological and ontogenetic variation in three osteological correlates of the longitudinal arch.**

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The longitudinal arch of the foot is a crucial adaptation facilitating a modern human-like bipedal gait. Certain osteological features have been argued to reflect the presence of an arch, yet our understanding of their relationship to external arch height is limited. This study uses an ontogenetic skeletal sample to test the hypothesis that these features are related to arch height. Arch height is unknown for skeletonized individuals. However, the arch is absent at birth and develops between the ages of 3-6. Therefore, individuals younger than age 6 are expected to differ from older individuals in metrics thought to be positively correlated with arch height. These metrics include the anterior inclination of the distal tibia (DTIA); the angle between the calcaneal plantar and calcaneocuboid surfaces (CCA); and the base-diaphysis angle of the fourth metatarsal (MT4BA).

Tibiae, calcanei, and fourth metatarsals of 134 individuals from the Sudanese Mis Island skeletal collection (ca. 500-1400AD) were photographed and respective measurements were made using Image J. Consistent with predictions, the CCA and MT4BA were significantly smaller in individuals aged 0-6 years compared to older individuals ( $p < 0.001$ ). While the mean DTIA was lowest for those aged 0-6 years, it was not significantly different from other age categories. This latter result is surprising given that the anterior tilt of the distal tibia has been proposed to develop as a by-product of arch development. A more thorough understanding of how these features relate to arch height is necessary for reconstructing the presence of an arch in fossil hominins.

**Trichromacy and red-hued pelages evolved independently in primates.**

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In primates, reddish pelage and red hair ornaments have evolved independently many times. It is generally assumed that these red-coat phenotypes, like red skin phenotypes, play a role in socio-sexual signaling and thus evolved in tandem with conspecific color vision. This study examines the phylogenetic distribution of color vision and pelage coloration across the primates to ask: 1) did red pelage and trichromacy co-evolve; or 2) did trichromacy evolve first, and then subsequently red pelage evolved as an exaptation? We collected quantitative, color-corrected photographic color data for 142 museum research skins from 92 species representing 41 genera spanning all major primate lineages. We quantified the ratio of Red/Green values (from a RGB color model) at 20 anatomical landmarks. We also compiled data

on color vision type (routine trichromatic, polymorphic, routine dichromatic, monochromatic) and data on variables that potentially covary with visual system and coloration, including activity pattern and body mass dimorphism. Analyzing the data with phylogenetic generalized least squares models, we found that the amount of red hair present in primates is associated with differences in visual systems, but not in the direction expected. Surprisingly, trichromatic primate species generally exhibited less red hair compared to red-green colorblind species. Thus, our results do not support the general assumption that color vision and red pelage coloration are a co-evolutionary product of socio-sexual signaling in primates. Our results have important implications for the evolution of primate coloration and visual systems.

**The use of geographic information system (GIS) software to identify and evaluate the spatial occurrence of drifting osteons in the cortical bone envelope.**

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The biological function of drifting osteons remains obscure and has been attributed to possible mechanical, metabolic or ontogenetic purposes. Capturing the spatial orientation and geometric attributes of drifting osteons may yield further insight to their biological significance. The use of geographic information systems (GIS) to analyze the spatial distribution of histomorphological features in human bone has recently been established as a promising direction in bone histology which offers a robust and flexible approach to examining the physiological function of periosteal, intracortical, and endosteal envelopes, and their respective bone microstructure. This study uses GIS software to identify and evaluate the spatial occurrence of drifting osteons in the cortical bone envelope with respect to age-at-death and sex.

Cross-sections from a sample of 90 mid-thoracic rib midshafts from modern cadaveric populations with known age-at-death were imaged using transmitted light at 100x magnification to create complete cross-sectional montages for each sample. Cross-sectional montages were individually imported into QGIS, and observations of intact and fragmented osteon were performed and manually annotated as point data. The periosteal contour, endosteal contour, intact osteons and their Haversian canals were manually traced as polygon data. A drift index was created from a minimum bounding rectangle, centroid and Haversian canal location to identify drifting osteons. A positive spatial autocorrelation for directionally drifting osteon can be identified in most cases. GIS-based method holds great promise for future research in bone histology.

**Health and disease at Ledford Island: A study of Late Mississippian human remains.**

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Late pre-Columbian agricultural populations of North America are routinely associated with chronic nutritional as well as endemic disease stress consequential to variables such as episodic agricultural shortfalls, population aggregation, social stratification, and sociopolitical change. In the Chickamauga reservoir of lower East Tennessee, the Late Mississippian period Dallas phase culture abruptly ended at the turn of the fifteenth century. It was replaced by the Mouse Creek (AD 1400-1600) culture; reflecting a fundamental sociopolitical reorganization from the previous phase. Although several Dallas phase sites have been assessed for basic health indicators (e.g., porotic hyperostosis, cribra orbitalia, linear enamel hypoplasia, periostitis), little health status information is available for Mouse Creek phase sites. The large Mouse Creek phase site of Ledford Island (40BY13) (N=441) was assessed for markers of health status by age and sex and then compared to the geographically adjacent Dallas phase (AD 1300-1400) site of Hiwassee Island. Sex differences within Ledford Island were evident in subadult-onset stress markers: males exhibit a higher rate of porotic pitting while females exhibit multiple LEH bands. The sample displays exceptionally thick, and a high prevalence of, endocranial hyperostosis. As porotic pitting and hyperostosis did not always occur in conjunction, the prevalence of porotic hyperostosis exceeds the frequencies based on ectocranial evidence alone. Nevertheless, when compared to Hiwassee Island, the multiple health indicators suggest that the Ledford Island sample is markedly less stressed.

**Tansies in the field: an odontometric assessment of orthodox perspectives on ontogenetic canalization, dental field theory, and sex dimorphism.**

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Over the last 70 years a consensus has emerged that dental development in humans is characterized by a greater degree of developmental buffering among females than males, that odontogenesis is characterized by a series of developmental fields which correspond broadly to tooth type by jaw, and that expression of sex dimorphism is uniformly expressed across adequately nourished human populations. This study tests these assumptions through assessment of mesiodistal and buccolingual dimensions of all permanent teeth except third molars among 2746 living individuals of 15 ethnic groups from South Asia. Bartlett's chi-square indicates that most ethnic groups follow the expected pattern of greater variability among males, but a

consistent minority displays the opposite pattern with greater variability among females relative to males. Dahlberg asserted that earlier developing “key” teeth within a dental field were less variable than later developing “distal” teeth, with one exception, the mandibular incisors in which the developmental field was held to have been reversed. Results obtained not only provide no support for wholesale reversal of the mandibular incisor field, but also indicate that sporadic reversals are common in all fields and corroborate Bartlett’s chi-square in demonstrating that reversals are equally common among females as males. Two-way ANOVA confirms that the two most important determinants of relative tooth size are position within a dental field and sex dimorphism, but ANOVA also reveals that expression of sex dimorphism differs in both the degree of expression and, to a lesser extent, in patterning throughout the dentition.

#### **Estimating age at death in bioarchaeology: A Rostock approach.**

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The “Rostock Manifesto” developed from a paleodemography workshop in Germany in 1999. Participants concluded that critical components to a sound theoretical approach to age estimation required Bayes’ Theorem and assessing the probability distribution of the age at death in the target population. Transition analysis, coupled with a Bayesian approach, has been suggested to better reflect the senescence changes and increase the accuracy of skeletal age estimation (Boldsen et al., 2002). However, due to the limited availability of appropriate data to use as informative priors, too few studies have been carried out in bioarchaeology.

In this study, Suchey-Brooks pubic symphysis age phases were scored on a male target sample of documented historic Italians (n=202). The resulting age estimates from this traditional approach were compared for accuracy to the estimates derived from transition analysis combined with a Bayesian approach using both uniform and informative priors. A Gompertz hazard model was applied to a comparable historic Italian sample to generate an informative prior age at death distribution. The hazard parameters were coupled with published ages of transition from the Terry Collection and Balkan genocide victims to calculate the highest posterior density regions for each pubic symphysis phase. The subsequent cumulative binomial tests at 50%, 75%, 90% and 95% indicated that the Bayesian approaches outperformed the traditional Suchey-Brooks method, demonstrating a higher probability of success at each level.

This paper strongly supports the use of transition analysis with Bayesian statistics to

estimate age in archaeological and forensic contexts.

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#### **Diagnosis and evaluation of causative factors for the presence of endemic treponemal disease in a Japanese tropical island population from the Edo period.**

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Endemic (non-venereal) treponemal disease is common in humid tropical environments throughout the world. Caused by the spirochaete bacterium *Treponema pallidum*, it is primarily spread during childhood via contact with open wounds on infected persons, although transmission can also occur via oral mucosa. Osteological signs of long-term infection include periosteal reaction in the lower limbs, as well as extensive destruction of the skeleton in advanced cases.

During the Edo period, Miyako Island, located in Okinawa prefecture, was controlled by Satsuma domain of southern Kyushu. Historical accounts suggest that the lifestyle of inhabitants was affected two-fold – in one hand being exploited for their labor and strategic proximity to the Chinese mainland and in another, because their distance from the political center would have translated into reduced economic returns for the population.

Survey of skeletal remains at the Nagabaka site, which dates to this period, has yielded convincing evidence of treponemal infection. Known geographical spread as well as diagnosis via morphological comparison with available paleopathological literature point to yaws (*T. pallidum* ssp. *pertenue*) as the pathogen likely present at the site. Furthermore, incidence of cribra orbitalia at the site provides evidence that health during childhood was possibly affected by poor diet or an unsanitary environment.

Our research presents a case study of treponemal disease at the Nagabaka site and briefly evaluates socioeconomic factors that the island underwent under Satsuma rule. Our findings contribute to a better understanding of the relationship between disease and inadequate living conditions, possibly exacerbated by repressive political rule.

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#### **The correlation of skeletal and molecular data: Concordance of cranial, dental, mitochondrial DNA, and Y-Chromosome DNA.**

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Genetic and craniometric data have previously been shown to be in concordance with each other, suggesting that they both express the same microevolutionary forces (Relethford, 1994, Gonzalez-Jose et al., 2004). However, peopling of the New World studies often differ in opinion about using molecular data vs. osteological data, as they appear to demonstrate differing patterns. The purpose of this study is to utilize nonmetric and metric cranial data, dental data, mtDNA haplogroup frequencies, and y-chromosome allele frequencies to ascertain microevolutionary patterns related to peopling of the New World.

The craniometric and nonmetric data were collected by the second author (TH) and the molecular data was obtained through previously published research. To best approximate each other, the molecular and skeletal data were taken from similar populations and regions. These populations include Inuits from Alaska, Asia, Canada, and Greenland, along with a sample of Aleutians. Kinship, R matrices, and distance matrices were obtained. Mantel tests were performed to assess the correlation between data sets, as well as Procrustes analyses. The statistics demonstrate significant correlations, some being 90% or higher, between the R matrices and kinship matrices. Thus, when investigating populations with multiple lines of biological evidence, differences may be attributable to sampling error and disparities in population composition, rather than disagreement of data types. In relation to peopling of the New World, interpretations should focus on reconciling the evidence from different data types, rather than discounting their ability to model population affinities.

#### **Examination of Archaic Period craniometric variation in the Middle Tennessee River Valley.**

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Examination of the biological variation of Early Holocene populations in the Eastern Woodlands is a critical area of study especially in reference to understanding the transition from Paleoamerican to Archaic populations across the western hemisphere. A dearth of well-preserved Paleoamerican burials in the Eastern Woodlands has made interpretations of the relationship to western northern hemisphere Paleoamerican

samples difficult. The Archaic Period samples in the Eastern Woodlands, as compared to the Paleoamerican specimens, are geographically well distributed with extensive collections in Alabama, Florida, Kentucky, and Tennessee and temporally well represented throughout the early to middle Holocene.

In this study three-dimensional coordinate craniometric data from various Archaic Period samples from the mid-continent and Florida is examined in reference to new data from Dust Cave (1LU496) and Russell Cave (1JA940). These two Archaic Period sites represent key locations in the Middle Tennessee River Valley which has a well-documented Paleoindian artifact history and extensive Archaic Period occupation. These sites have provided significant archaeological data. Material from Russell Cave helped define the Archaic Period in general and with Dust Cave aiding in our understanding of the Paleoindian to Archaic transition. Interlandmark and three-dimensional coordinate data will be examined within a quantitative genetics and landmark-based geometric morphometric framework in an attempt to understand the variation observed in these new samples relative to the larger region. The present analysis will be compared to other regional studies of Archaic Period samples based on dental morphology and other anthropometric methods.

**Pattern of facial and brain anatomical asymmetries in adult eastern lowland gorillas (*Gorilla beringei graueri*).**

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Both external and internal brain anatomical asymmetries have been shown not to be unique to humans. In 1973, Groves and Humphrey suggested that facial directional asymmetry (DA) could be indicative of asymmetric function in eastern gorilla's brain, whether the facial asymmetry was directly related to anatomical asymmetry of the cerebral hemispheres or the consequence of asymmetrical chewing behavior. Here, we quantify the asymmetry of the middle and lower facial skeleton of adult eastern lowland gorillas (*Gorilla beringei graueri*) to determine the presence or absence of directional asymmetry. These results are compared with those obtained by Balzeau and Gilissen (2010) on brain anatomical asymmetries for the same specimens. Three-dimensional landmark coordinates were recorded on CT images of 32 *G. beringei graueri*. Using two different methods, namely Procrustes ANOVA and Euclidian distance matrix analysis, our results suggest the presence of significant fluctuating asymmetry and the absence of significant DA in the facial skeleton of *G. beringei graueri*. A negative correlation was found between the direction (left-right) of middle and lower face asymmetries. We also found an association between brain anatomical

and facial asymmetries for the supero-inferior and antero-posterior dimensions. That is, the same side of the brain and face was more superiorly or inferiorly projected with even proportions for the left and right sides, while the right side of the brain and face was more often anteriorly projected than the left side. These results support previous reports of a relationship between brain and facial anatomical asymmetries in *G. beringei graueri*.

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**Effects of limb proportions on sloped terrain locomotion.**

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The consequences of limb length proportions on the locomotor economy of fossil hominins have been widely discussed. Studies relating limb length proportions to locomotor efficiency have focused on movement over flat surfaces. However, natural terrain is not flat and the geographic ranges of many fossil hominins contained sloped terrain. Theoretical models suggest that changes in terrain slope may have major effects on the relationship between limb proportions and gait kinematics (step length, joint excursion), and by extension, locomotor efficiency. These models predict that, unlike on level surfaces, locomotor cost will increase during uphill walking with a relatively longer distal lower limb segment and during downhill walking with an increase in total lower limb length.

This study tests these models using experimental methods applied to a sample of human subjects ( $n = 10$ ). Metabolic energy expenditure ( $\text{Jkg}^{-1}\text{m}^{-1}$ ) was evaluated during level, uphill, and downhill treadmill walking using a range of speeds for each condition and a ParvoMedics TrueOne2400. Results support the models and suggest 1) a significant relationship between relative distal lower limb segment length and uphill walking cost, and 2) a near-significant relationship between total lower limb length and downhill walking cost. Additionally, total lower limb length was positively correlated with uphill walking cost, and total lower limb length and limb proportions were found to have little effect on locomotor cost during level walking. These results suggest that the effect of limb length proportions on locomotor efficiency differs considerably on level and non-level surfaces.

**The costs of seasonal reproductive effort in Cayo Santiago male rhesus macaques.**

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Males of seasonally breeding mammals incur specific seasonal costs associated with mating activity and competition. Our studies of male rhesus macaques on Cayo Santiago have

aimed to elucidate these costs in a seasonally-breeding primate by integrating behavioral observations, physiological markers, morphometric variables, and life-history data. Here I synthesize these results to present an integrated picture of male seasonal reproductive costs. During the birth season, males have low androgen levels, and spend large proportions of time resting and feeding. This helps them build good physical condition, as assessed by high levels of urinary C-peptide of insulin (UCP), and high levels of body fat at the end of the birth season. During this time male mortality is low relative to female mortality. The mating season sees behavioral changes as males drastically reduce feeding and resting time to engage in mating activities, including consortships and serial mount copulations. These behavioral changes are associated with large increases in androgen levels and are demonstrably energetically expensive, with those individuals undertaking more mating exhibiting lower UCP levels. Rank instability during this period is rare, but when it occurs it brings specific costs to high ranking males, who experience elevated androgen and glucocorticoid levels compared to low ranking individuals. Probably as a consequence of these dynamics males experience high mortality relative to female mortality in the mating season; the inverse of the birth season relationship. These sex-specific costs of seasonal reproductive effort help to elucidate the basic differences in how male and female mammals compete.

**Sexual differentiation in humeral bilateral asymmetry during the Late Holocene at Roonka Flat, South Australia.**

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The Roonka skeletal population from South Australia is comprised of individuals from three distinct phases (Roonka II, IIIa, and IIIb) that broadly correspond to the Early, Middle, and Late Holocene. Sites throughout South Australia indicate that the relatively wet climate of the Early Holocene gives way to drier conditions in the Late Holocene. The accompanying environmental effects of this climatic shift would have caused a corresponding shift in human behavior and subsistence strategies. There is also palaeodietary and archaeological evidence that sexual differentiation became more pronounced during the Late Holocene as populations became denser, especially along the Murray River. Since the Roonka population covers a large portion of the Holocene, it provides the ability to test these assumptions. This study's objective is to compare trends in upper limb asymmetry between these phases to search for differing adaptive strategies to a changing climate and sexual differentiation in activity patterns. Circumference and diameter measurements were

taken on the humeri and ulnae of individuals with both sides present to determine the extent of asymmetry. Results show similar levels of upper limb asymmetry across all phases, but during the Late Holocene (Roonka IIIb), there is a marked difference between male and female asymmetry. Since asymmetry indicates differential use of the respective limbs, it is likely that during the Late Holocene males and females were performing different tasks. This evidence for sexual differentiation supports the hypothesis that Australian populations along the Murray River became denser and more stratified during the Late Holocene.

*This research was funded by Texas Tech University.*

**Does personality matter? Early life behavioral phenotype and subsequent survival, growth, and reproduction in female rhesus macaques.**

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Individual differences in stable behavioral phenotype (e.g. “personality,” “temperament,” “behavioral syndromes”) have been increasingly recognized to influence fitness parameters in numerous animal species, including humans and other primates. Our previous research suggested that infant macaques calibrate their behavioral phenotype to milk energy available from the mother; more milk energy predicted better coping and greater Confidence. We hypothesized that under conditions of limited milk energy, infants preferentially allocate energy to survival and growth rather than behavioral activity. Here we follow-up by investigating fitness outcomes as a function of behavioral phenotype among female rhesus in the outdoor breeding colony at the California National Primate Research Center from 2001-2009 (N=567). In infancy, subjects underwent a 25-hour standardized bio-behavioral assessment (BBA) to investigate responsivity to stressful challenges; measures included subjective temperament ratings and objective behavioral data. We constructed multiple regression models using AIC for model selection to analyze whether factor measures of behavioral phenotype predicted survival to reproductive maturity, growth, and age at first viable birth. None of the measures were associated with survival, however infants characterized as more ‘Gentle’ (temperament factor reflecting ratings of calm, flexible, curious, and gentle) had higher daily weight gain ( $p=0.014$ ). Additionally females who displayed an active coping style during BBA as infants successfully produced their first viable infant at younger ages ( $p=0.05$ ). Of particular importance, analyses controlled for maternal social rank. These results suggest that behavioral organization during early development has consequences for growth throughout juvenility and initiation of the reproductive career even in a well-fed captive population.

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**Locomotor kinematics of two semi-wild macaque species (*Macaca assamensis* and *M. arctoides*) in Thailand: A preliminary report.**

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The global goal of this project is to noninvasively study primate locomotor kinematics in the wild environment using advanced apparatus and techniques. In this preliminary study, we tried to develop the methods for such measurements in a semi-wild environment. The Assamese macaques (*Macaca assamensis*) at Wat Tham Pla, and the stump-tailed macaques (*Macaca arctoides*) at the Khao-Krapook-Khao-Taomor non-hunting area, both in Thailand, were chosen as the subjects because although they are originally wild, they are now living around the temple, being partly provisioned by humans. We recorded their positional behavior by using two video cameras, and estimated kinematic parameters during terrestrial quadrupedal locomotion. Limited data analyzed so far revealed that both species walked with greatly protracted forelimb and retracted hind limb postures, as compared with Japanese macaques. The stump-tailed macaque did so to increase stride length, and the shoulder girdle largely contributed to that. Their digitigrade gait and extended elbow joint suggest that this species is well-adapted to terrestrial locomotion, in which longer stride is one of the important factors. The gait of the Assamese macaques, on the other hand, did not seem to be optimized to terrestrial locomotion; their hands were often used in palmigrade postures, and were more abducted than those of the other two species. We postulate that protracted forelimbs and retracted hind limbs may be related to their cliff-climbing, in which it is important to keep the center of body mass close to the cliff.

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**A new 1 million-year-old hominid distal ulna and other 2012 fossil discoveries from Olduvai Gorge, Tanzania.**

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The Olduvai Vertebrate Paleontology Project recovered close to 400 specimens during the course of our 2012 field season at Olduvai Gorge, Tanzania. We focused our collection

mostly on the eastern part of the main Gorge. These fossils were recovered primarily from Beds I, II, and III. All of these fossils are catalogued in the online Comprehensive Olduvai Database Initiative at [www.olduvai-paleo.org](http://www.olduvai-paleo.org), including photographs. The mammalian part of the assemblage includes, Artiodactyla: Bovidae n=195, Giraffidae n=6, Hippopotamidae n=8, Suidae n=12; Carnivora n=21; Insectivora n=1; Perissodactyla: Rhinocerotidae n=6, Equidae n=66; Proboscidea: Elephantidae n=2, Deinotheriidae n=1; Rodentia: Hystricidae n=1.

The primate fossils are primarily Cercopithecidae, including a right mandibular fragment of *Theropithecus* with P3-M3 from Upper Bed II. A primate distal ulna was recovered from Bed III sediments on the north side of Main Gorge, immediately west of the Third Fault (~4.7 km from the junction). The age of these sediments places this specimen at approximately 1 million-years-old. This ulnar fragment preserves the distal end of a fairly robust adult, with a styloid process and extensor carpi ulnaris groove characteristic of the Hominidae. These two fossils and some of the other more complete fossils we discovered will be discussed.

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**Using a howler monkey hybrid zone (*Alouatta pigra* x *Alouatta palliata*) to understand social variation.**

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Natural hybridization occurs in several primate taxa, but primate hybrid zones remain relatively understudied, despite having the potential to offer insight into both causes and consequences of phenotypic variation. To analyze the causes of variation in social behavior, I examined proximity in two species of howlers and their hybrids: *Alouatta pigra*, *Alouatta palliata*, and *A. pigra* x *A. palliata* (respectively located in the Mexican states of Campeche, Veracruz, and Tabasco). Work in pure populations has shown that *A. pigra* maintain higher proximity than *A. palliata*, but we do not know how genetics, ecology, and other social factors (e.g. the smaller groups of *A. pigra*) contribute to this difference. Here, I compared spacing patterns across species ancestry, location (a proxy for environmental disturbance), group size, and sex in 17 groups of howlers (*A. pigra* = 3, *A. palliata* = 3, *A. pigra* x *A. palliata* = 11) using 10,175 scan samples recorded in 2011 and 2012. On average, *A. pigra* female-female and female-male dyads were significantly closer together than the same dyad types in *A. palliata* or hybrids. Interestingly, hybrid proximity overall resembled *A. palliata*, even though the sample contains an even mix of *pigra*-like and *palliata*-like hybrids, and the hybrid zone is more highly disturbed than the two purebred sites. Further analysis revealed that group size explains some of the similarity

(smaller groups are closer); however, after controlling for group size, ancestry continued to have an effect. These results are consistent with a genetic basis for certain behavioral differences.

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#### **Bioarchaeological investigations at Fernvale, a Middle Tennessee Archaic site.**

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The multicomponent Fernvale Site (40WM51), in Williamson County, Tennessee, yielded a small human skeletal sample of 32 individuals from an Archaic Period cemetery. A full bioarchaeological assessment of the remains was conducted according to standards for data collection set out by Buikstra and Ubelaker, supplemented by a narrative approach to recording paleopathological information. Our analysis identified three notable, yet contradictory, features of this sample: 1) extreme asymmetrical dental wear and robust cranial muscle markings, 2) strongly-developed lower extremities and degenerative joint disease of the spine, and 3) trophy-taking in two adult individuals. The great degree of dental wear and robust lower bodies are atypical of Archaic populations within the Mid-South, and suggest the Fernvale people may have engaged in a lifestyle or occupation not shared by contemporaneous regional populations. However, the practice of trophy-taking places the Fernvale people squarely within a cultural tradition found throughout the Mid-South during the Archaic period. We conclude that the Fernvale people were participating in cultural practices typical of a broader cultural tradition, while tailoring their lifestyle and economy to the narrower ecological niche in which they had settled, and that both of these decision-sets impacted their health and welfare as viewed from the perspective of the human skeleton. This dual-scale adaptation signals the diversity of Archaic period social systems, and echoes an emerging consensus among archaeologists regarding the complexity of Archaic societies.

#### **A radiogenic strontium isotope analysis of Neandertal prey movement patterns in the Dordogne Valley of France.**

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Did climate change impact local Neandertal habitats, and if so, what impact did these climatic shifts have on Neandertal life-ways? Understanding the migratory behavior of Neandertal prey species offers a window for tracking the impact of environmental changes on the local habitats. It is known that the migratory behaviors of herbivores are dictated by the food resources available and thus tied to the local environment: generally, populations of woodland

ungulates migrate less than tundra and grassland ungulates. Therefore, using radiogenic strontium isotope analysis, this study aimed to reconstruct the mobility patterns of Neandertal prey based on the teeth of fauna recovered from the sites of Pech de l'Azé IV and Roc de Marsal located in the Dordogne Valley of France. It has been observed that modern humans and carnivores that hunt migratory species are more mobile than hunter-gatherers and carnivores that hunt less migratory species. Thus, understanding if herbivores changed mobility patterns in differing climatic cycles is critical for understanding how Neandertal hunting behaviors and movement patterns changed with warm and cold climatic oscillations. Results from this study indicate that Neandertal prey species within the Dordogne Valley of France did not undertake long distance migrations in glacial or interglacial cycles. Reindeer stayed within the sedimentary basins of France, and bison moved very little and would have been available to hunt year round. These results suggest that Neandertals may have been more sedentary or regionally nomadic, living in small family groups, similar to recent hunter-gatherers who inhabited boreal forest environments.

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#### **Natural selection acts to maintain diversity between Out of Africa and sub-Saharan African populations in genes related to neurological processes and brain development.**

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The Yemeni and Mozabite are closely related Out of Africa (OOA) populations from the Arabian Peninsula and North Africa respectively, while the Maasai are a sub-Saharan African (SSA) population. Using genome-wide SNP data (publicly available for the Mozabite and Maasai, and collected here for the Yemeni) we show the Yemeni to have ~7% and the Mozabite to have ~26% recent sub-Saharan admixture, while the Maasai have ~27% Middle Eastern admixture. We use an adaptation of the locus specific branch length method to look for the effects of natural selection on alleles introduced to the three populations through admixture. We specifically look for 1) the adaptive introgression of alleles from SSA into the Yemeni and Mozabite, 2) the adaptive introgression of alleles from OOA into the Maasai, 3) purifying selection of SSA alleles out of the Yemeni and Mozabite, and 4) purifying selection of OOA alleles out of the Maasai. We found correspondence in patterns of adaptive introgression and purifying selection between the populations for 18 genomic loci, all of which

contain protein-coding genes. The correspondence in signatures of selection between three independent populations is strong evidence for natural selection, rather than the false positive signals common in genome-wide scans of selection. Strikingly, of the regions where purifying selection is acting to maintain diversity between the Out of Africa and sub-Saharan African populations, eight out of twelve genes with known ontologies are involved in neurological processes or brain development. A binomial test found this enrichment to be significant.

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#### **The decline of tuberculosis: A study of mortality rates.**

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Tuberculosis (TB) was a major cause of mortality in Europe during the 16<sup>th</sup> century and is re-emerging again in developing countries at present. This re-emergence is associated with the HIV/AIDS epidemic as well as developing drug resistance of the *Mycobacterium*. The aim of this study was to determine the non-drug-therapy related factors in the initial decline of TB in Europe and the United States during the 19<sup>th</sup> and early 20<sup>th</sup> centuries prior to the introduction of chemical therapies including antibiotics. We examined unpublished records from archives in Zürich, Switzerland covering the period 1840 - 1933 and compared the results with data from the literature for England and Wales, New York (United States), Japan, Brazil and Sierra Leone. Mathematical fitting showed the mortality rate followed a substantial logistic decline through time in Switzerland, England and Wales and the United States. The major decline of TB mortality occurred well before mid-20<sup>th</sup> century, from 370 per 100,000 in 1867 to 116 in 1931 for Switzerland. Analysis including historical dates corresponding to important events in the control of TB showed that milk quality was an important factor in the decline. Sanitation was also important while the introduction of chemical/antibiotic therapy was of minor relevance (mortality decline from 77 per 100,000 in 1946 to 35 in 1951 for Switzerland). Implementation of sanitation and milk control may aid in the treatment and control of TB in high-burden countries at present.

#### **Metopism and early human brain evolution.**

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A recent article by Falk *et al* (2012) has claimed that the presence of a metopic suture and

an open anterior fontanelle on the Taung natural endocast indicates that the species *Australopithecus africanus* was undergoing prefrontal neural reorganization. They speculate that this reorganization is demonstrated by prefrontal outline widening, but do not show any convolutional changes that would mark such a neural reorganization. Instead, the authors speculate that these changes were probably necessitated by some adaptation to a "pelvic dilemma". We show here that the Taung natural endocast does not show these metopic and fontanelle features, and that the prefrontal widening suggested for *A. africanus* is exceeded by bonobos and chimpanzees with smaller brain sizes. A careful examination of their Supplementary Data table claiming to have shown metopic sutures/anterior fontanelles in many early *Homo* endocasts indicates that most of the signs of metopic sutures are confined to the glabellar region of the frontal bone. Additional studies are being undertaken to settle the issue of metopism and fontanelles in the Taung specimen, and other early hominins.

**Tooth root and crown surface areas have different allometric relationships associated with diet in cercopithecines.**

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Scaling relationships among molar surface areas and their relation to dietary habits are an important focus in primate evolutionary studies. Recently, it has been proposed that root surface area (RSA), as opposed to crown surface area (CSA), directly reflects selection for heavy loading regimes. It was also suggested that RSA is susceptible to selection pressures independently of CSA. I hypothesized that: 1) within primate taxa displaying durophagous (*Cercocebus*, *Lophocebus*) or non-durophagous diets (*Macaca*, *Papio*), RSA scales isometrically with mandibular strength; 2) RSA is disproportionately larger in durophagous groups; and 3) RSA and CSA scales differentially among dietary groups. CT scans of each primate (n=47) were used to measure RSA and CSA for both Pm<sub>4</sub> and M<sub>1</sub>. Mandibular strength (Z<sub>x</sub>, Z<sub>y</sub>) was calculated posterior to each tooth. RMA regressions were used to test scaling patterns among these properties.

RSA was significantly correlated ( $r > 0.67$ ;  $p < 0.05$ ) and scaled isometrically with mandibular strength in all genera except *Lophocebus* ( $p = 0.184$ ). *Cercocebus* possessed disproportionately large RSA values, as expected. *Lophocebus*, however, is primarily an incisal loader which may explain unexpectedly low RSA values. These results support RSA as a predictor of dietary behavior. CSA and RSA regression correlations were only significant ( $p < 0.001$ ) for non-durophagous groups, suggesting independent selection of RSA and CSA. This project further highlights the need to consider unique species-specific patterns when investigating adaptive influences on the masticatory complex. It also suggests that scaling relationships within dentition are

complex, and future analyses should explore separate selective influences on molar crowns and roots.

**Predicting subgroup size in a lemur with high fission-fusion dynamics.**

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A growing number of primate species have been noted to live in social groups with low cohesion (i.e., high fission-fusion dynamics), yet the proximate causes for subgrouping dynamics remain obscure. The most frequently cited explanations for group fissions are ecological; species that feed on high-quality patchily distributed resources form small foraging parties to avoid intragroup competition. Here we investigate potential environmental influences on subgroup size in two social groups of black-and-white ruffed lemurs (*Varecia variegata*) at Kianjavato-Vatovavy, Madagascar. Focal individuals (N=17) were followed for 2-hour periods (N=192) during Jun-Aug 2012. Group membership, focal individual behavior, tree diameter, and phenology were recorded using instantaneous sampling at the start of each follow, and whenever group size changed. Climatic variables were collected on a daily basis. We conducted a multiple regression model to determine which independent variables best predicted subgroup size in this species. The model that explained the greatest percent of the variance in subgroup size (R-squared=0.0947,  $p = 0.006$ ) included tree diameter, behavior, maximum daily temperature, daily precipitation, phenology, and site variables. Tree diameter and behavior were the only variables accounting for a significant proportion of the variation in subgroup size ( $p < 0.05$ ). These results suggest that ecological factors, including food availability and climate, may influence fission-fusion dynamics in this species. Additionally, behaviors (e.g. social interactions) vary in tandem with subgroup size. Further research should address how seasonal changes in climate and food availability influence subgroup size in this species.

**Three-dimensional moment arms and architecture of chimpanzee (*Pan troglodytes*) leg musculature.**

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Knowledge of the moments produced by the muscles controlling ankle motion is critical to understanding the locomotor biomechanics of chimpanzees. During locomotion, moment arms can change considerably depending on joint position, altering joint moment-producing

capabilities. While three-dimensional (3D) muscle-tendon unit (MTU) moment arms are well documented for the human ankle joint, little comparable data exist for chimpanzees. Here, we report measurements from chimpanzee specimens of the 3D moment arms and muscle architecture for 11 leg muscles that act about the ankle to move the foot.

We partially dissected the right hind limbs of two adult, cadaveric chimpanzees (body masses: 63.4 kg and 81.3 kg), and mounted each specimen in a custom-built jig. A 3D motion-capture system simultaneously tracked MTU excursion and hind limb markers as we moved the knee and ankle through their full ranges of motion. We used MTU excursions and 3D joint displacements to calculate plantarflexion-dorsiflexion and inversion-eversion moment arms for 11 MTUs crossing the ankle. We also measured muscle mass, fascicle length, and pennation angle.

MTUs tend to achieve maximum moment arm lengths when the foot is near neutral position, with lengths typically decreasing in a nonlinear manner as the foot moves into larger plantarflexion-dorsiflexion and inversion-eversion angles. This finding suggests that larger muscle forces will be required to counter a given joint moment in behaviors that involve extreme ankle positions, such as climbing. Compared to humans, chimpanzees have relatively short plantarflexor and dorsiflexor moment arms. Muscle architectural data are generally consistent with those reported previously.

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**Ontogenetic scaling of the human nasal capsule using a longitudinal sample.**

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Recent studies of the adult human nasal region have documented key differences in nasal capsular form between males and females. These differences are potentially tied to sexually dimorphic differences in body size and energetics. As such, absolute and relative increases in male nasal capsular size are thought to allow for greater oxygen consumption to meet greater daily energy expenditure relative to females. If nasal capsular size is developmentally linked to body size and energetics, we would predict that the sexual dimorphism present in adult nasal form is manifest via different scaling relationships between the nasal capsule and the postcranium during ontogeny. To examine potential male-female scaling differences in nasal capsular size relative to body size, we utilized a combination of cephalometric and anthropometric measurements taken from the Iowa Growth Study at The University of Iowa. We examined male (n=20) and female (n=19) growth allometries of nasal capsular size and facial size relative to upper body dimensions from ages 3-20+ (n=290 total observations).

With respect to facial size, there was no significant difference in reduced major axis regression slopes between males and females ( $P=0.08$ ). In contrast, nasal capsular size in males was characterized by significantly greater positive allometry relative to females as evidenced by significantly different regression line slopes ( $P<0.001$ ). Thus, as body size increases, males exhibit a disproportionately larger nasal capsule during ontogeny indicating that aspects of nasal capsular size are linked to sexual dimorphism in body size and are potentially associated with differences in oxygen consumption and energetics.

**The legacy of Dr. Karen Ramey Burns: A focus on the individual.**

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Karen Ramey Burns leaves behind a remarkable legacy as a forensic anthropologist and bioarchaeologist. Internationally, she participated in successful prosecutions against military dictatorships and helped establish international forensic teams, empowering individuals to investigate crimes within their own countries. As a professor, she instilled a strong ethical approach and trained students equally competent in osteology as in legal testimony. Burns demonstrated an ability to look outside the box, while maintaining an emphasis on what was truly important, identification of the remains of each unknown individual. Two examples of this emphasis on the individual include the investigation of the Raboteau Massacre in Haiti and the historical investigation of Casimir Pulaski, the Polish-born American Revolutionary War hero. In the case of the Raboteau Massacre that took place during the military dictatorship in 1994, resources were limited for the presentation of evidence in court. This did not deter Burns, she not only brought in the skeleton to the courtroom, she brought in the door from the individual's home, using the rusted key found in the pocket of the victim to unlock the door. This was the first use of physical evidence in a Haitian court and led to the successful prosecution of many perpetrators of human rights abuses, including military leaders. In the historical case of Casimir Pulaski, Burns revealed something that even his contemporaries had not known; Pulaski had in fact been born a female. With a careful analysis of the skeleton and further investigation into historical records, Pulaski's true identity was revealed.

**Hunter-gatherer resilience after the agricultural transition in prehistoric Kyushu, Japan.**

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The diverse cultures of the Jōmon period of Japan (ca. 14,500-300 BCE) and their detailed archaeological and odonto-skeletal records have great potential to help us understand the resilience of modern hunter-gatherers in the face of major social and ecological changes. We argue that odonto-skeletal health serves as a proxy for assessing the resilience of prehistoric human populations in the face of social-ecological transformation. In this paper, we provide the first comparative analysis of the skeletal health of northwest Kyushu populations from the hunter-gatherer Jōmon period into the agricultural Yayoi period with a particular focus on resilience. Archaeological data indicate a persistent and autonomous Jōmon population into the Yayoi period in northwest Kyushu; thus, we hypothesize there will be little change in population health status across time. To test this hypothesis, we assessed the health of individuals from six sites in northwest Kyushu. All indicators except porotic hyperostosis and individual caries rate do not differ significantly among Jōmon and Yayoi periods; however porotic hyperostosis variation is likely attributable to inter-site variation and individual caries rate variation in the Late/Final Jōmon is likely a statistical artifact. What further light has this shed on the Jōmon-Yayoi transition in northern Kyushu? Despite a potential disruption to culture from immigrant agricultural populations to Kyushu, local hunter-gatherer health did not change significantly over time. Using odonto-skeletal health as a proxy of resilience, we believe prehistoric hunter-gatherers of Kyushu were resilient to change.

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**The evolution of Africa's domestic cattle: Evidence from complete mitochondrial genomes of modern and archaeological specimens.**

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That domesticated cattle were a significant component of African food-producing lifeways by about 7000 years ago is uncontroversial. Their origins, and their subsequent evolution as they settled across much of the continent remain poorly understood. To contribute to our understanding of the spread and development of Africa's indigenous cattle we have sequenced complete mitochondrial genomes of archaeological cattle from the Iron Age deposits in the Shashe-Limpopo River Basin and their likely descendants, modern southern African Nguni cattle.

Elaborating on a pattern found by Bonfiglio et al (2012) among Egyptian and Ethiopian cattle, we demonstrate a significant reduction in mitochondrial lineage diversity

among southern African cattle compared with those further north. This pattern is likely a consequence of serial founder effects at play as cattle moved south through the continent. Despite other evidence of Indian cattle having been introduced into Africa in substantial numbers, these mitochondrial data give no indication that the impacts of the founder effects were ameliorated by gene flow from Indian breeds.

Finally, we have found evidence that the Late Iron Age cattle mitochondrial gene pool, dating to the early 1800s, does not appreciably resemble that of the modern, and presumably descendant, Nguni cattle. We suggest that this is likely the consequence of a rinderpest panzootic known to have dramatically culled the cattle population in sub-Saharan Africa during the 1880s and 1890s.

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**Diagnosing *Mycobacterium* in marmosets.**

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Non-human primates can serve as potential reservoirs for zoonotic pathogens that can be transmitted to humans. As cities expand into primate environments, the potential for human and non-human primate contact increases, and thus the potential spread of zoonotic pathogens also increases. Identifying specific pathogens harbored in primates with close proximity to humans helps to assess disease spread and exposure threats in these areas. The purpose of this study is to diagnose whether marmosets (genus *Callithrix*) living in close proximity to humans in north and south eastern Brazil harbor *Mycobacterium* species that can be transmitted to humans, specifically *M. tuberculosis* and *M. leprae* which respectively cause tuberculosis and leprosy. Quantitative polymerase chain reaction (qPCR), using custom-designed TaqMan primers and probes designed to identify *M. tuberculosis* or *M. leprae* gene fragments, was used to identify the presence or absence of *Mycobacterium* in marmoset cheek swab samples. Initial testing indicates that these samples are negative for *M. leprae*. However, out of the eighty-eight tested marmoset samples, nineteen are positive for the *Mycobacterium* gene rpoB. Sequencing of these positive PCR fragments will allow us to confirm the specificity of this test and rule out the possibility of positives due to previously

undiscovered environmental mycobacterial species. Marmosets positive for *rpoB* were found in areas of Rio de Janeiro as well as other parts of north and south eastern Brazil frequented by humans. Identifying such pathogen exposed primate populations is important for determining zoonotic transmission pathways between human and non-human primates.

**Resource and mortuary patterns as an interpretation of spatial use at Cerro Mangote, Panama.**

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Cerro Mangote (7000-5000 BP) is a Preceramic site on the central Pacific coast of Panama. The archaeological evidence is consistent with a site used both as a mortuary and resource collection site (Piperno and Pearsall 1998, Ranere and Cooke 2003). The presence of a cemetery and with a multi-resource site suggests an important link between rituals by the living to particular foodstuffs and ancestors. To explore these connections, the mortuary treatments of the individuals recovered ( $n=110$ ) were compared to musculoskeletal stress markers (MSM) and cross sectional geometry. The results highlight the experimentation in mortuary patterns by the living population, illustrating variation not typically assumed in a Preceramic site. The MSM suggest sex-specific activities. Male MSM are consistent with more robusticity in the upper limbs than lower. Female MSM indicate an equal distribution between upper and lower limb markers. The cross-sectional geometry suggests a relatively round shape in both the humeri and femora for males and females, with an equally similar slight anterior-posterior loading. There does not appear to be a statistically significant pattern relating these activity markers with burial treatments, but results suggest sex-specific use of resources at the site potentially related to subsistence based rituals. Previous archaeofaunal studies at the site are used to contextualize these patterns.

**Is dental metric variation more sensitive to differences among regional populations than dental morphology? A case study from coastal Kenya.**

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The present study examines the concordance between reconstructions of biological distance using nuclear microsatellite, dental morphology, and odontometric data. Previous investigations found a significant and moderate correlation between biodistance matrices based on genetic and dental morphology data, suggesting that: 1) the two datasets can generally provide comparable information about population history even in regionally restricted contexts, but 2) reconstructions of detailed relationships between pairs of populations based on dental morphology

are less reliable when variation among groups is low.

Following methods established by Hillson and colleagues, buccolingual crown measurements and diagonal diameters of molars were collected from 295 Kenyan individuals (four populations) and compared with genotypes from fifty microsatellite loci in the same individuals. Biodistance matrices were constructed using a variety of statistics commonly used with dental (e.g., Mahalanobis' distance) and microsatellite (e.g., Delta Mu) data.

Preliminary results from a sub-sample of the 295 individuals indicate that, though metric data allow for more flexibility in analysis, metric variation was also too low among the four populations to provide much clarity about specific differences between population pairs. These findings underscore the need for new methods of quantifying and analyzing dental variation.

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**Modern human phenotypic variation: Exploring patterns of differentiation within and between continents.**

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Current consensus is that modern human cranial phenotypic variation is a result of isolation-by-distance and neutral evolutionary processes, with natural selection acting most notably in some anatomical regions of populations living in extreme environmental conditions. Under this model, there is an underlying assumption that the rate of morphological differentiation in the past was uniform across the planet. The goal of this study is to test this assumption by comparing the morphological differentiation of human groups between and within geographic regions. We analyzed a large sample of male individuals from 135 human series. Craniometric variation was assessed through *Fst* estimates calculated from 33 linear measurements for each pair of series. Series were grouped into 15 geographic regions and the average *Fst* values within regions were then compared with the average linear geographic distances between series. Our results show a very strong linear correlation between

average *Fst* values and geographic distances within each geographic region. However, between-regions analyses generally show lower correlations with distances, suggesting that geographic distance is not a good predictor for the *Fst* values between continents. These preliminary results indicate that the processes associated with the morphological differentiation within and between continents may have differed considerably, and probably a more significant influence of bottlenecks and natural selection. With the exception of the differences between North America and the Old World, isolation by distance may not be a good predictor of morphological differentiation between groups located in different continents. Alternative models should be taken into account to explain this pattern.

**Ontogenetic changes in the human tibial and femoral diaphyses: Mechanobiological analysis of cortical shape from a whole-bone perspective.**

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It is well-established that cortical bone geometry of weight-bearing bones is in part related to mechanical loading history. During ontogeny, load patterns shift in association with growth and gait maturation, resulting in changing bone morphology. We test the hypothesis that ontogenetic patterns of cross sectional cortical shape change in the human femoral and tibial diaphyses are age- and anatomical site-specific. Femora ( $n=46$ ) and tibiae ( $n=47$ ) ranging developmentally from neonatal to skeletally mature were obtained from the Norris Farms No. 36 skeletal series, an Oneota Native American assemblage (ca. A.D. 1300). Whole bones underwent high resolution x-ray CT scanning at the Pennsylvania State Center for Quantitative Imaging with size-specific resolutions ranging from 0.013 to 0.094 mm. Whole-diaphysis cortical drift patterns and relative bone envelope modeling activity across ages were assessed in five locations per bone (20, 35, 50, 65, and 80% of total bone length) by measuring the distance from the section centroid to the endosteal and periosteal margins in eight sectors in ImageJ. Changes in the periosteal/endosteal surfaces and cortical width were recorded for each diaphyseal slice. Correlation between age and the ratio of maximum to minimum bending rigidity ( $I_{max}/I_{min}$ ) was tested at each slice location. Results show that cortical shape changes are most strongly associated with age in the femoral extremities (20 and 80%) and tibial proximal diaphysis (80%), indicating that these locations may be more sensitive to developmental mechanical load shifts than the midshaft. These findings highlight

the utility of additional anatomical locations for bioarchaeologists investigating physical activity. *Grant Sponsor: NSF grant number BCS-1028799 (JHG and TMR)*

**Sternal rib end age estimation: Asymmetry and proxy ribs.**

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Skeletal age estimation is a common procedure in archaeology and forensic anthropology. Sternal rib ends are used in conjunction with the pubic symphysis and the auricular surface for age estimation. This presentation examines the similarities between the left and right rib ends and between the third, fourth, and fifth ribs. We hypothesize that all six ribs ends being investigated will be in general agreement with respect to their morphologies.

In this study, 176 sets of ribs from the William M. Bass Donated Collection were scored. The third, fourth, and fifth ribs of both sides were scored using both male and female nine-phase methods as well as three components of rib morphology. All observations were recorded by the first author.

Seven comparisons were made for each of the five variables for a total of 35. These comparisons were analyzed using simple mathematical calculations and Wilcoxon Rank Sum tests for directionality of the differences. All comparisons show a moderate amount of disagreement between ribs ranging in frequency from 10 to 40%. The variable "pit depth" performs the worst. The fifth rib surpasses the others in terms of symmetry and agrees with the fourth more often than the third.

This study shows that not all sternal rib ends have the same morphological expression. Based on our results the fifth rib is better than the third as a proxy for the fourth. It may even be a more stable age indicator than the fourth rib.

**An ancient crime scene: a genetic investigation of decapitated individuals from prehistoric Pacific Northwest coast warfare.**

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We provide DNA evidence of community association for decapitated individuals from presumed inter-tribal warfare on the North Pacific Coast of America. Northwest Coast warfare is well documented in the ethnographic, anthropological and archaeological literature (Ames and Maschner 1999; Angelbeck 2007) with skeletal evidence of interpersonal violence as early as 3000 ybp (Cybulski 1990) and fortification structures dated to 2000 ybp (Moss and Erlanson 1992). Five plausible decapitations were documented at archaeological sites in the Prince Rupert Harbour region, British Columbia: four at the Lachane site (cal AD 700-1130) and one skeleton (cal AD

810-1180) at Garden Island. Three of the five were morphologically female. A trophy skull at another site had radiocarbon dates not statistically different from those of the decapitations. Mini-STRs, HVS1 of mitochondrial DNA and Y-STR (males only) data were collected and analyzed for all ancient individuals. DNA extractions were completed in a clean ancient DNA laboratory. We estimated the genetic relationships of the four Lachane decapitated individuals, compared the genetic variation of all five decapitated individuals to contemporaneous Tsimshian genetic variation, and determined whether the trophy skull may have been from any of the decapitated individuals. The results of this project provide insight into ancient warfare on the Northwest Coast.

**Evolvability and integration in human and non-human primate limbs.**

BRANNON I. HULSEY. Department of Anthropology, University of Tennessee Knoxville.

Limb length proportions (LPs) in humans and other primates are widely assumed to be highly genetically controlled traits that change only in response to long-term selection. For instance, the global pattern of variation in human LPs correlates with latitudinal variation in the Old World, a pattern explained as a specialized adaptation that developed over hundreds of thousands of years for the efficient regulation of heat loss. The clinal differences seen in modern human LPs are therefore largely due to genetic variance among groups; however, the way in which this genetic variance evolved is unclear. A better understanding of the genetic variation and integration of these complex traits is needed to fully understand the modern pattern of human phenotypic variation.

Using four large, pedigreed primate samples (tamarins, two samples of baboons, and humans), this project seeks to explore the 1) evolvability, or the expected proportional change in a trait per unit of a mean-standardized selection gradient, and 2) integration, or covariation, of primate limb segments. Non-human primate samples were used as models for humans and to see if patterns of variation and integration are consistent across primates. Preliminary results indicate that while evolvabilities of limb segments are comparable across species, patterns of integration in some samples do not follow previously reported patterns. These results show that phenotypic variance alone cannot predict how limb elements will respond to selection pressures. Furthermore, these results will help model expected change in LPs, which may then be compared with observed clinal patterns reported among humans.

**Regional variation in sexual dimorphism among African and diaspora populations.**

ASHLEY L. HUMPHRIES, MEREDITH L. TISE and ERIN H. KIMMERLE. Department of Anthropology, University of South Florida.

Studies concerning human sexual dimorphism can provide valuable information regarding the human condition and may help in understanding the influence of environmental, biological, cultural, and other factors that contribute to this variation. The purpose of this study is to evaluate and compare the regional variation of sexual dimorphism of 331 crania representing western (Benin, Chad, Congo, Ghana, Nigeria) and southern Africa (Botswana), as well as African Americans. An Index of Sexual Dimorphism (ISD) was calculated for each of the sixteen standard craniometric measurements, as well as the mean ISD for all variables. The mean ISD suggests that Botswana males and females ( $ISD = 5.76$ ) are the most sexually dimorphic and the student's t-test indicates that the degree of sexual dimorphism is significant between Botswana and all other groups ( $p$ -value < 0.05) except for Congo ( $p$ -value = 0.08). Comparisons of individual cranial variable ISDs suggest that the primary difference in the levels of sexual dimorphism is observed in the craniofacial variables. Additionally, Mahalanobis squared distances indicates significant differences between the three regional samples. Overall, the western African samples are not significantly different from one another, while the southern African sample and the African Americans are significantly different from all other groups ( $p$ -value < 0.05). The separation of both Botswana and the African Americans from the western African populations and the high degree of sexual dimorphism in Botswana suggests underlying biological variation within the cranium, which may have implications for human identification in human rights and forensic contexts.

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**The Biological Anthropology Database legacy of Richard L. Jantz.**

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Due to his diverse research interests, Richard L. Jantz has established and continuously refined significant biological anthropology databases. Jantz's analytical work with historic and pre-historic skeletal series has produced a massive database of osteometric and non-metric observations of the inhabitants of North America. This large database has been instrumental in understanding early migrations, micro-evolution and secular changes of these populations. Having access to the W.W. Howells world-wide craniometric database, Jantz has made this important dataset available on-line to researchers.

With dermatoglyphics expert Heinz Brehme, a database of print classifications and ridge counts for over 40,000 individuals from population groups from around the world has been amassed. Jantz's anthropometric interests lead him to database and archive over 17,000 North Native American groups from the anthropometrics collected by Franz Boas in the 1890's.

The most noted databasing effort by Jantz is his establishment of the Forensic Data Bank (FDB), a repository of modern American osteological observations. These data are used by forensic anthropologists directly or indirectly through the use of FORDISC software. The FDB continues to expand through contributions by physical anthropologists, Jantz's students and Jantz own continuing efforts. The FDB was the inspiration for a subadult radiographic database being assembled, with the future in using CT scan data.

These significant contributions by the vision and untiring work of Richard Jantz has provided for hundreds of student papers, Master's theses, dissertations and professional research investigations. All that have utilized these data are indebted to this consummate scholar.

#### **Vertebral morphometric evaluation of stress in modern pediatric patients.**

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Multiple indicators of growth disruption have been implemented in evaluating systemic stress in past populations. The phenomenon of catch-up growth, however, can confound these interpretations. Researchers have thus utilized skeletal elements that cease growth during childhood relative to those that continue growth into adulthood to investigate lifetime stress. Vertebral neural canal (VNC) dimensions are fully formed by late childhood (approximately nine years old) while the vertebral bodies continue growth into adulthood. Prior studies have utilized the anterior-posterior (AP) and transverse (TR) measurements of the VNC in adults to identify "stunting" and evaluate childhood stress resulting in growth disruption. These morphometrics have been shown to be independent of age, sex, body size and ethnicity in adults. This study uses thoracic computed tomography (CT) obtained for multiple diagnostic purposes from 40 modern pediatric individuals to measure VNC dimensions. AP and TR thoracic VNC measurements are expected to vary with respect to age as well as chronic versus acute conditions. Results are consistent with previous studies using adult individuals to evaluate developmental disturbances. Patients less than nine years old with chronic illnesses experience stunted growth in the VNC compared to those with acute conditions. Meanwhile, patients greater than nine years old with no evidence of chronic illness show less variation in VNC dimensions as growth has ceased in this element. Access to the health history of known

age pediatric individuals is crucial to evaluating the developmental variation within vertebral morphometrics used to investigate stress and growth disruptions in past populations.

#### **Fiber type composition of spinal extensors is geared toward facilitating rapid spinal extension in the leaper, *Galago senegalensis*.**

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Leaping is considered a hindlimb-driven locomotor behavior, requiring enhanced maximum shortening velocity and excursion of some hindlimb muscles to facilitate acceleration during take-off. Some investigators note that spinal extension is also important during leaping, as it increases leap length by extending the spine from a flexed position at the beginning of take-off. If spinal extension is important during leaping, we hypothesized that the extensors of *Galago senegalensis* (a habitual leaper) should contain a higher proportion of Type II (fast), compared to Type I (slow) fibers. We used immunohistochemistry to compare Type I and Type II fiber proportions in thoracic and lumbar segments of mm. iliocostalis, longissimus, and multifidus between *G. senegalensis* (n = 3); and *Nycticebus coucang* (n = 3), a slow-moving arboreal quadruped. Stained fibers were counted, and ratios were computed.

*G. senegalensis* epaxial muscles comprise a higher proportion (58%) of Type II compared to Type I fibers (30%). Conversely, *N. coucang* epaxial muscles comprise a higher proportion of Type I (91%), compared to Type II (7%) fibers. Thus, *G. senegalensis* spinal extensors are capable of generating high contraction rates, thereby allowing rapid back extension during leaping. The higher proportion of Type I fibers in the *N. coucang* epaxial muscles is consistent with previous studies linking a predominance of slow-twitch fibers in some hindlimb muscles to posture and stabilization during slow-climbing. Collectively, these findings support previous studies linking vertebral morphology to trunk extension during leaping. Future studies should focus on more fine-grained analyses of fiber-types.

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#### **Feeding ecology of Gray's bald-faced saki monkey (*Pithecia irrorata*) during a single dry season in southeastern Perú.**

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With a few notable exceptions (e.g. *Pithecia pithecia*, Norconk 1996), relatively little is known about feeding ecology and diet variation among Pitheciine primates. We report on the feeding ecology of *Pithecia irrorata*, which has only been the subject of one such study to date (Palmenteri et al. 2012). Our goal was to contribute to a broader understanding of Pitheciine feeding biology by reporting on feeding flexibility in *Pithecia irrorata* in response to seasonal availability of food resources. From June 14 to July 21 2012, we observed a group of 8 Gray's bald-faced saki monkeys (*Pithecia irrorata*) at the Centro de Investigación y Capacitación Rio Los Amigos (CICRA) in the Madre de Dios region of Perú. We collected 78.33 hours of group scans at 10 minute intervals, in which we recorded ranging behavior, habitat type, topographic relief, and canopy height. Concomitantly, we collected 77.26 hours of continuous group activity and feeding data. During the majority of scans, the group utilized terra firme forest at the top edges of ravines and occupied a canopy height of 25 m. They spent the majority of their time feeding and focused 52% of feeding minutes on unripe seeds only, 32% on pulp and seeds, 12% on insects, 3% on flowers, and >1% on leaves. Insect consumption was greater than previously reported, suggesting the possibility of a seasonal shift in resource use. This study provides new data on the feeding ecology of a little known species and allows us greater insight into their natural history.

#### **Life and death in a Medieval Nubian farming community at the Fourth Cataract: An example from Mis Island.**

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An extremely well-preserved collection of 407 medieval Nubians from Mis Island offers a unique opportunity for an in-depth investigation of life experience from the Fourth Cataract. This study macroscopically investigates the prevalence and expression of pathology in adults and subadults from the 3-J-10 and 3-J-11 cemeteries. The goals of this research are twofold: first, to clarify whether 3-J-10 and 3-J-11 represent the same or two distinct populations and, second, to investigate important cultural development stages through the analysis of age-related pathology.

Results indicate that 3-J-11 had higher crude frequencies of cribra orbitalia (68.5%) and scorbutic lesions (37.4%) than 3-J-10 (56.6% and 23.4%, respectively). However, 3-J-10 had higher frequencies of porotic hyperostosis (54.9%) and periosteal reaction (66.1%) than 3-J-11 (51.5% and 60.3%, respectively). There were no statistically significant differences in true prevalence rates between adult age or sex groups among either cemetery 3-J-10 or 3-J-11; however, subadults (83%) were more often afflicted with cribra orbitalia than adults (47%), while adults (60%) exhibited more porotic

hyperostosis than subadults (45%). While there are no statistically significant differences between cemeteries for pathology, there are significant differences between adults and subadults for cribra orbitalia and scorbutic lesions, lending support to a relationship between cribra orbitalia and vitamin C deficiency. Overall, it seems that environmental context and resource availability were the main contributors to health in both samples, while the cribra orbitalia and scorbutic lesions may indicate that weaning diets were deficient in vitamin C.

#### Assessing site specific Changes in endocranial shape associated with frugivory in primates.

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Three hypotheses have prevailed in anthropology as the driving force of increased encephalization in primates: tool use, sociality and frugivory. Frugivory has been specifically targeted as a behavioral correlate with brain size as the temporal and spatial specificity of ripe fruit presumably requires the use of mental maps and is calorically better suited for a large, energetically expensive brain. For *Hominins*, fossilized endocranial surfaces provide the most direct evidence of brain evolution; yet endocasts may reflect only a fraction of the actual variation in brain anatomy. In the present study non-rigid deformation techniques were used to quantify localized variation in endocranial morphology across 19 non-human primate specimens using CT scans from the Open Research Scan Archive. Behavioral data on the percentage of fruit in each species diet was extracted from the literature. Correlations were calculated between these behavioral variables and the degree of localized distortion required to morph each species' endocranial form into a common atlas (*Pan troglodytes*). Maps of the endocranial surface illustrating these correlations on a voxel-by-voxel basis suggest that frugivory may be specifically associated with endocranial shape in the following areas: rostral prefrontal, lateral cerebellum and inferior temporal. These results suggest that it might be possible to infer level of frugivory in the primate fossil record from endocasts.

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#### Regional integration, subsistence, and health during the Formative Period in the Lake Titicaca Basin.

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The Middle Formative Period (800-100 B.C.) in Bolivia was characterized by the emergence of complex societies, regional integration, and an increase in long-distance trade. Central to the regional integration of the Middle Formative was a ritual tradition known as the Yaya-Mama. In this presentation, we address two principle hypotheses: 1) maize was a dietary component during the Middle Formative, and 2) that maize consumption varied between individuals interred in temple contexts, perhaps as part of ritual activities, as compared to those interred elsewhere. Burials from one temple and three non-temple sites were examined dating between 550 B.C. and 10 B.C. Stable carbon  $\Delta 13C$  ca-co signatures for all Yaya-Mama A-C individuals (6.2), reflective of whole diet, suggest that maize may have been consumed, although not as a dietary staple. Pathological lesion rates would seem to support such an observation. While carious lesions (49% of all Yaya-Mama A-C individuals) are common, the frequency is not overwhelming. Differences in the nitrogen and carbon signatures of temple individuals ( $\delta 15N=8.6$ ;  $\Delta 13C$  ca-co=6.4) as compared to those not interred in temples ( $\delta 15N=7.8$ ;  $\Delta 13C$  ca-co=5.7) would suggest that those two broad groups had different diets. Higher rates of carious lesions (51%) for Ch'isi temple individuals as compared to those who were not interred in the temple (38%) would also suggest a diet which incorporated additional enriched plant foods, potentially maize.

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#### An assessment of the growth and development of the pediatric tongue and mandible within a South African population.

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Studies assessing juvenile osteology have focused on age and sex related changes in the fetal and post-childhood mandible. However, few have assessed the relationship between the mandible and the growth and development of the tongue. The aim of this study is to evaluate the relationship between the growth of the mandible and tongue in a South African pediatric population (20 gestational weeks to 3 years). Our sample consisted of 171 pediatric cadaver specimens from the Pediatric Collection, University of the Witwatersrand. Osteometry was assessed using a microscribe G2 on 30 mandibular landmarks. These were digitized and converted to linear distances, to assess changes in the overall dimensions of the mandible. Osteometric dimensions included maximum

mandibular length, mandibular body length, bigonial and biantegonial widths of the mandible, interforaminal width of the mental foramina, distances between the superior and inferior borders of the mandible and mental foramen and calculated mandibular and mental angles. Tongue dimensions included the maximum and minimum tongue lengths and breadth. These were assessed using a manual sliding caliper. Statistical analysis included size and shape assessments. Size assessments included the geometric mean and analysis of variance (ANOVA). Shape assessments included Mosiman's shape variables, multivariate analysis of variance (MANOVA) and selected geometric morphometric analyses. Statistically significant increases were noted across all groups assessed. All significant increases occurred in the posterior region of the mandible, which was well correlated with tongue dimension increases. Hence, we conclude that mandibular growth is influenced by accommodation of dimensional changes of the tongue.

#### Three-dimensional geometric morphometric analysis of Late Pleistocene femora: Taxonomy and functional morphology .

VANCE T. HUTCHINSON. Anthropology, Tulane University.

FH Smith has elegantly described the distinctive craniofacial morphology of the Neandertals as a 'gestalt' of additive variation in numerous morphometric features that does not include unequivocal taxonomically relevant autapomorphies. Three-dimensional geometric morphometric analysis of 46 landmarks on the complete femur identified a similar pattern of low-level variation among Neandertal and Late Pleistocene Eurasian and recent modern human femora. Individual shape components did not discriminate the Neandertals as a group from modern humans and thus cannot be considered useful for taxonomic assignment of isolated partial femora. However, discriminant function analysis successfully identified Neandertal femora based on subperiosteal shape differences in complete femora from comparative samples representing modern humans spanning the Eurasian Upper Paleolithic to the present. Thus the cumulative variation in the complete femur does provide some taxonomic information. Significantly, the patterns of variation in the geometric relationships of shape components of partial and complete femora are consistent with morphological trajectories resulting from some combination of body mass and activity level differences in *in vivo* mechanical loading. Thus three-dimensional geometric morphometric methods are robust for investigation of functional geometries in the human locomotor skeleton.

#### A new look at frontal bone ontogeny.

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In the past, frontal bone ontogeny has been studied as a single unit focusing on ectocranial dimensions. With recent advances in skeletal genetics and molecular biology we, have observed multiple genetic influences affecting frontal development. This has given reason to look at the development of the frontal bone in a new light. We investigate the ontogeny of the frontal bone, looking at its overall development and the differences between ectocranial and endocranial functional units.

Our sample comprises dry skulls divided into four age categories ( $n=32$ ), 1-1.5, 3-3.5, 5-5.5 and 7-7.5 years-of-age. The sample was scaled on cranial index to eliminate cranial size as a variable. We made a series of metric and nonmetric comparisons from dry skulls and isosurfaces and meshes generated from CT reconstructions.

We found that the ectocranial surface exhibits the greatest amount of developmental difference. The endocranial surface, is alternatively, fairly stable. Although, the endocranium shows little change over the development time examined, we observed overall increases in length with age coupled with decreases in width at the base. The ectocranium increases in length and orbital width although there is a very stable region between the two bosses and the nasal region.

The endocranial and ectocranial aspects of the frontal bone have different developmental trajectories, possibly related to genetic influences on specific regions of the frontal bone. Having identified specific growth regions of the frontal and the morphological changes that result during ontogeny allows clarification of evolutionary and pathologic changes in frontal morphology.

#### **An investigation of a Shigellosis outbreak in a rhesus macaque population: The importance of rank and status.**

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In March of 2010, a free-ranging colony of rhesus macaques, *Macaca mulatta*, located on the island of Cayo Santiago, Puerto Rico, experienced an outbreak of shigellosis. The subsequent epizootic lasted approximately 49 days. There were a total of 105 reported cases and a total of 52 animals of 1058 died. It was evident that some groups were more adversely affected than others. Therefore, we proposed to examine the available data for any factors that may have caused greater vulnerability to the disease. We analyzed the relationships between those affected (including if they had symptoms, were treated, or died) and factors such as sex, age, group membership, and rank. According to the univariate analyses, sex was not a significant factor in whether or not monkeys were affected by the outbreak. However, age, group membership, and rank were all found to be significant at  $p=0.05$ . Logistic regression modeling procedures will allow us to further evaluate which of these several factors most

significantly increased the odds of both morbidity and mortality. This research will provide crucial direction in identifying where initial attention should be given at the onset of future such outbreaks. It also suggests that while rank has been shown to be significant in predicting rates of infection among other old world monkey troops, exactly how it does so may vary greatly by disease type and transmission pathways.

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#### **Changes in social behavior following the application of sensory-integration based therapy in a young adult female chimpanzee (*Pan troglodytes*).**

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A young female chimpanzee (*Pan troglodytes*) at the Saint Louis Zoo was identified with sensory integration and processing difficulties in 2009. At that time, Holly was conspicuous in range and frequency of stereotypies, restricted social interactions, lack of rest times and poor occupational performance in routine activities. Holly's abnormal behavior tended to isolate her and affected some group social dynamics, for example, through avoidance behavior. To improve Holly's situation, a plan providing therapeutic intervention based on human sensory integration theory was implemented. Frequencies of behavioral activity and social interactions were assessed using one-minute interval focal individual sampling, providing baseline, pre-intervention, and post-intervention data.

Prior to sensory integration therapy, Holly's behavior differed from her peers and had been consistent for more than one year. Therapy intervention occurred in late 2010 and early 2011, providing enhanced sensory inputs through environmental enrichment and keeper directed activities. Immediately following intervention, Holly demonstrated significant improvement in some measures, such as decreased frequency of stereotypies. Data on social behavior also indicated some positive changes. After intervention, Holly spent less time alone, decreasing from 19.67% to 7.67% of observed intervals, with more time spent in social proximity to group members. Social interactions increased, especially with older adult females and adult males. Time spent socially grooming increased from 20.47% to 24.37%, with gains as groomer and recipient. Following therapy, Holly continued exhibiting difficulties in some situations, especially outdoors. Some initial positive gains following therapy were not fully

sustained over longer periods of time. Continuing therapy may enhance benefits.

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#### **Mandibular helical axis during feeding in non-human primates.**

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Mandible movement is often described using the three-dimensional displacement of a single landmark. These trajectories, however, depend on the relative location of the point with respect to the center of rotation of the mandible and their interpretation can be equivocal. This problem would be even more important when comparing organisms of different body size. To avoid this, we can describe the mandible movement with traditional kinematic methods such as finite helical axis (FHA). The FHA describes the movement of a rigid object as translating along and rotating around an imaginary axis in space. Previous studies have shown that FHA is located mostly inferior to the temporomandibular joint (TMJ) and that changes its position and orientation continually through the gape cycle. Few data are available regarding the position and orientation of the FHA in non-human primates and it remains unclear to what extent the kinematic patterns of the mandible during feeding vary among primate species. Here we present data on the 3D feeding kinematics of four species of primates (*Macaca*, *Papio*, *Cebus* and *Saimiri*) obtained by using high-speed video recordings. As previously observed, the FHA was located below the TMJ in all species but the axis orientation changed throughout the gape cycle differently among species. Preliminary analyses show that jaw kinematics of *Macaque* and *Papio* are more similar than those of *Cebus* and *Saimiri* suggesting clade-specific differences in kinematics. These differences are expected to reflect differences in TMJ morphology as well as differences in patterns of muscle activation.

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#### **New results from an old excavation: The biological "place" of Jebel Moyans in the prehistory of Nubia and Sudan.**

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Innovative methods were used to excavate >3,000 burials (ca. 3000-100 BC) at Jebel Moya, central Sudan in 1911-1914, and their analyses were entrusted to leading anthropologists. Unfortunately, stratigraphy and dating were misinterpreted, and skeletal study

was not completed until 1955. By then, few remains survived curation problems, and study focused on craniometric-based “racial” categorization relative to African samples chosen simply because of availability.

The archaeology was reinterpreted in 1994, and new spatial and temporal data prompted the current author to undertake a 2007 analysis of the same Jebel Moya remains and comparative samples (or equivalents) from 1955. Using dental nonmetric data, the goals were to assess the craniometric relationships, and move beyond typology to estimates of inter-population affinity. Between-study links are evident, but much finer-grained results were achieved; a 1955 plotting error was also identified. Briefly, Jebel Moyans are intermediate to, but distinct from the African samples. Many of these samples are geographically distant, so phenetic divergence from Jebel Moya is not surprising.

Thus, the present study estimates affinity regionally to assess if site inhabitants were related to people from: 1) the north, i.e., Nubians, or 2) adjacent sub-Saharan Africa. Thirty-six traits were compared between Jebel Moya (n=58) and 22 comparative samples (n=1196) using the Mean Measure of Divergence. Jebel Moyans are like some Nubians, but closest overall to samples from Ethiopia, Chad, and Kenya. As such, they appear more at home in (northeast) sub-Saharan Africa—which helps settle, more conclusively, the place of these enigmatic people in African prehistory.

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#### **Nutritional ecology and nutrient balancing in a rainforest sifaka.**

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Despite advances in documenting macronutrient composition of wild primate foods, much less is known about constraints and goals governing absolute daily intakes and macronutrient balancing in the diet. There is increasing recognition that nutritional currencies are complex, some herbivores strictly regulate one or more macronutrients, and that the balance of dietary macronutrients has health consequences. In primates, Felton et al. (2009) found that spider monkeys prioritized protein intake while non-protein energy intake varied

(“protein-leverage”); Rothman et al. (2011) found that mountain gorillas optimized non-protein energy intake, while protein intake varied. We describe a third pattern in diademed sifakas (*Propithecus diadema*). From July 2006–July 2007 we collected 140 sifaka food samples at Tsinjoarivo, Madagascar, which we analyzed for protein, fat, and carbohydrates, collected feeding data (363 days, 18,253 feeding bouts), and calculated daily macronutrient and energy intakes. Dry matter and all macronutrient intakes varied considerably across seasons (~four times higher in the rainy season), as animals switched to different foods. Although consumed foods varied widely in protein content (% of macronutrient energy derived from protein=15.02, SD=12.62, n=78), sifakas had unexpectedly consistent proportional protein intake: 9.35% (SD 2.49) of daily macronutrient energy supplied by protein. Nonprotein energy was dominated by carbohydrates, especially in the lean season. These data suggest that sifakas follow a nutrient-balancing strategy with respect to protein, optimizing proportions rather than amounts. Much remains to be learned about diversity in how primates prioritize macronutrients, and the effects of different strategies on food selection, activity levels, physiologic health, and feeding competition.

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#### **Bioarchaeology at the multiperiod site of Al Khiday 2, central Sudan.**

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Al Khiday 2 is situated on the western bank of the White Nile, 35 km south of Omdurman. Ongoing excavations have revealed 126 burials belonging to three different periods—the pre-Mesolithic (>7000 B.C.; N=68), the Neolithic (4500-4000 B.C.; N=33) and the later Meroitic (radiocarbon dates from 100 B.C.-100 AD; N=25). This research aims to address differences in skeletal and dental health as well as biological parameters such as age at death and stature between these groups, hypothesizing that changing climatic conditions and subsistence strategies led to differences in disease exposure and dental health.

Using standard methods of paleodemography, childhood mortality was found to be highest in the Meroitic period, probably associated with higher population density and increasing desertification, although differential burial customs in the older samples may have excluded younger individuals from burial and biased the results. Macroscopic and radiographic analyses, however, attested to an increase in non-specific stress indicators such as cribra orbitalia, enamel hypoplasia and periosteal reaction in the Meroitic period, confirming that health deteriorated over time. In addition, adult stature was lower in the later period, while dental health (caries and antemortem tooth loss) was worse in the pre-Mesolithic and Neolithic individuals, which was an unexpected finding for non-agricultural populations.

Additional group differences, potentially signifying social identities, were found. Dental ablation was common in the pre-Mesolithic population, affecting maxillary central incisors. This custom, however, was rarely seen in the Neolithic group, where it only included mandibular central incisors, and was no longer observed in Meroitic individuals.

#### **Heightened diurnal endocrine levels in healthy women with a family history of hypertension: Reproducibility over the menstrual cycle.**

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Using cross-sectional data, we previously showed that otherwise healthy women with a family history (FH) of hypertension had diurnally elevated epinephrine levels and greater daily cortisol variability than women with no familial history. Whether the FH differences persist over the menstrual cycle is unknown. The purpose of this study was to compare the variation in diurnal urinary catecholamines (epinephrine and norepinephrine) and cortisol excretion and ambulatory blood pressures (BP) between women with (FH+) (N=31, age=34.9±7.2) and without (FH-) (N=40, age=34.9±8.2) a family history of hypertension over the menstrual cycle. The women all worked in clerical or technical positions at a medical center in NYC. Urinary hormone excretion rates and ambulatory BP were measured across three contrasting daily microenvironments: work (11AM-3PM), home (approx. 6PM-10PM) and during sleep (approx. 10PM- 6AM) on a mid-follicular and a mid-luteal workday. History group comparisons by microenvironment and menstrual phase were made using repeated measures ANCOVA models. The results of the analyses show that daily epinephrine excretion among FH+ women was consistently 34% higher than that of FH- women (p<.02) over the menstrual cycle, while cortisol values between the groups were similar. FH+ women also had consistently higher systolic BP (6 mmHg higher; p<.016) and diastolic BP (4 mmHg higher, p<.005) compared to FH- women over the cycle. These findings show that the epinephrine differences are consistent across the menstrual cycle and suggest that there may be genetically-linked mechanisms which elevate tonic epinephrine levels that contribute to the development of hypertension.

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#### **The mechanistic basis for phenotypic variation: an emerging frontier in evolutionary developmental biology.**

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The study of the mechanistic basis for phenotypic variation is of increasing interest in developmental biology as well in genetics. The reasons for this trend include the opportunities presented by the massive datasets generated through high-throughput phenotyping technologies, the increasing desire to compare multiple genetic perturbations and their interactions which may differ in subtle ways and the increasing understanding of the vast complexity of the genetic determinants of phenotypic variation. These large-scale trends beg for new techniques that push the frontier of integrating the measurement of form and the study of mechanism. Here, we discuss the potential of optical projection tomography in this domain and specifically address the quantification of the morphology of gene expression and its integration with the morphometrics of morphogenesis. We focus on the development of the mid-face in chicks and mice and illustrate how the quantification of gene expression in the fronto-nasal ectodermal zone provides important insights in the mechanisms of midfacial development and diversification.

#### Fred Smith and the Croatian Paleoanthropology.

IVOR JANKOVIC. Department of Archaeological Anthropology, Institute for Anthropological Research.

This paper discusses Fred H. Smith's influence on the development of contemporary Croatian paleoanthropology. He was among the first contemporary western scientists who drew attention to the importance of the Krapina Neandertal remains. His PhD dissertation (1976) and subsequent papers resulted in a renewal of interest in the Krapina sample (today these are one of the most studied Neandertal samples in the world). He has been continuously working on Croatian material since the early 1970's, always collaborating with Croatian scholars (the number of his papers dealing with Croatian material has long passed the centennial mark). He was, and is involved in archaeological excavations of Croatian prehistoric sites such as Mujina Pećina, Velika Pećina at Kličevica, Zala, pećina Bukovac among others. After working on the initial description of the Vindija Neandertal remains, he has worked on this material ever since. Thus, it is only proper that the Vindija remains have an important role in the Assimilation model of the modern human emergence, and that the recently published genomic research on Neandertals mostly stems from the Vindija fossils. Over the years Fred Smith has trained Croatian students (he is a visiting profesor at the University of Zagreb) and now one of this students teaches courses on human evolution at the University of Zagreb. In short, he had a crucial role in the development of contemporary field of Paleoanthropology in Croatia. For this he was awarded with the Gorjanović-Kramberger medal and award of the Croatian Anthropological Society in 2009.

#### Mandibular molar elongation distinguishes *Mabokopithecus* from other nyanzapithecine genera.

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The taxonomy of the nyanzapithecines has been challenged by the discovery of two mandibles at Maboko Island, Kenya. The M<sub>3</sub> hypoconulid of one mandible is like that of *Mabokopithecus clarki* while the other is identical to *Nyanzapithecus pickfordi*. The mandibles also differ in the height of the genial pit, the angle of the symphyseal planum, and the degree to which the lateral incisors are caniniform, as well as subtle differences in the degree to which P<sub>4</sub> and molar cusps are flared. The sample of isolated maxillary and mandibular teeth is highly variable, however, and difficult to sort into two discrete morphs. Consequently, determining whether two distinct genera or species occur at the site has been difficult.

In this study we examine mandibular molar crown shape variation in a large sample of Miocene and extant hominoids. We find both *Mabokopithecus clarki* and "*Nyanzapithecus pickfordi*" M<sub>1</sub>s to differ from other nyanzapithecines. Given their distinctive degree of first mandibular molar elongation, we suggest it is an important character uniting the two Maboko nyanzapithecine morphs into a single genus, *Mabokopithecus*, and distinguishing them from other nyanzapithecines. The two *Mabokopithecus* species share a restricted temporal and spatial distribution at Maboko, body size, and indications of folivory, including relative proportions of scratches and pits on their molar teeth. Among living primates bamboo lemur species with similarly specialized diets coexist in spatially restricted areas and may provide a model for understanding nyanzapithecine species diversity at Maboko. A nyanzapithecine ancestry of *Oreopithecus* is further corroborated by this analysis.

#### What 1<sup>st</sup> metatarsal cortical thickness distribution reveals about locomotion of Sterkfontein and Swartkran hominins.

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Two first metatarsals from Sterkfontein (StW562, StW595) and two from Swartkrans (SKX5017, SK1813) are analyzed. Early work demonstrated a mosaic nature of morphological traits on these metatarsals, complicating functional interpretations: these hominins were unquestionably bipedal, but likely possessed a toe-off mechanism different from modern

humans. Here we analyzed cortical thickness patterns in first metatarsal shafts of African apes. Fossil hominin metatarsals were analyzed similarly and patterns of thicknesses compared to the extant sample. We ask whether each of the four hominin metatarsals is most similar to one extant species, and if so, is it the same extant species in each case.

First metatarsals of chimpanzees, gorillas, modern humans, and fossils were CT scanned. For each metatarsal, we measured 17 cross sections from 25% to 65% of diaphyseal mechanical length. In each cross section, we measured cortical thickness along radii separated by one degree increments. Cortical thicknesses were size standardized, after which they were used in a penalised discriminant analysis (PDA) to assess species-specific or fossil patterns.

The first function of the PDA discriminates modern humans from chimpanzees and gorillas. The second function of the PDA discriminates chimpanzees from gorillas. SK1813 and StW562 metatarsals have patterns of thickness distribution most similar to gorillas. SKX5017 and StW595 metatarsals patterns occupy a space in the PDA between humans and chimpanzees. Thus, the fossils can be divided into two "morphs", showing different diaphyseal structure, possibly the result of different locomotor repertoires. Interestingly, both Plio-Pleistocene sites contain the two "morphs".

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#### Trade-offs between reproduction, aging and lifespan: biomarkers, confounders and genetic factors.

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Factors related to fertility play crucial, but often unappreciated, role in influencing health, aging and lifespan of modern women. Pregnancy, lactation and childcare are energetically expensive, especially in women with high lifetime reproductive effort and particularly those who are in poor nutritional status. Allocation of resources to support reproduction may cause their insufficient supply to other metabolic functions, resulting in compromised physiology, increased risks of diseases and, consequently, a reduced lifespan. Variation in health, aging and longevity among women may, therefore, be partially explained by differences in their lifetime reproductive effort.

I present an overview of a conceptual and methodological approach that could be used when studying tradeoffs between aging and reproduction. It is important to identify biomarkers of health and aging processes, account for polymorphism in genes having antagonistic pleiotropic effects and provide detailed description of confounding factors. Biomarkers of aging should include quantitative indices of inflammation, cognitive decline, and of muscle strength and symptoms of metabolic syndrome. Information about genotypic identity of participants (with respect to APOE, PPAR-gamma, and IL-10 loci) will allow controlling for pleiotropic relationships between

reproductive effort and health status of women. Factors that may alleviate costs of reproduction (e.g. social status, nutritional status, help provided by neighbors and relatives) magnify physiological variation among subjects and should be explicitly controlled in statistical models. Preliminary results of the FEM-AGING study conducted in rural Poland that utilizes this methodological approach will be presented.

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#### **Effects of bipedal infant-carrying on thoracic and pelvic rotations in walking gait.**

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Pedal grasping was likely lost in association with the evolution of hominin bipedalism; therefore, like humans, hominin mothers had to actively carry their infants. While it is known that infant-carrying is energetically expensive, its effects on maternal gait kinematics have been largely unexplored. In this study, I test the hypothesis that carrying an infant constrains normal rotations of the thorax and pelvis. Significant limitations in segmental motion are indicative of disrupted gait and may therefore contribute to the tremendous energetic cost associated with infant-carrying. By establishing the relationship between infant-carrying and human movement, we can employ a comparative approach to understand how early hominin mothers may have kinematically coped with the challenge of transporting their infants.

Multi-plane angular excursions of the thorax and pelvis were calculated from 3D kinematic data acquired from 1202 strides, taken from three subjects walking with and without a simulated infant on a treadmill at varying speeds. Wilcoxon/Kruskal-Wallis tests were used to detect significant differences in segmental rotations between normal and infant-carrying conditions.

As predicted, axial rotation of the thorax and pelvis decreased significantly when carrying an infant. Similarly, infant-carrying resulted in significantly decreased sagittal excursion of the thorax. In contrast to expectations, thoracic and pelvic obliquity, as well as anterior pelvic tilt, increased significantly when carrying an infant. While infant-carrying constrains thoracic motion more than pelvic motion, both segments undergo marked kinematic changes when carrying an infant. This deviation from normal gait suggests that infant-carrying may reduce stability, contributing to its high energetic cost.

*University of Cincinnati and the Charles Phelps Taft Research Center at the University of Cincinnati*

#### **Temporal patterns of auditory exostosis prevalence in pre-Columbian Tennessee: Controlling for geography and subsistence.**

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Auditory exostoses (AE), bony growths in the external auditory canal, are consistently clinically assigned a prolonged cold-water exposure etiology. Although a bias in male prevalence in several archaeological contexts has suggested a sex-specific subsistence-related behavior, the pattern remains equivocal. If AE do reflect subsistence-related behaviors (e.g., fishing, diving), a multiple site assessment between contrasting subsistence strategies should affirm this, but only if the ecological contexts are identical. The prehistoric cultures of the western Tennessee River Valley within what is now the Kentucky Lake Reservoir include a large multiple site sample from the Late Archaic (2500-1000 BC) period which is characterized as an intensive hunter-gatherer economy focused on the exploitation of riverine resources. The immediate environs also yielded two large river-bank site samples of Mississippian period (AD 1100-1400) intensive agriculturalists. Auditory meati were macroscopically examined in adolescents and adults for all overgrowths. An exostosis was identified as a distinct nodule with a circumscribed boundary.

The results indicate that nodular AE are more prevalent in the Mississippian sample than the Archaic (21% versus 15%). Additionally, males have a higher frequency of exostoses in the Archaic sample (28% versus 13%) but are comparable to females in the Mississippian (25% versus 30%). These results contrast with previous studies of Mississippian samples from East Tennessee and North Carolina which parallel the Archaic sample in raw frequency and male prevalence. If cold water is indeed the primary cause of nodular AE, these results contraindicate a simple association of division of labor by subsistence strategy.

#### **The Lubischew's test, an useful statistical tool for Forensic Anthropology.**

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The Lubischew's test (LT) is a parametric statistical tool, based on the Student's t-test, developed in 1961 by a Russian biologist (A.A. Lubischew) to evaluate the degree of overlap between two data sets of single variables. The coefficient of discrimination is expressed as  $K$  and is calculated as the quotient of the difference between the respective means squared (numerator) divided by the pooled variance multiplied by two (denominator). LT presents significant differences regarding the main statistical tool used for sex discrimination in Forensic Anthropology, the Discriminant Function Analysis (DFA): (1) LT emphasizes the

inter-groups differences; (2) LT requires of normal homocedastic distributions; (3) LT is more size-independent than other tests and well suited for small sample sizes because in the  $K$  coefficient the number of observations ( $n$ ) is removed from the numerator.

We have applied these two statistical techniques to Medieval cranial remains from a necropolis located in Southern Spain (Arenas del Rey, Granada). The sex of all individuals was reliably assigned based on the qualitative and quantitative features of the coxal bone and cranium. As an example, LT can improve the % of discrimination obtained by DFA in more than 7% (biasterionic breadth), what can represent a useful contribution of Forensic Anthropology to the criminal justice system. Although LT provides the highest discrimination, it does not always perform above the DFA on a variable-by-variable basis. Therefore, LT is a useful tool for sex discrimination by itself or combined with DFA.

#### **Female geladas form strong bonds with close kin.**

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Socioecology predicts that females should form strong, kin-based social bonds in species that exhibit within-group competition for clumped food resources. Females from many primate species support this prediction, demonstrating strong preferential social relationships with close female kin. Furthermore, in at least two species, these bonds are linked to measures of reproductive success. Here we test the predictions of the socioecological model in one primate, the gelada (*Theropithecus gelada*). Geladas forage on an extremely dispersed food resource (grass) and thus are not expected to exhibit the typical cercopithecine pattern of strong female-female bonds. We examined 3 years of behavioral observations of grooming and spatial proximity with molecular genetic analyses to determine whether female geladas form strong and enduring social bonds with close relatives within units. We found that, even within a unit of close female kin, mother-daughter pairs formed the strongest bonds. Finally, we examined how social bonds influenced unit cohesion and how changes in unit composition altered these relationships. Whether such bonds among female geladas lead to reproductive advantages (as in other papionins) or whether they are merely an example of 'phylogenetic inertia,' remains a future question.

### Hand postures during vertical clinging and grasping: Implications for digit length in primates.

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The presence of a grasping clawless hand presents biomechanical challenges when clinging to a vertical substrate in modern and fossil primates. Little is known about how primates solve this problem and whether hand postures are influenced and constrained by habitual locomotor mode and associated hand anatomy, body size, and trunk size. This study tested the hypotheses that hand posture should vary with: 1) locomotor mode of the species, 2) substrate size, and 3) body size. To study this, individuals of eight primate species from the Duke Lemur Center, ranging in size from 150g-4000g, with differing locomotor modes were prompted to vertically cling and grasp on clear PVC pipes of three sizes. Postures were filmed with two cameras, in order to record the angle between the tip of digit two, the wrist, and the tip of the pollex, as well as the position of the pollex relative to the substrate and other digits. We found that hand postures on vertical substrates vary with locomotor mode and substrate size but not body mass. Vertical clingers and leapers were more likely to have wider-angled hand grips on larger substrates compared with active arboreal quadrupeds, but slow arboreal quadrupeds had the widest hand grip angles. Additionally, as substrate size increased, most individuals in this sample decreased the engagement of the pollex with the substrate. When analyzed in the context of theoretical models of vertical clinging, these data can explain why many arboreal primates have reduced thumbs and animals, such as *Ateles* lost their thumbs.

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### Species concepts in anthropology and their relation to research interests.

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Discussion over what constitutes a species, especially in light of new fossils, specimens, or populations, can be a controversial process. Within anthropology, there are multiple species concepts that underlie the recognition and diagnosis of new species in practice. Each concept has its own strengths, weaknesses, and applications to research. It is unclear, however, how social and intellectual factors influence what species concept a given researcher chooses to use. This paper examines relationships among differing use of species concepts in biological anthropology. We evaluate the tendency of individuals to recognize a new species and to ascribe to particular species concepts, and how these factors are related to their sub-discipline within biological anthropology, their research methodology, and their academic lineage. In

2012, 229 members of the American Association of Physical Anthropology and the International Primatological Society answered an online survey on their academic backgrounds and use of species concepts; responses were analyzed using Pearson's Chi-Square tests. The analysis shows that research focus and lineage had strong impacts on species creation philosophy. Bioarchaeologists and human biologists were more likely to be lumpers, while primatologists tended towards splitting. Interestingly, paleoanthropologists showed no overall trend despite their focus on defining new fossil species. Further, students tended to follow the same species creation philosophy as their advisors. Lab versus field research and era of degree education failed to yield significant overall results. Further research is necessary to fully explore both the social and intellectual factors that influence the scientific acceptance of species assignments.

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### Measuring constraints on selection in human and chimpanzee life histories.

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An organism's life history is comprised of its age or stage-specific vital rates and trade-offs that bind them. Fitness in structured populations is given by the renewal equation and perturbation analysis of the renewal equation can be used to measure the force of selection on vital rates. While perturbation analysis provides information about the direction of selection, it is not informative about constraints that are central to life history theory. We derive a simple means of measuring the constraints on structured life histories. Assuming stabilizing selection, we use fitness elasticities to measure constraints on selection on the life cycle. The ratio of the fitness elasticities of two traits measures the slope of the constraint curve that binds them at equilibrium. We apply this method to understanding the differing constraints between human and chimpanzee life histories, focusing specifically on the trade-off between adult fertility and pre-reproductive survivorship. The shapes of the constraint curves linking fertility and pre-reproductive survival are quite different between the two species. Human curves show a pronounced U-shape, while the chimpanzee curves are more monotonic and shallow. This result suggests substantial costs associated with both very early and late reproduction in humans. Overall, we find that a unit of investment in fertility among humans must yield minimally five times the benefit of a unit of investment in infant survival. The switch from investment in infant survivorship to investment in further fertility is strongly influenced by the capacity of mothers' continued investment to contribute to the survival of offspring.

### Reconstructing early-life lead exposure and biocultural beginnings: The Armelagos Effect in African diasporic bioarchaeology.

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Through bone chemistry, bioarchaeologists established environmental lead as one of the many "life stresses of slavery." In this paper, we revisit the issue of lead in African-American biohistory using laser sampling of tooth enamel to measure biogenic concentrations in developmental real-time, i.e., during crown calcification. We report recent findings on early-life lead burden of those buried at the 18<sup>th</sup>-century New York African Burial Ground and discuss implications for reconstructing migration and health.

Mean M1/I1 lead concentrations for young children ( $5.88 \mu\text{g g}^{-1}$ ) are over four times those of adults ( $1.33 \mu\text{g g}^{-1}$ ), suggesting American versus African geographic origins of the children. Other findings raise questions at the intersections of natality, health and culture. For example, why were mean enamel-lead concentrations for males over twice that observed for females? Do differences in lead concentration correspond to differences in the timing (age), sources or nature of lead exposure? Do high lead levels indicate American birthplaces for a few adults with culturally modified teeth, contradicting the practice's well-established relationship to African natality?

We seek a better understanding of colonial-era manifestations of lead poisoning, a disease with distinct racial and class dimensions today. We draw insight and inspiration from the work of George Armelagos: his integrative (evolutionary, historical and political economic) analytical framework linking human health, migration and inequality through time and his fundamental concern with the biological consequences of social vulnerability, past and present. In Armelagosian fashion, this study explores new methodological and theoretical pathways for African diasporic bioarchaeology "as anthropology."

### Going against the grain at Gabati.

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Medieval travelers described the southern Nubian landscape as a continuous chain of villages and cultivated lands peppered with sagia irrigation, similar to northern Nubia and Egypt. A decline in dental health, notably caries, is associated with agriculturalists, particularly females, and is supported by the skeletal remains from several northern Nubian and Egyptian sites. The individuals recovered from the rural multiperiod site at Gabati afforded an opportunity to evaluate this hypothesis in the absence of domestic archaeological evidence in the 5<sup>th</sup> Cataract region. Dentitions of aged and

sexed individuals ( $n = 113$  Meroitic, 2<sup>nd</sup> C BC-3<sup>rd</sup> C AD;  $n = 54$  post-Meroitic /medieval, mid-5<sup>th</sup> - Late 11<sup>th</sup> C AD) were scored for caries, abscesses, calculus and AMTL using tooth and individual counts. The crude prevalence of caries indicated that the disease was infrequent among the Meroitic adults (.07%) and even rarer among the later adults (.03%); caries was less frequent among females and absent among subadults. Abscesses and AMTL followed a similar pattern, while calculus increased dramatically from 24.1% during the Meroitic period to 88.2% in the later period. Two general explanations may account for this pattern: 1) Agriculture was not the subsistence mode for the Gabati people, and/or 2) Non-cariogenic products were consumed. The skeletal evidence supports the lack of archaeological data that high-level agricultural subsistence was likely not practiced at Gabati.

### Three cases of trepanation from the Titicaca Basin from 200BC-200AD: Practice and results.

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Trepanation has been practiced for two millennia in the Andes, with the earliest specimens coming from the coastal Paracas culture (circa 400 BC) near modern-day Ica, Peru. Few early examples of trepanation have been found in the Southern Andes highlands near the Lake Titicaca Basin, Bolivia and most samples from this region date to AD 600 and later. Thus, it has been suggested the trepanation practices spread into the Titicaca Basin either from the coast, or from the central highland regions around present-day Cusco, Peru. This paper discusses three individuals with evidence of trepanation from the sites of Ch'isi and Cundisa in the southern Titicaca Basin. Two of these individuals date to 200 BC-200 AD and show that trepanning was practiced in this area before AD 200. These two crania also had evidence of healing, which may have meant long-term success for those undergoing the operation. The third individual in this study dates to AD 1000-1300 and provides an interesting comparison in that that styles of trepanning changed and diversified over subsequent centuries. This study shows that over time new techniques of trepanation were developed, including three examples of linear cutting cranial surgery and one case of boring and cutting. Finally, trepanation seems to have been called for in cases of violent trauma, as all three individuals suffered from cranial fractures prior to trepanation and implies that in the Titicaca Basin, trepanation was primarily a medical practice.

### Why study primate communities? The importance for anthropology and ecology, current knowledge, and future directions.

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It has been more than 10 years since the landmark volume, *Primate Communities*, was published, but research on the subject since then has been limited. This is surprising considering the wealth of important advances in GIS, ecological informatics, macroecology, and phylogenetics. Using data from ISI web of science searches, we demonstrate that these developments have spurred community ecology research in non-primate groups and have focused attention on the importance of variation in spatial, temporal and phylogenetic scales for structuring communities, but that analogous research on primate communities has lagged. We emphasize the important implications of primate community ecology research for many areas of interest to biological anthropologists and ecologists, including the distribution of extinct hominin species, mammal paleocommunities, primate biogeography, behavioral ecology, and conservation biology. We discuss the recently renewed interest in understanding primate communities, much of which utilizes new datasets and analytical techniques to investigate the importance of local ecology, historical patterns of dispersal and vicariance, and interspecific competition for shaping primate community structure. This is encouraging and we suggest that future research involving primate communities will be facilitated by increased utilization of quantitative methods focused on macroecological and phylogenetic approaches. This will enable researchers to address a variety of novel questions focused on the ecology and evolution of communities. We draw attention to training resources and publically available data and we highlight burgeoning areas of research that warrant further consideration in an effort to catalyze future research on primate communities.

### Preliminary Investigation of Forelimb Use among Cercopithecoid Primates in Côte d'Ivoire's Taï Forest.

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The *Cercocebus-Mandrillus* clade is characterized by skeletal adaptations associated with collecting and processing obdurate foods from the forest floor. Compared to other African papionins, drills, mandrills and terrestrial mangabeys exhibit greater radial and ulnar interosseous ridging, more proximally-extending supinator crests, and more pronounced brachialis flanges indicative of frequent, powerful manual foraging. Although these osteological features are readily apparent, whether they reflect significant differences in forelimb mechanics has not been examined quantitatively. Here we present preliminary field data testing a null hypothesis of no difference in forelimb activities

between sooty mangabeys (*Cercocebus atys*) and two sympatric cercopithecids (*Procolobus badius*, *Colobus guereza*) inhabiting the Taï Forest.

We used focal sampling to quantify use rates of five forelimb movements employed during foraging: "raking" through leaves while pronating and supinating the forearm, manipulating held objects, and introducing objects to the mouth from below (B), in front (F), or above the torso (A). Results indicate that sooty mangabey foraging involves over twice as many forelimb movements as colobine foraging ( $p = 0.018$ ,  $F=4.07$ ). Neither colobine species "raked," which comprised 52% of *C. atys* forelimb activity. Both colobines performed F more frequently than sooty mangabeys ( $p < 0.01$ ,  $F = 84.62$ ), while the latter performed B more frequently than colobines ( $p < 0.01$ ,  $F = 10.96$ ). There was no significant interspecific difference in A or object manipulation. These pronounced behavioral differences strongly support the hypothesis that the forelimb of *Cercocebus-Mandrillus* clade members is adapted to vigorous manual foraging activities.

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### X-ray study on the laterality of the humeral bone mineral density for determination of handedness.

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Several osteometric approaches to estimate physical side dominance have been reported recently. However, the reliability of these methods is far from satisfactory for forensic applications. Here, we report a very significant side-to-side difference of the humeri observed radiographically in an individual with unilateral hand amputation, and extend the study to a more comprehensive population of untraumatized individuals.

Specifically, the left-hand amputated male and additional 20 individuals (9 females, 11 males; 16 adults, 4 matures) recovered from the same medieval graveyard, were subjected both to osteometric measurements and single-shot digital x-ray screening of the bilateral bones. The region of interest (ROI) for measurement of mean gray-scale values, correlating with the mineral density, was defined distal from the midpoint of the humeri, sized to:  $ROI_{width}=250Px$ ;  $ROI_{height}=(Humerus_{maximum\ length}/366) \times 200Px$ . Standardized bilateral asymmetry (SBA) was calculated by the generalized formula:  $SBA=(R_{value}-L_{value}) \times 100 / ((R_{value}+L_{value})/2)$ . Accordingly, positive SBA values indicate right-handed (RH) and negative ones left-handed (LH) individuals.

Other than in the osteometric measurements, radiographically detected bone mineral density differences were highly

significant ( $SBA_{\text{mean}}=16.3\pm 5.1$ ;  $p<0.001$ ), allowing reliable prediction of handedness ( $RH=19$ ,  $LH=1$ ). No significant differences were observed between females ( $SBA_{\text{mean}}=17.4\pm 5.5$ ) and males ( $SBA_{\text{mean}}=15.4\pm 4.8$ ), nor between adults ( $SBA_{\text{mean}}=16.8\pm 5.1$ ) and matures ( $SBA_{\text{mean}}=14.2\pm 4.9$ ). The most significant difference in bone mineral density ( $SBA=43.6$ ) occurred, unsurprisingly, with the amputated individual.

Further studies with an larger population of individuals with known handedness are currently in progress to substantiate the value of the suggested X-ray screening approach for the estimation of handedness, and to establish its potential for forensic anthropology casework.

#### **The diet of Neandertals at Krapina: Evidence from dental microwear texture.**

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The burgeoning field of dental microwear texture analysis (DMTA) provides an opportunity to assess Neandertal diet-related occlusal microtopography via scale-sensitive fractal geometry. Variables included anisotropy (the degree to which microwear shares orientation), complexity (surface roughness), and textural fill volume (the surface removed by microwear). The authors gathered DMTA data from 19 Krapina molars in order to determine the diet of Neandertals at that site. During the time of Neandertal occupation, Krapina was surrounded by an open forest or parkland, therefore, we hypothesized that Krapina would have texture values that are lower than those reported for Neandertals and anatomically modern humans (AMH) living in heavily wooded environments. We found that Krapina had high anisotropy (0.0043), low complexity (1.12), and low textural fill volume (35,518) values. The low complexity indicates the consumption of softer foods including meat, while the high anisotropy indicates the consumption of fibrous plants, including grasses. Thus, the anisotropy value contradicts a diet solely of meat and indicates a broader dietary spectrum for Neandertals than is sometimes reported. This research contributes to the growing body of evidence in support of Neandertal plant consumption, and provides an opportunity to investigate whether the high anisotropy at Krapina is a result of eating grasses.

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#### **Sex-based health differences during the transition to agriculture in Ukraine.**

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The Tripolye archaeological culture of Eneolithic Ukraine (5500-2500 BC) was one of

the first fully agricultural populations in Europe. The site of Verbeba Cave in western Ukraine is one of the few sites to yield human remains associated with the Tripolye culture. In addition to human skeletal material, many ceramic models of human females have been excavated from Verbeba Cave. These have been interpreted as being the material remains of a "goddess cult". Comparatively few male figurines have been found. Female-centric religious practices may have led the Tripolye to preferentially provide women with resources such as protein and nutrient rich foods that led them to be healthier than males. This hypothesis is tested using skeletal material from Verbeba Cave. Specifically, enamel hypoplasias, dental caries, periodontal disease, porotic hyperostosis, cribra orbitalia, and stature are compared between the two sexes. Using the multiple indicator approach, we accept the hypothesis that females are healthier than males. This research suggests that the specific religious practices of prehistoric populations in Europe may have resulted in sex-based health differences.

#### **Molar enamel thickness in four macaque species.**

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Molar enamel thickness has an important role in studies of primate taxonomy, phylogeny, and functional morphology, although its variation among hominins is poorly understood. Macaque species parallel hominins in their widespread geographic distribution, relative range of body sizes, and radiation during the last 5.5 million years. In order to explore enamel thickness variation, we examined average (AET) and relative (RET) enamel thickness in 279 molars from 79 individuals of four species (*Macaca arctoides*, *Macaca fascicularis*, *Macaca fuscata* and *Macaca mulatta*). Virtual sections were generated from micro-CT images sectioned bucco-lingually across mesial cusps. Enamel cap area, dentine area, and enamel-dentine junction length were measured on unworn or lightly worn sections, yielding AET and RET indices. Sex differences were not found in tooth-specific AET or RET comparisons within species, which differs from great ape and human trends. Comparisons of macaque species reveal that *M. fuscata* has the highest AET and RET, *M. fascicularis* shows the lowest AET, and *M. arctoides* has the lowest RET. Patterns of AET, an absolute measure of enamel thickness, are consistent with average annual fruit consumption, with the most frugivorous species showing the lowest AET. Moreover, *M. fuscata*

consumes the highest percentage of nuts, seeds, and pods, which has been suggested as a correlate of thick enamel in hominins. Relative enamel thickness, a size-corrected metric, follows phylogenetic groupings from a recent nuclear genome study. Additional data on fallback foods and material properties are needed to assess current hypotheses about the relationship between primate dietary ecology and enamel thickness.

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#### **A preliminary report on the interactions between humans and squirrel monkeys in the southern Costa Rica countryside.**

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Human-modified landscapes are inarguably important to the survival and health of many primate species. As humans continue to expand into primate habitat, and as previously disturbed habitat regenerates, primates are increasingly found in land defined as countryside: any land without buildings where the ecosystem is strongly influenced by humans.

This research investigates how a previously unstudied population of an endangered subspecies of squirrel monkey (*Saimiri oerstedii oerstedii*) interacts with their human-impacted and modified surroundings in southern Costa Rica. I present pilot data here on the daily activity budgets, habitat use, and feeding behavior of two troops of squirrel monkeys living in and around Morphose Mountain Retreat, near Ciudad Neily.

Predictions of monkey habitat use based on earlier conversations with local landowners were unsupported, and in fact, the monkeys interacted with humans and human-modified landscapes in counterintuitive ways. My results indicate that in some cases squirrel monkey habitat may not be fragmented by the presence of roads and that monkeys in a populated area may be able to successfully avoid increased contact with humans. These results can be used to better inform management decisions for countryside habitats to ensure endangered squirrel monkey population survival.

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#### **Potential soft organic tissue preserved in association with the *Australopithecus sediba* fossils from Malapa cave site, South Africa.**

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The near complete Plio-Pleistocene aged *Australopithecus sediba* hominin specimens from the Malapa site, South Africa were analysed to determine whether soft tissue in the form of fossilised skin may have been preserved.

The taphonomic condition of the fossils suggests rapid burial, lack of predation, but some insect damage, making the preservation environment at Malapa exceptional. Any soft tissue found with the hominins, represented by MH1 (Malapa Hominid 1) and MH2 (Malapa Hominid 2) would be of some considerable value, although such preservation is at present unrecognized in the early hominin record.

A multidisciplinary approach that combined morphological techniques (optical coherence tomography, three-dimensional laser scans, micro-CT scans and light microscopy) in association with molecular imaging (Raman spectroscopy and Fourier transform infrared) investigated whether original organics may be recovered. Two primary specimens were analysed – a cranium sample from MH1 and mandible specimen from MH2. The examination included an analysis of soft tissue decomposition potential to determine whether the depositional environment may have facilitated soft tissue preservation. Overall the study produced a provocative body of evidence that the specimens were indeed organic in origin. The significance of such a discovery could provide insight into our understanding of ancient hominin behaviour, biological pathways and taphonomic processes. Support for this research was provided by the African Origins Platform of the Department of Science and Technology (South Africa), the National Geographic Society, the Gauteng Provincial Government, the National Research Foundation (South Africa), the University of the Witwatersrand and numerous other donors.

#### **Distinguishing cut marks from carnivore tooth marks using scale-sensitive curvature of mark profiles.**

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Cut marked bone resulting from butchery using stone tools provides evidence of both early tool use and the presence of meat in hominin diet. Recognition of cut marks has been based on qualitative criteria with respect to the shape of the mark cross-section and relies on the experience of the investigator. Thus, a quantitative and objective method for mark recognition is desirable. Here we present results of new methods to quantify shapes and sizes of cut marks and carnivore tooth marks. Impressions of wolf tooth scores on deer bones and stone tool cut marks on pig bones were scanned with a Nanovea white-light profiler with a lateral sampling interval of 2 µm. Mid-mark profiles were analyzed with a scale-sensitive curvature algorithm. Results of this analysis at a coarse scale (600 µm) were used to define the

base of the mark trough as the region of uniformly positive curvature. This positive curvature method allows for objective and repeatable recognition of a mark margin for shape analysis and calculation of mean curvature across scales. Preliminary results of a small sample showed no apparent difference in mean curvature between wolf tooth scores and cut marks. However, the width of the region of positive curvature appeared greater for the cut marks compared to the wolf tooth scores (455 µm versus 362 µm) and curvature appears more variable for the cut marks. This later result might be due to a sharper profile for the cut marks.

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#### **Bioarchaeological case studies from the early Medieval site of Pohansko near Břeclav, Czech Republic.**

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Within any skeletal population a bioarchaeologist may observe individuals with interesting skeletal anomalies, including individuals who present skeletal data that warrants presentation in the form of a case study. Two adult skeletons from the early Medieval site of Pohansko near Břeclav (Czech Republic) are described based on anthroposcopic analysis. Pohansko is one of three major administrative centers of Great Moravia, a Slavic state that flourished in the 9th and early 10th centuries, A.D. The first individual is a female with a mid-diaphyseal amputation of the right tibia and fibula with significant remodeling. The second individual is a male with asymmetrical degenerative joint disease and well developed muscle markings. He had moderate to severe tooth wear, which is consistent with using teeth as tools (Capasso, Kennedy and Wilczak 1999). The lower central incisors have significant wear on the labial surface, and the right upper canine and lateral incisor have V-shaped wear, indicating he used his teeth in the preparation and/or utilization of leather, string, or some similarly sinuous material. Both individuals were buried near the second church at Pohansko, located just north of the bastion. An initial mortuary analysis, and conclusions from previous archaeological research, suggests these individuals are of high status. For both individuals we discuss the consequences that their activity-related skeletal modifications, pathology and trauma may have had on day-to-day life. Using skeletal data and mortuary analysis we describe potential habitual activities, which could have led to the skeletal characteristics present at the time of their deaths.

#### **Dental metric variation in two species of howler monkeys and their hybrids.**

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Understanding dental variation in extant primates serves to inform questions about what constitute adaptive species-specific differences as well what degree of variation is expected within and between species. Dentition is known to have a strong heritable component; therefore, differences across taxa are suggestive of selection, often associated with feeding behavior. Here we investigate postcanine dental metric variation among two species of howler monkeys and their hybrids. *Alouatta palliata* and *A. pigra* are considered to be distinct species based on various lines of evidence, including morphological, genetic, and behavioral differences. Dental data from parental and hybrid individuals allowed for the unique opportunity to address within and between species variation. Measurements were obtained from casts of wild captured individuals as well as museum specimens. In particular, we measured the maximum mesiodistal and buccolingual dimensions of the right maxillary P1 thru M3. Measurements on hybrid individuals only came from wild captured individuals, where hybrid status was determined using a combination of diagnostic genetic markers, including mitochondrial, Y-chromosome, and autosomal microsatellite data. Results indicate that the mesiodistal dimensions of some teeth for both males and females on average discriminated among the parent species. Hybrid individual tooth size resembled that of the parental individuals with which they share most of their alleles and intermediate hybrids overlapped with both parent species. Some intermediate hybrids exhibited values well outside the ranges of all other individuals. The implications of these differences for species recognition in the fossil record as well as selection on tooth size are explored.

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#### **Genome-wide associations for Parkinson's disease on the X chromosome.**

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Nearly all genome-wide association studies (GWAS) published in the last 5 years focus on identifying novel associations within the autosomal chromosomes. Genomic regions

located on the sex chromosomes are included on most current microarray platforms, yet little attention has been given to these regions in GWAS. Sex chromosome variants are often excluded from GWAS analyses because of a preference for statistical methods that test the association between phenotype and autosomal genotype. However, appropriate techniques do exist, and much can be gained from analyzing these regions. We employed imputed genotyped data from 6 European ancestry cohorts containing 9,511 control and 8,497 case individuals. We tested for genome wide associations to Parkinson's disease status on the X chromosome. Our results are currently pending validation in another study cohort, but indicate number of statistically significant, small-effect SNPs clustered throughout the X chromosome confer risk to Parkinson's disease development. In addition, our utilization of X-chromosome GWA data facilitates a more comprehensive understanding of the complex disease architecture of Parkinson's disease in a previously unexplored region of the genome. Continued development of study designs examining the sex chromosomes and disease status are necessary, and our work documents the applicability of GWA analyses to complex diseases in the X chromosome.

**Migration during state expansion in the Nasca region: Strontium isotope evidence from Pataraya, a Wari outpost in Peru (AD 750-1000).**

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Migration of human populations is important in understanding state expansion. We examined the role of population mobility and migration in Wari state expansion in the Nasca region during the Middle Horizon (AD 750-1000) through the use of strontium isotope analysis of human teeth from the Wari outpost of Pataraya. Archaeological evidence suggests that textile manufacturing was important at Pataraya, located near the borderlands of the Nasca region with the highlands. Recent research shows that migration into the Nasca region increased during the Middle Horizon, coinciding with Wari expansion, but these data are the first to test if direct Wari emissaries were present at a Wari outpost. Previous stable isotope analysis of Nasca human bone and teeth suggests that Wari did not exploit the region for maize. Instead, Pataraya may have functioned for the acquisition of coastal cotton and shipment of the product to the Wari state. Most individuals buried at Pataraya exhibit strontium isotope values closer to the Wari average than the Nasca average, suggesting that they may be Wari migrants. A few individuals buried at Pataraya, however, fall within the average range for Nasca individuals, indicating that the Wari strategy likely involved local Nasca collaborators. When examined with

other regions under Wari influence, these data support the position that the Wari practiced a "mosaic of control" or different consolidation strategies shaped by local conditions.

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**Tracking Hunnic cultural influences through cranial deformation.**

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At the apex of their power, the Huns' cultural influences reached many parts of Europe that their armies had not, including the Roman city of Histria in Romania, located along Lake Sinoe near the Black Sea. Due to a lack of written accounts, bioarchaeology provides a new approach to track the spread of the Huns' cultural influences outside of their central European empire, which bordered the Roman Empire. Through discoveries made at Histria it is possible to apply cranial analysis to demonstrate shared practices indicative of the Huns' wider cultural networks. Excavations of Histrian burial sites revealed crania dating from 400-500 A.D., now located at the Institutul de Antropologie "Francisc I. Rainer" in Bucharest, that exhibit distinct cranial modification signifying that these Romans had adopted this Hunnic cultural practice.

Analysis of two of the crania from Histria documents evidence of artificial deformation produced by oblique circular bandages that had been wound around the frontal-occipital regions. This resulted in flattening of the frontal bone that produced frontal bossing inferior to bregma and sloping posteriorly into a sulcus. This type of cultural modification is consistent with that of the Huns who possibly used cranial deformation as a permanent symbol of affiliation. This study suggests that specific forms of cranial deformation may provide new evidence to explore and document the spread of Hunnic influences into the Western Roman Empire.

**Eye size as a selective determinant of vestibular sensitivity.**

ADDISON D. KEMP and E. CHRISTOPHER KIRK. Department of Anthropology, University of Texas at Austin.

The semicircular canals detect head rotations and trigger compensatory movements that stabilize gaze and prevent blurring of images on the retina. Precise gaze stabilization is presumably of greater importance in animals with large eyes because loss of visual resolution will begin at a lower threshold of uncompensated motion in species with high visual acuity. Semicircular canals with larger radii are more sensitive to angular accelerations and are therefore theoretically capable of providing the vestibular feedback necessary to stabilize gaze

more precisely in large-eyed species. Nevertheless, the relationship between eye size and semicircular canal sensitivity has not been examined in a comparative context.

We collected data on semicircular canal mean radius of curvature (R) and axial eye diameter (AD) for 110 species across twelve mammalian orders to evaluate the relationship between semicircular canal size and eye size. PGLS analyses show that animals with larger eyes also tend to have larger semicircular canals ( $p < 0.001$ ;  $r^2 = 0.58$ ). Though both variables are independently significantly correlated with body mass, the relationship between AD and R remains highly significant when the effects of body mass are accounted for using both PGLS multiple regression ( $p < 0.001$ ; partial  $r^2_{AD} = 0.30$ ) and phylogenetically informed partial regressions ( $p < 0.001$ ).

These results suggest that a significant portion of the interspecific variation in semicircular canal size among mammals is attributable to increased need for precise gaze stabilization in species with large eyes and acute vision. Evolutionary increases in eye size may therefore create selective pressure favoring concomitant increases in semicircular canal sensitivity.

**Novel method for detecting conserved and divergent regions in admixed populations.**

BRETT J. KENNEDY. Anthropology, University of Utah.

Principal component analysis (PCA) is a method of reducing the dimensionality of complex datasets. For large, highly inter-correlated data such as the HapMap or the 1000 Genomes Project, PCA is an ideal method for revealing internal structures that cannot be seen using other methods. PCA has been widely used in population genetics to examine population history and relationships between individuals and populations across the genome. Here we combine PCA with *Fst*-like measures of genetic distance to examine across each chromosome in a rolling window comparison of divergence or convergence by comparing an admixed population with its source populations. The result is a chromosome-by-chromosome map that plots where the admixed population is more similar to one of the parent populations than the other. Regions of significant regional lengths of divergence may be useful in suggesting gene regions where selection has recently taken place, as the combination of two historically distinct populations is likely to lead to adaptation and selection.

**Genetic characterization of the Roman/Parthian Period cemetery at Tall Šēḥ Ḥamad, Syria.**

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The site of Tall Šēḥ Ḥamad presents a unique opportunity to conduct genetic analysis of past populations due to its location at a political

boundary and distinct duration of occupations. Tall Šēḥ Ḥamad is hypothesized to be one of many small, but strategically important outposts used to defend the Roman Empire from Persian invasions during the Roman/Parthian period (0-300 CE) (Edwell 2008). However, due to its relatively small size and limited resources, the site was potentially abandoned and occupied multiple times over roughly four hundred years, creating a varied archaeological context played out in mortuary practices and other remains (Edwell 2008; Butcher 2003; Novak et al. 2000). Molecular profiles or 'molecular biographies' of an individual's remains provide a more complete understanding of populations in the past. This study presents forty molecular profiles of individuals from the Roman/Parthian period at Tall Šēḥ Ḥamad, Syria in conjunction with archaeological mortuary evidence to assess their cultural and biological characteristics.

**Using stable isotopes to ascertain paleo-foraging strategies through the study of woodland bison behavior.**

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Big Bone Lick State Park (BBL) in the Ohio River Valley is often considered the birthplace of American paleontology. The site is the final resting place for a number of extinct or locally extirpated large mammals. Skeletal remains from eastern woodland bison, *Bison bison*, are abundantly deposited in the creek bed. Past investigations have indicated that the presence of bison at this site is the result of a single kill event by humans dating approximately 530 years ago. This time is roughly equivalent to the Fort Ancient culture. The hunting decisions of the people who organized this kill event are important for understanding the impact of human activity on woodland bison ecology, and the role of bison in Fort Ancient subsistence strategies. The purpose of this project is to determine the extent of migration, nutrition, and age of woodland bison using isotopic analysis of carbon, oxygen, nitrogen, strontium, and comparative dating methods. This information can be used to better understand the foraging behavior of Fort Ancient People. Using this suite of methods we have examined the extent of the BBL bison habitat, and gathered information on their health and diet. We find that BBL bison had a mixed browse and grass diet, and relatively restricted range along Ohio River Valley waterways. It is therefore likely that bison was a relatively stable and abundant local food resource for Fort Ancient people.

**Size does matter: Variation in tooth size apportionment among major regional North and sub-Saharan African populations.**

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Twenty years ago Edward Harris proposed a new approach using principal components analysis to compare mesiodistal and buccolingual crown diameters in humans. A major goal, like other researchers (e.g., Penrose), was to remove overall "size" from the measurements – which is ineffective for biological affinity and phylogenetic analyses. Relative size, however, is important, i.e., to assess how it is apportioned along the tooth rows. To get at such data, Harris utilized three overall size predictors in multiple linear regression to calculate PC 1 residuals; these, and other uncorrected components were then used in the analysis. The approach was subsequently used by many to quantify population differences at global to local in scale.

Tooth size apportionment analysis, like many quantitative methods, was "in style" before something else gained attention. Here we demonstrate that it is still effective, by comparing 32 MD and BL measurements in 12 (n=712) and 18 (n=1251) samples from sub-Saharan and North Africa, respectively. Plotting of the first three components (50% of variance) shows clear sample separation between regions. Relative to sub-Saharan samples, North Africans are characterized by: 1) small LI1s, and BL dimensions of the UM1, LI2, and LM1, and 2) large MD diameters of the UM2 and LM1, and BL diameters of the LM2 and LM3. Comparisons of North Africans only show the ability to distinguish among samples from the Maghreb, Egypt, and Nubia. In other words, basic crown diameters can be successfully used for affinity estimation, if relative size, a.k.a., "shape" is accounted for.

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**Do two age-related characteristics identified in Korean archaeological skeletal samples influence Transition Analysis final age-at-death estimates?**

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One practical difficulty of "traditional" age-at-death phase methods is to properly identify skeletal features on each age indicator that strongly correlate with age. This is largely due to subjective inter-observer interpretation of age-related feature. Because of this, age-at-death assessments based on composite scoring system have recently been championed over phase methods. However, a dilemma still arises in the application of the composite scoring method when there is a potential age-related skeletal feature that does not fit the conventional

definition of the age-at-death methods. In this instance, the physical anthropologist's decision must be made with caution because either including the unclear skeletal feature into the age estimate as a variational form of the conventionally defined feature or excluding it as a non-metric trait unrelated to age may result in significantly different age estimates.

To address this issue, this study presents two unique features on the sacro-iliac articulation of the ilium that have been identified in Korean archaeological skeletal samples from the Joseon Dynasty (late 13th-early 20th century): 1) wide grooves on the auricular surface, and 2) accessory facets on the retroauricular area. Transition Analysis is used to evaluate differences in final age estimates (e.g. the wide grooves feature was scored as either presence or absence of billows, and influence of each score on age estimates was examined). The results of statistical tests suggest that physical anthropologists wisely make their decision on inclusion or exclusion of such features because scores of all the age-related features are closely interrelated to final age estimates.

***Ardipithecus ramidus* and the evolution of the human cranial base.**

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The early Pliocene African primate *Ardipithecus ramidus* was diagnosed as a hominin/d based on non-honing canines, relatively foreshortened cranial base, and postcranial characters related to facultative bipedality. However, postcranial traits related to arboreal quadrupedality, such as a grasping hallux and elongated ischium, have raised suspicions that this taxon instead exemplifies putative widespread homoplastic evolution of humanlike traits among apes around the time of the chimpanzee-human split.

Because the basicranium has undergone profound structural change during human evolution, we examined this region of the *Ar. ramidus* cranium (ARA-VP 1/500) for additional clues to its phylogenetic position with reference to African apes, humans, and *Australopithecus*. Besides the relatively anterior foramen magnum, humans differ from apes in the lateral shift of the carotid foramina and mediolateral abbreviation of the tympanic elements, which reflect a relative broadening of the central basicranium, a derived condition among catarrhines. These differences underlie changes in shape of the tympanic and the extent of its contact with the petrous. *Ar. ramidus* shares with *Australopithecus* each of these humanlike modifications.

We used the preserved morphology of ARA-VP 1/500 to estimate the missing

basicranial length, drawing on consistent proportional relationships in apes and humans. *Ar. ramidus* is confirmed to have a relatively short basicranium. A short, broad cranial base with an anterior foramen magnum is otherwise found exclusively in *Homo* and *Australopithecus* among catarrhines, warranting identification of *Ar. ramidus* as a hominin/d. Reorganization of the cranial base is among the earliest morphological markers of this clade.

#### **Aging methods across populations: Focus in Nigeria.**

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Building on a body of work by Jantz, Konigsberg, and Kimmerle (2008) which addressed questions about population variation in human identification, models for aging Nigerian populations are investigated. Demographic data for n=2,590 cases and biometric scores (n=356) for the pubic symphysis and fourth ribs, scored in the manners of Suchey-Brooks and Iscan and co-workers, were collected for identified individuals autopsied at LASUCOM, Nigeria. Overall the average ages and general age ranges for each phase are lower than that of the original methods. The Nigerian samples have a lower mean age at death, though the overall range is consistent, whereas the American sample tends to be slightly older. Comparing the distributions of the samples through independent sample t-tests, reveals they are significantly different, for both male and female groups, well below the 0.05 level. Interestingly, the mean difference is far less between Nigerians and Americans, 4.35 years, than it is among Nigerian and Balkan samples, 13.6 years. To calculate age-at-death parameters that can be used by investigators in the field – a Bayesian statistical approach is used. Combined parameters for both traits are calculated. For the 321 Nigerian individuals having both rib and pubic symphysis data, an “R” script “lrage.viewer.biv” applies single trait models for the rib and pubic symphysis stages and combines these with the total Nigerian age-at-death distribution (n=2,461). Of the 296 individuals in a bootstrap sample, 141 (47.63%) had ages that fell within their stated 50% HPD. This is not significantly different from the 50% expected (p=0.4158).

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#### **Age-related trauma incidence in the Gombe chimpanzees.**

CLAIRE A. KIRCHHOFF<sup>1</sup>, MICHAEL L. WILSON<sup>2,3</sup>, DEUS C. MJUNGU<sup>4</sup>, D.

ANTHONY COLLINS<sup>4</sup> and SHADRACK M. KAMENYA<sup>4</sup>. <sup>1</sup>Department of Cell Biology and Anatomy, University of North Texas Health Science Center, <sup>2</sup>Department of Anthropology, University of Minnesota, <sup>3</sup>Department of Ecology, Evolution, and Behavior, University of Minnesota, <sup>4</sup>Gombe Stream Research Center, Jane Goodall Institute.

Previous research indicates that adult chimpanzees accumulate injuries as they age, so that older chimpanzees have more skeletal traumata compared to younger conspecifics. We tested whether this same trend is apparent in sub-adults versus adults in an expanded skeletal sample of wild chimpanzees from Gombe National Park, Tanzania. We examined 30 chimpanzee skeletons (16 female, 14 male) for skeletal trauma, all with known sex and age (or a reliable age estimate), and represented by complete or near complete skeletons. Trauma incidence is the percent of observable bones affected by trauma, allowing for some broad comparisons between skeletons with differing numbers of bones (e.g. adults versus sub-adults, or in cases of a few missing hand or foot bones). We analyzed the relationship between trauma incidence and age using the statistical software Arc. This study confirms that number of traumata increases with age in adult chimpanzees. In the sample that includes chimpanzees of all ages, we did not find a linear relationship between age and trauma incidence ( $R^2 = -0.065$ ,  $p = 0.17$ ). This is due to 4 influential cases whose trauma incidences are an order of magnitude larger than the other chimpanzees in the sample. We argue that the influential cases should not be considered outliers because cause of death is conspecific aggression, one of the leading causes of death for chimpanzees at Gombe, and because in a sub-sample including only adult chimpanzees, cause of death did not affect trauma incidence (chi-square = 0.868,  $df = 1$ ,  $p > 0.1$ ).

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#### **Culture-Genetic models of information exchange among Pleistocene human populations.**

MARC KISSEL. Anthropology, University of Wisconsin-Madison.

*Homo sapiens* have a significantly larger census population size than any of the other hominoids and thus should show a greater level of genetic variation. Yet this is not the case, as ape species possess much more diversity than humans do at genetic loci (Charlesworth 2009). Here, I test models which explain this lack of genetic diversity as a result of a significantly low amount of gene flow between small regional populations of early humans during the Pleistocene (i.e. Premo and Hublin 2009). I derive predictions from these models by computer simulations and compare the results to the physical variability of fossil humans and Middle Paleolithic lithic traditions. This method utilizes a new application of Information Theory to allow for the comparison of

paleoanthropological data and genetic models. By building a database of both fossil data and cultural material from archaeological sites in Europe, assumptions about an increase in the amount of information concomitant with the introduction of a new human group to Europe during the Middle Pleistocene are tested. Results fail to falsify the null hypothesis that there is no change in the amount of information throughout the Middle Pleistocene, suggesting that many of these models are faulty. I argue that effective population size may be partially explained by patterns of human culture, but that we need to take into account other aspects. In fact, low effective population size may not be a good indicator of census size in the Pleistocene.

#### **Structural asymmetries in the human brain assessed via MRI.**

LINDSEY M. KITCHELL, P. THOMAS SCHOENEMANN and MACKENZIE LOYET. Anthropology, Indiana University.

The human brain is structurally and functionally different between hemispheres. Developmental, evolutionary, and genetic factors are thought to influence these asymmetries. Behavioral traits such as manual dexterity, motor control, and aspects of language are usually lateralized in the brain, but the extent to which these can be directly linked to specific anatomical asymmetries has been the subject of debate. Analyses of fossil hominin endocasts have revealed anatomical asymmetries that are assumed to reflect asymmetries in underlying brain regions. Clarifying where - and by how much - extant human brains are asymmetrical will allow better interpretations of these fossil asymmetries, both with respect to suspected brain asymmetries as well as possible functional/behavioral implications. Two areas of particular interest are Broca's and Wernicke's areas, because they play key roles in language production in modern humans. Previous research has suggested that these areas are asymmetrical, but studies to date have had small sample sizes and often use brain scans of unhealthy patients. To this end, we investigated the various left-right differences of the human brain through a voxel-based morphometric analysis of MRI scans of 72 healthy, female subjects. Left-right reversed versions of individual brains were mapped into their corresponding original versions, using non-rigid deformation methods. These mappings were then registered to a common atlas, and average degrees of left-right asymmetry were calculated for each voxel. Our results showed both Broca's and Wernicke's areas to have significant leftward asymmetry at the p-value of 0.001. Implications of this work for hominin evolution will be discussed.

#### **Revealing the evolutionary dynamics of pathogens in primate populations.**

ANDREW KITCHEN. Anthropology, University of Iowa.

Recent advances in DNA/RNA sequencing technology, combined with newly

developed population genetic and phylogenetic models, have allowed researchers to investigate the evolutionary dynamics of primate pathogens to an unprecedented level of detail. Predictably, this has sparked an exponential increase in the number of studies concerning the dynamics and origins of important primate pathogens and parasites. In this introductory presentation, I will discuss how these advances have led us to question previous assumptions about primate pathogen evolution, whilst revealing surprising aspects of pathogen dynamics in primates. I will use recent examples of studies that highlight notable insights at both the macro- and micro-evolutionary scales, and use this framework to relate these findings to inferences that we may make about the shared evolutionary histories of primates and their pathogens. Specifically, I will briefly discuss findings concerning the notably rapid evolution of dsDNA viruses (e.g., pox- and polyomaviruses), the propensity of RNA viruses to establish novel lineages via host-jumping (e.g., the flaviviruses), and the utility of large-scale bacterial genome sequencing for tracing the historical origins of on-going epidemics in developing countries (e.g., *Shigella sonnei*).

**Variation by variation: Differences in sexual dimorphism of the skull between African-Americans and European-Americans.**

AMANDA G. KITTOE. Geography and Anthropology, Louisiana State University.

This study assesses sexual dimorphism of the skull in samples of African-Americans (AA) and European-Americans (EA). Morphology of the skull is classically referenced as an indicator of sexual dimorphism in the fields of bioarchaeology and forensic anthropology. Variation in size and shape of cranial elements has been found to differ significantly between ancestral populations. This study uses a sample of 55 AA females, 50 AA males, 49 EA females, and 49 EA males from the Hamann-Todd Collection at the Cleveland Museum of Natural History and the WM Bass Donated Collection at the University of Tennessee, Knoxville. Nineteen linear measurements were taken on the cranium and mandible. Initial univariate analysis suggests inconsistent patterns of sexual dimorphism between AA and EA. Further multivariate analysis demonstrates that four of the measurements have significant interaction between sex and ancestry. In other words, fifteen of the nineteen measurements do not display significant variation in sexual dimorphism; however, four measurements do (i.e. cranial length, cranial height, cranial base length, and gonial angle). These findings highlight importance of considering human complexity when studying demography or developing a biological profile. This study provides a platform for further exploration of the diverse biological and environmental factors contributing to this phenomenon.

Robert C. West Graduate Student Field Research Fund, Dept. of Geography and Anthropology, Louisiana State University.

**A phylogenetically-integrated morphological analysis of the hominoid wrist.**

TRACY L. KIVELL<sup>1</sup>, ANNA P. BARROS<sup>2</sup> and JEROEN B. SMAERS<sup>2</sup>. <sup>1</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>2</sup>Department of Anthropology, University College London.

Although the functional morphology of primate wrist and hand bones has been extensively studied in a comparative context, few studies have incorporated phylogenetic information. Here, we apply a new phylogenetically-integrated method to the morphological analysis of hominoid wrist that reveals underlying evolutionary patterns of morphological change. Linear morphological variables of five wrist bones – the scaphoid, lunate, triquetrum, capitate and hamate – are analyzed in a diverse sample of extant hominoids ( $n=12$  species), Old World ( $n=8$ ) and New World ( $n=4$ ) monkeys and several fossil Miocene ape ( $n=7$ ) and Plio-Pleistocene hominin ( $n=8$ ) taxa. Using phylogenetically-weighted Principal Components Analyses for each wrist bone, we identify the morphological features that principally characterize primate wrist evolution and map these morphological changes along individual branches of an independently estimated (molecular) phylogenetic tree. The incorporation of phylogenetic information reveals several occurrences of parallel evolution within the hominoid clade, particularly between *Pongo* and hylobatids, and among hominines in the scaphoid, triquetrum and capitate. This analysis also reveals that among extant hominoids, *Pan* often retains the primitive, ancestral morphology, confirming that *Pan* can be an ideal comparative sample in studies hominin wrist evolution.

This research was funded by the UK National Environment Research Council (NE/H022937/1) and the Fundação para a Ciência e a Tecnologia (SFRH/BD/60349/2009).

**Current practices in Physical Anthropology for sex estimation in unidentified, adult individuals.**

ALEXANDRA R. KLALES. Anthropology, University of Manitoba.

The research presents an analysis of the methods currently employed by physical anthropologists to estimate sex in unknown, adult individuals encountered in forensic and archaeological contexts. Sex estimation is generally the first step when constructing biological profiles, primarily because many of the methods for the remaining parameters are sex-specific; however, the methods employed and way in which results are reported varies considerably by practitioner. By understanding the degree of variability, method preference, and modes of reporting, we as a field can work towards standardization for sex estimation practices.

An electronic, 32 question survey on sex estimation practices was created and participants were recruited from professional anthropology organizations. The survey software double-

blinded all identification information, so participation was anonymous. Responses were received from 154 individuals. The pelvis was preferred as the best indicator of sex (89.8% selected as first choice), followed next by the skull (69.1% selected as second choice), and then by the long bones (73.7% selected as third choice). Traits listed in *Standards* (Buikstra & Ubelaker 1994) ranked highest for the skull and for the pelvis, the three traits of Phenice (1969) ranked highest for non-metric methods. For metrics, FORDISC (Jantz & Ousley 2005) was the preferred method. Most practitioners (62.6%) prefer to use both qualitative and quantitative methods; however, when both are not used, non-metric methods (25.9%) were used twice as much as metric methods (11.5%). These findings highlight the variability in the methods used for sex estimation and the need for discussion and standardization within the field.

Financial support provided by the University of Manitoba Graduate Fellowship and the Manitoba Graduate Scholarship.

**Integrating pathophysiology, human biology, and epidemiology in studies of human remains: towards a clearer vision of stress and health in bioarchaeology.**

HAAGEN D. KLAUS. Dept. of Behavioral Science, Utah Valley University, Dept. of Biology, Utah Valley University, Assoc. Investigator, Museo Nacional Sican, Peru.

Debates over the concepts of “health,” “stress,” and the interpretation of skeletal pathological conditions cut to the existential core of contemporary bioarchaeology. We have much to gain from other anthropological subdisciplines, as developing formal integrations with mortuary archaeology and political economy has shown. However, to address health and stress more fully, it may be fruitful to go beyond anthropology entirely and initiate wider engagement with disciplines further afield. In this paper, I aim for a theoretical and conceptual exploration, highlighting three potential areas of enriching cross-disciplinary synergism for bioarchaeology. First, the field of pathophysiology can impart a very precise understanding of the origins and course of many skeletal conditions. Pathophysiology can rid bioarchaeology of its biggest ‘black box’ and transcend literalist and paradoxical interpretations of skeletal lesions. Second, the patterns and processes of health and disease in living populations as studied by human biologists are vitally instructive for the past; growing understanding of epigenetically-driven health phenomena may explain bioarchaeological relationships between, stress, developmental pathways, canalized biological damage, and age-at-death. Third, the field of epidemiology helps demonstrate that our predilection towards quantifying stress across time and space using crude prevalence may not be the most informative or sophisticated approach. Quantitative multivariate tools (odds ratios, person-years construct) may provide superior bases for bioarchaeological measurements of disease. Ultimately, this paper

is a call to consider how pathophysiology, human biology, and epidemiology can help stimulate further maturity and sophistication in bioarchaeological science and bridge “stress” and “health” in a biocultural framework.

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**How many points does it take to determine a home range? A meta-analysis of home range calculation methods from GPS collar data.**

AMY R. KLEGARTH<sup>1</sup>, AGUSTIN FUENTES<sup>2</sup> and HOPE HOLLOCHER<sup>1</sup>. <sup>1</sup>Biological Sciences, University of Notre Dame, <sup>2</sup>Anthropology, University of Notre Dame.

Recent reviews home range measurement methodology has highlighted a need for a standard currency of measurement and reporting. Across methods including, but not limited to minimum convex polygon, kernel density estimation, linear home range, and harmonic mean, researchers struggle with reproducibility in home range determination.

In an effort to aid standardization of home range estimation methodology we have sub-sampled data and calculated home ranges over a variety of methods from 3 GPS satellite collars. Collars recorded the locations of long-tailed macaques (*Macaca fascicularis*) over 1-4 week long periods in mixed, rainforest canopy and manicured park space in Singapore. The collars fixed a position in >98% of positioning attempts for collars deployed at Bukit Timah but only ~63% of the time for a collar deployed at Upper Seletar (1: 1786/1810; 2: 1704/1705; 3: 386/609 programmed positions). The dense amount of data taken across intervals varying from every 5 minutes to hourly across 1-4 week long time periods enable us to sub-sample data to determine the most efficient collar program settings. Furthermore, we will include data from other studies utilizing both VHF and GPS tracked individuals to compare the relative methodological efficiency to help researchers evaluate whether the man-hour costs or monetary investment associated with VHF telemetry and GPS collars respectively are most worth investing in. The meta-analysis will also examine the importance of sampling interval. Finally, we will report on the functionality of a remote-trigger drop-off mechanism and report on the impact of study site location and collar programming add/drop times.

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**From valley to coast: an isotopic study of Albanian diet across three millennia.**

STEFANIE A. KLINE<sup>1</sup>, ERIC J. BARTELINK<sup>1</sup> and TODD W. FENTON<sup>2</sup>. <sup>1</sup>Department of Anthropology, California State University, Chico, <sup>2</sup>Department of Anthropology, Michigan State University.

Isotopic data are presented for 65 burials from four sites in Albania dating from the Late Bronze Age to the Early Medieval period to explore variation in human diets. Ecological and cultural diversity place these coastal and inland Albanian settlements within a complex social context and history replete with periods characterized by colonization, migration, and urban development and decline punctuated by repeated invasions.

Stable carbon and nitrogen isotope ratios of human bone collagen, which track dietary protein sources, and stable carbon isotope ratios of bone apatite, which record macronutrient contributions from the whole diet, reflect different patterns of dietary variation at each site. In tracing the sources of dietary protein, the mean collagen  $\delta^{13}\text{C}$  value is more enriched at the Kamenica Tumulus in the Korçë Plain compared to the three sites on the southern Albanian coast (Butrint, Diaporit, and Vrina Plain). However, for  $\delta^{15}\text{N}$ , this pattern is reversed with higher values for the coastal sites. Surprisingly, the results for the coastal settlements revealed that the majority of individuals consumed a diet primarily of terrestrial and freshwater resources, despite the proximity to the Ionian and Adriatic Sea.

This presentation explores dietary variation between coastal and inland environments and between males and females. Human dietary patterns are also evaluated in relation to physical characteristics of the graves, with previous research suggesting a connection between burial form and social status. Further, we address the influence of proximity to land or sea trade routes, as well as possible religious dietary restrictions.

*This study was funded by a CSU-Chico BSS Strategic Performance Grant.*

**Intersexual proximity and female dominance in Verreaux's sifaka (*Propithecus verreauxi*).**

KATHERINE J. KLING and REBECCA J. LEWIS. Department of Anthropology, University of Texas at Austin.

Previous research on intrasexual relationships has shown that individuals tend to be in proximity with individuals of a similar rank and that dominant individuals are less likely to initiate proximity bouts with subordinates. The goal of our study was to examine whether this pattern holds true for intersexual relationships in a female dominant species. Verreaux's sifaka (*Propithecus verreauxi*) are female dominant lemurs with male-biased dispersal. We predicted that sexually-mature and unrelated individuals engage in intrasexual proximity at higher rates than intersexual proximity and for greater proportions of time. In addition, females are predicted to initiate intersexual proximity at

lower rates than males initiate intersexual proximity. Proximity data were collected on 14 Verreaux's sifaka in the Kirindy Mitea National Park of western Madagascar using focal animal sampling from June 2007 to December 2010 for approximately 1,400 observation hours. As predicted, males initiated proximity with females significantly more often (0.41 +/- 0.37 bouts/hr) than females initiated proximity with males (0.23 +/- 0.13 bouts/hr). Females also initiated intersexual proximity at significantly lower rates than males. These results suggest the importance of intersexual affiliative relationships with dominant females to males regardless of males' subordinate status and indicate that dominant individuals initiate affiliative relationships with subordinate individuals at lower rates regardless of sex.

**Relative canine size as a fitness signal: a test for positive allometric scaling in intraspecific samples of adult male baboons.**

EMILY B. KLOPP. Department of Cell and Molecular Biology, Northwestern University.

Exaggerated canine teeth in male baboons are often attributed to sexual selection in social groups where male competition for females is frequent and extreme. Scholars posit that the canine functions within a display context to facilitate male-male assessment of fighting ability but tests of the hypothesis are lacking in baboons. Positive allometric scaling of secondary sexual characteristics within adult males of a species is documented in the mammalian literature concerning fitness display and sexual selection. Theoretically, larger males increase reproductive success by investing in relatively larger display features that advertise overall body size and fitness to male competitors or choosey females as long as feature overbuilding is not associated with viability costs. A test of this scaling pattern in the primate canine utilizes large intraspecific samples of adult male *Papio anubis*, *Papio cynocephalus*, *Papio ursinus*, *Papio hamadryas*, and *Theropithecus gelada*. Canine height and canine longitudinal areas are regressed against known body weight in *Papio anubis* and *Papio cynocephalus*, and a size surrogate for the remaining species, using reduced major axis regression. Positive allometry is demonstrated in *Papio anubis* and *Papio cynocephalus* supporting the hypothesis that larger males with relatively larger canines are able to signal overall body size to conspecifics, but support is not found for *Papio ursinus*, *Papio hamadryas*, or *Theropithecus gelada*. The results suggest that selection regimes influencing relative canine size across males within a species are variable between baboons emphasizing the need for an intraspecific and intrasexual approach to canine selection in sexually dimorphic primates.

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### The effects of X-ray irradiation on obtaining CODIS STR profiles from X-rayed teeth.

ERIN L. KNAPP. Anthropology, University of Tennessee.

It is commonly assumed that once forensic skeletal remains have been x-rayed it is not possible to recover intact DNA because X-rays are known to destroy cells and DNA. The body of a living organism maintains the ability to repair or replace damaged DNA and cells. Once deceased, however, all bodily cell and DNA repair functions cease so that any human remains exposed to X-rays will have damaged DNA unsuitable for forensic DNA analysis. In order to show whether or not DNA markers can be reliably extracted, PCR amplified, and typed from bone that has been X-rayed, teeth from ten individuals have been sampled and analyzed in a control and an experimental group. The 13 core CODIS STR markers have been used to derive an STR profile for each sample. STR profiles of the same individual across groups have been compared to determine if X-rays prohibit obtaining full and accurate profiles of DNA extracted from skeletal remains. The results of this research will explore these assumptions about DNA damage from X-rays and show if this kind of irradiation makes CODIS markers unobtainable from skeletal material.

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### The evolution of *Treponema pallidum* in primates.

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*Treponema pallidum* is the bacterium that causes syphilis (subsp. *pallidum*), yaws (subsp. *pertenue*), and bejel (subsp. *endemicum*) in humans. Past serological surveys showed that infection is common in wild West African non-human primates (NHPs), but appeared rare or non-existent in East African and Asian/American NHPs. Clinical signs were described as mild lesions present on the muzzle, if they were present at all. Recently, using serological, histological, and molecular genetic techniques, we identified a strain of *T. pallidum* causing genital ulceration in olive baboons (*Papio anubis*) at Lake Manyara National Park in Tanzania. Using serology, we found that the infection was common at many other sites in Northern Tanzania but not in neighboring Kenya. In terms of genetic distance, the Tanzanian strains are most closely related to subsp. *pertenue*, although a phylogeny demonstrates that NHP strains are distinct from one another and, for the most part, fall outside of the clade of human *T. pallidum* strains. These data provide some evidence that baboon strains diverged prior to the divergence of the three human subspecies. In addition, the genetic variation among Tanzanian baboon strains suggests 1) sexual transmission evolved some time ago; 2) sexual transmission evolved multiple times; or 3) strain

genetics are not the determining factor in mode of transmission. We will discuss the implications of our findings for understanding the evolution and pathogenicity of *T. pallidum* transmission in primates and conclude by outlining future research plans to characterize *T. pallidum* strains and the immunological response they provoke in NHP species.

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### The relationship between talar morphology and habitual substrate use among living gorilla taxa assessed using 3D geometric morphometrics.

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Western gorillas (*Gorilla gorilla*) are known to climb significantly more often than eastern gorillas (*Gorilla beringei*), a behavioral distinction directly attributable to major differences in their respective ecological habitats. Current evidence suggests that the lineages leading to eastern and western gorillas began diverging from one another between approximately 1 and 3 million years ago. Thus, gorillas offer a special opportunity to examine to what degree morphology of recently diverged taxa may be 'fine-tuned' to differing ecological requirements. Prior research revealed shape variation of the medial cuneiform in gorillas corresponding to an ecological divergence between eastern and western taxa. The analysis of gorilla tarsal variation is furthered here through an assessment of talar morphology (N = 40) using 3D geometric morphometrics. Talus shape was captured with a series of landmarks and semi-landmarks superimposed by a generalized Procrustes analysis. Principal components analyses of talus shape clearly separate eastern from western taxa, and a multivariate analysis of variance shows that these shape differences are statistically significant. Relative to western gorillas, eastern gorillas are characterized by a distally wide but proximodistally shorter trochlea, a proximodistally shorter lateral malleolar facet, an expanded medial malleolar facet, a mediolaterally wider proximal calcaneal facet, and a more medially-oriented talar head. Several of these shape differences can be linked biomechanically to the facilitation of climbing in western gorillas and to stability and load bearing on terrestrial substrates in the eastern taxa,

providing an important comparative model for studying morphological variation in groups known only from fossils (e.g., early hominins).

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### Male bi-maturism and the costs of reproduction in wild Bornean orangutans.

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The existence of two, truly distinct, male reproductive morphs may be a unique mammalian feature of orangutans. Flanged males are twice the size of females and have well developed secondary sexual characteristics, whereas the unflanged males retain a smaller, sub-adult or female-like body size and lack secondary sexual features. Both male morphs are sexually mature and have sired offspring in the wild and captivity. Once a male has transitioned into the flanged form, the change is irreversible. Here we use nearly 20 years of data on energetic variables to compare the relative costs of reproduction in wild male orangutans (*Pongo pygmaeus wurmbii*) from Gunung Palung National Park, Indonesian Borneo. Data are presented on energy intake, energy expenditure, ranging patterns, and mating behavior in these two morphs. The physiological effects of these energetic and social behaviors are assessed through measurement of testosterone, cortisol, C-peptide, and ketones from non-invasively collected urine samples. Data demonstrate the significantly higher cost of being a prime flanged male orangutan. Maintaining the flanged male morphology and associated behaviors leads to increased energetic demands compared to the unflanged state. We also differentiate a third class of adult male - the past prime flanged male. These data are used to propose a new explanation for how the energetic demands of being a prime flanged male orangutan, coupled with the distinctive features of the Southeast Asian rain forest and long inter-birth intervals in females, selected for the flanged and unflanged morphological forms, with their differing reproductive and life history strategies.

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### Bioarchaeology in 3D: Employing three-dimensional technology in the field and in the lab.

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Bioarchaeologists integrate their knowledge of archaeological contexts with the analysis of human skeletal remains to address a myriad of research questions regarding past populations. By its nature, however, archaeology is a destructive enterprise, and researchers not present during excavation may have difficulties visualizing or appreciating the contexts from which skeletal remains have been derived. The use of three-dimensional technology in bioarchaeology can provide a permanent and interactive record of context, which can be made available to research colleagues, both present and future, who will not have had the chance to observe the human remains *in situ*. As a result, collaboration among bioarchaeologists, as well as our interpretive potential, can be strengthened. The 3D technology employed in this study requires only a basic digital camera and the use of relatively inexpensive or open-source computer software for merging photos into a 3D model (Agisoft PhotoScan) and georeferencing (MeshLab). Using 3D models developed through the Çatalhöyük Research Project, the accessibility, value, and power of such models for bioarchaeological research will be demonstrated. Some potential uses of 3D models in the field include reconstructing burial sequences, interpreting commingled remains, and visualizing the relationships between skeletal remains and grave inclusions. In the lab, 3D models can be used in lieu of 2D photographs for documenting trauma, pathological conditions, and other variables of interest. If adopted broadly, the use of 3D technology can greatly enhance the way bioarchaeologists engage in research and present their findings to the wider scientific and public communities.

#### **The partition of genetic distance into drift and admixture components.**

ANTHONY J. KOEHL and JEFFREY C. LONG. Anthropology, University of New Mexico.

Many distinct admixed populations exist throughout the world. Population geneticists usually characterize these populations in terms of estimated ancestry from two or more source populations. This approach works as a first pass, but it ignores the action of other evolutionary forces. In particular, factors such as founder effects and small effective population size may add to the distinctiveness between admixed populations. In this study, we introduce a method to partition Nei's genetic distance between a pair of admixed populations into three components. The first component relates to differences in ancestry from source populations. The second and third components relate to genetic drift in the two admixed populations. We present a way to relate the drift components to historical events, such as founder effects. To demonstrate this novel methodology, we present computer simulations of admixture and genetic drift performed using the package SimCoal. We also apply our method to genotypes in publicly available databases. Regarding the performance of the method, we find that the component of genetic distance related to ancestral populations

is highly sensitive to two issues. The first issue is ascertainment bias in marker selection. Ancestry informative markers inflate the genetic distance relative to genomic baselines. The second issue is the relatedness of the parental populations. Vastly different ancestry fractions will contribute little to the genetic distance if the source populations are closely related. Finally, we show that the drift components of genetic distance are robust to both marker sampling and the relatedness of the source populations.

#### **Agonistic relationships among female primates: the axes of despotism.**

ANDREAS KOENIG<sup>1</sup>, CLARA J. SCARRY<sup>1</sup>, BRANDON C. WHEELER<sup>2,3</sup> and CAROLA BORRIES<sup>1</sup>. <sup>1</sup>Department of Anthropology, Stony Brook University, <sup>2</sup>Cognitive Ethology Laboratory, German Primate Center, <sup>3</sup>Courant Research Center Evolution of Social Behavior, University of Goettingen.

Ecological models of female social relationships predict an association between competition and female agonistic relationships. If rank provides advantages in within-group competition, despotic dominance relationships should result. Measures of rank-related energetic gains are rare, however, and the variation in dominance relationships across all nonhuman primates is unknown. As an initial step to close this gap, we provide the first large-scale comparative analysis of female dominance relationships and hierarchies across the primate order, investigating if despotism varies along a predicted despotic-egalitarian gradient. Data were derived for 54 groups from 26 species of Platyrrhini, Cercopithecinae, Colobinae, and Hominoidea, including groups of at least 6 females from wild populations (strepsirrhine groups were too small to be included). We analyzed hierarchy characteristics of despotism, including directional consistency, linearity, and steepness, as well as types of relationships (transitive, inconsistent), sampling effort, and female group size. Principal component analysis extracted one axis related to directional consistency and a second related to linearity and steepness. In contrast to common expectations, the latter two factors were indistinguishable and their value strongly dependent on sampling effort. Two additional axes related to sampling effort and female group size. Variation across groups and taxa was primarily apparent in the directional consistency axis. Discriminant function analysis showed differences in consistency (but not linearity or steepness) for cercopithecines and hominoids (more despotic) versus platyrrhines and colobines (less despotic). Contrary to common assumptions, variation in despotism relates mainly to directional consistency, but less so to linearity or steepness, and includes a phylogenetic signal.

#### **Paleodemography and perinatal mortality from the Agora well, Athens, Greece.**

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The age-at-death distribution for perinatal individuals recovered from archaeological sites has been used previously to argue that infanticide might have been practiced in the past (Mays, 1993). Because there is no reason to believe that the protohistoric Arikara practiced infanticide, Owsley and Jantz's (1985) study of the Arikara has often been used as a baseline for comparison. We use a more direct approach here which is to estimate the age-at-death distribution in fetal weeks for 420 right femora recovered from a well in the Agora Site, Athens, Greece. To estimate the age-at-death distribution we first fit a fractional polynomial regression of femur length regressed on fetal weeks using Fazekas and Kosas' (1978) data for the fetal period and Maresh and Deming's (1939) data for neonates (with 40 weeks added to represent term birth). This regression model was combined with a skew exponential distribution model and the four parameters in the skew model were estimated by maximum likelihood until the best fit between the empirical distribution of femur lengths and the modeled distribution of femur lengths was obtained. This procedure returned a mean age-at-death for the Agora well remains of 40.4 weeks from the mother's last menstrual period, with very little dispersion around this mean (standard deviation of about 12 days). While the age-at-death distribution for the Agora remains is quite similar to modern live-birth age distributions and dissimilar to perinatal mortality distributions, this alone cannot be used to argue that infanticide was practiced, but evidence of pathology makes this unlikely.

#### **Distinguishing between stone tool burnishing and pot polish.**

DERINNA V. KOPP<sup>1,2</sup> and JACKIE RABB<sup>2</sup>. <sup>1</sup>Antiquities Section, State Of Utah, <sup>2</sup>Department of Anthropology, University of Utah.

The presence of pot polish in an assemblage of fragmented human remains is considered key to establishing the identification of cannibalism, yet in a recent study on the manifestation of pot polish Kopp and Graham noted the presence of burnishing, similar in appearance to pot polish, on time zero controls that had neither been boiled nor in a pot. It was hypothesized that the burnishing was caused by the use of stones to process and break open the whole bones. This poster will present the results of an analysis to distinguish between burnishing and actual pot polish on fragments from the previous study. Fragments from the time zero group and from the longest (40 minute) boil time group were examined under 40X magnification for the presence of bevel, sheen and striations on the fracture margins and points. Digital photographs were taken of all margins and points exhibiting the three criteria with a scale included to allow for measurement. Data on the distance between striations and the thickness of the bevel were collected and correlated with time groups. Preliminary analyses indicate that the distance between striations in the time zero are much more variable both among and between

fragments, margins, and points compared to the known pot polish ( $p < 0.05$ ). This suggests that the variation in spacing of striations along the bevel may be helpful in identifying true pot polish and in distinguishing it from the effects of processing induced burnishing.

**A case of diffuse idiopathic skeletal hyperostosis from Csíksofolyó- Szent Péter és Pál-plébániatemplom site (Harghita county, Romania).**

IVETT KOVARI<sup>1,2</sup>, ZSOLT BERNERT<sup>3</sup>, ISTVAN BOTAR<sup>4</sup>, ERZSEBET FOTHI<sup>3</sup>, KLARA K. KISS<sup>5</sup>, ANTONIA MARCSIK<sup>6</sup>, BOGLARKA TOTH<sup>4</sup> and TAMAS HAJDU<sup>7</sup>.  
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In our study we present a new paleopathological case of diffuse idiopathic skeletal hyperostosis (DISH) from Transylvania, Romania.

Archaeological excavations between 2002-2005 revealed the early periods of the parish church of Csíksofolyó (Romanian *Șumuleu Ciuc, Harghita county, Transylvania, Romania*). During the excavation period 70 graves were recovered.

Grave no. 65 was recovered from the "Sándor-crypt", which was dated to the 18th century. The skeletal analysis of the mature male revealed a severe case of DISH.

The anterior longitudinal ligament (ALL) was ossified between the 3-12 thoracic vertebrae. On the lumbar section the L1-L2-L3 vertebrae's ALL was ossified. Block evolved between the 5-11 thoracic vertebrae. On the corpus of each cervical vertebra osteophyte formation was noticed. The sacroiliac joint was unaffected. On both hip bones osteophytes were found: on os ilium, os ischium and on os pubis; extremely pronounced on both tuber ischiadicum and crista iliaca. Arthrosis was noticed on every joint, on both shoulders, elbows, hips, and knee joints. Enthesopathies were detected on: both scapulae, humeri, radii and ulnae; both femora (well pronounced on the greater and lesser trochanter and linea aspera) both tibiae (pronounced on both tuber tibiae and linea musculi solei); both fibulae, calcanei, patellae and clavicalae.

**Same sex aggression and reproductive competition: collective action in *Alouatta caraya*.**

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Many species of primates are reported to be territorial, with group members engaging in collective resource, mate, and range defense. We describe what we term coordinated same sex aggression (CSSA) in wild male and female *Alouatta caraya*. When engaged in CSSA behavior, resident male or female group members collectively and silently chased and attacked lone conspecific intruders of the same sex. CSSA was recorded at two sites: Isla Brasilera (27° 20' S-58° 38' W) and San Cayetano (27° 30' S-58° 41' W) in northern Argentina. We report 36 cases of CSSA during 1188 day-group follows (12 groups). In 30 instances at least two same-sex adult group members were observed to coordinate a sustained attack to drive the intruder from the group. In 3 cases, a resident adult acted alone in aggressively attacking the intruder (in the remaining 3 cases there were no available adult residents present for a coalition to form). Groups with more adult and subadult males were less likely to be invaded by intruders (Spearman correlation test,  $r = -0.74$ ,  $p < 0.05$ ), and groups with more adult and subadult males had greater success in repelling intruders (G test,  $p > 0.05$ ). CSSA occurred at a greater frequency during the breeding season than at other times of the year (Chi Square test,  $p < 0.05$ ) and was a highly effective behavioral tactic used by resident male and female howlers to collectively evict intruders. Additional relationships between CSSA, male takeovers, extragroup copulations, and female breeding competition are discussed.

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**A comparative morphometric analysis of cranial ontogeny in hominoids and cercopithecines: implications for the growth patterns of fossil catarrhines.**

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Research in hominoid cranial ontogeny has provided significant insight into the similarities and differences between apes and humans. It is also useful in reconstructing the biology of fossil taxa. This analysis completes the hominoid record of cranial ontogeny with the addition of the Hylobatidae, which has previously been left out of studies. The hominoid sample was then analyzed along with a cercopithecoid, *Colobus*, to investigate the possibility of a discrete hominoid cranial growth pattern.

Three-dimensional coordinates of 145 landmarks and 313 semilandmarks were measured on CT and surface scans from an

ontogenetic sample of crania from *Pan*, *Gorilla*, *Pongo*, *Hylobates*, *Symphalangus*, and *Colobus*. After Procrustes superimposition, principal component analyses were computed in shape and form space. We used regressions of shape coordinates on centroid size to assess within-group ontogenetic and static allometric trajectories.

Results show nearly parallel ontogenetic trajectories within the Hominoidea, which is consistent with previous studies. In the first three principal components of shape space, *Pan* and *Gorilla* plot closely together along with *Pongo*. The Hylobatidae are distinctly different from all great apes. *Colobus* displays a nearly parallel growth trajectory with hominoids, providing evidence for a generalized cranial growth pattern in catarrhines. With the addition of hylobatids and *Colobus*, this analysis demonstrates that cranial ontogeny is highly conserved in the Catarrhini. Given the existence of this basic catarrhine growth trajectory, it should be possible in the future to predict fossil taxa morphologies at any stage of growth.

This study is funded by the University of Toronto, NSERC, and the Max Planck Institute for Evolutionary Anthropology.

**Skeletal correlates of climbing behavior in the ankles of rainforest hunter-gatherers.**

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Paleoanthropologists use associations between behaviors and their skeletal correlates in modern humans to infer behavior in the fossil record. Rainforest foragers, many of whom express the pygmy phenotype, have diverse locomotor repertoires that include significant amounts of dense forest-walking, vertical climbing, and digging. While theoretical considerations and empirical data suggest that navigation through dense understorey, in addition to vertical climbing behavior, would favor small stature, skeletal correlates of behavior in modern rainforest hunter-gatherers remain largely unstudied, despite the relevance of these populations for reconstructing the activity patterns of hominins.

Great apes bear several features in the ankle that are associated with vertical climbing. To test whether habitually climbing humans express similar features, we compared five skeletal traits of the distal tibia between great apes, non-climbing humans, and climbing humans (African pygmies and Southeast Asian negritos): 1) Size-standardized anterior width, 2) depth of the tibial articular surface, 3) tibial angle, 4) thickness of the medial malleolus, and 5) metaphyseal shape. Our results indicate few differences between climbing and non-climbing humans. Although the precise activity patterns of the individuals we studied cannot be known, our results suggest that climbing behavior is not reflected in the aspects of ankle morphology studied here. In addition, it is not clear whether these traits in the ankle are controlled by genetic

or ontogenetically-plastic processes, and frequent climbing in humans may be also be facilitated by other mechanisms. Regardless, skeletal correlates of climbing in modern hunter-gatherers could inform functional interpretations of fossil hominins.

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#### Size or sex—which is more important for determining optimal velocity?

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Recent reports have demonstrated that morphology influences the minimum cost of foot transport (minCoT) and its associated optimal velocity. Men have higher minCoT and optimal velocity, but because men are on average larger, it is unclear if the effect is due to a sex-based difference in physiology or morphology or simply size differences.

In order to explore this question, the energetic expenditure (volumetric consumption of oxygen, VO<sub>2</sub>) of 15 women and 8 men was measured as they walked on a treadmill at 5 self-selected velocities wearing comfortable walking shoes. Standard anthropometrics were measured and optimal velocity and minCoT for each individual was determined from the first derivative of the best-fit curve between velocity, velocity squared and CoT. Participants were grouped dichotomously based on sex and for size as either being in the top or bottom half of the combined distribution for body mass, stature, lower limb length and calf length.

Men were larger than women in body mass ( $p = 0.002$ ) and stature ( $p = 0.005$ ), but not lower limb ( $p = 0.50$ ) or calf length ( $p = 0.13$ ). The overlap in range was, however, intentionally substantial (e.g. women's stature range = 1.5-1.74 m; men = 1.57-1.84 m). Men had higher optimal velocity ( $p = 0.001$ , 1.38 m/s) than did women (1.25 m/s). This difference in optimal velocity was similarly pronounced, however, when larger people ( $p$ 's < 0.022) were compared to smaller ones. Additional analysis indicates that sex and size may independently affect optimal velocity.

#### Chimpanzees and malaria parasites: Behavioral strategies to limit the infection.

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Mixed species malaria infections occur in wild chimpanzees (*Pan troglodytes schweinfurthii*) sampled randomly in Kibale National Park, Uganda. Recently the molecular

screening of chimpanzee feces also revealed infection with *Plasmodium falciparum*, the species highly lethal for human beings occurs. However, the long term health monitoring conducted on these habituated chimpanzees shows that the malaria infection is unlikely to be associated with severe clinical signs. We explored the hypothesis that the infection is controlled in chimpanzees. We combined chimpanzee health and behavioral monitoring to phytochemistry and mosquito survey. First, we observed that chimpanzees decrease the risk of being bitten by mosquitoes by avoiding sites where the night-biting anopheline mosquitoes are abundant. The choice of elevated areas to build their night nest thus reduces the risk of acquiring malaria. Second, we have also observed these apes consuming plant parts of low nutritional value (more than ten different plant species), which contain compounds with anti-malarial properties. In addition, shortly after the consumption of certain plant parts, chimpanzees ingest red soil. The association of these two natural products increases the biological activities against the malaria parasite. This evidence leads us to propose that preventive and curative behaviors may contribute to limit the effects of the parasite infection in the chimpanzee. These results point out the importance of combining different fields of research to better understand the relationships between chimpanzees, plants and pathogens and to preserve this knowledge for the well-being of great apes, but also for public health including traditional medicine.

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#### The use of Arctic samples as a proxy for Neandertals: Cautions and advances from incisor microwear texture analysis.

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The application of Arctic aboriginal samples as a proxy for Neandertals, especially as they relate to facets of dental wear and mandibular stresses associated with non-dietary anterior tooth use behaviors, is commonplace; however, Arctic samples are often used interchangeably. This is problematic as Arctic communities span vast geographic, temporal, and cultural areas, and dietary and behavioral strategies differ greatly. The purpose of this study is to examine the incisor microwear of several Arctic samples to identify these differences, and to better refine their application in paleoanthropological contexts.

Incisor microwear textures were collected from high-resolution casts of five arctic samples (Aleut, Coast Tsimshian, Ipiutak, Nunavut Territory, and Tigara) using white-light confocal profilometry with a 100x objective lens. Four adjacent scans were collected for each maxillary central incisor, totaling a work envelope of 204x276 µm for each individual. These scans were uploaded into Toothfrax and SFrax SSFA

software packages and the resulting data were analyzed.

Results show significant differences in complexity, anisotropy, textural fill volume, and both variants of heterogeneity. All five samples demonstrate evidence for non-dietary anterior tooth use behaviors; however, unique texture signatures are associated with specific behaviors. The Nunavut and Ipiutak have textures related to heavy, frequent clamping and grasping activities, while the Aleut and Tigara display a more relaxed regimen. The Coast Tsimshian have a signature related to softening vegetation. These data suggest that not all Arctic samples are alike in their anterior tooth use behaviors, and comparisons with Neandertals should be viewed in light of these differences.

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#### Seasonal changes in song structure and calling behaviour of the Bolivian Grey Titi Monkey (*Callicebus donacophilus*).

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Perhaps the most striking feature of the genus *Callicebus* is the loud, resonating song duets produced by a mated pair. Duets are proposed to serve in territorial defense, mate-guarding and/or pair-bond maintenance. Here we examine variation in duet structure and calling behaviour in relation to the annual breeding cycle.

Analyses of sound recordings and behavioral data recorded from 2008 to 2011 at Parque Yvaga Guazu in Santa Cruz, Bolivia revealed significant differences in both song structure and calling behaviour.

Syllables used during the mating season are 8% longer than those of the birthing season. In addition, the calls of the mating season have an 18% lower fundamental frequency and a 12% smaller bandwidth. The maximum frequency lies 12% lower during the mating season. The peak frequency showed no significant changes.

*GLMMs revealed that C. donacophilus* vocalizes significantly less in the birthing season, but 60% longer in duration. We argue that pair movement is restricted due to the energetic constraints of a clinging infant therefore permitting longer but less frequent vocalizations from a set location. Reduced intra-pair proximity with the birth of an infant likely functions in infant guarding and pair-bond maintenance. Duets are performed from higher canopy position in the mating season increasing signal transmission and announcing a pairs mated status. Type 1 duets are the most frequent form of inter-pair acoustic communication throughout the breeding cycle. In sum, *Callicebus donacophilus* possesses a highly complex communication system capable of adapting to the varied demands of the reproductive cycle

**Investigating lactase persistence in a Medieval German cemetery: A step towards understanding the rise of the European lactase persistence polymorphism (-3910C/T).**

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Milk and milk products are important foods in European, African, and Middle Eastern societies, but in other parts of the world lactose intolerance predominates. In mammals, lactase, the enzyme that hydrolyzes the milk sugar lactose, is normally down-regulated after weaning, but in Europe a single nucleotide polymorphism at -13910C/T in the gene MCM6 causes adult lactase persistence (LP). When and where this polymorphism evolved and the process by which it became the majority allele in Europe has been the subject of strong debate. A history of dairying is presumed to be a prerequisite, but current archaeological evidence is ambiguous.

In this study, DNA was extracted from the dentine of 36 individuals excavated at the Medieval (c. AD 1000-1200) cemetery of Dalheim in Germany. After PCR amplification and cloning, successful sequences were obtained for 25 individuals, of which 13 exhibited a European LP genotype (CT or TT).

Previous ancient DNA-based studies on the Neolithic found that the incidence of LP falls below detection levels in most regions. Our research shows that between the Neolithic and Medieval periods, the frequency of LP rose from near 0% to over 50%. Also, given that the frequency of LP genotypes in modern-day Germany is estimated at 78.5%, our results indicate that rather than being stable by the Medieval period, the lactase persistent genotype has continued to increase in frequency over the last 1000 years. This new evidence sheds light on the dynamic evolutionary history of the European lactase persistent trait and its global cultural implications.

**The children of Amarna: disease and famine in the time of Akhenaten.**

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What is now known as Amarna, Egypt there once stood a grand city. Hastily built and quickly abandoned this once capital city of Egypt was the creation of the Pharaoh Akhenaten and was meant to be a utopia for his people. The art of the time period reflects a city filled with food and an abundance of other resources, but the remains of the commoners tell us a different story.

An unusual high number of individuals aged 3-25 have been excavated at the South Tombs Cemetery. Out of the 298 individuals excavated thus far, 43% of them fall into the

adolescent and sub-adult category. Under normal circumstances this portion of the population tends to be the most robust and resilient, thus their representation in the archaeological record is generally very low. The skeletal material was analyzed, using the parameters set by *Standards*, for the presence of certain features indicative of stress; cribra orbitalia, linear enamel hypoplasias, and porotic hyperostosis, to determine why this is not the case for the commoner population at Amarna.

Out of 83 observable individuals aged 3-25, 51 show signs of cribra orbitalia and/or porotic hyperostosis, 34 have linear enamel hypoplasias, and at least four individuals show signs of possible scurvy, rickets, or folic acid deficiency. The result of such a high number of stress cases indicates a very unhealthy population who lacked access to proper nutrition, were malnourished, and diseased, which contradicts the historical images of a paradise in the desert.

**Cementochronology (TCA): Evaluation of a semi-automated counting software.**

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Tooth cementum annulation (TCA) is amongst the most precise anthropological age determination methods to date. In most TCA studies the incremental lines in tooth cementum are counted manually by various observers. This can lead to large inter- and intraobserver errors. In order to overcome observer bias and to receive statistically significant results, Czermak et al. developed in 2006 a semi-automated counting software.

The study at hand evaluates this software by applying it to 306 images of 65 soil-exposed teeth of 65 individuals with known age from the Spital field in Basel, Switzerland (19th century). Each image was counted with the software and an average age from all images of one individual (3-10 images per individual) was calculated. This process was repeated to test the software reliability.

The semi-automated software results indicate a clear trend of age underestimation. Both counts show stable results, with an average age deviation of -7.43 years (absolute 8.98 years) for the first count and an average age deviation of -7.78 years (absolute 9.09 years) for the second count.

Compared to the standard TCA method count results of 3 observers that range from an average absolute age deviation of 3.59 years (trained observer I) to 14.54 years (untrained student observer III), the actual software cannot reproduce the good results of a trained observer. However, the first evaluation of this software gives hints on how to improve it to make it a useful tool for anthropologists, especially for untrained observers.

**The effect of the achilles tendon on trabecular structure in the primate calcaneus.**

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Humans possess the longest Achilles tendon relative to total muscle length of any primate, an attribute that is likely beneficial for bipedal locomotion. Unfortunately, triceps surae muscles and Achilles tendons do not fossilize, so the only evidence of this anatomy is the insertion site on the calcaneal tuber, which is rarely preserved in the fossil record and, when present, is equivocal for reconstructing tendon morphology. To better understand how variation in Achilles morphology might affect the calcaneus, we analyzed the trabecular bone underlying the Achilles tendon insertion site in baboons, gibbons, chimpanzees, and humans to test the hypothesis that trabecular microarchitecture differs between primates with different tendon lengths. Though possessing very different Achilles tendon lengths, we were unable to find a statistically significant difference between the trabecular properties of chimpanzee and human calcanei in this specific region. There were regional differences within the calcaneus in the degrees of anisotropy (DA) in both chimpanzees and humans, though the patterns were similar between the two species (higher DA inferiorly). Our results suggest that while trabecular bone in the calcaneus varies, it does not respond to the tensile forces exerted on it by the Achilles tendon in the way we hypothesized. These results indicate that internal bone architecture is not an informative tool for reconstructing Achilles tendon anatomy in early hominins.

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**Pelvic and appendicular skeletal variability in humans.**

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Levels of phenotypic variability in a species are dependent on the interaction between plasticity (ability of an organism to adapt during life to stimuli) and constraint (genetic, developmental and selective limitations on morphology). Greater plasticity results in greater intraspecific variability, while greater constraint reduces it. The processes generating variation in humans are key to the study of our evolution, as this variation is the raw material for natural selection. The pelvic canal in humans displays differences in size and shape between males and females due to its differential functional roles in locomotion and obstetrics. These distinct roles in females may be postulated to result in stabilizing selection on canal morphology, which would limit pelvic canal variability. Levels of intrapopulation morphometric variability in the skeletal regions of the pelvic canal, non-canal pelvis, and appendicular skeleton were compared in females and males of nine skeletal samples (total N females = 126; males = 148). Mean

coefficients of variation, corrected for sample size ( $V^*$ ), were calculated for each skeletal region, and then compared between regions using Wilcoxon Signed Rank tests ( $N = 9$ ). Pelvic canal variability is significantly greater than non-canal pelvis and appendicular skeleton variability for both sexes. Levels of non-canal and appendicular variability do not differ. Males are more variable than females for the appendicular skeleton. These results suggest that stabilizing selection does not constrict pelvic canal variability in females. Plasticity in canal size and shape may instead enable females to accommodate obstetrically sufficient canals.

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**The South African Palaeocave Survey: A regional GIS approach to palaeoanthropological fieldwork.**

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Palaeoanthropological research about South African Plio-Pleistocene hominid evolution has concentrated historically on a small number of productive hominid fossil sites. All such sites correspond geographically to historic lime mines from the early 20<sup>th</sup> Century. We extracted map coordinates for lime (and other) mines in the Malmani dolomite geological subgroup from historic South African mining records, and geological and topographic maps, to facilitate a widespread regional GIS survey. Our aims were to utilize handheld GPS to relocate historic mine localities, and to produce a field inventory of potential localities for future research.

Our research involves historical archives, digital field reconnaissance, and web-based media applications to present our project in academic and public forums (<http://southafricanpalaeocaves.wordpress.com>). The project design presents the fieldwork experience in real time, and provides an educational archive as part of a broader public engagement involving regional history, geology, and palaeoanthropology.

We explored three broad regions within the Malmani Subgroup dolomites, and located over 20 previously undocumented potential sites including historic lime mines, sinkholes, and caves. Because only a few sites produced fossil deposits, a primary consideration for future research is the potential to sample useful resources (speleothem, cave infill deposits) from such sites irrespective of the occurrence of identifiable fossil materials. Can such sites produce useful information relevant to palaeoanthropological queries? Future fieldwork will incorporate sampling and excavation, and additional survey methods such as aerial

photography and other forms of remote sensing will be used to enhance our field reconnaissance technique.

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**Cranial morphological variation among ancient North Americans: a test of the coastal migration hypothesis using three-dimensional imaging and geometric morphometric methods.**

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The origins and migrations of the first Americans have long intrigued anthropologists. Molecular research has resolved the question of Native American origins, yet the question of the routes that the first Americans traveled as they made their way from Asia into the Americas still generates considerable debate. Recent archaeological and genetic evidence suggests an early coastal migration during the initial peopling of the New World. From these lines of evidence, it is hypothesized that the earliest North Americans should show morphological affinities to ancient skeletons from coastal sites if an early Pacific migration occurred. In this study, three male Paleoamerican crania (>9000 years BP) were compared to 95 males from coastal and interior sites in North America (7500-2500 years BP). After digital models were created with a high-definition 3D laser scanner, 16 craniofacial landmarks were recorded for each individual and imported into MorphoJ geometric morphometric software. Canonical variates analysis and computed Mahalanobis distances show that the three Paleoamericans are more similar to individuals from ancient coastal sites in California than to individuals from interior sites. Results from this preliminary study (1) support the hypothesis that an early Pacific migration occurred during the initial peopling of North America, and (2) demonstrate the utility of 3D scanning and morphometric methods to analyze Paleoamerican crania. Future work on larger samples will increase the statistical power of the analyses and provide valuable information about the population affinities of early North Americans.

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**The use of the body in the creation of collective identity: A bioarchaeological examination of Wisconsin effigy mound mortuary ritual.**

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Bioarchaeology has long emphasized contextualizing human skeletal remains within mortuary and social systems, yet many studies continue to treat remains solely as biological entities. Although acknowledging cultural context, skeletal biology often takes primacy

while context is relegated to an explanatory device for observed regularities and/or differences in skeletal features.

This study emphasizes the body, particularly secondary bundle reburial of skeletal remains, as a material construct used in ritual to create collective identity and social cohesion within Effigy Mound communities. For this study, a conceptual framework is developed using Eastern Woodland prehistoric mound studies and mortuary theory to explain the patterning of burial treatment afforded individuals interred within mounds belonging to the Wisconsin Effigy Mound Tradition.

Results indicate that interments within geometric mound forms are significantly different than those within effigy mounds along the lines of postmortem treatment and minimum number of individuals (MNI) interred within mounds. Specifically, secondary burial treatment is the most common form of burial disposition found within geometric mounds while effigy mounds most commonly contain primary burials. An analysis of MNI for each mound type reveals that geometric mound forms consistently contain significantly more individuals than effigy mound forms. However, an examination of age and sex distributions by mound form show no significant differences between mound forms. This study serves as a cautionary tale for bioarchaeologists to consider moving beyond evaluations of sex and age and instead focus on how bodies are interred within the mortuary domain and what that may mean within the broader social structure.

**Caries and other oral pathology in the Broken Hill (Kabwe) cranium.**

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The Broken Hill cranium exhibits some of the most severe oral pathologies seen outside the Holocene. The specimen has been central to discussions of Middle Pleistocene human evolution given its completeness—and despite its lack of a secure geological age. The few previous papers addressing the oral pathology of Broken Hill have focused on diagnosing a larger syndrome to explain the extensive caries and alveolar resorption, often in the context of diagnosing its temporal lesions (lead poisoning, honey consumption, ignorance of toothpicks, etc.). However none of these papers or the original monograph has provided a detailed tooth-by-tooth description of the pathologies themselves. All but five of the present maxillary teeth have carious lesions, some of a gross stage (one tooth was lost postmortem). There is also periodontal resorption, periapical infection, pulpal exposure and secondary dentin, which are all partially inter-related, as well as with the mastoiditis. Caries are rare in the Pleistocene (presently known before the latest Pleistocene from Zhirendong, Qafzeh, Aubesier, Palomas, and Les Rois, all outside Africa); therefore, a detailed study of the severity of the pathology in Broken Hill is highly warranted. Caries have been recorded in tropical contexts in

chimpanzees and *Paranthropus robustus*, but remained extremely rare in *Homo* until the dietary and morbidity changes of the Agricultural Revolution, making Broken Hill highly exceptional. Ultimately many of the previous diagnoses are conjectural and a thorough analysis of the pathologies themselves provides the basis for a comprehensive diagnosis of the lesions and further comparative research. Supported by the Leakey Foundation and Washington University.

#### Mandibular remodeling in sympatric West African cercopithecids.

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The sympatric cercopithecids of Ivory Coast's Taï Forest consume foods of varying toughness. The diets of *Colobus polykomos* and *Procolobus badius* consist largely of leaves and may require significant masticatory activity. In contrast, the cercopithecines have less tough diets; *Cercocebus atys* ingests predominantly durophagous foods and *Cercopithecus diana* eats mainly soft fruits. Previous work suggests that mechanical challenges faced by colobines require greater loading frequencies resulting in greater remodeling in the postcanine mandibular corpus relative to *Cercocebus atys*. The present study aims to determine whether another cercopithecine, *Cercopithecus diana*, can be similarly distinguished from both colobines in terms of secondary remodeling. We expect that the differing masticatory demands in the diets of colobines and cercopithecines will be reflected in osteonal bone density.

We measured secondary osteonal density and area in thin sections prepared from the postcanine mandibular corpus of adult *Cercopithecus diana* specimens (N=3). These measurements were compared with remodeling data for *Colobus polykomos*, *Procolobus badius*, and *Cercocebus atys*. Values for osteon density were higher for colobines than for cercopithecines, with *Colobus polykomos* exhibiting the highest values and *Cercopithecus diana*, the lowest. This result suggests that a predictable relationship exists between masticatory frequency and rate of mandibular bone remodeling. The higher remodeling observed in colobines may represent a response to mitigate fatigue failure risk engendered by mastication of a folivorous diet and provides further support for an association between food material properties and the metabolic activity of bone.

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#### Hungry, tired, and stressed: Why are lemur females dominant to males?

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Lemurs have a number of traits that are unusual when compared to other primates, such as female dominance. The Energy Conservation Hypothesis (ECH) posits that lemur traits enable lemurs to conserve and extract energy from their seasonally and stochastically resource-poor environments, and that this is particularly important for females who bear the energetic costs of gestation and lactation. Data were collected on two groups of ring-tailed lemurs in the spiny forests of the Tsimanampetsotsa National Park, Madagascar. We tested aspects of the ECH through the following hypotheses: 1) food nutrients and/or calories are seasonally limited, 2) behavioral mechanisms are used to save energy, and 3) the dry season is more stressful for females. We also investigated the nutritional contents of the lemurs' feces. Our results suggest that the protein to fiber ratio of foods consumed by all animals is higher in the wet season ( $t=3.18$ ,  $df=84.5$ ,  $p=0.001$ ), that females consume more calories than males throughout the study ( $t=2.06$ ,  $df=66.9$ ,  $p=0.022$ ), and both females and males consumed more calories in the wet season ( $t=2.09$ ,  $df=85$ ,  $p=0.021$ ). Additionally, males appear to use behavioral strategies to conserve energy, and females appear differentially stressed. Interestingly, preliminary analyses suggest that some of the nutritional contents of the animals' feces vary between seasons and sexes, which could be an important direction for future research. This study supports the ECH and suggests that lemur female dominance facilitates a caloric advantage, which is likely critical to their ability to survive and reproduce during resource-poor periods.

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#### A new ~1.5 Ma hominin distal humerus from Ileret, Kenya.

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Although variation among Plio-Pleistocene hominin distal humeri tends to be subtle, previous studies have identified unique morphology shared by several 2-1.5 Ma specimens from Koobi Fora. Here, we analyze a new 1.51-1.53 Ma hominin distal humerus

(KNM-ER 47000) from the Koobi Fora Fm, Kenya (FwJj 14E, Area 1A). KNM-ER 47000 is an associated right upper limb that includes portions of the scapula, humerus, ulna, and hand. The entire distal half of the humerus is preserved apart from the capitulum and part of the trochlea. Using linear dimensions and landmark data, we compare KNM-ER 47000 to extant hominoids and a wide range of Plio-Pleistocene hominins.

Transverse diaphyseal sections of KNM-ER 47000 yield extremely high values for total cortical area (CA) and percent cortical area (%CA) that exceed those reported for a wide range of fossil *Homo* species, suggesting extreme strength in axial loading. In other aspects, KNM-ER 47000 is most comparable to the 2-1.5 Ma Turkana humeri, particularly to KNM-ER 739. Similarities include: deeply grooved trochlear central sulcus, highly projecting medial epicondyle, relatively shallow olecranon fossa, relatively wide medial and lateral pillars, salient lateral supracondylar ridge (indicative of a powerful *m. brachioradialis*), and unusual posterior surface convexity of the distal shaft. Given their morphological resemblance and shared spatiotemporal context, it is likely that KNM-ER 739 and KNM-ER 47000 are conspecific. KNM-ER 47000 thereby expands the sample size of the enigmatic set of Koobi Fora humeri and links this unusual elbow morphology to that of other skeletal regions.

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#### Occlusal surfaces and chewing efficiency in modern humans.

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Occlusal surface area varies among fossil hominins, and this variation is thought to reflect chewing performance; however, there is morphological equifinality when enlarging an occlusal surface; for example, both increasing slope (sharpness) and two-dimensional area of the post-canine teeth would increase the total occlusal surface. In order to explore this variation in modern humans, we quantified occlusal surface morphology and tested its relation to chewing efficiency. Occlusal surfaces were measured using the program ArcGIS from three-dimensionally scanned dental casts of each subject's upper and lower right dental rows, third premolar to terminal molar. Slope, two and three-dimensional area, and volume were recorded for each subject and used to calculate morphological indices. Each subject participated in a series of almond chewing trials which were recorded using high speed motion capture and surface electromyography of the masseter muscle. From these trials, chewing efficiency was calculated from the change in particle size

relative to mechanical work of the masseter. Chewing efficiency was significantly higher in individuals with smaller occlusal areas (both two-dimensional and three-dimensional areas) and volumes. However, chewing efficiency increased in individuals with greater occlusal slopes. For almonds and foods with similar mechanical properties, these results indicate that highly sloped but small dentitions are more efficient in modern humans. We discuss the implications of these results when estimating chewing efficiency in occlusally diverse hominins including *Australopithecus* and *Paranthropus*.

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#### Testing inter-teeth variability in adult individual age-at-death estimate using cementochronology (TCA).

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The study of intra-individual variability of acellular cementum apposition is a major issue in the estimation of age-at-death using cementochronology.

Since the literature is scarce on the subject we extracted 51 modern teeth from 15 of known-age patients. We manually counted the acellular cementum increments on five cross-sections from the middle third root of each tooth. Age estimation was then calculated by summing the number of lines to the average age of dental eruption.

Our results showed some variability between counts within tooth, especially on premolars. The intra-individual variability of cementum deposition has been highlighted by comparing age estimates obtained for each tooth of one individual which is not surprising considering problems already described in the literature on this issue. Once premolars were excluded, the variation between teeth of an individual dropped to 0 to 5 years in 73% of cases.

In conclusion, the intra-individual and intra-dental variability of cementum have to continue to be studied and quantified to obtain the most accurate and reliable estimation of age-at-death and potentially predict which region of interest should be considered prior to sectioning and counting.

#### Preliminary evidence suggests that two-male siamang (*Symphalangus syndactylus*) groups at Way Canguk live in larger, higher quality home ranges than monogamous groups.

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Siamang groups at Way Canguk contain one adult female but one, two, or occasionally three adult males. Food abundance and distribution affect grouping patterns in many animal populations, but the effects of ecological factors on siamang group dynamics are poorly understood. We examined the relationship between group composition, home range size, and an indirect measure of habitat quality to test the hypothesis that home range size and quality are important predictors of grouping patterns at Way Canguk.

Group composition and ranging data were collected from 11 groups from 2000-2002 (7 groups) and 2007-2009 (11 groups). We collected feeding data from 6 groups from 2000-2002.

Home range size was a near-significant predictor of the number of males in a group (GLMM with group as a random factor;  $F_{1,13.8}=4.2$ ,  $P=0.060$ ). However, there was not a significant relationship between home range size and the density (feeding trees/ha) of important food trees used by the siamangs ( $r_s=-0.143$ ,  $N=6$ ,  $P=0.787$ ). Thus, larger home ranges should contain more food, and indeed, groups that contained more males fed from more important food trees ( $r_s = 0.851$ ,  $N=6$ ,  $P=0.016$ ). Groups containing more males also contained more infants and juveniles ( $F_{1,15.9}=14.0$ ,  $P=0.002$ ), suggesting that birth rates, offspring survivorship, or both were higher in multi-male groups. Alternatively, the association between reproductive rates and the number of males in a group may be driven by underlying relationships between both variables and home range quality. Our results may shed light on the determinants of group composition in primates.

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#### Does height matter? Evaluating the need for height specific stature estimation equations.

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Stature estimation is an integral part of skeletal analysis. A common approach is to use the mathematical method, which uses an equation developed from long bone lengths such as those established by Trotter and Gleser (1952). Using one equation for the entirety of a population can overestimate individual height at the extremes of the stature spectrum. Duyar and Pelin (2003) developed three equations from measurements of the tibia for a Turkish sample, with separate equations for short, average and tall. They concluded that more accurate stature estimates were possible for their test sample using this method. The present study uses femur and tibia measurements of 126 European American males between the ages of 20 and 78

to test the method developed by Duyar and Pelin (2003). A comparison of  $R^2$  values of the regression analysis shows that dividing up the sample into different height groups does not improve accuracy of the equation developed from the regression. Examination of the standard errors of these equations confirms these results.  $R^2$  values for the entire sample range between 0.35 and 0.60, the tall group between 0.58 and 0.63, and the average group between 0.52 and 0.63. The short group had the least fit line and  $R^2$  values between 0.02 and 0.06. It is possible that with a larger sample more accurate equations could be developed. Overall, the results of this study indicate that there does not seem to be a need to develop height specific equations for stature estimation for European American males.

#### Does footwear change energy expenditure? Application to understanding the energetics of extinct bipeds.

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Although extinct hominins did not wear shoes, most energetic studies conducted to explore their energetics have used shod participants. Using this data to understand the hominin fossil record might, therefore, be misleading. In this study we explore the effects of footwear on velocity profiles and the variables that describe energy expenditure.

Twenty-three women walked on a treadmill at five self-selected velocities (15 shod and 8 unshod) while their oxygen intake ( $VO_2$ ) was monitored. Standard anthropometrics were also measured. For normal ( $p=0.015$ ), medium fast ( $p=0.022$ ) and fast ( $p=0.025$ ) velocity trials, unshod participants chose to walk at lower velocities than those subjects wearing shoes. After controlling for velocity and mass, the shod group was not, however, different from the unshod group in  $VO_2$  ( $p=0.71$ ), cost of transport ( $p=0.57$ ), minimum cost of transport ( $p=0.81$ ) or optimal velocity ( $p=0.97$ ).

The self-selected velocity differences between the shod and unshod groups might be due to the increased ground reaction forces associated with faster velocities. Although footwear does change the velocity profiles, the energy expenditure variables of the shod group were not different from those of the unshod group. Using shod data to understand the fossil record should, therefore, not be misleading regarding energy expenditure variables.

#### Variation in nonmetric traits of the pelvis between population groups.

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The os coxa has been shown to be the most accurate bone used for sexing an individual. Studies have shown that males exhibit more variation than females in the pelvis (Coleman 1969; LaVelle 1995; Listi 2010;

Walker 2005). Age has also been shown to affect the nonmetric traits (Tague 1989; Walker 2005). Few studies have tested whether or not nonmetric traits of the pelvis are population specific (Listi 2010). This study examined nonmetric trait variation among modern Black, White, and Hispanic groups. The effects of aging on the expression of these nonmetric traits is also taken into consideration between the sexes.

Five nonmetric traits of the os coxa, including the ventral arc, subpubic concavity, ischiopubic ramus ridge, greater sciatic notch, and preauricular surface were scored following methods outlined in "Standards for Data Collection from Human Skeletal Remains" (Buikstra and Ubelaker, 1994). These samples came from the William Bass Donated Skeletal Collection at the University of Tennessee (n=197) and the Documented Skeletal Collection at the University of New Mexico (n=12). Preliminary results showed that there is no significant difference in the nonmetric traits of the pelvis. Men appeared to show more variability than females; however, age did not appear to have an effect on the nonmetric traits. A potential explanation for more variation in males could be attributed to the amount of growth during puberty. Understanding these differences can help more accurately assess the sex of individuals.

**Spatial variation in mandibular bone stiffness and its effect on structural bending stiffness: a test case using the Tai Forest monkeys.**

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In this study we test the hypothesis that spatial autocorrelation of mandibular bone stiffness is associated with elastic modulus distribution patterns that maximize structural stiffness. Using previously collected microindentation data, we found a general pattern of positive spatial autocorrelation of bone stiffness in the mandibles of four monkey species (*Procolobus badius*, *Colobus polykomos*, *Cercocebus atys*, and *Cercopithecus diana*) from Tai Forest, Côte d'Ivoire. This finding indicates that the distribution of mandibular bone stiffness is non-random, which potentially impacts biomechanical interpretations.

These same microindentation data were used to develop heterogeneous models of bending stiffness of mandibular coronal sections from the four species. These weighted moments of inertia (*WMOI*) differ from unweighted (homogeneous) moments of inertia (*UMOI*) by accounting for intra- and inter-individual variation in bone material stiffness (Bhadavadekar et al. AJPA 131:243–251). We calculated *WMOI* based on 1) average modulus within a section and 2) assignment of local modulus values in discretized sections. Lower observed *WMOI* in discretized sections would undermine the hypothesis under test.

Inclusion of average elastic modulus data in structural property calculations magnifies the apparent stiffness of *Cercocebus* mandibles relative to those of other monkeys, while

colobine mandibles exhibit reduced stiffness. This underscores the interpretive costs of ignoring elastic modulus variation, which is inherent in the comparative application of *UMOI*. Examination of discretized weighted moments suggests that mandibular bone stiffness is not distributed in a manner that maximizes structural rigidity. Systematic differences in bone stiffness have implications for inferring strain magnitudes in comparative contexts.

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**In sickness and in death: What do age, stress, and illness in life tell us about skeletal remains?**

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Among the living, exposures and physiological responses to chronic and acute stressors factor heavily into individuals' future morbidity and senescent decline. Individuals who experience acute stress frequently or chronic stress incessantly tend to be more morbid and have shorter life expectancies than their less stressed counterparts. Whereas physiological responses to stress seem to be strongly predictive of morbidity and life expectancy, markers of chronological old age are highly individualistic and poorly predict future health and longevity. Age associates weakly with future morbidity and mortality when included in allostatic load (AL) and frailty models.

Current models for evaluating associations between stress and health among the living, including AL and frailty, are poorly adapted to archaeological populations because parameters typically assessed are not available from skeletal material (eg. neuroendocrine biomarkers, body habitus measurements and indices of whole body function). As a starting point, we propose a model of "skeletal" frailty based on associations between common frailty indicators assessed among the living and the effects these characteristics exert on the skeleton. Frailty indicators among the living and our proposed replacement parameters for "skeletal frailty" include (living/skeletal): slow walking speed/arthritis and joint degeneration, inflammation/enthesopathies and periostitis, muscle strength and level of physical activity/osteoporosis (associated with sarcopenia), and telomere length (strongly associated with life expectancy). Validated among the living and refined among skeletal populations, "skeletal frailty" will provide useful insights into the health of past populations and reduce dependence on skeletal stress markers as proxies for health among the previously living.

**A descriptive study of African American deciduous dentition.**

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Descriptive studies of the deciduous dentition morphology have been presented as an inclusion in permanent dentition studies (e.g. Aguirre et al. 2008), the focus of archaeological populations (e.g. Sciulli 1998) or on specific traits within modern populations (ie. Hanihara 1967). The present study examines 25 morphological traits in two African American samples from Memphis, TN and Dallas, TX (N=218). These traits represent the most commonly used traits in population microevolution studies, describing various ancestral groups.

Results indicate there is a great deal of trait frequency variation between the two African American samples, as well as in comparison to European American samples. Traits, which vary in frequencies between the two sample populations, include maxillary lateral incisor shovel shape trait (69% vs. 46%), canine tuberculum dentale (40% vs. 22%), canine mesial ridge (3% vs 7%), and the maxillary posterior molar hypocone development (76% vs 92%).

Trait frequencies higher than previous studies include maxillary central incisor shovel shape trait (38%) and maxillary lateral incisor shovel shape trait (68%), canine tuberculum dentale (40%), maxillary molar complexity (20%), cusp six (33%) and seven (68%), and the Y-groove on the mandibular posterior molar (69%). Traits frequencies lower than previous studies include tuberculum dentale trait on both maxillary incisors (8% and 3%) and the hypocone development of the maxillary posterior molar (76%).

The level of trait expression is also informative when comparing populations, especially the molar traits. For example, Carabelli's pit/fissure is the most common trait expression in African American samples, unlike European American samples.

**Evolution, ecology and political economy: Biocultural perspectives on nutrition and disease in the works of George Armelagos.**

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Beginning with his dissertation on Sudanese Nubian health and his seminal articles on disease and the ecological perspective, to later contributions on the biocultural synthesis, work on the epidemiological transition, and many contributions on the evolution of food systems and patterns of eating, George Armelagos and his students, colleagues and collaborators have made profound and lasting contributions to biocultural theory in the discipline. This paper traces the evolution of his ideas and major contributions at the interface of biological, medical and nutritional anthropologies.

Early on, Armelagos pioneered an ecological perspective that examined the intersection of host, pathogen and environment to study human health and disease in contemporary and archeological populations. Over time he expanded this model particularly in the area of environment by arguing for stronger

social, behavioral and economic determinants of health, and recognizing the importance of political-economic perspectives. Thus his contextual frame shifted from physical environments to, for example, globalization, racism, global warming, viral superhighways, and social violence. While Armelagos expanded his biocultural model to include more social, economic and political perspectives, he never abandoned a core evolutionary focus and indeed worked to show how evolutionary and more socio-cultural perspectives can inform and strengthen one another. The extensive network of students he has mentored and the breadth of research expertise and publications on topics ranging from epidemiological transitions to paleopathology, to food and nutrition studies, to race and human variation, has both strengthened his perspectives and the scope of his contributions to biological, medical and nutritional anthropology.

**Whole mitochondrial genome sequences from South America: insights into the demographic history of the continent.**

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When and how the first people entered into the Americas has continued to be of interest to scholars from various disciplines. Previous genetic studies have suggested four founding maternal lineages (A2, B2, C1, D1), and utilizing their time depth correlated with archaeological and environmental records, different scenarios have been proposed. The use of higher resolution mitochondrial DNA data has expanded the original four founding Native American lineages to fifteen, including A2, B2, C1b, C1c, C1d\*, C1d1, D1 and D4h3a that appear in both North and South America. Still, genetic data from South America has been relatively lacking and inferences on demographic events in the southern continent have not been fully investigated. We sequenced twelve whole mitochondrial genomes of Yekuana individuals, an indigenous group native to the lowlands of southern Venezuela, and identified Native American haplogroups, A2, B2, C1b, C1c, C1d, and D1, which are consistent with the ancestral founders of the Americas. Examining the expanded whole genome data set of Native American populations, we compare nucleotide diversity levels and other population statistics between North and South American groups and suggest certain lineages (C1, D1) expanded and diversified more rapidly than others in South America. Overall, the results from this study support the archaeological evidence indicating the antiquity of South American lowland indigenous populations and contribute to our understandings of the broader demographic history.

**Determining the effects of defleshing methods on the structural integrity of bone through mechanical testing.**

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This study compared the effects of commonly used defleshing methods on bone tissue stiffness. These methods are widely used in forensic anthropology, despite the lack of empirical data on their effects on the structural integrity of bone tissue. An Instron 5564 with a 2kN capacity was used to conduct unconfined compression tests on 7.4mm bone core samples drilled from metatarsals (n=60) of white-tailed deer (*Odocoileus virginianus*) before and after defleshing.

Defleshing methods tested included maceration, dermestid beetles, plain water boiling, enzymatic laundry detergent, household bleach, and sodium perborate. The detergent, bleach, and sodium perborate were tested in low, medium, and high concentrations. The results indicated that maceration, dermestids, and the medium concentration of sodium perborate significantly (p<0.05) altered the stiffness of the bone in at least one of three variables tested (strain at 1790N, stress at the first peak, and the tangent modulus). Maceration of the bone caused the strain to increase and the stress to decrease. The dermestid beetles decreased the modulus of the bone. Sodium perborate increased the strain and decreased the stress and modulus of the bone. In general, these three treatments made the bone less stiff and strong.

This investigation found that the use of mechanical testing offers valuable insight into the effects that defleshing methods have on bones in addition to macroscopic, histological, and genetic analyses. It is especially important to understand these processing effects on human remains from forensic cases, as they may be called into question in the courtroom.

**Is this yaws? Possible treponemal induced cranial vault lesions in a young chimpanzee.**

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A considerable amount of research in both living and past human populations has been conducted with respect to skeletal responses to treponematoses. Those affecting humans are usually classified as Pinta (*Treponema carateum*), Yaws (*T. pallidum pertenue*), or Syphilis (*T. pallidum pallidum*, both venereal and congenital, and *T. pallidum endemicum* for endemic). However, very little work has been undertaken among the great apes to identify the presence of these diseases and the processes that they might follow if present. We present a case study of a young, wild-shot, female chimpanzee

(*Pan troglodytes*) from Cameroon, housed at the Powell-Cotton Museum (Birchington, UK) that is likely affected by a treponematoses. Macroscopic examination revealed healed and healing lesions of the cranial vault, significant enamel defects in the permanent dentition, maxillary asymmetry, and mild periostitis in several postcranial elements. The cranial and dental anomalies observed are most consistent with yaws in humans, albeit with some key differences.

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**Evolutionary ecology of pitheciinae communities: Evidence for energetic equivalence or phylogenetically structured environmental variation?**

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Despite extensive research on Neotropical primates, there are few data on the evolutionary ecology of body size variations in extant Pitheciinae (*Callicebus*, *Pithecia*, *Chiropotes*, and *Cacajao*) in differing ecological communities. I first tested the energetic equivalent rule (EER) in non-flooded and flooded forests, which predicts that density and body size will be negatively correlated and exhibit of slope of -0.75. I also tested for phylogenetically structured environmental variation (PSEV) as a model for the evolution of Pitheciinae body size variations. PSEV refers to the shared attributes that related taxa have acquired because they tend to have occupied similar niches during their evolutionary history. Species-specific data on phylogenetic relationships, density, and body mass were collected from the literature. Regression models indicated that the EER can only be applied to *Callicebus* in non-flooded forests and to Pitheciini (*Pithecia*, *Chiropotes*, and *Cacajao*) in flooded forests. Partitioning methods revealed that Pitheciini body size variations are the result of PSEV in non-flooded forests and phylogeny in flooded forests. The evolutionary ecology of Pitheciini body size variations in differing ecological communities is best explained as resulting from stabilizing selection to meet metabolic needs and to deal with predation pressures.

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**When animals disappear: An examination of factors influencing which individuals disappeared from a wild population of lemurs.**

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In the course of research on wild primates, individual animals inevitably disappear from study populations. The reasons for these disappearances are often difficult to determine but may include dispersal or death. Here I

analyze long-term data to determine which factors increased the likelihood that an individual disappeared in a Verreaux's sifaka (*Propithecus verreauxi*) population from Kirindy Mitea National Park of western Madagascar. Since the beginning of the study in 2006, 69 individuals in 9 social groups have been marked with collars. Individuals in 5 social groups have been censused monthly, and 4 groups have been the focus of behavioral observations. In an analysis of these individuals representing 233 lemur years, 38 individuals disappeared, including 5 confirmed deaths. Disappearances occurred at a rate of 0.16/lemur year, much lower than at the nearby Kirindy Forest sifaka population. In a mixed effects logistic regression model, group size and sex were significant predictors of whether an individual disappeared from the study population but age was not. Nearly half (47%) of the disappearances were infants and juveniles, who were unlikely to have dispersed. Infant mortality (32%) was unrelated to mother's rank and substantially lower than the Beza-Mahafaly sifaka population but similar to the Kirindy Forest population. These differences between sifaka populations are probably the result of variation in habitat and population density. These results showing an effect of group size and sex but not rank on the probability of disappearance fit expectations for folivorous primates with male-biased dispersal according to socioecological models.

**What is the role of geometric morphometrics in testing functional hypotheses? A case study using 3D pelvic shape .**

KRISTI L. LEWTON. Human Evolutionary Biology, Harvard University.

The pelvic girdle is a complex structure with critical roles in locomotion and obstetrics, and efforts to model these mechanical effects on its shape remain difficult because it is not amenable to structural simplification. While geometric morphometric (GM) analysis yields important information regarding changes in shape among groups, its utility in testing biomechanical hypotheses has been questioned. This study evaluates the contributions of both univariate and GM methods to testing hypotheses relating pelvic form to locomotor function.

Three-dimensional landmarks were collected on a phylogenetically-broad pelvic sample of 787 individuals from 40 primate taxa. Linear interlandmark distances were calculated to facilitate testing of biomechanical hypotheses, and a principal components (PC) analysis was performed on Procrustes coordinates. Both linear dimensions and PC scores were subjected to phylogenetic ANOVA by locomotor group. Many of the hypotheses relating linear dimensions to locomotor loading mechanics were rejected, but lower ilium cross-sectional area varies as predicted among groups ( $F=17.28$ ,  $p<0.001$ ), demonstrating an adaptive signal. Shape analyses support the univariate results, with significant differences evident along the first five PCs separating vertical clingers and leapers from arboreal and terrestrial quadrupeds

(all  $p<0.05$ ). While both analytical approaches suggest that ilium dimensions differ among locomotor groups, the GM analysis also suggests that ischiopubic shape differentiates groups. Although GM provides additional quantitative results beyond the univariate analyses, it cannot replace all tests of specific, directional hypotheses of pelvic biomechanics and adaptation; it would be prudent to use both approaches concurrently until more targeted GM hypothesis-testing methods are developed.

**Using admixture mapping to identify genetic linkages with variation in human facial shape.**

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Using a dataset of 594 individuals from three populations with genetic ancestry contributions primarily from European and West African parental populations, we tested 72 SNPs in 45 selection-nominated candidate genes that are known to be involved in Mendelian craniofacial dysmorphologies as well as 68 ancestry informative markers with no known involvement with craniofacial variation for association with normal variation in facial shape. A dense mesh of over 7,000 high-density landmarks was placed on three-dimensional images of adult faces taken with the 3dMDface imaging system. Principal Component (PC) scores were then calculated as a representation of normal morphological variation across the surface of a face. A subset of the top PCs that showed significant associations with West African genetic ancestry was selected for the association study.

The program ADMIXMAP was used to test for admixture linkages between these 140 SNPs and facial shape variation. Sex, height, weight and BMI were included as covariates to control for the effects of body size on face shape morphology. After applying a correction for multiple testing, four SNPs were found to be significantly associated with facial variation. Two of these SNPs were located in craniofacial candidate genes, suggesting a role for these genes in determining normal facial variation. Interestingly, two of the AIMS, which are not located in candidate genes, were also significant. This suggests that these SNPs may be in admixture linkage disequilibrium with variants in the region that may have a previously unknown role with craniofacial variation.

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**The relationship between clinical markers of frailty and measured physical activity using accelerometers: Results of a SAGE sub-study among older adults in India.**

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Frailty is common in old age and increases risks of adverse health outcomes. However, few studies have examined frailty across countries, and even fewer have evaluated the relationship between markers of frailty and measured physical activity among older adults in non-Western settings. The present study examines associations between measured activity (total daily energy expenditure [TDEE], physical activity level [PAL], activity counts [AC], activity energy expenditure [AEE]) and clinical markers of frailty (grip strength, self-reported exhaustion, timed walking speed) among 200 older adults in urban India as part of a sub-study of the World Health Organization's Study on global AGEing and adult health (SAGE). Participants wore ActiGraph GT3X accelerometers for seven consecutive days, combined with pre- and post-health interviews.

Results indicate that men had higher TDEE levels than women ( $P < 0.001$ ). Self-report exhaustion differed significantly by sex ( $P = 0.001$ ), with 87.3% of men and 66.1% of women reporting none/mild exhaustion whereas 12.7% of men and 33.9% of women reported moderate/severe exhaustion. For men, grip strength was positively correlated with TDEE, PAL, and AEE ( $P < 0.05$ ). For women, all physical activity measures were positively correlated with grip strength ( $P < 0.01$ ), while average walking time was negatively associated with all activity measures ( $P < 0.001$ ). This study illustrates the utility of using accelerometry to examine the relationship between measured physical activity and factors associated with frailty in aging populations. This area of research provides an opportunity to target modifiable risk factors for frailty with increasing age and chronic diseases.

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**Native American genetic diversity before and after European colonization: Evolution, pathogens, and the environments of the Americas.**

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From the 15<sup>th</sup> to 19<sup>th</sup> Centuries, Native American populations suffered staggering losses due in part to pathogens stemming from European colonization. Chief among these was smallpox, tuberculosis, and measles, which decimated entire nations according to historical documents. During this same period, colonizing European populations suffered far fewer losses with respect to these same diseases. To explain this discrepancy, prevailing hypotheses suggest that European contact altered Native American population density, diet, and genetic diversity, which may have increased their susceptibility to European-borne endemic disease. However, most of this evidence is either indirect or based on genetic studies of living populations, making it difficult to examine to what extent genetics contributed to this presumed susceptibility.

Recent advances in ancient DNA techniques have allowed us to reconstruct the entire coding region (i.e., the exome) of ancient Native Americans for comparison with living individuals from the same geographic region. In this study, we examine relevant genetic differences in pre- and post-colonization populations. We hypothesize that adaptation to pathogens prevalent in the Americas and/or the absence of endemic European-borne pathogens may have altered specific immune related genes in ancient Native Americans. These changes may therefore serve to explain aspects of the historical experiences of Native peoples with European-borne pathogens. This work emphasizes the evolutionary consequences of an initial demographic separation followed by a dramatic merging of populations that had been separated for thousands of years. This work thus helps to illuminate the dynamics of adaptation to new environments in the context of demographic change.

**Meat transfer among savanna chimpanzees at Fongoli, Senegal: The female perspective.**

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Transferring food to mates or other unrelated social group members is unusual in most animal species but characteristic of humans. Hypotheses to explain food transfer in nonhumans usually involve immediate or delayed benefits for the giver, such as enhanced coalitional support and mating opportunity. In chimpanzees (*Pan troglodytes*), meat transfer among nonrelatives is common. Meat transfer behavior in Fongoli chimpanzees is similar to patterns seen elsewhere. Additionally, since females at Fongoli hunt frequently, we were able to examine meat transfer from the female perspective. A third of the cases we examined involved female ownership of a prey carcass and in approximately 20% of these events, females had procured the prey. A similar pattern of tolerance emerged as had been seen with plant and tool sharing at Fongoli, which we recently reported. Males rarely monopolized carcasses, unlike the case in many chimpanzee communities, and while females transferred meat to males, they also effectively ignored males'

begging behavior. We suggest such behavior supports the social bonding hypothesis, where individuals' affiliative behaviors translate into positive social relationships that function as investment in mates and/or coalition partners in this species, largely in the form of male tolerance. We further examine the meat transfer behavior in Fongoli chimpanzees within the context of hominid evolution.

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**Spatial position in feeding trees and its relationship to nutritional quality in wild howler monkeys (*Alouatta palliata*).**

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Howler monkeys are the most folivorous primates of the New World. To process the large volume of leaves, they have developed a suite of behavioral adaptations to aid in digestion. Many studies have shown that howlers are selective in the types of leaves and species of trees from which they feed. Recent studies suggest that the nutritional quality of leaf parts vary according to the section of the tree crown they occupy, with the upper and terminal sections containing the highest quality resources. We tested the hypothesis that mantled howler monkeys (*Alouatta palliata*) position themselves within high quality sections of the tree crown, so as to forage on more nutritious leaves, while expending little energy. Data were collected at La Suerte Biological Field Station in northeastern Costa Rica in July, 2012, using continuous focal animal sampling and recording behavior and position of individuals in the tree crown. Howler monkeys spent 65% of their total resting time and 84% of their total feeding time in the upper-terminal sections of the tree crown. Thus, it appears individuals exhibit preferential placement in high quality sections of the tree crown. However, this correlation is greater during feeding bouts and other variables may contribute to their selection of position within the tree crown while resting. These findings, combined with planned nutritional analyses of leaves in different parts of the canopy, indicate possible complexities, not only in the foraging strategies of the genus *Alouatta*, but also perhaps in the foraging of all folivorous, arboreal mammals.

**Peeling back the layers: additional evidence for the date of the Petralona skull (*Homo heidelbergensis*), Greece.**

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A controversial fossil hominin is the Petralona skull, discovered in northern Greece in 1960 by local villagers. The cave was later excavated, but the exact findspot of the skull is not known with absolute certainty. The specimen is nearly complete, but the date remains controversial. The consensus now assigns the skull to *H. heidelbergensis*, as one of the earliest known in the European Neanderthal lineage. A. Poulianos suggested a date of about 700-800 ka. ESR and U-series dates have also been attempted, producing a wide range of results, in part because of the lack of definitive association between the deposits and the skull. ESR dates by Henning et al. on the brown speleothem deposited on the skull itself can provide the only truly reliable dates, and suggest a date of 200+40 ka. However, N. Poulianos suggested in 2005 that the upper part of the Petralona skull was covered by both a white (older) and brown (younger) layer of sinter (speleothem). He reasoned that because only the brown layer was dated, the skull is much older. We examined the skull for evidence of white sinter in the skull. We found all the sinter left in the recesses of the skull, such as the sutures, was of the brown type. We conclude that there is no white sinter deposited directly on the skull and therefore the initial date of the skull given by Henning et al. and Grun's revised date of ca. 200 ka are correct.

**A radiographic study of human mandibular permanent tooth eruption and root stage.**

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The relationship between root growth and eruption is poorly understood. The aim of this retrospective cross-sectional study was to describe eruption levels of human mandibular teeth in terms of root stage and age. The sample was 944 panoramic dental radiographs from children aged 3-16 years. Left mandibular teeth (excluding M3) were assessed for eruption level and root stages described by Moorrees, Fanning and Hunt. Eruption levels were defined as tooth within bone, cusp tips at or just above the alveolar bone level (AE), partially erupted (PE) and fully erupted. The distribution of tooth stage and age was described for AE and PE for each tooth type and data were pooled for boys and girls. Mean age for M1 was 5.20 (SD 0.80, N=110) and 6.00 (SD 0.90, N=49) for AE and PE respectively. Values for M2 were 10.35 (SD=1.26, N= 112) and 11.93 (SD= 1.48, N=46). The oldest child with no fully erupted tooth was 7.68 years. The youngest child with a fully erupted tooth (M1) was 4.87 and with seven fully erupted teeth was 10.69 years. The modal root stage at AE for molars and incisors was R1/4 and R1/2 respectively. Modal stage for the canine and premolars was R3/4. The modal root stage at PE for most teeth was R3/4 with the exception of M1 (R1/2) and canine (Rc). These findings show a wide range of root stage and age for eruption levels and that M2 erupts relatively later in root formation terms compared to M1.

**Seasonal variation in group movement patterns in the Sanje mangabey (*Cercocebus sanjei*), Udzungwa Mountains National Park, Tanzania.**

EMILY K. LLOYD and CAROLYN L. EHARDT. Department of Anthropology, University of Texas at San Antonio.

Sanje mangabeys (*Cercocebus sanjei*) are an Endangered primate species restricted to the Udzungwa Mountains, Tanzania. When available, mangabeys feed on ripe fruit which are typically widely distributed within a home range. During the wet season, when ripe fruits are most available, daily paths are expected to be longer and more linear than during the dry season. Group location data were collected every thirty minutes using handheld GPS units during 67 full-day follows of a fully habituated Sanje mangabey troop (n = 39) between January 2005 and December 2007. Daily path lengths (DPL, m) and a measure of linearity (sinuosity) were calculated using Hawth's Animal Movement Extension in ArcGIS. No significant seasonal differences were found in mean daily path length or mean path sinuosity, but Levene's tests revealed significantly larger variance in DPL during the wet season (F = 3.008, p = 0.038) and in sinuosity during the dry season (F = 6.546, p = 0.013). These results reveal an alteration in foraging strategy by season. During the wet season, Sanje mangabeys may travel long distances each day to reach ripe fruits, or may take advantage of large, slowly depleting patches on sequential days, resulting in a highly variable DPL. Foraging for dispersed food resources during the dry season may result in variable backtracking movement patterns which can account for higher variation in sinuosity. GIS technologies and associated inferential spatial statistics are becoming increasingly important in examining the spatial dimensions of animal behavior, an under-studied aspect of primatology.

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**Chanka mobility and diet in the Central Highlands of Peru: A multi-isotope analysis.**

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Bracketed by the disintegration of the Wari and the emergence of the Inca, the early Late Intermediate Period (LIP, ca. AD 1000-1250) was marked by small scale regional warfare and alliance building in the Andean highlands. Strontium isotopes (<sup>87</sup>Sr/<sup>86</sup>Sr) and light stable isotopes of oxygen ( $\delta^{18}\text{O}$ ) and carbon ( $\delta^{13}\text{C}$ ) derived from human tooth enamel (N=44) are used as proxies to elucidate geographical

origin and diet of individuals from four burial areas (two LIP Chanka, one LIP Quichua, one Wari) surrounding present day Andahuaylas, Peru. While several individuals sampled exhibit "non-local" <sup>87</sup>Sr/<sup>86</sup>Sr values, results do not support previous hypotheses of non-local origin invoking migrant salt mine labor in the region. However, both adult males and adult females exhibit outsider <sup>87</sup>Sr/<sup>86</sup>Sr values, suggesting dual patterns of exogamy. Stable oxygen isotope ratios reflect water consumed in food and drink, and complex patterns of water composition and evaporative regimes that vary by altitude and biological age (weaning).  $\delta^{18}\text{O}$  results show an overlapping range of values, with small inter-site differences which likely underscore the complexity of oxygen in highland contexts. Stable carbon isotope ratios help to distinguish between consumers of C<sub>3</sub>, C<sub>4</sub>, and mixed dietary regimes.  $\delta^{13}\text{C}$  values suggest high consumption of C<sub>4</sub> plants (e.g. maize) for all individuals sampled, but also point to increasing inequality in the post-imperial era. Supplemented by bioarchaeological analyses including cranial modification, trauma and trepanation, this study informs Chanka and Quichua inter-group dynamics in the wake of societal collapse and reformulation.

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**Exploration of First Intermediate Period Burials at Mendes.**

ANDREW M. LOPINTO. Behavioral Sciences Department, Triton College.

The site of Mendes (modern Tel El-Ruba) occupies a place of prominence in the history of Egypt. Located approximately 120 kilometers north of modern Cairo, in the eastern delta, Mendes served as an ancient capital, trade center, and point of entry from the earliest periods of Egyptian history through to the Late Period.

Led by Drs. Donald and Susan Redford, the Pennsylvania State Expedition to Mendes returned in summer of 2012 to continue excavations, unearthing five First Intermediate Period burials. Radiocarbon dates from past seasons securely placed these burials in the First Intermediate Period (approximately 4200 BP). Of the five burials, three were classified as "adult" and two were classified as "sub-adult." The very poor skeletal preservation made exact age and sex estimation difficult.

These burials offer new information about health and burial strategy in a period of Egyptian history which is little studied. Because of the degraded skeletal tissue, the most important information about health was gleaned from the teeth, which were relatively well preserved. Linear enamel hypoplasia were observable on the teeth, in occlusion, of all individuals, and in the case of the sub-adult individuals, on un-erupted dentition also. This observation becomes very important when viewed vis-à-vis burial strategy and age. Though

buried in similar fashion, these burials do exhibit distinction which could be attributed to socio-economic differentiation. That being the case, it appears that inadequate nutrition and disease affected the population of First Intermediate Period Mendes irrespective of social position and over an extended period.

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**An ethnoprimate assessment of human impact on the parasite ecology of silky sifaka (*Propithecus candidus*).**

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To date, the silky sifaka (*Propithecus candidus*) is among the rarest of nonhuman primates (NHPs) with perhaps as few as 1,000 individuals remaining. Pressures impacting their survival include hunting and habitat loss due to logging and agriculture. Parasitic diseases pose another increasingly recognized threat to their health. This study assesses the parasite patterns of two populations of silky sifaka inhabiting Marojejy National Park (Camp 2) and Makira Natural Park (Andaparaty), both located in northeastern Madagascar. The Marojejy population consisted of 7 individuals each of which harbored *Lemurostrongylus* sp. infections and an unidentified oocyst. The Makira population consisted of 3 individuals of which 1 harbored *Lemurostrongylus* sp. The Marojejy site is characterized by montane, largely undisturbed rainforest while the Makira site is a fragmented, low elevation habitat with considerable anthropogenic disturbance. Using an ethnoprimate approach, we conducted interviews with local Tsimihety and Betsimisaraka people who revealed that local fauna including the silky sifaka are hunted, and no significant fady or taboo exists prohibiting the hunting of this species. By understanding the patterns of silky sifaka parasitism and their anthropogenic pressures, we hope to develop durable conservation initiatives at both parks.

**Using digital photogrammetry to estimate growth in wild geladas.**

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Recent studies suggest that digital photogrammetry offers a promising non-invasive method to estimate stature in wild populations.

In one version of this method, researchers use two parallel lasers mounted on a digital camera to provide a measurement scale within each photograph. However, if measurement landmarks are difficult to identify or if the photographed animals have different postures, the precision of this method can be undermined. Here, we used digital photogrammetry to measure shoulder-to-rump length in wild female geladas (*Theropithecus gelada*) in the Simien Mountains National Park, Ethiopia. First, preliminary trials on domestic dogs indicated that laser-based measurements were accurate on animals of comparable size and coat thickness. Second, in the field, we measured shoulder-to-rump length in a cross-section of photos from our adult, adolescent, and immature females. We calculated two sources of variation: (1) inter-measurer error (i.e., comparisons across people taking measurements from the same photo), and (2) inter-photo error (i.e., comparisons across multiple photos and postures taken from the same animal on the same day). The inter-measurer CV was low and comparable to previous studies. The inter-photo CV was slightly higher, with differences in stature contributing to higher CVs. These results suggest that researchers should select only the most comparable photos, as measurement error seems to be attributed more to differences between photos of the same individual, and less to differences in landmark identification by measurers. Because measurement error is particularly important for longitudinal studies on growth, it is critical to identify the appropriate interval for repeated measurements.

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#### **People on the move: Examining Tiwanaku State expansion in the Cochabamba Valley of Central Bolivia through strontium isotope analysis.**

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Previous research in outlying Tiwanaku territories in the south-central Andes demonstrates a varied approach to state expansion and integration during the Middle Horizon period (A.D. 500 to 1100). This presentation examines the nature of Tiwanaku state expansion into the Cochabamba Valley of central Bolivia using strontium isotope analyses of archaeological human remains. Patterns of mobility are reconstructed for six individuals recovered from the proposed Tiwanaku colony of Piñami in the Cochabamba Valley to determine if the Tiwanaku state had a direct, physical presence in the region. Data from individuals interred at the site indicate that most

were local inhabitants rather than migrants from the Tiwanaku heartland or another regional community. The low appearance of Tiwanaku migrants at Piñami and high occurrence of Tiwanaku material culture supports existing research that Piñami was connected to the highland polity indirectly rather than through direct state influence. These findings offer a more nuanced understanding of Tiwanaku state expansion and integration during the Middle Horizon, and contribute to a broader knowledge on prehistoric human migration and interaction in the south-central Andes.

#### **New developments in field mechanics.**

PETER W. LUCAS. Bioclinical Sciences, Kuwait University.

The measurement of food material properties generally requires simultaneous monitoring of force and displacement while a specimen is loaded. The advent of the Darvell HKU portable mechanical tester about 20 years ago gave field researchers an opportunity for this on small specimens within a displacement-controlled framework. Yet some properties remain difficult to estimate with that tester, particularly via indentation, due to an inability to time loading ramps precisely. Recent developments have solved these issues by detaching force readings from increments in displacement. The result is a new range of possibilities, based largely around types of indentation. Blunt indentation is a relatively recent development in materials testing that can be applied to visco-elastic-plastic materials like soft foods. Force relaxation under a blunt probe (6 mm dia.) allows the modulus of even the ripest fruit flesh to be assessed in terms of two extremes: an instantaneous and an infinite value. The ratio of the two gives a quantitative estimate of how rate-sensitive such tissues are. The technique can also be adapted to obtain the modulus of the laminae of leaves, something not possible previously, via arranging for a blunt probe to deflect a circular portion of lamina that has been clamped evenly around its edges. This test offers insights into the mechanical behavior of leaf tissue, including the possibility that during their development, leaves transform from floppy sheets at flushing into stiff beams at maturity. This transformation has implications for primate feeding behavior, with respect to oft-stated preferences for 'young' leaves.

#### **Body frame variation and adiposity in development, a longitudinal study of 'Cape Coloured' children.**

TEGHAN A. LUCAS and MACIEJ HENNEBERG. Biological Anthropology and Comparative Anatomy unit, The University of Adelaide.

The obesity epidemic is impacting both developed and undeveloped countries worldwide. Obesity and its underlying health concerns are often explained as an imbalance between nutritional intake and energy expenditure. The public campaigning based on this approach – eat less exercise more – has been

largely ineffective. Individual variations in food metabolism and energy expenditure are responsible for much of the adiposity present amongst individuals, considerations for which are not included in public health attempts to reduce obesity. A mixed longitudinal growth study had been conducted between 1987 and 1994 among "Cape Coloured" children in the Western Cape Province of South Africa. The sample studied here consists of 127 females and 130 males between the ages of 6 and 20 years. The growth of each child was measured between 6 and 9 times. The following anthropometric dimensions, standardised for age: trunk length, elbow width, knee width, bi-acromial and bi-iliac diameters correlated significantly ( $p < 0.05$ ,  $r$  between 0.087 and 0.511) in both males and females with three skinfolds: triceps, subscapular and abdominal. This means that wider body frame correlates with increased adiposity. The latter supports earlier conclusion (Henneberg and Ulijaszek 2010 *Am.J.Hum.Biol.* 22:83-91) that the increased size of the abdominal cavity indicating larger gastrointestinal tract is related to greater adiposity. Future preventive obesity interventions should be individualised taking into account body build and, possibly, physiological characteristics of people.

#### **Cochlear labyrinth volume and predicted hearing abilities in *Adapis*, *Necrolemur*, *Homunculus*, and *Tremacebus*.**

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Previous analyses of cochlear labyrinth morphology provide evidence of a functional relationship between hearing abilities, cochlear volume, and basilar membrane length. Among therian mammals, cochlear volume is negatively correlated with both the high and low frequency limits of hearing. These functional relationships make it possible to reconstruct attributes of the hearing abilities of extinct taxa based on the anatomy of the cochlear labyrinth. We analyzed the cochlear labyrinths of four fossil primate crania, including two species from the Eocene of Europe (*Adapis parisiensis* and *Necrolemur antiquus*) and two species from the Miocene of Patagonia (*Homunculus patagonicus* and *Tremacebus harringtoni*). Fossils were CT scanned at a resolution of 20-40 microns and the cochlear portion of the bony labyrinth was segmented using a variant of the half maximum height method. Cochlear volumes of fossil taxa were compared with data for 27 extant species with known audiograms from 8 mammalian

orders. High and low frequency limits of hearing at 60db SPL were estimated using phylogenetic generalized least-squares regressions. These methods yield estimated hearing ranges of: *Adapis* (100Hz -42.0kHz); *Necrolemur* (100Hz - 65.0kHz); *Homunculus* (70Hz - 43.0kHz); *Tremacebus* (70Hz - 43.0kHz). *Necrolemur* is thus estimated to have exhibited better high frequency hearing than the other fossil taxa in our analysis. These results suggest that *Tremacebus* and *Homunculus* had very similar hearing abilities that were comparable to those of some extant platyrrhines (e.g., *Saimiri*). Similarly, estimated thresholds for *Adapis* and *Necrolemur* are comparable to those of some living strepsirrhines (e.g., *Perodicticus* and *Galago senegalensis*, respectively).

*This project made possible by NSF Grant 0851272 awarded to Richard F. Kay.*

#### **A comparison of catarrhine genetic distances against pelvic and cranial morphology: implications for determining hominin phylogeny.**

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The extent to which various skeletal elements differ in their reliability for recovering catarrhine phylogenetic history is currently poorly understood. This is partly due to the dichotomization of the cranium and postcranium in studies of evolutionary morphology, with the majority of phylogenetic studies focusing on craniomandibular or dental traits. Here, we test the relative efficacy of the catarrhine pelvis (innominate) and cranium for recovering the genetic relationships of 11 catarrhine taxa including *Homo sapiens*. Mahalanobis' distance matrices based on 3D geometric morphometric quantification of the shape of the cranium, mandible and innominate were statistically compared (via Mantel and Dow-Cheverud tests) against a common genetic distance matrix. Analyses were repeated for males and females separately, and with *Homo sapiens* removed. The results found that, when humans were included, the cranium and pelvis were consistently correlated with the genetic matrix, while the mandible was not. Moreover, there was no statistical difference in the strength of the genetic congruence of the cranium and the pelvis in the sex-specific analyses. When humans were removed from the analysis, all elements were significantly and equally strongly correlated with the genetic matrix. Furthermore, a neighbor-joining analysis of the pelvic dataset found that cercopithecoids and hominoids formed exclusive groups, there was clear distinction between colobine and cercopithecine taxa, and lesser apes were distinguished from great apes (including humans). Hence, these results suggest that there is no *a priori* reason to favor craniodental data over pelvic morphology when attempting to reconstruct the phylogenetic relationships of the fossil hominins.

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#### **The lateral angle and cranial base sexual dimorphism: a morphometric evaluation.**

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The lateral angle (LA) is formed by the internal meatus acusticus (IMA) and the medial surface of the petrous bone, and the LA size has been proposed as a method for sex evaluation. The aim of this study was to determine the association between petrous bone morphology, and hence the LA size, and that of the cranial base.

CT scans of the heads of 51 female and 51 male autopsy cases were used. The LA was measured by direct measurement on CT-scan slices, and 12 landmarks were identified using 3D visualizations of the internal cranial base. Procrustes superimposition was used to extract the shape information from the set of coordinates.

We found a significant sexual dimorphic difference in cranial base shape, but with a large overlap and low predictive rate (76.6%) with high misclassification values. The male cranial base shape was more elongated, but also narrower in the IMA region with a shorter distance between the IMA and the labyrinth, than females. While this difference is in agreement with the LA size being smaller for males than for females, we also found a large overlap in LA sizes. Thus, we posit that LA size is a reflection of the petrous bone and cranial base shape and that given the rather low degree of sexual dimorphism in this area, it follows that the LA will have a low degree of sexual dimorphism.

#### **Stable isotope analysis of human bones from Roman Ephesus (Turkey, 2<sup>nd</sup> and 3<sup>rd</sup> ct. AD).**

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Skeletal remains of 37 individuals from several graveyards in Ephesus, Roman capital of the province Asia, were investigated. Basic osteology and stable isotope analysis provide new information about the 2<sup>nd</sup> and 3<sup>rd</sup> century AD living conditions of this ancient megacity's citizens.

Bone collagen was extracted and stable isotope ratios of carbon, nitrogen and sulfur were measured with mass spectrometry. So far, 29 males, five males and three sub adults (< 12 y) were investigated. All 34 adults belong to the age classes adult and mature. The mean female body height was 162cm± 4cm, the mean male body height was 169cm± 5cm. This is within the range of known values for ancient Roman populations.

The male individuals (n=29) show  $\delta^{13}\text{C}$ -data of  $-18.93\text{‰} \pm 0.3$ ,  $\delta^{15}\text{N}$ -values of  $9.43\text{‰} \pm 0.8$  and  $\delta^{34}\text{S}$ -values of  $7.71\text{‰} \pm 1.5$ . The female

individuals (n=5) show  $\delta^{13}\text{C}$ -data of  $-18.89\text{‰} \pm 0.5$ ,  $\delta^{15}\text{N}$ -values of  $9.12\text{‰} \pm 1.0$  and  $\delta^{34}\text{S}$ -values of  $6.94\text{‰} \pm 2.7$ . The sub adults (n=3) show  $\delta^{13}\text{C}$ -values of  $-19.10\text{‰} \pm 0.2$ ,  $\delta^{15}\text{N}$ -values of  $9.12\text{‰} \pm 0.4$  and  $\delta^{34}\text{S}$ -values of  $7.11\text{‰} \pm 1.3$ .

All individuals consumed C3 plants as basic subsistence with a light intake of C4 plants. Seafood and animal proteins was also a small part of the nutrition.

The quite heterogeneous values for the females with signs for migration are less surprising than the homogeneous data of the males, as this was to be expected regarding an ancient "melting pot" like Ephesus. Further studies will concentrate on social strata and different occupational groups.

#### **The development of aggressive play behavior in wild chimpanzees.**

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Chimpanzee males are well known for their aggressive behaviors and in all study communities, males are consistently more aggressive than females. Differences also exist between individuals within each sex but there is little known about what shapes the development of these differences. We examined the extent to which sex and individual differences in aggressive play behavior are the result of exposure to aggression and/or innate predisposition. We used four years of behavioral data behavior from 2006-2009 from 28 non-adult individuals from the Kanyawara community of chimpanzees in Kibale National Park, Uganda. This included data from over 15,000 play bouts. We tested the hypotheses that (1) males are exposed to more aggression before adulthood than females, (2) males exhibit more rough-and-tumble play behavior than females and (3) individual variation in the amount of aggressive play is affected by the amount of exposure to aggression. We found no sex difference in the amount of exposure to aggression among our non-adult individuals, but young male chimpanzees did engage in aggressive play behavior significantly more than young females. We also found a positive correlation between exposure to aggression and the probability that subsequent play on the same day would be aggressive. Our results indicate that sex differences in aggression in chimpanzees may occur early in life and manifest themselves through differences in the frequency of rough-and-tumble play. We also suggest that individual differences in aggressive play may in part be mediated by differences in exposure to aggression.

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### Functional morphology of the Neandertal scapular glenoid fossa.

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Neandertals and *Homo sapiens* are known to have substantially different upper limb morphology. Several morphological distinctions are attributed to disparity in behavioral repertoires, and are potentially indicative of shifts in behavior over the Pleistocene. However, other factors – e.g. allometry, ontogeny, phylogeny – must be considered during exploratory shape analysis before functional explanations may be attributed. The shape of the scapular glenoid fossa was compared among Neandertals, early and anatomically modern human populations, as well as chimpanzees and two species of *Australopithecus*. Geometric morphometric analysis revealed that Neandertals were morphologically most similar to active human populations. While overall size was significantly correlated with certain morphological aspects, many components of shape were not associated with allometric scaling. Considerations of outgroup taxa supported previous studies of evolutionary development and its influence on fossa shape, but a considerable degree of morphological variation remained unexplained. Articular rim morphology and fossa curvature were associated with other features previously attributed to function, particularly morphology of the glenoid notch. Bilateral analyses of a broad range of populations indicated the aforementioned morphologies drive asymmetry in active populations as well as for La Ferrassie I. Thus, functional morphology may best explain these specific aspects of shape. This may be related to Neandertal subsistence strategy, particularly with respect to long-range projectile tool use.

### Distal radioulnar joint morphology of short-tailed semi-terrestrial cercopithecines and its implications for the evolution of hominoid taillessness.

AMBER E. MACKENZIE and DAVID R. BEGUN. Department of Anthropology, University of Toronto.

Semi-terrestrial cercopithecines are an ideal group with which to test hypotheses concerning the evolution of hominoid taillessness due to the frequent reduction in tail length that has occurred in parallel within this group. It has previously been proposed that the loss of the tail among the earliest hominoids was associated with an increase in forelimb mobility (Kelley, 1997) related to a greater reliance on forearm pronation-supination, which would have served as a functional correlate for the tail in maintaining balance (Larson and Stern, 2006). If this hypothesis is correct, I predict that short-tailed semi-terrestrial cercopithecines will

exhibit a greater range of pronation-supination than their long-tailed relatives.

To test this hypothesis, five indices were calculated from seven skeletal measurements that reflect the range of rotation at the distal radioulnar joint. Eight semi-terrestrial cercopithecine species (n=70) were included in this analysis, and were divided into two groups (short tail, n=32; long tail, n=38) based on relative tail length and published observations of tail use during locomotion (Larson and Stern, 2006). An analysis of variance was used to compare the functional morphology of the distal radioulnar joint between these two groups.

The results indicate that semi-terrestrial cercopithecines with a reduced tail exhibit a significantly greater mediolateral expansion of the radial facet around the ulnar head (p=0.000). This morphology is indicative of a greater range of forearm pronation-supination (O'Connor, 1975), and therefore these results provide quantitative support for the relationship between tail loss and greater forelimb mobility.

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### Dietary patterns in Medieval northern Spain.

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Stable isotope analysis of human bone may reveal differential access to dietary resources due to a variety of cultural and environmental factors. The goal of this study is to reconstruct the diets of individuals living in predominantly rural communities of Medieval Asturias, Spain (10–19<sup>th</sup> centuries). Although the history of high status individuals is documented in written records, little has been recorded on the daily lives of the peasant classes that made up the majority of the population. Dietary inequality is explored through evaluation of dietary differences between the sexes and between different socioeconomic groups.

Human burials (n=45) and faunal remains (n=12) excavated from eight archaeological sites comprise the dataset for this study. Stable carbon and nitrogen isotope analysis of bone collagen and stable carbon isotopes of bone apatite were analyzed to explore dietary variation. Historic records suggest that the human diet consisted of C<sub>3</sub> plants, animal domesticates, wild herbivores, and marine resources for coastal groups.  $\delta^{13}\text{C}$  values vary from -20.2 to -12.4 ‰, whereas  $\delta^{15}\text{N}$  values vary from 8.4 to 13‰. Although much of this variation can be attributed to geographic location, there is also significant intra-site variation. We explore these patterns with regard to sex differences in diet, dietary inequality, and migration history. This project will be among the first isotopic study undertaken in this region, and

will shed new light on the dietary patterns of rural Medieval Spanish populations.

*This research was funded by a grant from the College of Behavioral and Social Sciences, California State University, Chico.*

### Building a code of best practices for field primatology.

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The last few years have seen a revitalized discussion concerning the need for a set of ethical guidelines that would be of use to primatologists working in field conditions. Field primatologists must grapple with a wide variety of ethical issues, including the conservation and health of wild populations, and balancing the interests and needs of both human and nonhuman primates at our research sites. However, we currently maneuver through these complex landscapes without a set of relevant and internationally agreed-upon guidelines. In keeping with the aims of this session we highlight some ethical issues inherent in primatological fieldwork, and the need for inter- and intra-disciplinary conversation and action. We will review recent professional symposia/workshops (e.g., at the 2009 American Society of Primatologists, 2012 American Association of Physical Anthropologists, and 2012 International Primatological Society meetings) and publications on these topics, and discuss how to move forward toward the development of a formalized code of best practices. To this end, we will present an outline of a proposed code we recently published as part of a book chapter in an edited volume. We feel strongly that field primatology would benefit greatly from a source of best practices (including online case-study examples), and would be of particular use in the teaching and professionalization of our students. We suggest a list of best practices appropriate for adoption by the American Society of Primatologists, the International Primatological Society, and their respective flagship journals, *American Journal of Primatology* and *International Journal of Primatology*.

### Determining ovarian follicle reserve from Anti-Mullerian hormone as detected using dried blood spots gathered in a remote field setting.

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Anti-Müllerian hormone (AMH) is a protein produced by the granulosa cells of the ovarian follicles and is well-correlated with the size of the residual ovarian oocyte reserve. Since the reduction of serum AMH levels is an indication of a decline in the ovarian follicular reserves, the hormone has proven useful for fertility assessments in clinical settings. The natural reduction in ovarian oocyte numbers closely parallels fertility declines with advancing age and is also negatively correlated with body size. Recent advancements in biomarker assay technology have allowed for the testing of AMH from dried blood spots gathered using minimally-invasive methods in remote field settings. The present research tested the applicability of this technique using samples collected from 38 indigenous Shuar women (19-46 years old) living in Amazonian Ecuador. We had two main objectives: 1) to examine age-related associations with AMH levels, and 2) to investigate relationship between AMH and anthropometric correlates of reproductive health and developmental life (e.g., height, weight, body mass index, skinfold thickness). Using multiple regression analyses we examined associations among AMH, age, and anthropometric data. AMH levels range from 0.04 – 4.45 ng/mL. Although AMH levels decline significantly with age ( $p < 0.05$ ), they are not significantly associated with anthropometric measures. As this is a preliminary study, these results may be explained by the small sample size. Nevertheless, we discuss the potential application of this assay in human biology research and establish its potential to illuminate upon female reproductive biology and more specifically, ovarian physiology in non-Western populations.

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#### **A tale of two sisters: Mitochondrial HVI sequence variation in Accompong Town Maroons.**

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Jamaican Maroon oral histories uses an allegory of two sisters as means to explain the relationship between Maroons and the African-descended populace of Jamaica. In this allegory, one sister fought and won her freedom while the other chose not to fight thereby remaining enslaved. In the current study, we also sought to learn about the relationship between Accompong Town Maroons and the greater Jamaican populace. To address this issue we calculated standard diversity indices, tested for founder's effect, and ran a median-network analysis using a sequenced segment of the mitochondrial hypervariable region I (mtDNA HVI) from fifty-two Accompong Town Maroons. Comparative mitochondrial sequence data were gathered from online databases. Our analyses indicated that the

mitochondrial genetic diversity among Accompong Town Maroons is comparable to that observed among Jamaican and other Caribbean communities. Secondly, there is some evidence of rapid recent population expansion among the Accompong Town Maroons, and finally the presence of divergent lineages within the network may be indicative of varied origins of the women in this Maroon community. This study provides a glimpse into how cultural and historical factors have worked to shape the genetic history of a Caribbean community.

*This research was supported with a Pilot Grant from the Institute of Scholarship and Learning in the College of Arts and Letters at the University of Notre Dame.*

#### **Taking a closer look at the institutionalized: the late 19th century Colorado Insane Asylum.**

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In late 1879, Colorado opened its State mental hospital. From 1879-1900, nearly 2000 individuals were admitted. Slightly more than half were discharged after varying amounts of time, while about 500 died by 1900. Two hundred were reported to have been buried on the hospital grounds. About 155 of them were excavated and analyzed.

Those committed to the asylum were generally poor, and the majority of males with a listed occupation were laborers, farmers, or miners. Women were generally domestics or housewives. Among males, important causes for admission were intemperance or syphilis, while for females admission was often due to heredity or reproductive problems. Men were admitted at higher rates than women, and being single or widowed increased the risk of incarceration. Foreign-born individuals were admitted more frequently than their native counterparts, especially Irish women.

At least 13% of admissions were due to neurosyphilis. We document one clear case and four likely cases of syphilis. The number of cases is lower than expected. Chemical testing of a sample of the series using ICP-BM analysis showed no evidence of elevated levels of mercury which was often used to treat syphilis, although a few cases of lead and arsenic poisoning were identified. A number of individuals showed traumatic injury. It is likely that the traumatic injuries occurred prior to admission. Finally, a detailed study of osteoarthritis showed an unexpectedly low prevalence of joint degeneration, even though patients were lower class laborers.

#### **High spatial resolution isotopic analysis of human primary bone: New methods for reconstructing short-term environmental and dietary change using the endosteal lamellar pocket.**

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Stable isotopic research has contributed greatly to our understanding of past human lifestyles, environs, and health. Incrementally growing tissues such as fingernails and hair have yielded time series data that enable the reconstruction of ancient short-term geographical relocation and dietary seasonality. Unfortunately, these tissues are rarely preserved relative to bone and bone is so microstructurally complex that its isotopy has been limited to bulk techniques that obscure short-term data, until now. Recent histomorphological findings uncovering predictable patterns in sequential primary bone growth could be combined with high spatial resolution isotopic methods to permit these detailed time-series inquiries in human long bones. Specifically, three techniques for testing the endosteal lamellar pocket, a remnant of bone modelling drift during growth, are compared here: microdrilling, infrared laser ablation, and ion probe isotopy. Results and discussion further develop methods offering a previously impossible degree of direct interrelation among environmental, behavioural, and biological circumstance, augmenting our inquiry of past populations.

#### **Using formal languages to determine the similarity of Paleolithic stone toolmaking and language syntax.**

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Linking behavior with paleoneurological morphology is challenging. Holloway (1969) proposes that there is a common neural substrate for aspects of language production and stone toolmaking. Though there is functional overlap between stone toolmaking and language production in the brain, it is not clear how similar the sequencing in stone toolmaking and language actually are. Does enlargement of Broca's cap in *Homo habilis* and emergence of Acheulean technology indicate the initiation of linguistic behavior?

In this pilot study, techniques from generative linguistics were used to empirically derive a formal language description of the process of replicating a late Acheulean handaxe by a single expert knapper. A formal language is a technique in linguistics and computer science to describe and compare the complexity of sequentially structured processes.

The derived model is best categorized as a Context-Free Grammar (CFG). This categorization is based on the observation that the knapper (1) chunked the sequence of actions into multiple hierarchical levels and (2) manipulated the sequence of actions flexibly at multiple levels. Most generative linguists class natural (spoken) language as a CFG. Compared to natural language, this CFG is 'expressively' limited by the constraints of lithic technology.

The derivation of the CFG allows us to describe the sequencing of actions in Late Handaxe manufacture in terms of a push-down automata. This provides a minimal cognitive model for this aspect of stone-toolmaking. If future research supports this architecture, then it suggests an intriguing role for cores as memory storage devices in the process of tool manufacture.

#### **Deciduous enamel thickness and chewing mechanics in human children.**

PATRICK MAHONEY. School of Anthropology and Conservation, University of Kent.

Studies have shown that enamel thickness generally increases along the human permanent tooth row from incisors to distal molars. Some attribute this trend between molars to a functional purpose, related to bite force during chewing. Others propose a morphological explanation, arguing that the relatively increased molar enamel thickness can be explained by a reduction in the distal molar crown size, which is facilitated by a reduced proportion of dentin. Here I assess average enamel thickness (AET) and dentin proportions along the entire human deciduous mandibular ( $n=91$ ) and maxillary ( $n=95$ ) tooth rows (incisors, canines, molars) in an archaeological sample of human children. Thin sections were prepared using standard histological methods. Sections were examined under a microscope (Olympus BX51), digital images were produced (Olympus DP25), captured, and analyzed (Olympus Cell D). Results were evaluated against functional and morphological interpretations of enamel thickness derived from permanent teeth.

Mean AET (and RET) increased from deciduous incisors to distal molars. Distal molars had the smallest proportion of dentin. These trends are similar to reported values for permanent teeth. However, changes in crown size do not explain the trends in deciduous teeth, in the way that has been proposed for permanent molars. For example, the deciduous distal molar is larger not smaller than the first molar. In contrast, there is some support for a relationship between bite force and enamel thickness in children's teeth. The greater deciduous molar AET, compared to incisors, corresponded to recently reported differences in bite forces between these tooth types.

*Maxillary molar sections were funded by the Royal Society.*

#### **Cancer-related lesions in a contemporary skeletal collection with known cancer cases.**

HELI MAIJANEN and DAWNIE W. STEADMAN. Department of Anthropology, University of Tennessee.

The William M. Bass Donated Skeletal Collection is the largest collection of contemporary human skeletons in the United States. Most individuals are of advanced age and have accumulated a number of pathologies. The goals of this study are to evaluate the

morphology of bone neoplasms among contemporary individuals with both treated and untreated cancer and situate cancer prevalence in relation to other pathology categories within the collection. In addition, this study looks at conditions that might be associated with disease wasting and/or cancer treatment (e.g. anemia, osteopenia) among those with diagnosed cancer.

The Bass Collection consists of over 1000 individuals of known sex, age, ancestry, weight, and medical history. Primary bone cancers are rare in the collection so our study focuses on individuals with the seven most reported cancers in the collection that metastasize to bone: lung, breast, prostate, leukemia, colon, skin and pancreatic cancers ( $N=84$ ; 41 females, 43 males). Of these, 36 individuals received some form of cancer treatment while four did not. Treatment status is unknown for 44 donors.

The skeletal analysis of known cancer cases consisted of visual observations of skeletal lesions. The authors were blind to the type of cancer and treatment choices during analysis. The results demonstrate that the cancer lesions are predominantly lytic but only a small proportion of individuals demonstrate skeletal lesions directly attributable to cancer. Periosteal lesions, whether cancer-related or not, were the most common condition associated with these cases.

#### **Morphological variation in adapiform and omomyoid distal phalanges.**

STEPHANIE A. MAIOLINO. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

The earliest fossil euprimates (adapiforms and omomyoids) possess distal phalanges that indicate the presence of flattened nails. However, adapiform distal phalanges are morphologically unique among fossil primates. They have been described as having a "nail-like" flattened tip combined with a "claw-like" proximal end. To evaluate and interpret the morphological affinities of these fossils, a sample of adapiform ( $n=12$ ) and omomyoid ( $n=16$ ) non-hallucal and non-pollical distal phalanges are compared to those of 21 living primate and 42 claw-bearing mammal species. A set of 13 measurements was taken from each specimen and converted into size-adjusted shape variables via division by the geometric mean. Data were explored and summarized using an array of principal component and discriminant function analyses.

Adapiform and omomyoid distal phalanges are shown to differ consistently and strongly from each other. The proximal ends of adapiform distal phalanges are indeed intermediate in form between claws and nails, while distally they closely resemble the phalanges of extant nail-bearing primates. The similarity to claws is caused by an elongated and flattened platform on the volar surface of the proximal end of the phalanx. A similar, though smaller and less-flattened, volar process is present in claw-bearing mammals; it is associated with bilateral nutrient foramina positioned near the process. The volar platforms

of adapiforms are also characterized by paired, enlarged nutrient foramina. Omomyoids lack a discernable volar process, though nutrient foramina are variably present. Among living primates, adapiform distal phalanges are most similar to those of lemurs while omomyoids overlap in morphology with tarsiers.

#### **Skeletal estimates of upper limb effective mechanical advantage do not predict joint strength or speed in living humans.**

JULIA M. MAKI. Department of Anthropology, Washington University in Saint Louis.

Effective mechanical advantage (EMA) is often estimated in fossil hominins as a measure of joint rotational force and velocity. To estimate EMA in skeletal remains, the muscle moment arm ( $r$ ) is measured as the distance between the center of rotation of the joint and the line of action of the muscle, and the external load arm ( $R$ ) is assumed to be proportional to the distal limb segment length. The relationship between EMA and joint mechanics is often cited on theoretical principles, but it has not been demonstrated empirically. Furthermore, the correlation between  $R$  and distal segment length has not been demonstrated.

Here, the effects of variation in EMA on elbow joint isometric strength and joint angular velocity are explored in a sample of 30 athletes. EMA at the elbow was measured using MRI, isometric strength was assessed with a load cell, and maximum joint angular velocity was assessed during throwing with a high-speed infrared camera system. Additionally,  $R$  measured during throwing was compared with ulna length to determine if skeletal measures of  $R$  are relevant to living behaviors.

Contrary to predictions, independent of muscle size, EMA does not significantly correlate with elbow isometric strength, or angular velocity during throwing. Furthermore,  $R$  measured during throwing is not correlated with ulna length. Instead,  $R$  varies within and between individuals due to elbow angle and arm position. These results strongly suggest that skeletal estimates of EMA should not be used to infer joint strength or angular velocity in fossil hominins.

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#### **Habitat preferences and population assessment of *Microcebus murinus* in the remaining transitional littoral forest of Petriky, South-East Madagascar.**

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The littoral forests on sand of south-eastern Madagascar are among the hottest hotspots in the country because of threats represented by a large-scale mining project and forest exploitation due to anthropogenic encroachment. The southern-most forest fragment, Petriky (~920ha), represents a unique

transitional ecosystem between the wet and spiny forest and currently lacks systematic lemur studies. QIT Madagascar Minerals proposes to mine Petriky, but a conservation zone of ~120ha in the core of the fragment. In this paper, we compared habitat structure and density of *Microcebus murinus* between the proposed conservation zone and the rest of Petriky to rapidly assess the suitability of the zone to preserve Petriky's biodiversity. From April to July 2012, ten 1km transects (5 in the conservation area and 5 in the unprotected area) were walked four times each. The data were then analysed via the software DISTANCE 6.0. Vegetation was assessed with 20 plots (20x50m) and a line-intercept technique used to estimate canopy cover. We collected 180 *M. murinus* sightings resulting in density values of 4.8 ind/ha (3.0-7.4) in the unprotected zone and 6.5 ind/ha (4.6-9.3) in the conservation zone. Two-thousand-forty individual trees were measured representing 72 species from 42 families. The conservation zone had more trees, taller average height, and better canopy cover. When compared to other forest types, Petriky showed intermediate lemur density between the dry and the wet forest. To summarize, there is still a large population of *M. murinus* in the Petriky conservation zone which seems to contain a preserved habitat structure.

**Genetic diversity and phylogenetics of two hybridizing Atlantic Forest marmoset species, common marmosets (*Callithrix jacchus*) and black-tufted marmosets (*Callithrix penicillata*).**

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As an evolutionary force, outcomes of hybridization include introgression, admixture, speciation, or reproductive isolation. While hybridization has been studied in several primates, the marmoset genus *Callithrix* is an important, but little studied example of Neotropical hybridization. Low reproductive isolation is a hallmark of *Callithrix* species, and hybridization occurs throughout the Brazilian Atlantic Forest, either at natural species borders or between introduced, native marmosets and exotic *C. jacchus/C. penicillata* populations. Interbreeding between various *Callithrix* species carries important implications for the biodiversity and genetic integrity of this genus. However, genetic levels of introgression and admixture in hybrid zones are generally

unknown. Additionally, there are few population genetic studies of individual *Callithrix* species.

Here we explore the genetic diversity of *C. penicillata* and *C. jacchus* among pure marmosets, as well within two hybrid zones. Using the mitochondrial (mtDNA) control region, we reveal the existence of a previously undocumented natural hybrid zone along the São Francisco River in NE Brazil. Median-joining network analysis and a maximum likelihood phylogeny shows two largely distinctive mtDNA control region clades for each species. Although, we identify a total of 45 different mtDNA haplotypes among *C. jacchus* and 25 among *C. penicillata*, the latter show higher levels of nucleotide diversity than the former. We have also identified a panel of over 20 diagnostic microsatellite markers between *C. jacchus* and *C. penicillata* which will be used to study admixture within the newly discovered natural hybrid zone, and a previously established artificial hybrid zone in Rio de Janeiro state.

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**Founder effect impacts APOE variability in northern Europe.**

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The apolipoprotein E (APOE) locus with its associated protein product is involved in multiple metabolic pathways. There is evidence that the three most common alleles— $\epsilon 2$ ,  $\epsilon 3$ , and  $\epsilon 4$  (ancestral)—confer differential risk for specific chronic disorders including Alzheimer's, atherosclerosis, and hyperlipoproteinemia. APOE allele frequencies are variable among global populations, and it has been argued that diversity at this locus is shaped by natural selection. Less well documented are the effects of relatively recent demographic events, such as genetic bottlenecks, on APOE allele frequencies. This study set out to document APOE frequencies in Scandinavia, as well as populations of the North Atlantic which are characterized by relatively recent population migrations, founder effects, and isolation.

Samples from seven populations—Norway, Sweden, Iceland, Denmark, Ireland, the Shetland Islands, and the Isle of Man—totaling 210 individuals were scored for APOE genotype. Taken as a whole, genotype frequencies among the populations are concordant with other northern but not southern European populations. Within population variation, however, is dependent on location. While continental populations are consistent with regional frequencies, island populations—Iceland, the Isle of Man, and the Shetland Islands—have much higher proportions of  $\epsilon 3/\epsilon 3$ , the highest of which can be found in the Shetland Islands (81%).

Additionally, relatively rare genotypes such as  $\epsilon 3/\epsilon 2$  are found at higher than expected frequencies among island populations. These results document that while allele frequencies at the APOE locus are predictable at a regional level, sub-structuring of local frequencies can vary significantly.

**Water isotopes of Ontario: investigating the applications of hydrogen and oxygen isotopes as geographical indicators.**

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The oxygen and hydrogen stable isotope compositions of organic matter are increasingly being explored as geographical indicators following the principle 'you are what you eat and drink.' The relationship of human hair isotopes to geography has promising forensic applications for the determination of geographic origin and recent residence of unidentified human remains. This research examines variability in oxygen and hydrogen stable isotope values found in 17 human hair and 17 water samples encompassing eight geographical sites in the greater Hamilton and southern Ontario region. The results were then compared to established isotopic values for southern Ontario provided by the Canadian Network for Isotopes in Precipitation using the Online Isotopes in Precipitation Calculator, hosted by Purdue University ([http://wateriso.eas.purdue.edu/waterisotopes/pages/data\\_access/oipc.html](http://wateriso.eas.purdue.edu/waterisotopes/pages/data_access/oipc.html) [1]). The results suggest that the oxygen and hydrogen isotopes in the individuals' hair correlate with the isotopic values of the water in their place residence. This research adds to the growing body of research on the potential of using hair to determine an individual's place of residence shortly before death.

**Cementochronology and gender: A reappraisal of adult survival in past societies.**

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Knowledge of the mortality hazards linked to status for women in past populations meets two obstacles: the first is our inability to statistically control maternal and infant mortality due to bad taphonomic preservation of fetal bones; the second is the low correlation of individual age estimates by conventional methods.

The application of cementochronology to 23 series representing a total of 1037 individuals from the antiquity to the end of the medieval period in northern France allows calculations and comparisons of survival curves by sex for adults.

The study of these curves shows that male and female groups in cemeteries associated with religious institutions (monasteries and church burials) demonstrates significantly higher survival rate for all ages categories compared to more secular communities, both rural and urban. For the latter, if in the vast majority of series and pooled samples there was no statistically significant difference, a gradual decline in female survival rate of various intensities is visible between 20 and 50 years of age. After 50, the two survival curves merge or intersect. A smaller sample of 45 skeletons with tuberculosis lesions shows an equivalent decline of survival for women.

The attribution to maternal mortality of these survival rates during the reproductive period illustrated by cementochronology is also discussed.

#### **Tetracycline labeling in Early Christian burials from Kulubnarti, Nubia: Measure of class differences.**

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The prevalence of tetracycline labeling was analyzed in 38 individuals from Early Christian cemeteries on the island of Kulubnarti in Upper Nubia (546 CE to 848 CE). Thin sections were analyzed under Ultra Violet light using Image-Pro Plus software. The S (716 CE) and R (752 CE) cemeteries are contemporaneous (the 36 year difference is not significant) and provide evidence for a Nubian underclass in what has always been seen as a non-stratified society. Located on the west bank adjacent to the modern village of Kulubnarti is the R cemetery which is representative of landed villagers. The S cemetery, which is likely to have been an itinerate population of landless folk moving from place to place and working the lands of others, is located on an island adjacent to the west bank. Health, as measured, is poorer and mortality higher in the S population. Total labeled osteons in the R population (25.23%) (average age 17.8 years) was greater than the (24.71%) than in the S population (average 22.8 years) ( $p = 0.02$ ). In the S population, 28.52 % of bone was labeled compared to 29.03% of bone labeled in the R population ( $p = 0.051$ ).

#### **Mastication-related and age-related changes in the dentognathic apparatus of hominoids.**

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Mastication in hominoids is a process with a complex biomechanical basis. Several degrees of freedom permit the mandible to move in relation to the skull while teeth interact with the food by means of masticatory muscle action. Additionally, dental arcades define occlusal planes exhibiting specific geometries, which are functionally relevant for the biomechanics of mastication. Mastication as well as general processes of aging lead to dental attrition and dentognathic pathologies, which are major factors triggering dentoalveolar remodeling. Dentoalveolar remodeling can be understood as mechanisms of *in-vivo* modification maintaining dentognathic homeostasis for optimal masticatory function. Here we study patterns of dentoalveolar remodeling resulting in modification of the occlusal plane geometry and ask whether these patterns are similar in humans and great apes, or whether they reflect taxon-specific mechanisms of mastication, food processing, and aging. Studying these modifications in extant hominoids is crucial for interpreting dentognathic morphologies of fossil hominins in terms of function, taxonomy and phylogeny. We use CT data of a sample of  $N=108$  adult skulls (exhibiting a wide intraspecific range of dental wear) of *Homo sapiens*, *Pan troglodytes*, *Gorilla gorilla*, and *Pongo pygmaeus*, and apply geometric morphometrics to quantify three-dimensional occlusal surface geometry. Our results indicate that processes and patterns of dentoalveolar remodeling during adulthood have a common phylogenetic basis in all the hominoid species, independent of species attribution, architecture of the masticatory system, and type of diet.

#### **New anchomomyin primate from the Late Eocene locality of Sossis (Catalonia, Spain).**

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A new adapoid primate genus attributed to the tribe anchomomyini has been identified from the collections of the Institut Català de Paleontologia Miquel Crusafont. The material consists of a right maxilla fragment with M2/ and M3/ and several isolated teeth ranging from P4-/M3/ and dP4, P3-/M3/. All the remains were recovered from the classical Southern Pyrenean locality of Sossis (Late Eocene, Headonian, MP17a). The levels in which this primate was found are grey and black marls interpreted as lacustrine deposits. Additional faunal remains from this site such as those attributed to amphibians and reptiles, together with microchoerine primates are now under study. This new anchomomyin differs from all the other members of this tribe in presenting no enamel wrinkling, in its buccolingually

compressed P4/, upper molars with no pericone, medium-sized hypocone, straight postcingulum and incipient mesostyle, and the extremely-reduced metacone in the M3/, lower premolars with no paraconid and discontinuous buccal and lingual cingulids, hypoconid present in the P4 together with a trace of a metaconid. Its lower molars bear no paraconid and present a premetacristid joining the paracristid and the metaconid, closing the trigonid basin, and its M3/ has a centered and elongated hypoconulid lobe, and the trigonid wider than the talonid. Preliminary phylogenetic analyses suggest that this genus may be more closely related to *Mazateronodon* than to any other anchomomyin, and also suggests a closer relationship of European anchomomyins with asiadapines and sivaladapids than to other adapiforms.

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#### **Without anthropology, Biological Anthropology is just Biology, only more poorly funded.**

JONATHAN MARKS. Anthropology, UNC-Charlotte.

While explicitly arguing about the nature of the “biological” component of biological anthropology, Washburn (1951) tacitly assumed that the “anthropology” component was self-evidently valuable. Historical studies have shown how Washburn derived his paradigm for the study of wild baboon behavior not from ethology, but from the way in which his anthropological colleagues were studying human behavior – the “structural-functional” model of Radcliffe-Brown, practiced at the University of Chicago. In retrospect, there is considerable phylogenetic sense behind that decision. Some years later, as primatology was intellectually overtaken by sociobiology, Washburn decried the biologized (and to him, pseudo-evolutionary) study of human behavior as “the science that pretends humans cannot speak.” Further, by de-centering race as a central analytic concept, Washburn marked a break with pre-War physical anthropology – in which the German version of the science was disreputable, but had been difficult to distinguish from the American version. Several papers by biological anthropologists published in the 1950s and 1960s helped form the modern view that to the extent that race is real, it is an unfamiliar bio-cultural reality, not a familiar biological reality. Archival research has shown that the posture that race is merely biology permitted the AAPA president, Carleton Coon, to privately aid the segregationists in 1961-62, while publicly calling for the field to be apolitical. Consequently, much of mainstream biological anthropology had already rejected the concept of race as an analytic biological tool by the time that

Lewontin published his famous paper on "The Apportionment of Human Diversity" in 1972.

#### **Histopathology and differential diagnosis of a pelvic calcification.**

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Due to rarity and poor preservation, the discovery of extra-osseous neoplastic inclusions with prehistoric, historic or modern skeletal remains has received limited attention. Komar and Buikstra (2003) developed a differential diagnostic approach in their examination of a prehistoric pelvic calcification and this presentation offers a similar opportunity to histologically examine and diagnose a modern pelvic neoplasm.

A spherical, calcified tissue shell was recovered within the pelvic inlet of a decomposing 65 year old White female allowing diagnosis as an obstetric or gynecological neoplasm. Malignant and benign growths include ovarian sarcoma, fibroma, cyst or lymphoma; uterine leiomyoma, leiomyosarcoma, Brenner's tumor or abnormal fetal neurocranial bone.

Light microscopy at 10x, 20x and 60x was utilized to differentially diagnose demineralized and non-demineralized sections of the calcification. The degree and quality of calcification and the cellular appearance of the cortex provided the main differential diagnostic features. Uterine leiomyomas, ovarian fibromas, Brenner's tumors frequently calcify and of course, cranial bone mineralizes. However, sarcomas, cysts and lymphomas rarely undergo calcification and have different cellular structure. Histologically, spindle cells and abundant cartilage are pathognomonic for fibromas and this specimen is characterized by these features. An absence of smooth muscle cells rules out the uterine leiomyomas. Besides clinical anecdotal interest, this case serves as an exemplar for extra-osseous inclusions associated with the pelvis of prehistoric, historic or forensic skeletons.

#### **Is thicker better? Testing adaptation hypotheses for cranial vault thickness.**

HANNAH E. MARSH. Anthropology, University of Iowa.

Several adaptations have been proposed to account for variations in cranial vault thickness between populations of recent *Homo sapiens*, and between *Homo* species, including protection from interpersonal violence, and masticatory strain. The protection hypothesis states that codified interpersonal violence, in the form of ritualized, face-to-face dispute settlement, would result in increased bone thickness on the anterior vault. This hypothesis is mainly applied to Native Australians. The strain hypothesis states that vault thickness would covary with the intensity of masticatory forces, based on the placement and orientation of muscle attachments on the vault. In this study, I compare

thickness of the frontal bone versus the parietal bones for 9 populations of recent *H. sapiens* to assess whether Australians have uniquely greater frontal thickness. Also, I will compare patterns of thicker and thinner bone with patterns of vault strain to determine any relationship of thickening to buttress against strain. I find that Australians are not the only population with thicker frontals than parietals, which does not support an adaptive interpretation specific to Australians. When comparing locations of strain to thickened vault regions, 26% of the sample had thickening in the midsagittal plane, the plane along which nuchal muscle strain radiates, while masticatory strain registers in the coronal plane, along the coronal suture, a location that does not seem to show increased thickness in this sample. These hypotheses are refuted. For cranial vault thickness, "thick" versus "thin" is an oversimplification. There are complex patterns of variation within individuals and the entire species.

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#### **Feeding niche overlap and differentiation among sympatric vertebrate frugivores at Gunung Palung National Park, West Kalimantan, Indonesia.**

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The high diversity of vertebrate frugivores in many tropical forests raises the possibility that interspecific competition for fruit may play an important role in structuring communities of tropical vertebrates. An important step in assessing the role of such competition is to characterize the extent of niche overlap among sympatric species and determine whether they are able to mitigate the potential for competition by habitat switching or utilization of distinct foods during periods of fruit scarcity. I present an analysis of vertebrate feeding observations gathered over a five-year period along a series of 14 established transect routes in seven forest types at Gunung Palung National Park, West Kalimantan, Indonesia. These independent, unbiased observations permitted a quantitative assessment of the degree of niche overlap among 24 families encompassing five mammalian and seven avian Orders. Concurrent monthly phenological monitoring in all seven forest types enabled examination of the effects of spatial and temporal variation in food availability on patterns of niche overlap. There were high degrees of overlap among many taxa, especially hornbills, primates, and squirrels. Generally, the diets of vertebrate frugivores diverged significantly during periods of low fruit availability (with interesting exceptions), indicating that some, but not all, taxa reduced the potential for inter-specific competition during periods when resources were scarce. In contrast, habitat switching (e.g., by orangutans and

hornbills) did not affect general patterns of dietary overlap. These results provide insights into the ecological forces currently influencing communities of tropical frugivores, and inform hypotheses about the evolution of diverse mammal communities.

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#### **Ancient DNA recovery from Angel Mounds: DNA degradation attributed to archaeological field methods.**

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Legacy collections offer a potentially rich resource for ancient DNA research; however, unknown issues affecting DNA preservation may limit the success of a collections-based ancient DNA project. The Angel Mounds skeletal series is a culturally unaffiliated legacy collection curated at the Glenn A. Black Laboratory of Archaeology at Indiana University, and comprises the remains of more than 300 individuals from the Mississippian period Angel Mounds site (ca. A.D. 1050-1400) east of Evansville, Indiana. The goal of the current project was to examine the relationship between burial location and genetic relatedness at Angel Mounds, to examine mitochondrial diversity at this Mississippian site, and to compare genotypic results with previously published data from burials at other ancient Midwestern archaeological sites. Small postcranial fragments from one hundred individuals were sampled for ancient DNA analysis, which was completed at the Indiana Molecular Biology Institute using widely accepted ancient DNA laboratory methods. The rate of mitochondrial genetic sequence recovery was poor: five individuals yielded replicable results, five additional individuals yielded results that were partially replicated through two independent DNA extractions, and fifteen individuals yielded partial data that could not be confirmed through subsequent DNA extractions. DNA degradation is retrospectively attributed to archaeological field methods that caused the sun drying of human remains during excavation. Explanations for DNA preservation in the five burials yielding replicable results are explored, and archaeological methods affecting collections-based ancient DNA research are discussed.

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#### **Excavating method, theory and data with George: Bringing together Bioarchaeology and Social Theory.**

DEBRA L. MARTIN. Anthropology, UNLV.

In working with ancient human skeletal remains, George was insistent on keeping a range of perspectives in the mix, from the ethics of what we do, to formulating questions that can be answered with empirical data, to using models that keep important variables from being swamped by all other variables. The biocultural model that George and his students worked on to improve was very valuable in the early years of bioarchaeology because it located the biological remains within a richly conceived cultural context. In using archaeological remains to explain human behavior in the past, it meant that social theory was a necessary and important component in the interpretive potential of the data. George insisted that in thinking through why people died before their time, ideas and theories about human behavior be incorporated into bioarchaeological studies. Theories about gender differences/similarities, inequality and hierarchies, demography, political-economy and stratified societies all began to show up in his graduate student's work. In part, George always wanted to know: What is your question? What is driving your research? How will you make sense of the data? These in turn demanded a rigorous use of empirical data to address the large and pressing questions of our time. He captured all of this in a timely, concise and ultimately seminal publication entitled "Bioarchaeology as Anthropology" (2003 Archaeological Papers of the American Anthropological Association Vol 13, pp 27-40).

#### **The fertile window in the human ovarian cycle.**

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The existence of a fertile window in the human menstrual cycle, lasting just a few days bracketing mid-cycle ovulation, has long been accepted. Duration of the window has often been restricted to 3 days, allowing 48 hours for sperm survival and 24 hours at most for egg survival. This "eggtimer" model has been recognized as generally typical for Old World monkeys, apes and humans. Yet it has also been accepted that mating often extends outside the fertile window, potentially throughout the cycle in humans. But mating on the boundaries of the fertile window introduces the danger of fertilization with senescent gametes. For gestation periods inferred from intervals between single matings and births, coefficients of variation are typically about  $\pm 2\%$  across mammals (including prosimian primates), but approximately twice that level in higher primates. Doubled variability of gestation lengths in higher primates is unlikely, so the problem seemingly resides in equating mating with conception. Possibilities for sperm storage in the uterine cervix and/or oviduct have rarely been considered for humans or other higher primates. But evidence from clinical studies and procedures such as artificial insemination indicates that sperm storage for  $\sim 10$  days is a real possibility, at least for humans. Moreover, analysis of data for pregnancies following single copulations indicates an extensive window for conception in the human cycle. These findings

have important implications both for studies of reproduction in non-human primates and for human reproductive biology.

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#### **First molar dental fluctuating asymmetry and the pace of life history in non-human primates.**

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Fluctuating asymmetry (FA) occurs in morphological structures as small, random deviations from perfect bilateral symmetry without any directionality between sides. Extended periods of growth are argued to provide a 'window of opportunity' for growing body structures to accumulate deviations from perfect bilateral symmetry resulting in elevated FA. Utilizing the traditional continuum of slow-fast life history (LH) schedules as a proxy for developmental timing, this study examines if variation in primate first molar FA is associated with developmental timing. The following hypothesis is tested: species with slow LH schedules will exhibit elevated first molar FA relative to species with fast LH schedules. Using weaning age as an indicator of LH schedules, this study also tests if first molar FA is strongly correlated with weaning age.

Mesio-distal and bucco-lingual dimensions of maxillary and mandibular first molars of thirteen primate species were measured to calculate FA. The results support the hypothesis that species with prolonged LH schedules exhibit elevated FA relative to those species with shorter LH schedule. Great apes, who have slow LH schedules relative to other anthropoids, exhibit significantly greater first molar FA. Consistent with developmental differences in the dentition of frugivorous and folivorous species, the fast-growing folivore, *Colubus guereza*, expresses the lowest FA among Old World monkeys; however, not all comparisons are statistically significant. Finally, the correlation of first molar FA and weaning age is statistically significant. These results suggest that species with prolonged LH schedules are experiencing a greater number of developmental perturbations than species with fast LH schedules.

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#### **Quantitative genetic variation and selection on skull shape in humans.**

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Quantitative genetics is an important field of application for geometric morphometrics because it provides information that key for many important questions concerning the evolution of shape. In particular, the demographic information that is available for human populations make humans a unique study system. We investigate skull shape in the population of Hallstatt (Austria), where a collection of human skulls with associated records offer a unique opportunity for such studies. We use an individual-based statistical model to estimate the genetic covariance matrix, and characterize selection using fitness estimates from demographic data. We find clear evidence for directional selection, but not for nonlinear selection (stabilizing or disruptive selection). The predicted response to this selection, computed with genetic parameters from the population, does not match the estimate of secular change over the approximately 150-year range of the data. We discuss possible reasons for the mismatch.

#### **Cerebral hemisphere dominance and craniofacial constraint of the visual system: Evidence for the development of astigmatism and reduced visual acuity in humans.**

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This study examined the relationship between cerebral hemispheric dominance and reduced vision in humans to assess the impact of greater lateral brain development on the visual system. Encephalization and reduced facial prognathism in hominin evolution have circumscribed the orbits between the neurocranium and viscerocranium. Expansion and anterior placement of the brain has repositioned the frontal cortex atop the eyes, and resulted in the juxtaposition of two different functional systems in modern humans. This study aimed to investigate if greater cerebral lateralization, measured by hemispheric dominance, correlated with side-dependent reduced vision.

750 participants (55% female) were asked to report astigmatism (left, right, both eyes, and no astigmatism), uncorrected visual acuity (measured in dioptres), and hemispheric dominance, which was derived from a 15-item dominance test. This hemicity scale, ranging from 7.5 (very right-hemisphere dominant) to -7.5 (very left-hemisphere dominant), was used to investigate how lateral dominance varies in association with vision in each eye.

Results indicated that astigmatism occurred more frequently on the side of the dominant cerebral hemisphere, and that those with no astigmatism or with astigmatism in both eyes, fell between these disparate groups. A significant relationship also existed between a participant's worse eye (difference > 0.5 dioptres) and hemisphere dominance, even after accounting for the effect of astigmatism. These results suggest that side-dependent cerebral and

neurocranial development contribute to reduced visual acuity by constraining the hard and soft tissue of the eye and orbit, situated between an outsized brain and orthognathic face in modern humans.

*This research was funded by a faculty seed grant from Montana Tech.*

#### **Manual phalangeal curvature and locomotion in Primates.**

STACEY A. MATARAZZO. Anthropology Department, University of Massachusetts at Amherst.

Primate manual phalanges are directly affected by the loads inflicted during locomotion. The degree to which these elements are curved has been used to infer the use of suspensory or non-suspensory locomotion in primates. An index comparing the curvature values of middle and proximal phalanges of digit 3 (the Index of Relative Curvature) was shown to be successful at differentiating between knuckle walkers, quadrupeds, and brachiators. Given the rarity with which phalanges are recovered in the fossil record, and the difficulty of assigning such elements to the proper digits or individuals, it must be determined if the locomotor signal seen within digit 3 can also be seen: 1. in the other rays, 2. using elements attributed to different rays of the same hand, and 3. using elements attributed to different individuals of the same species. The present study extends previous analysis by examining the relative curvature of the proximal and middle phalanges of digits 2, 3, 4, and 5. The study includes knuckle-walking (*Pan troglodytes* and *Gorilla gorilla*), quadrupedal (*Macaca* spp. and *Cebus apella*), and suspensory primates (*Pongo pygmaeus*, *Hylobates lar*, and *Ateles* spp.). The Indices of Relative Curvature for digits 2-5 and those derived from middle and proximal phalanges of different rays retain the strong locomotor signals. This suggests that Indices of Relative Curvature can be applied successfully to fossils and other cases for which digit identity cannot be discerned, and for which isolated proximal and middle phalanges may not belong to a single digit.

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#### **Frailty, social identity and treponemal disease in the Southeastern US.**

SARAH A. MATHENA, MOLLY K. ZUCKERMAN and NICHOLAS P. HERRMANN. Anthropology and Middle Eastern Cultures, Mississippi State University.

Treponemal disease studies are ubiquitous in bioarchaeology, but most address the diseases' geographic and demographic profiles. Little is known about past relationships between the functional, social and health related costs of infection, especially among prehistoric populations. This study investigates these relationships in a sample from the Morton Shell Mound Collection, a multicomponent,

commingled site dating to the Coles Creek Period (AD 700-1200). Historical and anecdotal evidence suggests that poor overall health exacerbates the symptoms of treponemal disease. Historical evidence also shows that the disfiguring and debilitating effects of treponemal disease can reduce social status in sufferers. It is therefore hypothesized here that a negative synergy exists between overall health, treponemal disease, and social status over the life course. Employing the Developmental Origins of Health and Disease hypothesis, this study tests for relationships between early life health indicators, namely linear enamel hypoplasia, severity of treponemal disease, later life health indicators, namely caries, and mortuary indicators of social status, using a population-based rather than individual skeleton-based approach. Preliminary results suggest that the Morton shell mound sample exhibits very high frequencies of treponemal disease, with 50% manifesting lesions suggestive or specific to treponemal disease (N=60), and moderately high rates of caries (25%). Social status will be reconstructed through analysis of differential patterning of mortuary archaeology, including burial pattern, burial location, and post mortem processing.

#### **The primate upper arm: A study on the deltoid index.**

SANDRA MATHEWS<sup>1</sup>, MARTIN F. HÄUSLER<sup>1</sup> and PETER SCHMID<sup>2</sup>. <sup>1</sup>Centre for Evolutionary Medicine, Institute for Anatomy, University of Zurich, <sup>2</sup>Institute for Human Evolution, University of the Witwatersrand.

On the proximal humerus we find several features that help making the shoulder joint stable and at the same time more mobile and it provides the attachment place for the main rotator cuff muscles.

The humerus of *Hylobates lar* (n=67), *Pongo sp.* (n=21), *Gorilla gorilla* (N=37), *Pan troglodytes* (n=43) and *Homo sapiens* (n=89) was analyzed and compared to casts of the humerus MH2 (*A. sediba*) and KNM WT 15000 (*H. erectus*). A number of 9 landmarks were defined on the humerus and digitized with a MicroScribe-3DX. Based on this, indices have been calculated in order to enable a comparison with older studies.

The deltoid index is an indicator for the position of the most distal insertion of the deltoid muscle. The deep insertion of the deltoid muscle in humans and great apes helps to increase the lever advantage of the arm. *Hylobates lar*, in contrary, shows a much higher insertion of the deltoid muscle. This higher position of the insertion of the deltoid muscle results from the elongation of the hylobatid arm and the special distribution of the muscle mass as an adaptation for the much specialized form of locomotion in this species.

For *Australopithecus sediba* and *Homo erectus*, nearly equal values have been calculated, both of which fall into the range of *Homo sapiens* and are significantly different from the values of *Hylobates lar*.

#### **Ethical practices for outdoor anthropological research facilities with willed body donation programs.**

SOPHIA R. MAVROUDAS. Forensic Anthropology Center, Texas State University.

Anthropological research facilities that depend on willed bodies face unique ethical dilemmas. The first outdoor anthropology research facility opened in 1981 at the University of Tennessee, Knoxville. Since 2006, three additional facilities have opened across the United States including the Forensic Anthropology Research Facility (FARF) at Texas State University. As a direct result of this growing area of research, the number of anthropologists associated with these facilities will continue to rise in the coming years. While this is an exciting new trend in anthropology, the creation of such facilities means that the anthropologists directing these programs are facing new ethical dilemmas. While there are local, state, and federal regulations governing these facilities and corresponding donor programs, universal ethical codes of conduct have not yet been established. Using FARF and the Willed Body Donation Program at Texas State as examples, this presentation will discuss the unique ethical dilemmas that anthropologists in these programs face. Specifically, it will address the issues of informed consent, ethical use of donated remains (including research design and destructive analyses), ethical treatment of curated skeletal remains, and public education. By elucidating these challenges, this presentation hopes to initiate dialogue among anthropologists and help promote the creation of standard ethical practices among all such facilities.

#### **Investigating the relationship between diabetes mellitus and bone mineral density.**

SHANNON E. MAY. Department of Anthropology, University of Tennessee, Knoxville.

Clinical studies have revealed a type-specific relationship between diabetes mellitus and bone. Individuals suffering from type 1 diabetes generally demonstrate lower bone mineral density (BMD), while type 2 diabetic patients show increased BMD values, particularly in the proximal femur and vertebrae. This is usually attributed to the greater mechanical loading imposed by overweight and obesity, common co-morbidity factors for type 2 diabetes. Conversely, both forms of diabetes show increased risk of fractures, suggesting that the additional bone deposition in type 2 diabetic individuals may not be biomechanically advantageous.

The purpose of this study was to investigate bone mineral density between diabetics and non-diabetics, at three separately loaded skeletal sites: femur, tibia, and forearm. The Bass Donated Skeletal Collection was utilized to construct a sample of 80 individuals (40 diagnosed type 2 diabetics and 40 individuals without diabetic medical history). Samples were pair-matched on sex, age, and

weight-at-death. Average diabetic weight was slightly heavier; however this difference was not statistically significant. It was hypothesized that the diabetic sample would demonstrate considerably elevated BMD values.

Results generally supported the hypothesis. The diabetic sample possessed higher mean BMD values at all skeletal sites, though not significantly greater ( $p \leq 0.05$ ). When separated by sex, ANOVA revealed that only females demonstrated significant differences between sample-groups. Diabetic females showed higher BMD for six variables in the femur, two sites on the tibia, and two in the forearm. Males did not replicate this pattern. Results corroborate clinical observations, suggesting diabetic females are protected from osteoporosis and major fracture.

#### **A world apart: Dental variation and the New York African Burial Ground.**

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Origins are central to understanding the past and present identity of a people. Origin studies provide, under optimal conditions, context for all other assessments, such as archaeological, biomedical, and nutritional evaluations. Determining the origins of the New York African population and those individuals interred in the African Burial Ground was one of the project's primary themes. A template based on historical and archaeological data supported the skeletal biological lines of evidence including dental morphology. Such information helps to elucidate the origin of enslaved Africans to the Americas.

Recognizing world population variation, the dental morphology was used to identify whether they are of predominantly African or non-African origin and, if they are African, which regions of the continent they share ancestral affinities with. Furthermore, existing variation will allow us to characterize these individuals in relation to themselves and to address questions of kinship within the group.

Recent comparisons confirm the African regional backgrounds of those interred in the cemetery and probe the current limits for establishing greater ethnic specificity using such traditional methodology and comparative statistics. This investigation is an integral part of the overall research paradigm and contributes to a baseline in population variation from which all other discussions can take place.

#### **Prepping for pregnancy: Energy balance, hormone production and diet quality during pre-conception in Sanje mangabeys (*Cercocebus sanjei*).**

GRÁINNE M. MCCABE<sup>1</sup> and DAVID FERNÁNDEZ<sup>2</sup>. <sup>1</sup>Anthropology, University of Calgary, <sup>2</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

Physical condition has a direct impact on female reproductive function as an increase in energy balance during the preconceptive period can influence the production of reproductive hormones. If a female cannot maintain a sufficient energy balance when cycling, she may be unable to produce the required hormone levels and consequently, may be unable to conceive. Here, we investigate the relationship between energy balance and ovarian hormone production, and the dietary strategies used to maintain adequate energy balance to ensure conception. To do so, we observed eight wild adult female Sanje mangabeys during 16 weeks prior to conception and collected data on urinary C-peptide (UCP, an indicator of energy balance), fecal estradiol (fE<sub>2</sub>), nutritional and feeding behavior, and phenology to control for food availability. Mean UCP ( $r = 0.480$ ,  $p = 0.019$ ) and number of cycles before conception ( $r = -0.591$ ,  $p = 0.004$ ) were significantly correlated with mean fE<sub>2</sub> level, explaining 36.6% of the variance in fE<sub>2</sub> during pre-conception ( $F = 4.619$ ,  $p = 0.026$ ). With each successive cycle both mean UCP and fE<sub>2</sub> increased with the highest levels observed during the conceptive cycle. Females conceiving during the high food period improved dietary quality by consuming a greater proportion of fat and protein compared to females conceiving in the low food period. In contrast, the latter females tended to spend more time feeding and had a faster food intake rate (g/h), consuming more food overall. Thus, female mangabeys responded to variation in food availability by utilizing divergent strategies in order to increase their energy balance.

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#### **Alpha male status predicts long life expectancy in wild chimpanzees.**

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The benefits accruing to alpha males in primate social groups have been debated for many years. In wild chimpanzees, alphas may reap enhanced reproductive success and resource access, but also incur increased cortisol levels and a higher parasite load, in addition to a greater risk of injury. We surveyed published data from five long-term chimpanzee study sites on 17 alpha male tenures and longevity compared to the longevity of 14 males who never reached alpha rank. We excluded males with unknown life histories and those that did not reach adulthood. The life expectancy for males that reached age 15 was 14.3 years (equals an overall lifespan of 29.3 years), similar to the result reported by Hill et al. (2001). Adult life

expectancy was 33.4 years for alpha males ( $n = 17$ ), versus 24.4 years for never-alphas ( $n = 14$ ;  $t_y = 3.17$ ,  $p = .005$ ). Alpha males were deposited at a mean age of 29.3 years, on average 6 years after achieving alpha status. Alpha males live on average an additional 4 years after being deposited compared with their never-alpha counterparts. Fifty-nine per cent of alphas outlived the oldest never-alpha male in the dataset.

We discuss possible explanations for the correlation between alpha status and extended life expectancy, including the parallel with humans. Alpha male chimpanzee status is more fluid and less stable than is reported in human demographic studies. We consider the evolutionary similarities and contrasts between nonhuman primate and human cases.

#### **Presenting evidence concerning human remains: Improving expert testimony.**

JOHN M. MCCULLOUGH and CAITLIN N. DARDENNE. Department of Anthropology, University of Utah.

As forensic anthropologists we have a fundamental understanding that our role as scientists does not end with the creation of a biological profile, trauma analysis, or a potential identification. To fully serve the medico-legal system we must be willing and able to defend our actions, methods, and conclusions in a court of law. We must be expert witnesses. This is something that the late Dr. Karen Ramey Burns strongly emphasized, both in her own career and in her teachings. She understood the importance of presenting information in a comprehensible manner, while maintaining the integrity of the methods, analysis, and the evidence itself. Being an effective witness requires an understanding of the law, the expectations of retaining counsel, and our own limitations. However, these are not aspects typically available in the repertoire of a newly minted anthropology PhD. Thus, in order to be an effective expert, we should look to the interactions Dr. Burns was trying to promote in her last years and foster relationships between forensic scientists and counsel, while both are still in school. This presentation will discuss how increased interaction between graduate and law students during training can cultivate better experts who are familiar with the law and Federal Rules of Evidence, as well as lawyers who better understand the services and limitations of the experts they employ. This interdisciplinary instruction should become a vital part of the education of these individuals in order to promote improved expert testimony.

Non-funded

#### **Local-level habitat differences and patterns of feeding ecology in groups of *Propithecus coquereli*, NW Madagascar.**

KERIANN C. MCGOOGAN and SHAWN M. LEHMAN. Anthropology, University of Toronto.

Many studies of primate feeding ecology focus on examining differences between different species or populations. However, variation in feeding ecology can occur at the

local-level of groups within a population, especially in a heterogeneous habitat.

We sought to determine if groups of *Propithecus coquereli* living in Ampijoroa Forest Station, NW Madagascar, exhibited local-level differences in feeding behaviour and diet. We compared four groups living in different locations at this site. We placed a series of 25 x 25 meter quadrats within each groups' home range and compared the number of tree species, number of food tree species, diameter at breast height (dbh), and tree height. We conducted full-day group follows and calculated the proportion of time spent feeding by each group, plant parts and species consumed, dietary overlap, and dietary diversity.

Group ranges showed microhabitat differences: there were significant differences in tree dbh ( $\chi^2=8.499$ ,  $df=3$ ,  $P=0.037$ ) and height ( $\chi^2=202.205$ ,  $df=3$ ,  $P=0.001$ ), and a Principal Components Analysis revealed that group ranges varied in terms of ecological space. While the groups did not show differences in activity budgets or dietary diversity, we did find low levels of dietary overlap for plant parts consumed. Finally, the top ten food resources for each group varied. This study provides us with information on the adaptive flexibility of *P. coquereli* and illustrates the importance of determining the behavioral ecological responses of a species to microhabitat differences.

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#### **Characterization of human cortical gene expression across development in relation to glucose utilization.**

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<sup>1</sup>Center for Molecular Medicine and Genetics, Wayne State University School of Medicine, <sup>2</sup>Department of Anthropology, University of Oregon, <sup>3</sup>Department of Anthropology, The George Washington University, <sup>4</sup>Department of Anthropology, Northwestern University, <sup>5</sup>Departments of Pediatrics and Neurology, Wayne State University School of Medicine.

Using genomic data to identify developmental changes in gene expression is of fundamental importance in understanding human brain evolution. Human brain development follows a unique pattern characterized by a prolonged period of postnatal growth and reorganization, in addition to a postnatal peak of glucose utilization. The molecular processes underlying these developmental changes are poorly characterized. We used microarrays (48,803 probes) to determine age-related patterns of mRNA expression in human cerebral cortical samples ranging from infancy to adulthood. In contrast to previous developmental gene expression studies of human neocortex using

postmortem tissue, we measured mRNA expression derived from surgically resected samples. We used regression models designed to identify transcripts that followed significant linear or curvilinear functions of age and used population genetics techniques to examine the evolution of these genes. We identified 40 transcripts that demonstrated gene expression trajectories that were significantly associated with age. Sixteen transcripts show similar patterns of expression change with age, characterized by high expression in infancy and childhood and decreasing expression postadolescence. In addition, we downloaded sequences of noncoding regions of these genes in 21 recently sequenced human genomes available from 1000 Genomes Project. We used an extension of the McDonald-Kreitman test that compares neighboring coding and non-coding sequences to examine adaptive evolution in putative regulatory regions. Comparative genomic analyses revealed that three of these genes (*BCAN*, *GRIN3A*, *STAT4*) show evidence of adaptive evolution. These findings provide evidence that a subset of genes expressed in the human cerebral cortex mirror developmental patterns of cortical glucose consumption.

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#### **Explaining the vocal repertoire of *Alouatta palliata*, the mantled howler monkey.**

DANICA L. MCGUIRE and MICHELLE F. BEZANSON. Anthropology, Santa Clara University.

In this study, we examined the vocalizations of *Alouatta palliata*, the mantled howler monkey. Specifically, we focused on the different types and contexts of vocalizations that occurred. Previous research has suggested that howler vocalizations function as a way of regulating intergroup spacing, a way for males to assess the strength of their opponents, and as a mechanism for males to protect mates. We collected behavioral data using a combination of instantaneous sampling and all occurrence sampling during a two-month period at Estación Biológica La Suerte in Costa Rica during summer 2012. The data presented consists of 170 hours of behavioral data and 2,919 instances of individual vocalizations. A majority of the observed vocalizations (49.5%) occurred in response to the vocalizations of a distant troop. While males completed a majority (88.9%) of these observed vocalizations, all troop members (males, females, and juveniles) were most vocal during foraging and feeding bouts, which constituted 10.69% (320 instances) of total vocalization data. The results presented in this study suggest that mantled howling monkeys vocalizations function in several differing contexts including inter-troop and within group communication.

#### **The subpubic angle: A new method for assessing sex in a single os-coxa.**

KAITLIN MCGUIRE. Physical Anthropology, University of California, Santa Barbara.

The pubis is extremely reliable for determining the sex of an individual, with methods that return accuracies of up to 96%. However, these methods can be time consuming, and portions of the pubis are often broken and render the bone useless for sexing. The method introduced here seeks to remedy these issues by providing a simple and reliable way to sex an individual using a singular os-coxa by analyzing one half of the subpubic angle. To test this new method, the sex of unidentified os-coxae were determined using Phenice and other qualitative categorical methods and the Ischium-Pubic Index. The os-coxae were placed into male and female groups and the angle of the pubic symphysis with the ischiopubic ramus was calculated. A student's t-test demonstrated that male and female means are different with a *p*-value of 0.034 (method was considered successful if the t-test returned a *p*-value less than 0.05). The success of this pilot study demonstrates that this method has great promise for being a quick, efficient, and easily reproducible way to accurately sex an individual on both whole and fragmented os-coxae.

#### **A look at the literature: Recent developments and long-term trends in the interpretation of skeletal stress markers and ancient health.**

BRITNEY KYLE. MCILVAINE<sup>1</sup> and LAURIE J. REITSEMA<sup>2</sup>. <sup>1</sup>Department of Anthropology, University of Northern Colorado, <sup>2</sup>Department of Anthropology, University of Georgia.

The term "health" has broad colloquial recognition but is impossible to quantify. Even within the health care community, there is debate about the definition of "health" because any number of factors, including disease, infection, nutritional quality, social status, and psychological factors, can influence a person's wellbeing. Bioarchaeologists commonly discuss health, lifestyle, and wellbeing in past populations. However, as difficult as these concepts are to define and measure in living populations, health becomes even more complex when dealing with past populations. As a result, stress—or physiological disruption—is often used as a proxy for health in past populations. Although physiological disruption cannot be measured directly in skeletons, numerous skeletal manifestations are used to infer stress, including porotic hyperostosis, cribra orbitalia, linear enamel hypoplasia, dental caries, periostitis, osteoarthritis, and skeletal trauma. When discussing stress, rather than health, bioarchaeologists recognize that the social, political, and psychological aspects of health may not be readily identifiable in the skeleton.

A meta-analysis of the American Journal of Physical Anthropology (1980-present) indicates a need for greater clarity in bioarchaeological understanding of the terms "stress" and "health." In approximately one of every five instances of bioarchaeological papers

concerning paleopathology and paleodemography, authors are overly ambitious in their claims to be studying past "health." Rather than fatally limiting bioarchaeology, stricter definitions of "health" and "stress" improve bioarchaeologists' accuracy in interpreting the lives of ancient peoples, and offer an impetus for increased interdisciplinarity.

#### Demography and health in Roman York.

LAUREN J. MCINTYRE. Archaeology, The University of Sheffield.

This study presents new demographic and health status information from a comprehensive study of the Roman inhabitants of York, England. The establishment in the first century AD of a Roman legionary fortress at *Eboracum* (present-day York) was followed by the development of a both a *canabae* and a *colonia*. Many of the cemeteries that served Roman York have been archaeologically excavated, and the aggregated assemblage constitutes a large skeletal sample. Prior to this study it was hypothesised that the combined military and civilian population would have numbered approximately 8000 individuals, with a substantial male bias, an average life expectancy at birth of approximately 30 years, and with health status similar to other Romano-British urban sites such as Gloucester and Colchester. Osteological data were collected for 594 individuals from previous publications. New osteological analyses were conducted on a further 191 skeletons, giving a total sample of 785 individuals. Sex ratios were calculated and mortality profiles constructed using raw osteological data. The combined military/civilian population size was estimated using settlement size and burial density. True and crude pathological prevalence rates were compared to those from eleven urban Romano British sites. The results of this study show significant male sex bias and average adult age at death of 36-37 years. Combined military/civilian living population size was estimated at 10,000-14,500 individuals. Compared to other urban Romano-British sites, York had significantly elevated prevalence of craniofacial trauma, os acromiale, brucellosis and porotic hyperostosis.

*This doctoral study was fully funded by the Arts and Humanities Research Council.*

#### Geometric morphometric analysis of Arikara craniofacial morphology.

ASHLEY H. MCKEOWN. Department of Anthropology, University of Montana.

This study investigates geographic and temporal patterns in craniofacial morphology across pre- and post-contact sites associated with the Arikara in the Middle Missouri region of South Dakota. Specifically three-dimensional coordinate data observed on 27 cranial landmarks were used to test for microevolutionary changes in cranial shape and size. Geometric morphometric methods were employed for initial analyses of the coordinate data and to identify morphological variation

among the samples. Regression and matrix correlation analyses were used to statistically assess variation within a geographic and temporal framework that integrates updated chronological and archaeological classifications of these sites.

After a Procrustes fitting of the raw coordinates that effectively partitions the shape and size components, both were employed in traditional statistical analyses. Results indicate that craniofacial morphological variation is patterned by geography and time with significant differences present in facial height and cranial vault height and length. Morphological similarity is associated with both geographic and temporal proximity and conforms to a model of isolation by geographic distance.

This research draws on the pioneering work of Richard L. Jantz, seeking to answer some of the same questions he originally posed over 40 years ago and has continued to address since. Employing new data and modern statistical approaches, this study highlights some of his important contributions to the field of biological anthropology.

#### Evolutionary ecology of nausea and vomiting of pregnancy in Yasawa Island, Fiji.

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Nausea and vomiting of pregnancy (NVP) refers to a suite of traits, including nausea, vomiting, and novel food aversions, that many women experience during early pregnancy. Given that many of these traits impose energetic costs, the existence of NVP is puzzling from an evolutionary perspective.

Three main hypotheses have been advanced to explain NVP. The byproduct hypothesis suggests that embryos prevent mothers from aborting them by disrupting maternal endocrinology and this disruption incidentally causes NVP. The compensatory placental growth hypothesis holds that embryos cause NVP to reduce maternal calorie consumption because mothers invest more energy in pregnancies when mildly calorie restricted during placentation. The maternal-embryo protection hypothesis contends that NVP minimizes embryo exposure to pathogens and chemical toxins during a crucial phase of embryo development.

We tested these hypotheses with dietary and NVP data obtained from interviews with 70 women from Yasawa Island, Fiji. The hypotheses offer different predictions regarding the foods likely to become aversive during early pregnancy. The byproduct hypothesis predicts that aversions should focus on foods encountered by mothers most frequently. The compensatory placental growth hypothesis predicts that aversions should focus on macronutrient-dense foods. The maternal-embryo protection hypothesis predicts that relatively high pathogen and toxin loads should be foci for aversions.

We found that, in Yasawan women, novel aversions focus on animal foods and on toxic plants. Thus, our findings are most consistent with the maternal-embryo protection hypothesis, as the foods most aversive during early pregnancy are those most likely to disrupt embryo development and maternal health.

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#### Varying responses to tourist interactions by white-faced capuchins (*Cebus imitator*) and mantled howlers (*Alouatta palliata*) in a Costa Rican wildlife refuge.

TRACIE MCKINNEY. Sixth Form Academy, City of Bristol College.

While ecotourism shows potential for primate conservation in human-modified habitats, data concerning the specific effects of tourist presence are limited. This study measured human interactions with white-faced capuchins (*Cebus imitator*) and mantled howlers (*Alouatta palliata*) at the Curú Wildlife Refuge in western Costa Rica. Data were collected through 15-minute whole-group scan samples between January 2006 and December 2007.

For the capuchins, 545 samples (136.25 hours) were collected, representing 1,080 human-monkey interactions. The capuchins encountered 26.68 people per hour, and engaged in 8.75 interactions per hour. Mean interaction length was 63.3 seconds. Multiple actors were involved in 45% of interactions. Humans initiated 32.68% of interactions with this troop. There was no relationship between tourist numbers and the frequency of interactions ( $r=0.322$ ,  $p=0.134$ ). For the howlers, 611 samples (152.75 hours) were collected, yielding 305 interactions. This troop encountered 13.44 people per hour, and engaged in 1.98 interactions per hour. Mean interaction length was 461.3 seconds. Adult males were the principal actors in 66.12% of interactions, and 68.09% of interactions were initiated by humans. Interaction rates for the howlers were related to tourist numbers ( $r=0.670$ ,  $p=0.000$ ).

These data suggest that the qualitative differences in human-monkey interactions are more important than their relative frequency. At this site, howlers seem most vulnerable to noise disturbance, while capuchins are at higher risk of disease transmission through provisioning. This study illustrates the need to shift focus from tourist numbers to tourist behavior, and suggests that species-specific guidelines for ecotourism would reduce visitor impact on non-human primates.

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#### Comparative study of metric sexing Software using the os coxa.

BRITTA MCMULLAN. Sociology and Anthropology, North Carolina State University.

Sex estimation from the skeleton is of great importance in both the bioarchaeological and forensic settings. Recently, two computer software programs have emerged that can estimate sex from the os coxa using metric measurements. In the present study, measurements from 58 male and female individuals of both known and unknown sex were entered into FORDISC 3.1 developed by Jantz and Ousley (2005) and DSP (Diagnose Sexuelle Probabiliste) developed by Murail, et al. (2005). Individuals of unknown sex were morphoscopically sexed using the Phenice (1969) method prior to measurements being taken. Per the requirements of the DSP software, the following assessments were performed: all 10 variables, the "best" eight, the "best" four, and the "worst" four. Considering a posterior probability of .95 a success, FORDISC was able to assign sex for 24.14% of the sample, with 67.24% accuracy. When all 10 measurements were input into DSP, 86.21% were able to be sexed (posterior probability ( $p \geq .95$ ), with 96.00% of determinations found to be accurate. Of the three remaining combinations of DSP variable measurements, the "best" four were found to provide the most successful results, with an 89.66% sexing ability rate and 100% accuracy rate. This combination obtained better rates than when all 10 measurements were input. Due to higher sexing and accuracy rates obtained from DSP and its ability to provide more versatility in employable measurements, this software program may offer researchers better sex estimation from the os coxa than FORDISC 3.1, especially if the os coxa is fragmentary.

#### Y-chromosome library construction for next-generation sequencing.

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The Y-chromosome is particularly useful for population history inferences through the investigation of haplogroup diversity among males. These haplogroups are defined by single nucleotide polymorphisms (SNPs). The cost of high-throughput sequencing of the entire Y-chromosome of multiple individuals for population analyses renders it prohibitive for SNP investigation. Selectively enriching for those areas of the Y-chromosome that provide the most useful information, via library construction, can make next-generation sequencing cost-effective. To this end, we are creating a protocol in which we enrich for Y-chromosome fragments containing lineage-defining SNPs through hybridization with PCR products of selected haplogroups. Two thousand base pair fragments were generated from these PCRs to serve as probes to capture complementary sequences on the Y-chromosome. The resulting PCR products were sheared to create a tiling effect that increased sequence diversity and coverage during

hybridization. Individual samples were tagged with unique identifying sequences, allowing multiple samples to be pooled and sequenced on a single lane of the Illumina GAIIx after capture on custom probes. Sixty-three primer pairs were designed to produce probes containing over 150 Y-chromosome SNPs. SNPs were chosen that define major haplogroups, as well as more divergent subgroups of E and J haplogroups, which are of particular interest in our samples. Ninety-five samples were uniquely tagged and pooled for library construction. Approximately 1.824 billion bases mapped to the Y-chromosome, allowing for haplogroup determinations of all 95 samples. This method provides an unprecedented amount of Y-chromosome sequence data in order to address questions that have been intractable thus far.

*Samples sequenced in the study were collected with support of NSF grant BCS-0518530.*

#### The femoral morphology of *Hadropithecus stenognathus*: a multivariate evaluation.

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*Hadropithecus stenognathus* has been considered one of the most terrestrial extinct lemurs; it is frequently likened to the most terrestrial cercopithecoids. Its locomotor reconstruction, however, has been hampered by hind-limb bone misattributions and indeed by gaps in our knowledge of its hind-limb anatomy. Fossil discoveries at Andrahomana during the past decade have remedied some of these problems. We now know that the revised attributions of Godfrey and colleagues in 1997 are correct, suggesting that cercopithecoid likenesses have been exaggerated. However, a detailed assessment of the implications of new attributions is lacking.

Here we use Principal Component Analysis of functionally meaningful indices (measuring the mechanical advantage of various muscle groups, the mediolateral buttressing of the femoral shaft, femoral condyle proportions, etc.) to compare the femoral morphology of *Hadropithecus* to that of other extinct lemurs, extant lemurs and lorises, arboreal and terrestrial cercopithecoid monkeys, platyrrhines, and hominoids. Our database includes 233 individuals belonging to 8 extinct lemur species and 30 extant primate species. We show that: (1) extinct lemur femora differ fundamentally from those of extant arboreal quadrupedal lemurs or vertical clingers and leapers, undoubtedly because leaping was minimal or absent from extinct lemurs' locomotor repertory; (2) most femoral indices situate both *Archaeolemur* and *Hadropithecus* considerably closer to gorillas than to *Papio* or *Mandrillus*; (3) *Hadropithecus* was a heavy and powerful quadruped; (4) climbing was likely an important component of its locomotor repertory; and (4) its femur offers little evidence that this lemur was more terrestrial than *Archaeolemur*.

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#### The A.L. 333-160 fourth metatarsal from Hadar compared to that of humans, great apes, baboons and proboscis monkeys: non-evidence for pedal arches or obligate bipedality in Hadar hominins.

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Based on non-statistically representative samples of human, *Pan troglodytes*, and *Gorilla gorilla*, Ward et al. 2011 concluded that a complete hominin fourth metatarsal (MT4) from Hadar, AL 333-160, belonged to a committed terrestrial biped with fixed transverse and longitudinal arches. According to Ward et al., the Hadar MT4 had 1) torsion value indicating a transverse arch, 2) angles between the diaphyseal long axis and the planes of the articular surfaces indicating a longitudinal arch, and 3) narrow mediolateral to dorsoplantar base ratio, an ectocuneiform facet, and tarsal articular surface contours, all indicating a rigid mid-foot. Comparisons of the Hadar MT4 characters to those of statistically representative samples of humans, five great ape species, baboons and proboscis monkeys show that none of their character interpretations are supported. The Hadar MT4 characters are common to catarrhines that have a midtarsal break and lack fixed transverse or longitudinal arches. Further comparison of length, as well as base, midshaft, and head circumferences to those of catarrhines shows that this bone is uniquely short with a large base suggesting poor leaping ability, with limited arboreal behaviors. The MT4 long axis was usually held perpendicular to gravity, i.e. the foot lacked a longitudinal arch. Overall, AL 333-160 is most similar to the MT4 of eastern gorillas, a slow moving quadruped that sacrifices arboreal behaviors for terrestrial ones. This study highlights the peril of using small and narrow samples for localized anatomy and relying on a single bony element to reconstruct overall locomotor behaviors.

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#### Craniomandibular variation in an experimental model for primate dietary variability.

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The influence of diet on the evolution and function of the primate skull is a well

established topic, bolstered by considerable experimental and comparative work demonstrating craniomandibular plasticity related to elevated loads associated with fracture-resistant diets. The diets of wild primates, however, are often seasonal and thus individuals may experience multiple masticatory loading regimes throughout ontogeny. Indeed, the consumption of seasonal “fallback foods” has been invoked to explain skull form and diversification in early hominins. Yet, exactly how dietary variability affects craniomandibular development and thus the ability to identify seasonality in the fossil record remains unknown. To address this gap, this study raised four dietary cohorts (n=10/cohort) of a well-established experimental species, the laboratory rat, from weaning to skeletal maturity. Two cohorts were fed a stable diet of either solid or powdered pellets. The other two cohorts were fed a variable diet consisting of either solid/powdered pellets for the first half of the study, followed by a shift to the opposite diet. Results indicate that the presence of groups with temporally variable diets decreases the accuracy of classifying mature individuals into their correct dietary cohort based on craniomandibular characters. In order to resolve this issue, this study identifies those characters that best sort individuals by diet. The complexity of correctly classifying plastic morphotypes within a single species may translate into difficulty recognizing the presence of dietary variability in the fossil record, particularly in sister taxa. Furthermore, this research highlights the importance of ontogenetic studies for understanding patterns of feeding behavior.

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#### “Top-down” socialization of sex-typed behavioral development in *Lemur catta*?

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Previous work on wild ring-tailed lemurs from Beza Mahafaly Special Reserve (Beza) has identified a number of behavioral sex differences in this species that arise before sexual maturity, suggesting a possible role for sex-typed socialization in behavioral development. Socialization can occur in two ways—via: sex-differential responses by subadults to the same social experiences and/or sex-differential treatment of subadults by others. This study uses behavioral data collected during focal animal follows over 12 months on three age cohorts of *Lemur catta* at Beza (infant, 0-11 months, n=29; juvenile, 12-23 months, n=8; adult, n=13). GLMMs were fit to test for sex differences in rates at which subadults received approaches, grooming, aggression, rejections, and dominance by mothers or other adults of each sex. Few significant sex differences in treatment by adults were found. Infant cohort females were

supplanted more often by adult females (p=0.02) and juvenile cohort females received more aggression from their mothers (p=0.003) than male peers. These results indicate that sex-differential treatment of subadults by adults is either rare or substantially less marked than subadult behavioral sex differences themselves. Rare and/or subtle sex differences in treatment by others should not be discounted as potentially important drivers of sex-typed development, but I argue that these particular cases are more reasonably interpreted as responses to sex differences in subadult behavior rather than causes of it. If so, these results suggest that ring-tailed lemur sex-typed development is not strongly shaped by adults and arises, instead, from subadults themselves.

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#### The influence of body size on adult skeletal age estimation.

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When skeletal remains are found in prehistoric, historic, or forensic contexts, establishing age at death is an important step in reconstructing life histories, building demographic profiles, and identifying victims. One variable not often considered in adult age estimation is that of body size; namely, how the degeneration of weight-bearing joints and non-weight-bearing joints in individuals with varying heights and weights may be affected by skeletal aging. Age estimation studies have not systematically considered body size as a variable that could influence our standards. This study assessed age from weight-bearing and non-weight-bearing bone surfaces in skeletons of individuals with known heights and weights at death.

Eight age estimation methods were applied to over 750 skeletons from the Hamann-Todd and William Bass Collections. Individuals ranged in size from 4'3" to 6'3" (1.30m to 1.93m) and 53lbs to 220lbs (24kg to 99.8kg). The pubic symphysis, auricular surface, sacrum, and acetabulum represented the weight-bearing joints; the first and fourth ribs represented the non-weight-bearing joints. Preliminary analyses show that underweight individuals are typically under-aged by the largest margin at all sites, regardless of weight-bearing or non-weight-bearing joint, while the trend for average-weight, overweight, and obese individuals is less clear. For average-weight and heavier individuals, the pattern of age markers tends to be more important in assessing age. On the weight-bearing joints of obese individuals, osteophytic lipping is more pronounced but macroporosity is less common. These results suggest body size is important in age estimation.

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#### Human craniometric sexual dimorphism and Rensch's Rule.

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Rensch's Rule states that sexual size dimorphism increases with size and has been demonstrated in many non-human animals including primates. In humans, tests of Rensch's Rule have been limited to stature, with no significant relationship, but tests using human craniometrics have not been investigated to our knowledge. This study tests Rensch's Rule using craniometric data collected from geographically and temporally diverse human skeletal samples.

Thirteen cranial measurements were analyzed from 26 groups in the Howells Data Set as well as modern groups from South Africa, Thailand and the Forensic Data Bank (n=3305). Sexual dimorphism was calculated as the Mahalanobis distances (D<sup>2</sup>) between males and females of each group independently; the larger the D<sup>2</sup>, the greater the sexual dimorphism. Cranial size was represented as male and female geometric means and their logged values were analyzed using major axis regression.

Our results show that male and female cranial sizes within groups are highly correlated (r<sup>2</sup> = 0.92), and that sexual dimorphism is greatest in cranial length and bizygomatic breadth. In general, Pacific Island groups show the largest size and the greatest sexual dimorphism; Asian groups are variable; African groups are smaller and show lower sexual dimorphism. A statistically significant positive allometric relationship (p < 0.05) exists between cranial size and sexual dimorphism, but modern groups tend to be relatively large with lower sexual dimorphism. These results suggest that human cranial sexual dimorphism follows Rensch's Rule, but also that other factors influence the relationship between size and sexual dimorphism.

#### Genetic analysis of some mountain communities of Central Italy isolated areas.

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The human genetic variation in Italy is the result of ancient population movements, demographic changes and geography. The increasing possibility of studying the genetic structure of selected Italian population samples at a high level of phylogenetic resolution provides a particularly useful model to assess the presence of genetic traces of the ancient people who lived in Italy in pre-Roman times in present populations. In this study we reconstructed the paternal and maternal genetic history of seven small villages, mountain communities in Central Italy, and identified possible genetic barriers between them. The involved communities, because of their geographic location, have experienced during centuries an evident geographic isolation and biodemographic stability. For investigating both the maternal and paternal genetic background, we analyzed 406 individuals for mtDNA, in particular D-Loop HVS I and HVS II and informative SNPs within the coding region, and 253 for Y chromosome STRs. All the mtDNA and Y chromosome haplogroups found are mainly of Western Eurasian origin, but there are some typical of Near East. The distribution of both mtDNA and Y chromosome diversity, although similar to that found in other European populations, shows the typical signs of a certain degree of isolation. The results suggest that, despite their close geographic proximity, each village has a typical genetic background due to a low degree of gene flow with the neighboring communities, probably related not only to the mountain features of this area, but also to a cultural separation.

**Trunk modularity in recent human populations: a preliminary look at rib and pelvis covariation.**

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The evolution of hominin body form remains a central issue in paleoanthropology. Recent work has shifted from studies of individual skeletal elements to investigating higher-level relationships within the body using a modular framework. Few studies, however, focus on the trunk skeleton, even though this region is subject to various functional, obstetric, and energetic selective pressures. I present results from a pilot study investigating trunk modularity in three recent human populations (European- and African-Americans from the Hamann-Todd Collection and AmerIndians from the Indian Knoll Collection) using three-dimensional morphometric data on ribs and articulated pelvises from adult individuals collected using a Microscribe G2X digitizer (n=132). All analyses were performed in MorphoJ. Matrix permutation tests reveal a higher magnitude of integration between rib 4 and rib 7 in the AmerIndian (0.968) and African-American (0.945) samples than in the European-American sample (0.865), with all correlations

significant at  $p < 0.01$ . Two-block partial least squares analyses confirm the strong relationship between the thorax elements and also suggest that elements within the thorax are more strongly integrated with each other than each are independently with the pelvis (e.g., rib4-rib7 CV=0.43 while rib7-pelvis CV=0.17), while also revealing additional population differences in the magnitude of covariation. These results suggest a degree of modularity in human trunk proportions, which may translate into greater independence in responding to selective pressures, an advantageous condition for a species with a worldwide distribution.

**Disease dynamics in Åland, Finland - 1750 to 1950.**

JIM MIELKE. Anthropology, University of Kansas.

Understanding long-term disease patterns and their linkages to demographic and cultural features is important in today's emerging epidemiological landscape. Åland is an excellent location to examine these temporal dynamics. Historical data are complete, detailed, and accurate. Since the seventeenth century Swedish Lutheran ministers have kept records of baptisms, marriages, and burials as well as a general register of their parishioners. In addition, the archipelago is relatively isolated making it easy to define the affected population and trace changes in the composition and structure over time and space.

Analyses show that Åland's demographic transition differs in character and timing when compared to both Finland and Sweden. Growth of the population was relatively steady from 1750 to the mid-1850. Then there was a marked increase that corresponded to a decrease in mortality. Infant mortality rates were initially high (averaging about 300), falling abruptly after the 1808-09 War. IMRs continued to fall, reaching 140 by 1900. Death rates for children under 10 years drop steady over time becoming much less variable after 1790, reflecting changes in disease pressures. There is also a steady increase in death rates for those 70+. Causes of death changed over the 200 year time period, reflecting an epidemiological transition. Epidemics of smallpox, measles, typhus, and other infectious diseases dominated during the 1700s and well into the mid-1800s. A shift to a more chronic disease pattern occurred at end of the 19th century. These historical epidemiological and demographic changes are discussed within the evolving socio-cultural landscape of the archipelago.

**Patterns of enthesal changes in modern humans and African great apes.**

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Research on enthesal changes (EC) in humans have demonstrated the relevant role of age and sex in the expression of these features,

suggesting the potential usefulness of EC in studies of life history. EC have, however, been scarcely investigated in non-human primates and mostly from a functional perspective. As a consequence, no data are available on the ontogeny of entheses in extant hominids. Here, we fill this gap by comparing patterns of aging and sexual dimorphism in EC in a skeletal sample including modern humans ( $N=484$ ; known age and sex), *Pan troglodytes / paniscus* ( $N=48$ ) and *Gorilla gorilla* ( $N=42$ ). The African great ape sample comprises adults and juveniles (erupted M2) with documented sex and for which age was estimated on the basis of tooth wear. 23 postcranial entheses were scored according to Mariotti et al. (2004, 2007) for the development of enthesal robusticity (surface rugosity) and proliferative as well as resorptive changes. We tested the hypothesis that differences in longevity and post-reproductive life span together with distinct locomotor patterns lead to different EC patterns among taxa. Results evidence: (a) a significant influence of age on EC in all taxa; (b) taxon-specific age- and sex-related patterns; (c) taxon-specific patterns of bilateral asymmetry and upper/lower limb ratios in EC. Altogether, our results highlight derived processes of aging of the musculoskeletal system in modern humans compared to great apes.

**The looming legacy of deforestation for red colobus monkeys in Kibale National Park.**

KRISTA M. MILICH. Anthropology, University of Illinois at Urbana-Champaign.

Anthropogenic changes to wild habitats can have far-reaching effects on primate populations, including changes in feeding behaviors, activity budgets, reproductive function, and hormone concentrations. Using the endangered red colobus monkey (*Procolobus rufomitatus*) as a model, this study examines behavioral and physiological responses to habitat disturbance in and around Kibale National Park, Uganda. By comparing individuals in unprotected forest fragments, previously logged protected park land, and unlogged protected park land, I aimed to examine 1) ecological variation between habitats, 2) hormonal differences across different forest types, and 3) behavioral variation in different habitats. Twelve groups of red colobus monkeys were followed and sampled (including groups from forest fragments, unlogged park land, and logged park land). Fecal samples were analyzed for reproductive and stress hormone concentrations. There were significant ecological differences between the fragments, unlogged park area, and logged park land. For individuals in fragments, these ecological differences also correlated with significant differences in reproductive hormone concentrations; however, there were no significant differences in reproductive hormones for females in protected park lands, regardless of whether they were previously logged or not. Individuals in previously logged, now protected park land show behavioral variations from those in unlogged areas, which may suggest that they are adjusting their behaviors to offset ecological

constraints. Behavioral plasticity may be particularly important for wild primate populations who face habitat loss or degradation. Behavioral adjustments may represent a strategy for maintaining successful reproduction in stable, albeit degraded, habitats, but cannot offset the stress of living in a fragmented environment.

#### Putting pieces together again: Statistical formula for os coxa and sacrum.

MICKI MILLER. Anthropology, Western Michigan University.

Ancient and modern mass graves with commingled human remains are in need of investigation all over the world. Important collections include those of the Holocaust, Iraqi Kurds, the Battle of Wisby and the *Titanic* (if she is raised), just to name a few. One major hindrance to this investigation is the sometimes difficult task of putting individuals back together again due to postmortem processes that can take place in and around mass graves such as fluvial movement, grave site disturbances or the settling of dirt separating different elements. Many bones can be matched by color or general fit as belonging to a given individual. But when these methods do not work due to investigator bias or inexperience, more than one element as a possible fit or, there are no matching colors, a statistical formula may be helpful.

This study explores the possibility of deriving a formula to statistically match both left and right os coxae with its respective sacrum. Approximately two hundred males and two hundred females from the Hamann-Todd collection housed at the Cleveland Museum of Natural History (CMNH) were examined. Two different measurements each were taken from the left and right os coxa auricular surface and left and right sacro-iliac joint articulation surface for a total of eight measurements from each individual. The values were statistically assessed using regression formulae. Male regression analysis results show 76% with a p-value of >0.001. Upon completion, female results are expected to show similar results.

#### Potential genetic determinants of dental arch form.

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Human dental arch shape is an important aspect of craniodental variation with implications in evolutionary biology, comparative anatomy, functional morphology, and clinical treatment. Most studies have focused on characterizing the morphological variation in dental arches; however the genetic determinants underlying such variation are largely unknown, particularly in individuals with severe malocclusion. To

address this knowledge gap, a largely Euro-American adult sample (n=276) of dental casts (100 males, 179 females) presenting moderate to severe distal and mesial malocclusion (i.e. Class 2 and Class 3 malocclusion) were digitized in occlusion and landmarked with 58 landmarks along the gingival margins of the maxillary and mandibular arches. 3D coordinate landmark data were analyzed in MorphoJ using relative warps analysis (RWA) to extract symmetric and asymmetric arch shape phenotypes. For a subsample of 115 individuals, phenotypes were regressed (adjusting for sex) against genotypes of 23 single nucleotide polymorphisms (SNPs) within 16 candidate genes (*PAX7*, *EPB41*, *ABCA4*, *IRF6*, *LEFTY1*, *LEFTY2*, *MSX1*, 4p16, *PITX2*, *GHR*, *ISL1*, 8q, *FOXE1*, *MAFB*, *SNAI1*) implicated in human midfacial and mandibular phenotypes, symmetry, and dental variation. Significant (p<0.05) correlations for symmetric shape components representing variation in antero-posterior and transverse arch relations were found with *GHR* and *LEFTY2* respectively. Also, significant correlations were found for asymmetric shape components demonstrating right to left arch rotations and *ABCA4*, *IRF6*, *LEFTY1*, *PAX7* and *TGFB3*. Finally, centroid size was correlated with *LEFTY1* and 4p16 and fluctuating asymmetry was correlated with *PITX2*. Results provide insights into the craniofacial genetic pathways that are also important in determining arch shape.

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#### Longitudinal changes in macronutrient and hormone concentration in orangutan milk during peak lactation.

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Data on milk composition of nonhuman apes are essential for testing hypotheses about derived features of human milk composition, and for understanding species-specific infant nutritional requirements and links between ontogeny and lactation. These comparative data are rare, particularly from orangutans. Here we report on longitudinal milk samples (n = 15) collected between 6-12 months of lactation from a Sumatran orangutan (*Pongo abelii*) at the Fresno Chaffee Zoo. Each sample was assayed for nutrients [dry matter (DM), crude protein (CP), fat, sugar, and ash (total mineral)], the metabolic hormone adiponectin, the growth factors epidermal growth factor (EGF), transforming growth factor beta 2 (TGF-β2), and

their receptors (EGF-R and TGFβ-R3). The nutrients and bioactive molecules are expressed as a concentration (percent for nutrients, pg/ml for other molecules) and on a per energy basis (mg/kcal, pg/kcal), with gross energy (GE) calculated from CP, fat and sugar. Mean nutrient values are: DM=11.3% (SD=1.8%); CP=0.8% (0.2%), fat=2.9% (0.8%); sugar=7.4% (1.4%); ash= 0.13% (0.05%); GE=0.535kcal/g (0.096 kcal/g). Nutrient composition was not related to infant age whether expressed as concentration or per kcal. Concentrations of adiponectin (r=-0.846, p=0.001), TGFβ-R3 (r=-0.630, p=0.038) and EGF (r=-0.569, p=0.068) declined with infant age, but appear relatively constant over lactation when expressed as pg/kcal (p>0.2, all molecules). Adiponectin was positively correlated with EGF (r=0.789, p=0.004) and TGFβ-R3 (r=0.860, p=0.001). These correlations were strengthened when expressed as pg/kcal. These findings suggest that mammary synthesis of these molecules may be linked to other metabolic pathways in the orangutan, and possibly other apes, including humans.

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#### The effect of sex and biological stress on the skeletal expression of infectious disease during the reproductive years.

JOCELYN D. MINSKY-ROWLAND. Department of Anthropology, The University of Tennessee, Knoxville.

Infectious disease susceptibility may be affected by various demographic factors, including age, sex and pre-existing stress. This project addresses the permanence of disease susceptibility in two late prehistoric skeletal samples from west-central Illinois, Norris Farms (1275-1425 AD) and Orendorf (1150-1250 AD). Previously recorded demographic and pathological data from the Orendorf and Norris Farms 36 cemetery samples were compiled and analyzed for this study. These collections share many similarities, including geographic location, date range, disease patterns and warfare patterns and, therefore, a combined sample of these two collections is justified.

Two questions are of interest: 1) Are males or females in the Orendorf and Norris Farms 36 cemetery skeletal samples more likely to suffer from an infectious disease, specifically tuberculosis and/or treponematoses, during the reproductive years? And 2) is an individual in his/her reproductive years more likely to exhibit evidence of an infectious disease after experiencing a childhood stress as indicated by lesions of the skull or linear enamel hypoplasia?

A total of 75 skeletons, 36 male and 39 female were available for study. Odds ratios and logistic regression were used to address both research questions. The results of the analyses indicated that there were no statistically significant sex differences in infectious disease during the reproductive years, nor were there any associations between pre-existing childhood stress and infectious disease presence. Future studies with larger samples may illuminate the

potential correlations between childhood conditions and the later susceptibility of surviving adults to infectious diseases.

#### **Paleohistopathology of a Harris line.**

JUSTYNA J. MISZKIEWICZ and PATRICK MAHONEY. School of Anthropology and Conservation, University of Kent.

Identification of Harris lines (HLs), a non-specific indicator of bone growth disruption, is usually achieved radiographically. Histological methods have only been implemented to explore the underlying processes of HL formation in longitudinal sections of animal bone. No prior study has examined HL histopathology in a human skeletal specimen. Here, a first insight into HL formation, from transverse sections in a human distal tibia, is provided. Results will aid understanding about the nature of HL, and its identification from histology.

Distinct HLs were identified macroscopically, and from a radiograph, in a left distal tibia taken from an adult male dating to the British Medieval period. Multiple transverse sections were taken through the HL, and also from trabecular bone regions located immediately proximal and distal to the HL. Thin sections of undecalcified bone were produced following standard histological procedures. Slides were examined under a high-powered microscope at 20x, 40x, and 60x using polarized light. Images were captured using a digital microscope camera and imaging software, and later assembled into montages.

Trabeculae proximal and distal to the HL exhibited no abnormal growth, displaying numerous osteocyte lacunae and a healthy lamellar structure. However, the microanatomy of the HL was characterised by three main features: 1) non-lamellar appearance, 2) lack of osteocyte lacunae, 3) presence of irregular bundle-like canals oriented in multiple directions. These histopathological features indicate an abnormal manner of bone deposition, implying that trapping of osteoblasts does not take place during HL formation. Pictorial and descriptive records of tibial HL histopathology are provided.

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#### **How to measure phenotypic variation in human development and evolution?**

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Phenotypic variation is a central quantitative concept in evolutionary biology and ecology. Since phenotypic variation results from variation in developmental processes, it is also key to any connection between developmental and evolutionary biology. It is relatively simple to measure the variance of a single phenotypic trait, but a biologically meaningful quantification of phenotypic variation for multiple traits is surprisingly difficult. I suggest one criterion

(affine invariance) for biological meaningfulness and demonstrate quantifications of phenotypic variation that fulfill this criterion. I apply these statistics to study phenotypic variation in postnatal cranial development of humans. Variation of cranial shape decreases until about 7 years of age and increases again thereafter. Decreasing variance results from developmental canalization, i.e., targeted growth compensating environmental perturbations of development. Interestingly, not all cranial shape features are equally canalized. For example, the size of the face relative to the cranial base is highly canalized, whereas the overall length relative to the height of the cranium does not appear to be canalized throughout postnatal development. These different developmental dynamics likely are important determinants of phenotypic evolution and are also relevant for orthodontic treatment.

#### **Anomalous malocclusions in Windover Pond (8BR246): The origins of anterior dental crowding in the Florida Archaic.**

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This study investigates the origins of the high rate of anterior dental crowding in the Early Archaic Windover population (8BR246) of Florida. The dentition of the Windover population is quite unique, exhibiting non-metric traits and wear patterns that are not common in hunter-gatherer populations. This research identifies an unusually high frequency of total dental crowding (47%) and severe crowding (25%) at Windover Pond that has not been identified in any other prehistoric hunter-gatherer society. To evaluate possible explanations for this unusual prevalence of dental crowding at Windover, this research utilizes the Little Irregularity Index (Little 1975) to examine dental crowding and its relationship to tooth size, arch size, and dental wear. The population from Windover is then compared to six Early to Middle Archaic period Florida sites.

I argue that dental crowding at Windover has a predominately environmental origin but is the product of mostly non-masticatory practices (e.g., using teeth as tools). The results of this study demonstrate that dental crowding development within Florida Archaic populations had different primary influences based on crowding severity. Mild/moderate crowding within the samples most likely represents a normal occlusal variant. Conversely, severe dental crowding is rare amongst hunter-gatherers and appears to have a predominantly environmental etiology. This study also indicates that environmental influences on crowding were gender-specific and mitigated to some extent during the aging process. These data suggest non-masticatory cultural practices alter dental occlusion differently and more radically than previously thought.

#### **Sexual dimorphism in catarrhine sacra: Obstetrics versus body size dimorphism.**

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As part of the bony pelvis, the sacrum contributes to the size and shape of the pelvic inlet and outlet, and could be an important tool for interpreting the evolution of cephalopelvic proportions in fossil primates. However, while patterns of sexual dimorphism in the human sacrum are relatively well-understood, comparatively little is known about sacral dimorphism in extant non-human primates. In this study, sacra of adult male and female *Homo sapiens* (n=73), *Hylobates lar* (n=70), *Gorilla gorilla* (n=31), *Nasalis larvatus* (n=21), *Pan troglodytes* (n=20), *Pongo pygmaeus* (n=15), and *Pan paniscus* (n=13) were evaluated for dimorphism in relative sacral breadth (i.e. the ratio of overall sacral breadth to S1 vertebral body breadth). Only *Homo sapiens*, *Hylobates lar*, and *Nasalis larvatus* were found to be sexually dimorphic in relative sacral breadth. While these three species exhibit variability in overall body size dimorphism (monomorphic to highly dimorphic), all three species bear relatively large neonates. The four remaining species were not dimorphic for relative sacral breadth. These four species also vary in levels of overall body size dimorphism, but all give birth to relatively small neonates. These results indicate that the existence of sexual dimorphism in relative sacral breadth among non-human primates is primarily influenced by cephalopelvic proportions rather than body size dimorphism. Thus, it appears that among species bearing relatively large-brained neonates, lateral expansion of the female sacrum functions to increase the transverse diameter of the pelvic inlet. Accordingly, these results have important implications for interpreting cephalopelvic relationships among fossil primates, including hominins.

#### **A case of a malign tumour from La Tène Burial Site of Münsingen Rain, Switzerland.**

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The famous La Tène burial site of Münsingen Rain in Switzerland was discovered in 1904. The individuals were dated by horizontal stratigraphy to 420 - 240 BC.

One of the 77 individuals showed an alteration of the bone, so the skull, the left humerus with scapula and the right femur were retained. The aim of this study was to reconsider a differential diagnosis and examine it with different methods.

Sex and age were determined anthropologically. Radiological examinations were performed with plain x-ray imaging and a multislice CT-scanner. For histological analysis, a fragment of the lesion was taken from the back side of the humerus. Pathologic processing with staining after fixation, decalcification, and paraffin embedding was performed. Hard cut sections were also prepared.

The individual is male, the estimated age at death is more than 60 years. There is a malignant bone forming tumour at the left proximal humerus with extraosseous growth and involvement of the adjacent scapula. Radiologic examination showed a large, mainly sclerotic tumour. The 'sunburst' appearance of the periphery is a sign for an aggressive malign periosteal reaction. Histology showed an irregular bone formation consistent with osteoid matrix.

In summary, there are two major differential diagnoses: if the tumour represented a single lesion, it can be considered as a primary malignant bone tumour. Due to the irregular matrix formation resembling osteoid, the most likely diagnosis is an osteoblastic osteosarcoma, followed by chondrosarcoma with osteoblastic features.

#### **Functional morphology and variation: The effects of obesity on the cross-sectional geometry of the humerus.**

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Research using a functional morphology approach to address the effects of obesity on the human skeleton has had success with the load bearing bones of the lower limb. The upper limb, however, can play a significant role in sit-to-stand locomotion in obese subjects and could prove useful for the estimation of body mass from the skeleton. Focusing now on the humerus, this research continues previous work on the cross-sectional shape of the long bones, work that was originally encouraged and supervised by Richard Jantz. With increased compressive forces acting on the humerus in sit-to-stand locomotion, the current hypothesis is that the cross-sectional area will be greater in obese subjects compared to normal or underweight subjects. The sample consists of known individuals from the Bass Donated Skeletal Collection (n=40). Cross-sectional area of the humerus was calculated at three locations along the diaphysis. When comparing the cross-sectional area of the midshaft of obese individuals (BMI>30) to non-obese individuals (BMI<30) using a stepwise regression, the ANOVA yielded insignificantly low correlations for both males (R-squared=0.037) and females (R-squared=0.036) at all locations. The male humeral cross-sections were significantly larger than the females, with sex having the greatest correlation with cross-sectional area (R-squared=0.568). Thus, the results of this preliminary study do not warrant rejection of the null hypothesis. Though the signal is stronger for sexual dimorphism, changes in locomotion due to obesity inevitably affect the cross-sectional

geometry of the long bones, but more so in the lower limb than in the humerus.

#### **Femoral morphology and evolution of hominoid locomotion: insight from fetuses of humans and great apes.**

NAOKI MORIMOTO, CHRISTOPH ZOLLIKOFER and MARCIA PONCE DE LEÓN. Anthropological Institute and Museum, University of Zurich.

The femur is a key locomotor element, and femoral morphology is of special relevance to understand the evolution of human and great ape locomotor adaptations. Inferring locomotor function from long bone form, however, is a complex task, since long bone morphology reflects processes of taxon-specific evolutionary adaptation, development, and *in-vivo* modification. Here, we analyze the femoral diaphyseal morphology in fetuses and neonates of *Homo sapiens*, *Pan troglodytes*, *Gorilla gorilla*, and *Pongo pygmaeus* to explore morphological variation before the onset of taxon-specific locomotor behaviors. CT-based morphometric mapping shows that taxon-specific features of the femoral diaphysis are present already at birth. Our results indicate that humans and chimpanzees show various shared-derived features despite substantially different locomotor behaviors, while chimpanzees and gorillas have clearly distinct femoral diaphyseal morphologies despite similar terrestrial locomotor behaviors. These results indicate that patterns of femoral diaphyseal variation of hominoids contain a strong phyletic signal, which may reflect retained adaptive traits of ancestral taxa, or alternatively, phyletic divergence not related to locomotor adaptations. Our data are consistent with the hypothesis that chimpanzee and gorilla modes of knuckle-walking are a consequence of convergent evolution, and that evolution of human bipedality is unrelated to extant great ape locomotor specializations.

#### **Ethnic variation of DNA methylation identified in Leptin's C/EBP $\alpha$ TFBS.**

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The leptin protein signal mediates homeostasis of energy intake, expenditure, storage, and reproduction. Leptin effects begin *in utero*, influencing future adaptive capacity as the fetus tailors its developmental trajectory to signals generated by maternal energy intake. Recent research associated variation in DNA methylation of the leptin gene (*LEP*) with timing of perinatal maternal nutritional insult and subsequent long-term health effects in humans, thus supporting the epigenetic hypothesis underlying fetal origins of disease. Yet, identification of variation in epigenetic

architecture is incomplete. Leptin gene (*LEP*) expression is modulated by C/EBP  $\alpha$  transcription factor binding site located in a core promoter CpG site. We compare methylation density of C/EBP  $\alpha$ TFBS in three populations.

Our pilot study analyzed 50 maternal/offspring duos of migrant populations from West Africa, Ethiopia and Mexico. Mothers were born in their native countries, their offspring born in the United States. We pyrosequenced the *LEP* core promoter in DNA from peripheral blood. Mean levels of DNA methylation percentage in maternal samples are statistically different (Friedman's ANOVA:  $p = 0.007$ ) for methylation of the C/EBP  $\alpha$  TFBS site among populations: Ethiopians (62%), West Africans (36%) and Mexicans (43%). Offspring analysis is in progress to examine age and sex variation. We suggest this site as a candidate for nutritional studies when examining vulnerability to obesity and other chronic diseases upon exposure to rapid and dramatic changes faced during modern migration.

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#### **To whisk or not to whisk: Implication of proportions of myosin fiber type on the functional anatomy of vibrissa musculature in primates.**

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Vibrissae (whiskers) are specialized sensory hairs that respond to mechanical stimuli such as tension and displacement. Typically, vibrissae on mammals are organized into discrete rows and are sometimes associated with intrinsic muscles, which form a sling around the vibrissa capsule and protract vibrissae. In primates, intrinsic muscles are documented in tarsiers and some, but not all, strepsirrhines. Some mammals that present with both intrinsic muscles and highly organized vibrissae can move those vibrissae in a fast, rhythmic, repetitive pattern called whisking. Whisking mammals such as rodents have a higher proportion of fast twitch (type-II) muscle fibers relative to slow twitch (type-I) fibers. It is unknown if primates with organized vibrissae and intrinsic muscles can whisk. To address this question we compared the internal (proportion of type-I and type-II muscle fibers) and external (length) vibrissa morphology of five prosimians and three non-primate mammals. Micrographs of specimens prepared using fiber-type immunohistochemistry were used to evaluate the proportion of type-I and II muscle fibers. Like previous researchers, we

found that among our non-primate sample, whisking animals have the highest proportion of type-II fibers, while type-I fibers are more ubiquitous in non-whisking mammals. Fiber typing results suggest that prosimians probably do not whisk as they have a high proportion of type-I fibers. Moreover, prosimians have shorter vibrissae than most non-primate mammals ( $P < 0.05$ ). Despite these differences, the anatomical evidence suggests most prosimians can protract their vibrissae and that these hairs do play an important role in navigating through low light conditions.

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#### **Primates and emerging infectious diseases.**

MICHAEL P. MUEHLENBEIN. Anthropology, Indiana University.

Emerging infectious diseases are those that have recently increased in incidence, expanded in geographic range, moved into a new host population, or are caused by newly evolved or discovered pathogens. Emerging infectious disease affect both human and nonhuman primate populations, and their primary causes have been associated with anthropogenic modifications of the environment. Examples that facilitate cross-species transmission include encroachment, deforestation and forest fragmentation, changes in water usage, and global climate change. Rapid human and livestock population growth and transportation continue to increase the number of hosts potentially susceptible to novel infections. Behaviors that increase contact with wildlife, like illegal pet trade, bushmeat usage and even tourism, can exacerbate emergence of these pathogens. Increased contact between humans and wild primates will likely continue to be a source of zoonotic infections, as nonhuman primates act as a reservoir for potential filaria, Chikungunya virus, malaria, and Yellow Fever infection in humans. And the likelihood of anthroozoonotic pathogen transmission to wild primate populations is significant; their remaining wild populations are relatively small with increased inbreeding and decreased genetic diversity, their reproductive cycles protracted, and their immune systems usually naïve to human pathogens. Examples of pathogens particularly problematic in wild primate populations are respiratory viruses and bacteria (including tuberculosis), hepatitis, herpesvirus, and anthrax. Future responsible human-wildlife contact requires that we carefully consider how to manage wild primates as both sources and sinks of human infections. We must be conscious about how our behaviors may inadvertently affect the risks of zoonotic and anthroozoonotic pathogen transmission.

#### **Biogeographic evolution of Madagascar's primate communities: Endemism, elevation, and the fossil record.**

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Comparisons of primate diversity across subfossil and modern localities in Madagascar have concluded that there is a strong distinction between eastern (humid forest) and western (dry forest) communities. However, the subfossil record demonstrates that several extant species currently restricted to humid forests once had more widespread distributions. Furthermore, an east-west distance effect in extant mammal distributions has been interpreted as evidence that faunal exchange routes once crossed the central highlands. We ask: Can geographic patterning in lemur occurrence data shed light on hypotheses about past dispersal corridors? We assembled a database of extinct and still-extant lemur occurrences, geographic coordinates, elevation, and radiocarbon dates for subfossil and modern localities across Madagascar. These data were analyzed using spatial analysis software. Our results indicate that several inferred dry forest-dwelling extinct lemur taxa are shared among southern localities and south-central highlands. This lemur assemblage is fundamentally different from those recovered from subfossil sites crossing the mid-central highlands through the Antananarivo Province, which include still-extant eastern rainforest-dwelling lemurs, among others. The higher elevational distribution of subfossil sites in the mid-central versus the south-central highlands may have acted as a filter to limit species that may have dispersed across the island in the past. It has been suggested that watersheds with sources at high elevation may have maintained mesic conditions during Quaternary climate shifts due to orographic precipitation. For humid forest-dependent mammals, such mesic conditions may have allowed dispersal across a more northern passage, but limited dispersal of moisture-restricted animals in the south.

#### **The dual role of vigilance behavior in tufted capuchin monkeys.**

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Although decreased individual investment in vigilance is frequently posited as a benefit of sociality, the increased within-group competition for food and mates associated with living in groups may promote increased levels of individual vigilance. Rather than serving an anti-predator function, vigilance in this case is used for social monitoring. In this study, we assess the correlates of vigilance among tufted capuchin monkeys (*Sapajus [Cebus apella] nigritus*) at Iguazú National Park, Argentina. Previous studies of capuchins at Iguazú indicate that duration of vigilance increases with neighbor density, suggesting that social monitoring is more important than predation risk as a means of driving vigilance in this population. Yet in avoiding predators, frequency – and not duration – of vigilance may be more important. We conducted instantaneous focal animal samples ( $N = 592$  hr) of all adult individuals in four

habituated groups, recording individual activity, spatial position, and vigilance behavior. We used generalized linear mixed effects models to examine the factors predicting the occurrence of vigilance. Consistent with the intense within-group feeding competition observed among tufted capuchin monkeys, vigilance is more common during feeding and resting, when individuals may benefit most from monitoring the activity of group mates. Yet increased vigilance is also associated with decreased neighbor density and height in the canopy, contexts associated with increased predation risk. These results suggest vigilance in this population is used in both an anti-predator and a social context, and support previous suggestions that these two types of vigilance behavior may be qualitatively different.

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#### **Intergroup aggression and within-group cohesion in wild chimpanzees.**

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Aggressive competition between groups has long been proposed as a major factor selecting for human cooperation. If cohesion between group members is important for success in intergroup competition, then increased levels of conflict should favor increased levels of cooperation. Although several theoretical models support this idea, there is little empirical work testing it directly. In this study, we used 7 years of data from the Kanyawara community in Kibale National Park, Uganda, to examine the impact of intergroup conflict on affiliative behavior among male chimpanzees. Chimpanzees represent an appropriate study species because males are territorial, cooperatively defending a feeding range against other groups. Kanyawara represents an ideal study site, because intercommunity interactions are strongly tied to the consumption of ripe fruit from a single tree species, *Uvariopsis congensis*. These synchronously fruiting trees produce high-quality fruits in large groves clustered along the boundary with a neighboring community. Consequently, more than 75% of intergroup interactions at Kanyawara occur when chimpanzees are eating *Uvariopsis*. If external threats lead to reduced competition within groups, and increased levels of social bonding, we hypothesized that during periods of *Uvariopsis* consumption: (1) adult males would show increased levels of proximity with other adult males, (2) rates of male-male grooming would increase, (3) males would spread their grooming more equitably among available male partners, and (4) both the rate and intensity of male-male aggression within the group would be reduced. Our results have implications for the

idea that intergroup aggression has selected for extensive cooperation in humans.

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**The effect of maternal stress on newborn birth outcome and methylation profiles: Efficiency of RRBS technology in population studies.**

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Our ongoing project in the Democratic Republic of Congo is to investigate support for an epigenetic mechanism that mediates the effects of maternal prenatal stress on newborn birth outcome. We are interested in determining the methylation status of CpG sites throughout the genome, at coding and non-coding regions. In order to determine the most cost-effective method, we conducted a pilot study to create indexed reduced representation bisulfite sequencing (RRBS) libraries and sequence them for methylation quantification. In an effort to systematically evaluate the yield and reproducibility of RRBS libraries, we produced and sequenced four technical replicates from a single human placental sample. Libraries were tagged and sequenced on a single lane of an Illumina GAIIx yielding over 40 million reads. These reads yielded coverage for ~1.5 million CpGs per library. However, after estimating a minimum necessary coverage of 20x for accurate epi-genotyping and identifying library overlaps, the number of informative sites was reduced to ~0.2 million per library. Scaling up to include the total 75 samples in our study would further reduce the number of informative CpG sites per library, or sample. Thus, we opted to switch to Illumina's HumanMethylation450 Bead Chip. Preliminary analysis indicates that ~485,000 CpG sites were assayed for 72 samples, far exceeding what could be acquired from RRBS at a similar price. Further analyses are ongoing.

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**Living together in the night: abundance and habitat use of sympatric and allopatric populations of slow lorises and tarsiers (*Nycticebus* and *Tarsius*).**

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Throughout much of Asia slow lorises (*Nycticebus*) and tarsiers (*Tarsius*) live allopatrically but on several islands they occur in sympatry. As habitats dwindle, competition for resources may increase within the area of

sympatry. An understanding of how they are coping with competition is necessary for conservation measures. To address this we gathered data on the abundances and vertical strata preferences of slow lorises and tarsiers species from the literature. We predict sympatric species will favour different heights from congeners. Allopatric species will have lower abundances compared to sympatric species. In addition, we studied tarsiers and lorises in sympatry in Sabah, Borneo. We estimated abundances of Bornean lorises (*Nycticebus menagensis*) and Western tarsiers (*Tarsius bancanus borneanus*) and investigated habitat use. Through the literature review we found lorises do not vary in densities, whether allopatric or sympatric. Abundances of sympatric and allopatric tarsiers were significant (sympatric: 3-27 individuals/km<sup>2</sup>, allopatric: 57-268 individuals/km<sup>2</sup>). Vertical strata use of sympatric and allopatric tarsier populations was not significant, but was for sympatric and allopatric loris populations ( $p=0.036$ ). On a small scale estimated densities of Bornean lorises were 5.105 slow lorises/km<sup>2</sup> and 3.646 individuals/km<sup>2</sup> for Western tarsiers. Slow lorises favoured the upper and middle level of the forest (10-30 m) and tarsiers the lower levels (<5 m). In our analysis of vegetation plots we found that tree heights and diameter at breast height preferences differed between genera. Results indicate sympatric genera are able to share their nocturnal environment due to niche separation.

**The effects of dietary hardness on occlusal variation and the masticatory apparatus of savanna baboons.**

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Variation in dental occlusion and craniofacial shape is the result of a multitude of environmental and genetic factors. Although environmental and genetic variables are often difficult to disentangle, previous research into environmental correlates has documented a relationship between masticatory stress and maxillofacial-dental development (e.g., Corruccini 1999; Larsson et al. 2005). These studies indicate that variation in dental occlusion and maxillofacial development correspond with variation in dietary consistency experienced during ontogeny. This study expands upon previous research by examining the relationship between diet and craniofacial development among two groups of savanna baboons. Here, a number of craniofacial measurements and dental occlusion scores are compared between a captive, soft-diet experiment (SDE) group (n=24) and a sample of wild-captured savanna baboons who ate natural, harder diets (n=19).

Univariate, bivariate, and multivariate statistical procedures were used to examine differences in occlusion and absolute and relative size between the two samples. The results

indicate significant differences in craniofacial development and occlusion between savanna baboons reared on soft diets and those who experienced normal dietary conditions in the wild. Paramount among these differences was significantly shorter palates in the SDE group. These results provide further evidence that the biomechanical stresses associated with chewing have a measurable effect on the growth and development of the masticatory apparatus leading to variation in occlusion and craniofacial development between individuals experiencing long term variation in dietary consistency. The findings reported here have implications for the interpretation of both anthropological and clinical data.

**Ten thousand years of population interaction at the Prairie-Woodland interface in the upper Midwest and contiguous areas of Manitoba and Ontario.**

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PreContact Minnesota was characterized by significant cultural and environmental diversity. Throughout its 10,000-year history, this region has witnessed the interaction of human populations with their physical and social environments, developing adaptive strategies to effectively utilize the natural resources and navigate relationships with their neighbors. The current research applies a contextual analysis and explores the interaction between social practices and human biology by integrating the results of both a biodistance analysis and a mortuary pattern analysis.

A multivariate discriminant function analysis was conducted on skulls recovered from sites dating from 10,500 – 600 B.P. in Minnesota and surrounding border areas in Ontario, Manitoba, the Dakotas, Nebraska, and Iowa. Forty-one measurements were taken on 380 skulls. The results provide information about the degree of genetic continuity between groups and biological homogeneity/heterogeneity of defined archaeological cultures (i.e. Blackduck) and burial complexes (i.e. Arvilla). Results indicate overall biological continuity between the earlier PaleoAmerican, Archaic, and Initial Woodland groups. Significant biological discontinuity, however, was observed between the Late PreContact Woodland groups in the northern portion of the study region and the more southern horticultural groups. Additionally, the more northern Woodland groups (i.e. Blackduck) are characterized by significant genetic heterogeneity while the southern horticulturalists (i.e. Oneota) are more genetically homogeneous. Mortuary pattern analysis focused on body preparation, body orientation, single/multiple interments, and grave goods.

The results of the biodistance and mortuary analyses indicate different patterns of social integration, network/"alliance" formation, and intraregional constructions of social identity at the community level during the late PreContact period.

### A diverse primate fauna from the early Eocene of southwestern Wyoming.

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Fieldwork in early Eocene deposits of the Great Divide Basin (GDB), Wyoming, has uncovered a significant new fossil locality (WMU-VP-2009-01) preserving a diverse mammalian fauna. This fauna includes at least four primate taxa. Notably, the primate fauna is dominated by small-bodied omomyids, rather than the larger adapids that typify most of the Wasatchian localities within the GDB. The quality of the fossils is unique for the GDB, exhibiting excellent preservation, with most jaws including 3-5 teeth. Similar to the primates, the remainder of the mammalian assemblage is likewise dominated by small-bodied morphs that are normally rare within GDB localities. The geology of the locality suggests that the unique faunal composition and associated preservation could represent an environment characterized by high energy flooding and rapid deposition.

The locality has been dated biostratigraphically, in part based on the recovery of a nearly complete hemi mandible of the omomyid, *Tetonius matthewi*. This fossil is morphologically identical to the Stage 2 transitional morphotype within the proposed *Tetonius-Pseudotetonius* lineage. Correlation of this fossil with the well-dated faunal sequence in the nearby Bighorn Basin demonstrates that this GDB locality is temporally located near the base of Wa-4. While only one adapid (*Cantius mckennai*) has been recovered from WMU-VP-2009-01, two additional omomyid taxa are present, including a probable new species of *Anemorhysis* and an enigmatic new species that exhibits morphological affinities with later occurring omomyines. These taxa mark WMU-VP-2009-01 as one of the most diverse omomyid localities within the Wa-4 biochron.

### Cranial non-metric affinities and kinship ideologies among Post-Meroitic and Christian period Nubians from the 4th Cataract Region, Sudan.

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Kinship can serve as a powerful social force governing social obligations, the distribution of resources, and the legitimacy of claims to power and authority. This study investigates the impact of changing political, economic, and religious environments on the types of genealogical relationships emphasized in the mortuary record during the Post-Meroitic (c. A.D. 350-550) and Christian (c. A.D. 550-1500) periods of the Ginefab School Site in the Fourth Cataract Region of Upper Nubia.

Complementing recent investigations of biological distance using dental metric information, the current study collected data on 53 cranial non-metric traits from a total of 68 individuals from the Ginefab School site. Inter-individual phenetic distances based on the Gower similarity measure were visualized for the Post-Meroitic (n=25) and Christian period (n=43) samples using both multidimensional scaling and agglomerative hierarchical cluster analyses. Resulting patterns were compared to the spatial distribution of burials within the cemetery.

Results suggest that though biological relationships between adult males impacted burial location during the Post-Meroitic component of the cemetery, the emphasis on genealogically-based burial intensified during the Christian period and extended to include more complete family groupings including related adult males, females, and children. This trend may conceivably reflect changing conceptualizations of family structure during the Christian period, or may reflect differing gender and age ideologies that rendered a greater range of individuals eligible for ancestral status. This study highlights the potential of intrasite biological distance analysis to elucidate the changing social significance of genealogically-based social distinctions within communities experiencing economic, political, and cultural change.

*This skeletal collection derives from fieldwork directed by B.J. Baker under licenses granted to Arizona State University by the US Department of Treasury, Office of Foreign Assets Control (Nos. SU-1897 & SU-2122), with support for fieldwork and lab processing provided by the Packard Humanities Institute (Award Nos. 07-1391, 07-1424, & 08-1472 [OFAC license No. SU-2071]) and The Regents of the University of California, and by the National Science Foundation (BCS-0647055).*

### The impact of socio-political changes on activity patterns in a late Meroitic to Christian period community at El-Ginefab, Sudan.

BETHEL L.B. NAGY and BRENDA J. BAKER. School of Human Evolution and Social Change, Arizona State University.

The Ginefab School site, near the top of the Nile's Great Bend, was used as a cemetery from the end of the Meroitic period (c. 350 B.C.-A.D. 350) through the Christian period (c. A.D. 550-1400). The local populace experienced dramatic socio-political and religious changes during this interval. The extent to which habitual behavior patterns were affected is investigated using 28 musculoskeletal stress markers in 50 well-preserved adults.

Comparisons between the Meroitic-Post-Meroitic males (N=20) and females (N=8), Christian period males (N=10) and females (N=13), and for each sex between time periods were made using  $\chi^2$  tests. Results show that a sexual division of labor persisted through time, although socio-political changes had a greater impact on male activity patterns than those of

females. However, as little variability is seen within the samples of males from the same time period, these differences seem to reflect changes in agricultural practices or other routine activities rather than role specialization. This finding is underscored by the comparison of late Meroitic and Post-Meroitic males interred with (N=10) or without (N=10) archery equipment, in which no significant differences in habitual behavior indicators were found. Men who seem to be identified in death as archers appear to have participated in routine male activities rather than as specialized warriors. This study illustrates the utility of analyzing musculoskeletal stress markers to elucidate general patterns of behavior and the impact of major social transformations on routine activities.

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### Cementochronology, to cut or not to cut ?

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The use of cementum annulations for estimating adult age-at-death has been recently successfully revived through careful methodological advances with several tests on reference collections indicating very high correlation ( $r > 0.9$ ) between civil and observed age. Cementochronology is however still not widely implemented, often because of misunderstanding of underlying biological processes or lack of training. The question thus remains for bioarchaeologists or forensic anthropologists today, to cut or not to cut?

To answer this question, we are presenting a systematic review of the cementochronology literature from all disciplines to highlight both the reliable facts and the remaining possible biases. We will then synthesize recent results that stemmed from our new "Cementochronology Research Program" which addresses some of the major issues recently expressed in the literature such as the nature of the observed increments, the variability of intra individual cementum apposition or the influence of taphonomy and pathological conditions on acellular cementum.

Finally, we present several new practical tools to help improve the implementation of cementochronology such as full protocols, automated counting software (beta version), recording spreadsheet, and self-training databases of histological sections from our reference collections.

Even though cementochronology is somewhat expensive to set up, time consuming and destructive, it is also the only method without a scoring protocol based on reference populations and without any statistical processing, which effectively remove most known methodological biases. Since cementochronology is the most precise adult age estimator published so far, the authors strongly recommend its implementation with careful supervision and training.

#### **Suspensory behaviors and the neck: A comparative analysis of the cervical vertebrae of extant primates.**

THIERRA K. NALLEY. School of Human Evolution and Social Change, Institute of Human Origins, Arizona State University.

As the interface between the head and trunk, the cervical spine performs a range of functions, including directing head movement and withstanding the forces of gravity and soft-tissue loading associated with the pectoral girdle. Morphological variation in the pectoral girdle's bony components (scapula and clavicle) and the nuchal musculature has been linked to differences in locomotor behavior among extant primates, particularly between suspensory and nonsuspensory taxa. However, the degree to which these morphological differences are reflected in cervical vertebral morphology has yet to be examined. The goal of this study was to test biomechanical models of the cervical spine by comparing extant suspensory and nonsuspensory primates. Vertebral features were quantified using linear and three-dimensional coordinate data in 525 specimens representing 31 primate species. Relationships between vertebral morphology and locomotor behavior were analyzed using pairwise comparisons and phylogenetic comparative methods. Results support a functional link between cervical morphology and positional behavior in some features. Specifically, spinous process length and cross-sectional area are greater in suspensory primates when compared to nonsuspensory taxa. A number of features appear to mimic lumbar patterns of morphological adaptation to posture previously documented among primates, such as reduced craniocaudal height of the vertebral bodies in more orthograde taxa. The cervical spine thus presents locomotor- and posture-related functional signals, suggesting that this anatomical region can aid in inferring positional behaviors in fossil taxa.

*This research was funded by the Wenner Gren Foundation.*

#### **Are lorises really slow? Ecological context of rapid locomotion in slow lorises (*Nycticebus*).**

K. A-I. NEKARIS<sup>1</sup> and CARLY R. STARR<sup>2</sup>. <sup>1</sup>Nocturnal Primate Research Group, Oxford Brookes University, <sup>2</sup>School of Agriculture and Food Science, University of Queensland.

In many languages lorises (*Nycticebus*) are branded by the sobriquet of slow, shy, fat or lazy. Asia's slow lorises certainly are committed tree dwellers, and with an inability to leap, a cryptic anti-predator strategy, and a tendency to freeze, one can see how these terms have arisen. Here we present data from a study of the pygmy slow loris (*N. pygmaeus*, 2008-2009) in Seima Protection Forest, Cambodia. We collected observational, morphometric and spatial distribution data from 10 radio-collared individuals (5 ♀, average weight 427 g; 5 ♂, average weight 411 g) to estimate home range for 358 hours. Using kernel and MCP analysis, home range sizes (mean  $\pm$  SD) measured 22.23  $\pm$  10.28 ha in adult males ( $n=3$ ); 12.08  $\pm$  1.73 ha in adult females ( $n=4$ ); and 12.49  $\pm$  2.16 ha in sub-adults ( $n=3$ ). Utilisation Distribution Overlap Indices (UDOI) ranged from 0.002 – 0.977 at the 95% isopleth, and 0.097-0.130 at the 50% isopleth. Nightly path lengths ranged from 800 m to 6 km. Limited movement correlated with cold temperatures and light moon nights. When comparing the context of rapid movement to six other recent studies, patterns can be observed. Extensive movement was used for targeted travel between feeding sites including gum and floral nectar. Rapid movement also occurred while lorises moved on a single substrate to cross gaps, during which lorises appear markedly vulnerable. Finally comparative analysis of the ranging behaviour of lorises with other nocturnal primates suggests that lorises are in fact not so slow after all.

*Leverhulme Trust, People's Trust for Endangered Species, International Primate Protection League, Columbus Zoo, Cleveland Zoo, CBOT Endangered Species Fund, Primate Conservation Inc, Primate Action Fund, Mohamed bin Zayed Species Conservation Fund, ZGAP, Quantum Conservation.*

#### **Burial patterns at the Chelechol ra Orrak cemetery, Republic of Palau.**

GREG C. NELSON and SCOTT M. FITZPATRICK. Department of Anthropology, University of Oregon.

The Chelechol ra Orrak cemetery (ca. 1700-3000 BP) in the Republic of Palau is one of the earliest and largest burial grounds in Remote Oceania. Prior to our 2012 excavations, elements representing approximately 30 individuals had been recovered, but little had been revealed concerning basic mortuary behaviors such as burial orientation, interment style, propensity of grave goods, and other aspects important for understanding burial practices and processes. With nine square meters of the burial zone now excavated, and several complete or partial skeletons recovered, a better picture of the Orrak cemetery is emerging. To date, all individuals discovered lie on their backs in an extended

position with the feet together and the hands placed in the pelvic region. Burial orientation shows no pattern of individuals lying in a particular cardinal direction. The narrow graves appear to be simple trenches dug into the coarse, loose, limestone sand. Although sometimes partially lined along the sides with rocks, this seems to have been done to prevent the grave from collapsing. Although pearl shell scrapers were found with two previously excavated burials, no grave goods were discovered during the most recent excavations. These aspects, and other evidence, point to a quick burial process that included little attention to body placement within the cemetery and apparently little concern for disturbing previous burials. The mortuary practices at Orrak appear remarkably utilitarian and may reflect the more egalitarian nature of early settlers to the archipelago prior to more complex forms of behavior that emerged centuries later.

#### **The benefits of girlhood in the patriarchy: Natal familial composition, institutional care setting and child health outcomes in Jamaica.**

ROBIN G. NELSON. Anthropology, University of California, Riverside.

In West Indian culture, child socialization is imbued with a complicated mix of patriarchal institutional structures and cultural practices, and dynamic feminism. This paper explores associations between gendered childrearing practices, and variability in the health outcomes of boys and girls. Specifically, it examines the relationship between current place of residence, natal familial composition, and the health outcomes of a particularly vulnerable group of children: those living in children's homes or orphanages. Ethnographic and anthropometric data were collected from 125 children ranging in age from 4 months to 18 years living in children's homes in Manchester Parish, Jamaica. Preliminary findings suggest that natal familial size is significantly correlated with variability in gendered health outcomes. However, current place of residence is also correlated to variability in gendered health outcomes. Familial composition of the natal home is correlated to variability in anthropometric measures for girls, but not for boys. However, current place of residence is correlated to variability in health measures for boys, but not for girls. These findings support cultural and medical anthropology studies suggesting that despite patriarchal practices, girls are the favored gender within the natal home. Additionally, boys may fare better when removed from unsafe home environments and placed in single gender children's home settings. This presentation considers how experiences of gender socialization and vulnerability impact boys and girls differently, and how these experiences become encoded within the body.

*This research was funded by the Wenner Gren Foundation and The University of California, Riverside.*

### What can we predict from first birth interval?

ILONA NENKO and GRAZYNA JASIENSKA. Department of Environmental Health, Jagiellonian University Medical College and Epidemiology and Population Studies, Institute of Public Health.

**Objectives:** Women should differ in their reproductive strategies according to their nutritional status. We tested a hypothesis that women who have a good nutritional status early in life, as indicated by a shorter waiting time to the first birth (first birth interval, FBI), are able to afford higher costs of reproduction than women who have worse nutritional condition.

**Methods:** We collected data on 377 women who got married between the years 1782 and 1882 in a natural fertility population in rural Poland. The study group was divided into tertiles based on the length of FBI.

**Results:** Women with the shortest FBI had a higher number of children ( $p = 0.005$ ), higher number of sons ( $p = 0.01$ ), and shorter mean inter-birth intervals ( $p = 0.06$ ). Women who had ever given birth to twins had shorter FBI than women of singletons (20.1 and 26.1 months, respectively;  $p = 0.049$ ). Furthermore, women with a shorter FBI, despite having higher costs of reproduction, did not have a different lifespan than women with a longer FBI.

**Conclusions:** Our results suggest that women who were in better energetic condition (shorter length of FBI), achieved higher reproductive success without reduction in lifespan. FBI reflects inter-individual variation which may result from variation in nutritional status early in life and thus may be a good predictor of subsequent reproductive strategy. We propose to use FBI as an indicator of women's nutritional status in studies of historical populations, especially when information about social status is not available.

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### Morphological integration of the maxillary dentition and the cranium in hominoids.

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The dentition and maxillae are abundant in the hominin fossil record and have many important morphological and metric characteristics that are used to identify species. For example, *Homo sapiens* is distinguished from nonhuman primates and other hominin species by a smaller anterior dentition and reduced subnasal prognathism while some species of *Paranthropus* share a distinct suite of cranio-dental traits. In addition to their use in taxonomy, these traits are frequently treated as

independent characters in phylogenetic analysis. However, facial and dental morphology may be developmentally correlated, and therefore not independent. This study analyzed how the size and shape of the face and palate covaried with the maxillary dental roots to determine the extent to which the face and dentition are morphologically integrated as a functional unit. First, we analyzed linear dimensions of *Pan*, *Pongo*, *Gorilla* and *Homo* crania measured from CT scans. Two-block partial least squares analysis was used to explore the covariation between dimensions of the maxillary dentition and the face. The results indicated dimensions of the face and dentition exhibit a similar magnitude and pattern of covariation across taxa, although the facial size dimensions had a stronger pattern of covariation with the dental variables than did those representing facial shape. Specimens with larger anterior dentition had larger faces that were broader and more protruding. These interspecific results will be compared to intraspecific analyses within *P. troglodytes* and *H. sapiens*. This study has implications for phylogenetic analyses and for understanding how dental development influences facial morphology.

### Sleep may provide a molecular model of the functional impact of increasing brain size.

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The Energy Trade-off Hypothesis (ETOH; Aiello and Wheeler, 1995) argues that brain tissue is metabolically costly and that increasing the relative mass of the brain would increase the overall metabolic requirements needed to sustain an animal. The ETOH proposes that species can maintain a balanced metabolic budget by reducing the mass of other metabolically costly tissues (e.g., gut), or altering diet, behavior, and/or life history. Benington and Heller (1995) suggest that sleep functions to replenish energy stores in the brain that have been depleted during wakefulness. Variation in sleep and wake cycles across primates (including humans) and mammals may be one behavioral mechanism by which taxa with relatively large brains may maintain a viable energy budget. A wide variety of evolutionarily conserved molecular pathways support the energy hypothesis of sleep (e.g., adenosine and glycogen metabolism, unfolded protein response, electron transport chain, circadian rhythm regulators, AMP activated protein kinase, astrocyte to neuron lactate shuttle, oxidative stress, and uncoupling proteins). These molecular and physiological responses to depletion of energy stores in the brain resulting from wakefulness may provide additional mechanisms by which animals can meet metabolic demands. Exploring the molecular pathways of sleeps may provide new insights on primate and human evolution.

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### A preliminary three-dimensional geometric morphometric analysis of fetal and neo-natal maxillary ontogeny in extant *H. sapiens* using cross-sectional data.

CHRISTINA L. NICHOLAS. Department of Anthropology, University of Iowa.

The mid-face of extant *H. sapiens* is known to undergo shape changes through fetal and neo-natal ontogeny; however, little work has been done to quantify these shape changes. Further, while mid-facial traits which vary in frequency between populations of extant humans are presumed to develop prenatally, patterns of populational variation maxillary shape across ontogeny are not well documented. Only one study has taken a 3D geometric morphometric approach to studying prenatal maxillary ontogeny, and that study was limited to one population (Japanese). The present research project seeks to augment our understanding of fetal maxillary growth patterns, most especially in terms of intraspecific variation. The primary hypothesis tested is whether fetal maxillary dimensions can accurately predict ancestry. 3D coordinate landmark data was taken on the right maxillae of 80 fetal and neo-natal individuals from three groups (Euro-American, African-American, "Mixed Ancestry") using an Immersion Corp. Digital Microscribe. Data were analyzed using regression, principle components analysis (PCA), and canonical variates analysis (CVA) using the programs Morphologika and MorphoJ. Shape changes were seen mainly in the lateral wall of the piriform aperture, the anterior nasal spine, and the anterior alveolar region. Specimens did not cluster distinctly by age in the CVA. However, the Euro-Americans and African-Americans did cluster by population with only modest overlap, indicating that populational variation in maxillary morphology appears very early in ontogeny. The mid-face is a critical region of the skull for assessing ancestry, and these results indicate that maxillary dimensions may be useful for estimating ancestry for prenatal individuals.

### Talus, a new mobile application for biological profiling of human skeletal remains.

EMILY NIESPODZIEWANSKI. Anthropology, Michigan State University.

The purpose of this presentation is to introduce the Talus mobile application for use in the creation of a biological profile from human skeletal remains.

When working in the field, human osteologists have to transport heavy, bulky hard copies of reference material. They also have to search each reference for the critical information. The goal of Talus is to provide a mobile web application (accessible via smartphone browser) and a native mobile app (downloaded through iTunes or Google Play) that consolidates the desired information and makes it easily accessible and portable.

The current release of Talus compiles references for the analysis of adult remains only. Future releases will include dentition and subadult remains and embed additional functionality to generate results (e.g., solving for  $x$  in a stature regression equation). Due to the high standards set for scientific testimony and peer-reviewed publishing, Talus uses only scientifically tested, widely accepted methods. All sources are cited, and permalinks to original references are provided when possible.

Talus allows easy access to measurements, formulae, and images from the most commonly used methods for estimating aspects of the biological profile. Ease of access streamlines the data collection process and increases an osteologist's efficiency in the field and in the lab. The integration of traditional osteological methods with contemporary, user-friendly digital platforms is important to continued growth in human osteology.

#### **Obstacles and results of screening ancient skeletal samples with real-time PCR.**

MARIA A. NIEVES-COLON, KELLY M. HARKINS and ANNE C. STONE. School of Human Evolution and Social Change, Arizona State University.

The ability to detect ancient DNA (aDNA) in archaeological samples is a crucial step in the process towards implementing enrichment and sequencing strategies. Quantitative real-time PCR is a commonly used tool in aDNA studies used to detect, authenticate, assess quality and quantify ancient template. But there are significant challenges to creating reliable assays, choosing appropriate user-based parameters and interpreting the output for low quality samples.

Here we report the results of two case studies. We tested over 100 human skeletal remains displaying lesions characteristic of military tuberculosis with three qPCR assays (IS6110, IS1081 and rpoB) targeting single and multi-copy regions within the MTBC. The obstacles for detecting ancient pathogen DNA are exacerbated by the existence of a wide range of unrelated environmental *Mycobacteria*, making an assessment of MTBC presence, sequence specificity, and quality a non-trivial matter. We also tested the skeletal remains of four chimpanzees from Gombe National Park, Tanzania, with a qPCR assay targeting a small region of the *Pan troglodytes* mtDNA genome. Our assay indicated that none of the chimpanzee samples was positive for the endogenous target.

While it is claimed that double stranded DNA-binding dye (e.g. SYBR Green) is a more cost-effective and sensitive qPCR method, our results support the use of fluorescent reporter probes (here, Taqman technology) for acquiring highly specific PCR product in low quantity template, and for effectively assessing sample preservation. Downstream enrichment procedures and sequencing validate the results yielded by our qPCR assays, helping to authenticate any aDNA determination.

This work was supported in part by grants from the Leakey Foundation and the National Science

Foundation to ACS, and National Science Foundation Graduate Research Fellowship grants to KMH and MANC.

#### **Densities, distribution and detectability of a small nocturnal primate (*Javan slow loris* *Nycticebus javanicus*) in a montane rainforest.**

VINCENT NIJMAN, J. A. PAMBUDI, DUAN ACHMED and K. A. NEKARIS. Nocturnal Primate Research Group, Oxford Brookes University.

Nocturnal mammals can be challenging to survey; for those that live in dense forests limited information is available on densities. The Javan slow loris *N. javanicus* confined to the island of Java, Indonesia has been classified as Critically Endangered on the basis of a high demand in the illegal pet trade and dramatic loss of forest. Still virtually nothing is known about their numbers in the wild. We aimed to report on the presence and distribution of Javan slow lorises in Mt Gede-Pangrango National Park, West Java and to present data on their densities and population size. We examine relationship between detectability and speed at which transects are walked, habitat, and moon phase. We provide density data using Distance from 23 transects walked for a total of 260 hours covering 93 km. Transects measured between 0.5 and 4.7 km, and were walked at speeds between 200-550 m / hr. Transects occurred mainly or exclusively in secondary forest, mainly or exclusively in primary forest or in a combination of both. Lorises were found at a density of 0.16/km<sup>2</sup>, with an estimated population of 70 individuals, with a detectability of 0.57. Neither forest type, nor moon phase related to loris abundance, but walking speed did ( $F_{1,5}=17.3$ ,  $P=0.014$ ) with numbers declining at a faster pace. The very low densities in this important protected area correspond with a conservation status of Critically Endangered for *N. javanicus*. Our methodological findings are of relevance to all those who survey nocturnal animals.

*The Leverhulme Trust, The Little Fireface Project.*

#### **Grasshopper's children: Bioarchaeological reconstruction of social age identity.**

DEJANA NIKITOVIC. Department of Anthropology, University of Toronto, Department of Anthropology, University of Toronto Scarborough.

The present study examines the social construction of childhood at Grasshopper Pueblo (AD 1275 - 1400), Arizona. Although Grasshopper's "children" have been the focus of both mortuary archaeology and biological anthropology, childhood has always been equated with biological immaturity, while the social construction of age identity has not been examined. Although modern Puebloans consist of a number of various ethnolinguistic groups, an analysis of ethnographic literature suggests that despite differences, modern tribes (particularly Hopi, Zuni and Tewa) share a common social construction of childhood.

Mortuary and skeletal data for 664 Grasshopper burials were examined to determine if (the?) Grasshopper Pueblo follows the pattern of social construction of childhood recognized among modern Puebloans. Both juveniles and adults were included in the analysis to establish children and adult specific patterns and to contextualize the differences. Analysis of mortuary data revealed that the location of the burials, as well as burial practice, reflects age-related mortuary practices in modern Puebloans. Analysis of skeletal data, particularly mortality and growth patterns, and results of paleopathological analyses, further support this social construction of childhood. The results will be discussed within a regional and temporal context. Furthermore, the link between child mortality and morbidity, and social construction of childhood in the context of ancestral and modern Puebloans will be explored.

#### **Segment-specific analysis of prehensile tail use and morphology in *Cebus capucinus* and *Alouatta palliata*.**

ABIGAIL C. NISHIMURA. Department of Anthropology, Yale University.

Prehensile tails have evolved independently in several arboreal mammalian lineages, yet our understanding of the behavioral impact of morphological differences in these analogous tail types remains unclear. To help address this uncertainty, I recorded segment-specific patterns of tail flexion and weight support in white-faced capuchins (*Cebus capucinus*) and mantled howler monkeys (*Alouatta palliata*), representative species of primate lineages with anatomically distinct prehensile tails. The caudal vertebrae of capuchins and howler monkeys differ in number, robusticity, muscular process shape and size, and articular surface curvature, while tail musculature differs in cross-sectional area sizing patterns. Sixteen and a half hours of behavioral data were collected on habituated capuchins and howler monkeys at the La Suerte Biological Research Station in northeastern Costa Rica using instantaneous focal animal sampling at one-minute intervals. I tested whether segments of the tail are used with differing degrees of flexion and weight support within species and whether the two species use the same segments in different ways. Behavioral observations indicate that howler monkeys have more flexibility in all tail segments, with particularly significant differences found in proximal segments. Though capuchins demonstrate less tail flexibility, they more frequently use proximal segments for weight support. Howler monkeys use distal segments to support weight more frequently and in greater amounts. These results corroborate documented morphological differences and address how capuchins and howler monkeys solve similar ecological problems in different ways. Linking such specific behaviors with morphology can provide valuable information for ecological interpretations of the fossil record.

**Fossils from Olduvai Gorge come home and go online.**

JACKSON K. NJAU<sup>1</sup>, JACKSON KIHUYO<sup>2</sup>, PAUL MSEMWA<sup>3</sup>, AMANDUS KWEKA<sup>3</sup>, JOHN PARESSO<sup>4</sup>, AGNES GIDNA<sup>3</sup> and LESLEA J. HLUSKO<sup>5</sup>. <sup>1</sup>Department of Geological Sciences, Indiana University, <sup>2</sup>National Museum of Tanzania, <sup>3</sup>Museum & House of Culture, National Museum of Tanzania, <sup>4</sup>Tanzanian Department of Antiquities, <sup>5</sup>Human Evolution Research Center, University of California.

Two efforts have been undertaken that improve and alter research access for the vertebrate fossils from Olduvai Gorge, Tanzania. Since the site's scientific discovery in 1911, numerous projects have undertaken work there. Fossils collected by these various projects are curated in museums around the world. The largest of these collections was in Nairobi, following the excavations by L.S.B. and M.D. Leakey between 1931-1983. In 2011, officials from the Tanzanian and Kenyan governments agreed return of the fossils to the National Museum in Dar es Salaam, including all of the hominid fossils.

Simultaneously, the Comprehensive Olduvai Database Initiative (CODI) began. This project has built a web-accessible database of all fossils known from Olduvai Gorge ([www.olduvai-paleo.org](http://www.olduvai-paleo.org)). Over 5,200 fossils have been entered into CODI, including 3,577 from scientific publications, 806 that are located in the museum in Munich, 245 that are a small part of a much larger assemblage of Bed III and IV material at the Leakey Camp at Olduvai Gorge, 367 are new fossils recovered by the Olduvai Vertebrate Paleontology Project in 2012, and 248 represent the cercopithecoid fossils recently returned from the Kenyan National Museums. The recently returned fossils from Nairobi and the Bed III/IV material at Olduvai Gorge continue to be inventoried. The database is updated online regularly.

We ask that anyone with knowledge of Olduvai fossils please contact us. Researchers interested in studying these fossils can use the database to plan their research and are most welcome to the Museum and House of Culture in Dar es Salaam.

*CODI is supported by funding from the National Science Foundation.*

**Status in prehistory: Exploration of Maya social tiers with cross-sectional geometry.**

LARA K. NOLDNER. Maxwell Museum of Anthropology, University of New Mexico.

Bioarchaeological investigations of prehistoric complex societies largely rely on skeletal indicators of health and/or associated grave goods to infer the status of individuals. However, absence of skeletal evidence of disease or malnutrition does not necessarily mean an individual was "healthy," and quantity and quality of grave goods does not necessarily correlate with status across cultures. This research explores the use of long bone cross-sectional geometry (CSG) to delineate

individuals of different social tiers by their activity patterns. Skeletal samples examined include pre-contact Maya from elite (n=43) and non-elite (n=60) contexts. The external diaphyseal shapes of the humerus, femur and tibia of each individual were measured for general robusticity and strength in resistance to torsional and bending forces (*I<sub>max</sub>/I<sub>min</sub>*, *J* and *TA*) from 3D models of long bones created with a Nextengine® 3D laser scanner. Cross-sections were taken from 3D models at 35% of humerus length, and 50% of femur and tibia length. Mann-Whitney U tests were used to detect significant differences in upper and lower limb CSG between status groups. Differences are most pronounced between elite and non-elite Maya females. Elite females have more robust femora than non-elite females, but non-elite females have relatively greater tibia *I<sub>max</sub>/I<sub>min</sub>* (p=0.052) than elite females. Despite the presence of sexual dimorphism in other CSG properties, non-elite males and females are similar to each other in tibial *I<sub>max</sub>/I<sub>min</sub>*, with more pronounced antero-posterior (AP) expansion of the tibia, while the tibiae of elite females have a more circular cross-section.

**Childhood social disadvantage, cardiometabolic risk and chronic disease in adulthood.**

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Adverse childhood environments are thought to become biologically embedded during the first few years of life, potentially leading to dysregulation of multiple biological regulatory systems. Among the studies that have examined this question, many have relied on retrospective or limited information on the child's social environment. Using prospective data from a subset (n's ranging from 452-591) of a US birth cohort started in 1959-1966, the National Collaborative Perinatal Project, this study examines associations of social disadvantage in childhood with cardiometabolic function and chronic disease status over 40 years later. We constructed an index of social disadvantage using information about adverse socioeconomic and family stability factors experienced before age 7. We also constructed an index of cardiometabolic risk (CMR) based on 7 CMR biomarkers, and an index of chronic disease status, based on 8 chronic diseases. Poisson and logistic models were fit to investigate relevant associations, while adjusting for potential childhood confounders and pathway variables.

A high level of social disadvantage ( $\geq 5$  factors) was significantly associated with both CMR (IRR=1.47, 95% CI:1.08, 2.00) and with increased number of chronic diseases (IRR: 1.4, 95% CI: 1.05, 1.86). Associations with CMR were even stronger among females (IRR: 1.87, 1.31, 2.68). These relationships were largely mediated by adult behavioral factors, such as depression and BMI, though the early social

environment maintained an association with each outcome even after accounting for these factors. These findings highlight the importance of psychosocial stressors early in development, which may have maladaptive physiological consequences throughout the life course.

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**How hard can it be? Exploring the feeding ecology of sakis.**

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The Pitheciinae have highly specialized dentition. There is now a clear association between extraction and mastication of seeds (their preferred resources) and a dental complex that consists of procumbent incisors, large, laterally splayed canines and flat, crenulated molars with thin, decussating enamel. This trait complex is best developed in the largest-bodied genera (*Cacajao* and *Chiropotes*), scaled down with smaller-bodied *Pithecia*, and essentially absent in *Callicebus*, the primitive member of the clade. Warren Kinzey, trained as an anatomist, was a pioneer in adapting simple tools borrowed from soil science to generate a quantitative assessment of what wild sakis eat. Warren and I initiated feeding ecology studies in Suriname and Venezuela in 1986 that would define the limits, as well as variability and subtleties of ingestion and mastication of two species: *Pithecia pithecia* and *Chiropotes satanas/sagulatus*. In a nutshell, sakis use canines to generate cracks in fruit pericarp or brittle seed coats. They use procumbent lower canines to plane the surface of thick pericarps or scrape lipid-rich mesocarp from palm nuts, and crenulated molars to position wet, slippery seeds during mastication. They ingest both young seeds and (more resistant) mature seeds. If they have fallback foods, they do not seem to be related to food hardness, yet their use of very hard fruit and seeds is relatively rare. Dental adaptations enable sakis and uakaris to open well-protected fruit and brittle seed coats and provide feeding options in a complex, labile environment.

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**Age as a factor in inter-tissue spacing of stable carbon isotopes in juvenile human remains.**

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Analyses of stable isotopes from different tissue types within the same individual reveal disparate isotopic values for a variety of

physiological and biological reasons. The effects of growth, development and tissue turnover rates on these values are not well understood. Utilizing data collected from 52 well-preserved juvenile human remains from Kellis 2 Cemetery (c. 100-360 AD) in the Dakhleh Oasis, Egypt, this project examines how the distances between the  $\delta^{13}\text{C}$  values in bone collagen, skin, hair, and nail, vary between different age groups. Three age cohorts were chosen along developmental lines: 1-4 years, 5-10 years, and 11-15 years. The mean carbon isotope values for each tissue were compared across each age group, and used to calculate the differences between each tissue type. Although distances between tissues were found to vary across all age categories, the distances between collagen and hair, collagen and skin, and collagen and nail are all substantially greater in the 11-15 year cohort than those in the 1-4 and 5-10 year cohorts. Possible physiological, developmental and social factors are discussed in an effort to explain this discrepancy, in particular the possible effects of the adolescent growth spurt, and nutritional or other physiological stress.

**Distribution of *TYRP1* 923C allele across Island Melanesia and possible association with hair color phenotype.**

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A recent study identified a genetic mutation in the *TYRP1* gene that is significantly associated with blond hair color in populations from the Solomon Islands. Although this blondism phenotype is observed across much of Island Melanesia, little is known about the broader distribution of the blondism allele throughout the region, or of its association with hair color in populations outside of the Solomons. Here we report the frequency of this allele in 424 individuals from populations sampled across western Island Melanesia. While the frequency of the blondism allele at this locus (0.20) is slightly lower than, but still consistent with, that reported for the Solomon Island populations further to the east (0.26), this frequency is not uniform across the region. In order to test the hypothesis that this allele is associated with lighter hair and/or skin pigmentation in western Island Melanesia, ANOVA analyses were used to compare mean skin and hair pigmentation levels (measured as the M index) across all three genotype classes. While no significant differences were observed in skin pigmentation, hair M index values differed significantly across groups ( $F = 3.23$ ,  $p < 0.05$ ). However, this association may be confounded by the extensive population structure known to characterize this region. We explore methods to control for stratification, as well as examine pigmentation phenotype-genotype associations on individual islands.

*Funding provided by the University of Cincinnati.*

**A death in the borderlands: Oxygen isotope evidence for mobility from a Pithos burial at Oġlanqala, Azerbaijan.**

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During the late 1<sup>st</sup> c. BCE and early 1<sup>st</sup> c. CE, the Caucasus became a focus of attention for the Roman and Parthian Empires as tension rose between the powers over political influence in the region. Yet, archaeological evidence, particularly human remains, of their physical involvement in the Caucasus is sparse. At the site of Oġlanqala in Nakhchivan, Azerbaijan, a pithos burial found containing an individual buried with Roman artifacts from the period may be a representative of the foreign presence attested by texts. This project presents the results of an oxygen isotope study on dental enamel collected from the individual in order to determine local or non-local status. Comparative local ratios were determined from dental enamel collected from nearby archaeological fauna. Isotope results of the individual were considerably different from local ratios, suggesting the individual was a foreigner. Based on these biochemical results and with the support of textual and archaeological evidence, I hypothesize that the individual originated from Europe and suggest possible reasons for his or her presence in the region.

*Fieldwork for this project was funded, in part, by Emory University's Scholarly Inquiry and Research at Emory.*

**Parasites and primate communities: Amplification and dilution effects.**

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The majority of primate parasites are generalists, meaning that they infect multiple species of primates or other animals. Hence, the community of hosts found at a site is expected to impact parasitism. Two main non-null effects are possible. In some cases, we might find an "amplification effect," with higher levels of parasitism in richer primate communities. In other cases, we expect a "dilution effect," with reductions in parasitism in richer primate communities due to the existence of less competent hosts that fail to transmit the infection. We investigated these possibilities using the *Global Mammal Parasite Database*. In analyses of prevalence at different sites, we found some evidence for associations between parasitism and mammalian or primate richness at a site, with a mixture of positive and negative effects. When examining range overlap at the host species level, we found stronger evidence for amplification effects: parasite richness covaried positively with the number of overlapping primates and degree of range overlap. Finally, in a meta-analysis of 16 studies at 12 study areas, we found a very weak effect of disturbance to increase parasitism. Assuming that more disturbed habitats have lower host

diversity, this weak positive effect is consistent with a dilution effect, but only approached significance. Thus, using data compiled at multiple scales, our findings were generally most consistent with weak amplification effects. However, we found clear heterogeneity in effects depending on host, parasite and environmental characteristics. An important goal for research moving forward is to understand the drivers of this variation.

**Patterns of ant-fishing for carpenter ants (*Camponotus* spp.) by Gombe and Mahale chimpanzees.**

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Cross-site comparisons of termite-fishing (for *Macrotermes*) and ant-dipping (for *Dorylus*) suggest that both cultural traditions and microecological factors influence tool-assisted insectivory by chimpanzees. Predation on *Camponotus* ants with tools (or "ant-fishing") is reported at fewer long-term sites than other insectivory patterns. Here we compare patterns of predation on *Camponotus* at two sites and four communities- Mahale (K- and M-group) and Gombe (Kasekela and Mitumba).

Ant-fishing was identified as 'customary' in K- and M-group and 'habitual' in Mitumba soon after habituation on each began. In contrast, ant-fishing was conclusively documented in Kasekela only in 1994, after decades of prior observation. Circumstantial evidence suggests that a Mitumba immigrant introduced ant-fishing to Kasekela in 1992.

Ant-fishing was 'customary' in Kasekela by 2010. Nevertheless, Kasekela chimpanzees fished for fewer species of *Camponotus* than the other three communities, though the same prey species were available. Ant-fishing occurred at a lower frequency, for shorter durations, in fewer tree species, and at fewer locations in Kasekela than in Mahale. Ant-fishing was observed by all non-infant members of M-group and most adult males and females in Mitumba. In Kasekela ant-fishing was observed almost exclusively by younger cohorts and immigrant females, and was never observed among adult males.

This cross-site comparison is consistent with O'Malley et al.'s (2012) conclusion that ant-fishing in Kasekela is a recent cultural phenomenon, though also suggests that differences in ant-fishing behavior even in neighboring communities are influenced by local environmental conditions (e.g., the abundance and distribution of *Camponotus*-infested trees), consistent with prior studies.

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**The ontogeny of sex differences in ring-tailed lemur feeding ecology: costs of reproduction and niche partitioning.**

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Sex differences in primate feeding ecology are a common phenomenon, but for most species it is unknown when in development they appear and how they are related to metabolic and ecological strategies of males and females. They may function to minimize feeding competition within a group or may simply be a behavioral response that compensate for fluctuating physiological costs, particularly to females during reproduction. Clutton-Brock (1977) proposed three potential scenarios for the evolution of sex differences in feeding ecology: (1) sexual size dimorphism, (2) costs of reproduction, and (3) ecological competition avoidance or niche partitioning. As a primate-wide pattern, sexual size dimorphism does not reliably predict sex differences in feeding, emphasizing a need for a better understanding of how female reproductive costs and niche partitioning structure ecological sex differences. Using a mixed-longitudinal sample of ring-tailed lemurs (*Lemur catta*) at the Beza Mahafaly Special Reserve we show that both reproductive costs and niche partitioning structure sex differences in the feeding ecology of ring-tailed lemurs. Sex differences in this species are strongest when females are lactating, but there is early divergence of dietary diversity between males and females that begins at weaning and continues through adulthood. The early emergence of sex differences in dietary diversity in juvenility that are maintained throughout adulthood indicate that niche partitioning is an important and overlooked aspect of sex differential feeding ecology, and that ontogenetic studies of feeding are particularly valuable to understanding how selection shapes adult, species-typical diets.

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**Stance and swing phase joint mechanics in chimpanzee bipedal walking.**

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Humans are known to be exceptional bipedal walkers, having considerably lower locomotor costs than our closest living relative, the chimpanzee. The lower locomotor costs in humans should, in part, be attributable to

differences in how hind limb joints produce and absorb mechanical energy across a stride. However, the mechanical work and power requirements of the chimpanzee gait cycle are still poorly defined. Here, we present new data on the joint work and power output of the chimpanzee hind limb across stance and swing phases of a bipedal stride.

Synchronized video and force plate data were collected from three chimpanzees (*Pan troglodytes*) walking bipedally along an overground runway. Three-dimensional marker positions and ground forces were then integrated with scaled, subject-specific chimpanzee musculoskeletal models. These models were used to solve for hip, knee and ankle work and power output over a full stride cycle in OpenSim<sup>TM</sup>.

Initial results indicate that, like humans, the hip and ankle are the primary sources of mechanical energy generation over a stride in bipedal chimpanzees, while the knee is the major energy sink. However, chimpanzees attribute a larger fraction of their total joint power to limb swing than do humans. Thus, limb-swing mechanics may contribute to the reported differences in the energy cost of walking between these species. Taken together these data provide new insights into the joint-level mechanics of chimpanzee bipedalism, which will lead to a better understanding of adaptations for habitual bipedal locomotion.

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**Getting the word out: Community consultation and continuing engagement in Anthropological Genetics research.**

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Community consultation is an essential component of the informed consent process in community based genetic research. Anthropological genetic research among North Alaskan Inupiat communities provides insights into the dynamics of community/researcher communication.

Genetic analyses of population history and migration have often been contentious in indigenous communities, although not in North Alaska. Among North Slope communities, genetic analyses proved generally concordant with local narratives regarding community interaction and exchange, although both ancient and modern DNA analyses revealed some surprises regarding long-range interactions with Siberian populations, patterns of shared ancestry among communities, and non-Native admixture. Despite community enthusiasm for the project, and regular community updates, visits to each community at the end of the study to return and discuss results elicited little if any community interest. This was unexpected given the oft repeated complaint of researchers taking material from communities but rarely if ever returning to provide results of the analyses performed.

A variety of issues, including timing of community visits, packaging of results for community feedback, clarifying relevance of the results, and even the weather in a changing arctic, are possible reasons for the lack of interest in final community feedback. Continual updates over the course of the multi-year project may also have led communities to assume they already knew the results. Increased community and ethical awareness in anthropological genetic practice, including community consultation and explanation of the greater resolution of genomic analyses, will become increasingly important.

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**Measuring and predicting daily energy expenditure of highly active humans in natural environments.**

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Current models for predicting human daily energy expenditure (DEE) in both industrialized and non-industrialized populations significantly underestimate actual DEE, particularly among highly active populations. A great number of studies have examined the cost of the individual components of DEE (thermoregulation, activity, and resting metabolic rate) in laboratory settings, but few have done so comprehensively in natural environments. In this study, we provided a new model for predicting DEE and then tested it with measured DEEs of healthy, highly active adults (N=55) participating in National Outdoor Leadership School semester long courses. Two of the semester-long courses took place in both hot and temperate climates (N=25) and the other two in both temperate and cold climates (N=30). This enabled DEE measurements in a variety of climatic conditions, allowing a greater examination of the impact thermoregulatory cost has on DEE in natural environments. DEE was measured for a six-day period within each climate setting using the doubly labeled water and flex-heart rate methods. Daily food logs were kept to measure caloric intake, and daily activity logs were kept to document the type, intensity, and duration of the various activities performed by each subject. The DEE data collected from this study was then used to test the efficacy of and improve our new model for predicting DEE at any activity level in any given climate. Our new predictive model will enable us to examine the DEE of not only current human populations but also that of past hominin populations.

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### Anthropological studies on mummified human brains from archaeological fields in Korea.

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Mummified brains have been discovered in archaeological fields of Korea. Although the morphology of the brain had been perfectly preserved on gross examination, we still do not know how well biomolecules were preserved within it. Fortunately enough, we had the chances to investigate the mummified brains, through various forms of anthropological examinations. In general, the mummified brains showed well-preserved grey and white matter within well demarcated brain lobes, on which gyri and sulci could be easily identified. On histological examination, lipids were mainly discovered in the remaining brain tissue, which might be correspondent to the preserved myelin sheath. The preservation status of ancient DNA (aDNA) in mummified brain tissue was also determined by means of molecular studies. Quantifier analysis revealed that aDNA in the mummified brain was less fragmented than that contained in the femurs. The better preservation status of the brain DNA was shown also in another study on autosomal and mitochondrial DNA. By a series of these studies, we could know that mummified brain tissue promises to be the preferred source for future anthropological studies on the individuals discovered from archaeological fields in Korea. Author email: Dong Hoon Shin (cuteminjae@gmail.com).

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### Human bone artifacts as markers of prehistoric populations: critical assessment of evidence from Central California.

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Evidence for the presence and spread of biological populations in prehistoric contexts frequently relies on cultural markers. A range of artifacts is employed to define a distinctive Central California population (Windmill Culture, 4700-750y BP) and track this group's migrations and subsequent assimilation into more recent populations. One of these markers is the manufacture of human bone artifacts. Evidence authentication has relied more on

expert opinion, however, than critical evaluation. We provide taxonomic and taphonomic assessment of these artifacts and assess their value in identifying biological populations.

We examined ~60% of the California skeletons in the Phoebe Hearst Museum of Anthropology, UC Berkeley ( $n > 8000$  individuals), including all Windmill-associated remains ( $n=246$ ). We also examined associated site records, reports, and artifact collections to recover material misidentified as non-human and clarify burial contexts. SEM and digital imaging were employed to clarify cultural and non-cultural taphonomic events. Only one Windmill-associated human bone artifact was authenticated; the remainder are non-human or non-artifactual. Two new non-Windmill human bone artifacts were identified in the collections while several obscure ones were located in the literature.

Based on a broad assessment of the California collections, we demonstrate that a small series of human bone artifacts derive from prehistoric contexts, but that they are widely distributed in time and represent a pan-Central-California phenomena. This work underscores the need for critical assessment of 'cultural markers' of biological populations. Such work is particularly important, until such time as population-level ancient DNA studies can be widely conducted on prehistoric skeletal collections.

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### Root dentine translucency aging in burned human teeth: A preliminary study.

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The use of root dentine translucency (RDT) for determining age at death in human remains is a widely used technique in forensic anthropology. While reported rates of accuracy differ depending on sample size and methodology, RDT has been found to accurately predict age at death within  $\pm 5$  years in modern sample populations. Despite this potential, its applicability to burned teeth remains untested. While forensic cases involving extreme heat-related degradation may be rare, RDT aging could provide an alternative when traditional aging methods are no longer suitable. Moreover, if proven accurate, the use of RDT on cremated remains could contribute significantly to bioarchaeology, as severely burned remains often go unstudied when traditional aging methods are not feasible. This study explored the preservation of RDT in extracted cadaver teeth ( $n = 30$  canine antimere pairs) from individuals ranging in age from 54 to 98. Teeth were experimentally burned in a Paragon FireFly digital kiln at 50 degree increments from 300-800 °C and at 100 degree increments from 800-1200 °C. Results show that RDT is a visible, and potentially reliable, age indicator until partial calcination obscures the microstructure of the

dentine. The visibility of RDT in the 1200 °C test group also indicates that RDT may become visible again if the remains reach a state of complete calcination. Further applications for use on cremated material in forensic and archaeological contexts are explored.

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### The earliest hominins were rigid wristed.

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Reconstructing the evolution of hominin wrist mechanics is critical for understanding the adaptive history of human locomotion and manipulative capabilities. In this study, the complex series of bone rotations that occurs during wrist extension (dorsiflexion) is examined via three-dimensional (3D) computed-tomography-based analysis of carpal kinematics in several anthropoid taxa. In addition, 3D morphometrics are used to identify anatomical correlates of wrist function. In turn, these data are employed to reconstruct wrist mechanics in fossils and infer the probable sequence of functional transformations in hominins and other anthropoids. The results indicate that proximal-carpal-row mobility during extension is restricted in extant apes vis-à-vis palmigrade-capable monkeys due to a volar declination of the distal radius and consequent dorsal ridge, which is present in *Ardipithecus ramidus*, *Australopithecus anamensis*, and *A. afarensis*, but absent in later hominins. More distally, chimpanzees and humans exhibit shared-derived midcarpal kinematics resulting in rapid engagement of the proximal and distal rows, such that the midcarpus is close-packed midway through wrist dorsiflexion. Scaphoid-centrale fusion and an abbreviated lunatocarpitate articular arc are key correlates of the *Pan-Homo* kinematic pattern, and these features characterize all hominins for which wrist anatomy is known—indicating that a rigid wrist in extension is primitive for the lineage. Later hominins primarily owe their increased total dorsiflexion to secondary reorientation of the distal radius, which increased radiocarpal mobility while retaining midcarpal constraints. These secondarily-derived radiocarpal modifications may have resulted from relaxed selection on hand mobility (possibly to facilitate tool behaviors).

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### Dietary toughness constrains juvenile feeding efficiency in Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*).

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Studies of primate foraging ontogeny have found mixed evidence for juvenile competence. For some species, juveniles feed and forage no differently than adults, while in others, juveniles exhibit signs of reduced ability. Smaller size and lesser strength may constrain juvenile foraging competence, particularly for species relying on tougher diets. Here, we examined the influence of food toughness on diet and feeding rates for Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*) at Phu Khieo Wildlife Sanctuary, Thailand. Bites per minute were counted and feeding data collected for adults (n=13.4 per month) and older and younger juveniles (n=8.3 and 7.4 per month respectively) in three groups. Food toughness was measured using a portable mechanical tester. Lastly, photogrammetric measures were used to estimate limb lengths in order to rank juveniles by size. We calculated individual monthly toughness profiles incorporating feeding time per food species. Using GLMMs, we found no age-related differences in overall dietary toughness. Similarly, preliminary analysis of a smaller juvenile subset provided no evidence for a size-related pattern in toughness profiles. To gauge the impact of toughness on feeding efficiency across age classes, bite-rate ratios were calculated for each age pair (e.g., adults vs. younger juveniles). For both age pairings involving younger juveniles, toughness was a significant positive predictor of bite-rate ratio ( $p < 0.0001$ ), that is, the degree of difference increased with tougher foods. Our results suggest smaller size does not limit the overall toughness of juvenile diet, however, toughness does take a greater toll on feeding efficiency in younger juveniles.

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#### **Archaic trophy taking in the Eastern Woodlands.**

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The taking of human body parts as trophies is a practice documented in the American Midwest during the Middle and Late Archaic periods. It was particularly common around the Ohio and Green Rivers, and extended south into the Tennessee River valley. Trophy elements included scalps and heads, forelimbs, mandibles, tongues, and ears. Victims of trophy taking exhibit diagnostic patterns of traumata, generally manifest as cut and chop marks adjacent to where elements were removed. The current study sought to determine the extent to which Archaic trophy taking extended west along the Ohio River. Over one hundred adult and subadult skeletons from the Black Earth site in Southern Illinois were closely examined for evidence of trophy taking. All bones were

studied and a 10X hand lens was used in instances where taphonomy obscured surface visibility. No evidence of trophy taking was found, though Black Earth is culturally similar to and contemporaneous with trophy sites in Indiana. The Black Earth finding contradicts evidence from the Ohio and Green Rivers, where trophy taking is found at numerous cemeteries of all sizes (i.e., Indian Knoll, Kentucky n= 800+ and Firehouse site, Indiana, n=5). The Black Earth results indicate that trophy taking, while widespread, was not ubiquitous. It does not sit directly on the Ohio River like its counterparts in Indiana; perhaps this explains why its people were not victimized by trophy taking. In sum, it is clear that trophy taking has a geo-cultural boundary that studies like the current one are helping to define.

#### **A feature-based method for the determination of the minimum number of individuals from the Tell Abraç Tomb, UAE.**

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The tomb at Tell Abraç (UAE) was excavated in 1993 and 1998 and dates to the Late Bronze Age (c. 2100 BCE). This is a large collective tomb in the Umm an-Nar style and represents a 200-year period of usage by the community. Contained within the tomb are the remains of adults and children, males and females. All are commingled, some may represent secondary burials, and almost all bone elements are relatively identifiable, but fragmentary due to normal taphonomic processes. Determining the minimum number of individuals (MNI) and demography of the large number of commingled human remains from Tell Abraç required recording of both individual bones and bone features. This project focuses on the representation of elements and the resulting demographic profile. For example, the MNI for adults is 286 based on the right talus but 131 based on the distal left humerus. Sex ratios for post-cranial elements are consistent demonstrating approximately 65% male and 35% female regardless of the element examined. The cranial MNI is significantly lower, particularly for adult males. The sex ratio within cranial elements is approximately equal between males and females. Variation in element representation can reveal cultural practices (such as the removal of adult male crania as part of a secondary burial practice) and taphonomic variables (differential preservation, missing elements, secondary interments). This method for the determination of MNI for large commingled assemblages that are fragmentary demonstrates the utility of using bone features.

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#### **Sex determination by discriminant function analysis of lumbar vertebrae.**

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Anthropology, Duke University, <sup>2</sup>Institute for Human Evolution, University of the Witwatersrand.

Sex determination is a critical part of developing a biological profile for unidentified human skeletal remains. When more commonly used elements for estimating sex, such as the pelvis, are not available, methods utilizing other skeletal elements are needed. Previous studies have suggested a pattern of sexual dimorphism in the lumbar vertebrae, which may be due to biomechanical differences in the way males and females bear load through the vertebral column. In addition, as an important weight-bearing region, the lumbar vertebrae should reflect body size, which on average tends to be larger in males than in females. Using osteometric data from the lumbar vertebrae, statistical analyses (SPSS 20) were conducted on a sample from the Dart Collection (47 males, 51 females) to evaluate the usefulness of the lumbar vertebrae in estimating sex. Eleven characters—including linear dimensions as well as the vertebral body wedging angle—were examined at each lumbar level (L1 to L5). Multiple variables at each lumbar level showed significant sexual dimorphism ( $p < .01$ ), and univariate discriminant function analysis (DFA) generated equations with accuracies ranging from 57.7% to 83.5%. The highest accuracies tend to be associated with dimensions of the vertebral body. Stepwise DFA generated discriminant functions with cross-validated classification rates of 88.7% for L1, 81.4% for L2, 85.9% for L3, 80.5% for L4, and 75.9% for L5. These results are comparable to other methods that use discriminant functions for sexing the skeleton, and indicate that measures of the lumbar vertebrae can be used as an effective tool for sex assessment.

#### **Geometric morphometrics and statistical classification: Size matters.**

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Geometric Morphometrics (GM) includes powerful methods for exploring and understanding shape variation in human crania. Recently, software such as 3D-ID (Slice and Ross 2009) and MorphoJ (Klingenberg 2011) utilize Linear Discriminant Function Analysis (LDFA) for classification using all Procrustes coordinates, which are adjusted landmark coordinates after translation, rotation, and scaling. Classification methods are especially useful in forensic and bioarchaeological settings. However, landmark data can be analyzed in other ways, and classification goals are different from GM goals. This study investigates the performance of classification techniques applied to various transformations of landmark data.

Three-dimensional landmark coordinate data from 155 black and white males and females in the Terry collection were analyzed in four-way classifications using from 4 to 40 landmarks. Procrustes coordinates (PCoos), with centroid size ((PCoosCS), principal component

scores of the PCoos, and interlandmark distances (ILDs) were employed in LDFA and stepwise selection of up to 10 variables. Classification accuracy was assessed using leave-one-out cross-validation in Fordisc 3.1 (Jantz and Ousley 2007).

Results highlight the Curse of Dimensionality (overfitting due to too many variables) in all datasets and the value of using size in classifications involving the sexes. Accuracy using all variables peaked at 14 landmarks for all data sets, and PCoosCS generally showed the highest accuracy, but stepwise selection produced the highest accuracies of all, especially using ILDs or PCoosCS. Classification using all PCoos was generally low, and was only 50% accurate using 40 landmarks. In using GM data for classification, optimized classification methods should be used.

#### Regional health in Late Prehistoric of East Tennessee: A meta-analysis of Dallas Phase sites.

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Literature concerning the mid-to-late Mississippian period (AD 1200-1600) in East Tennessee describes a culture context typified by social differentiation, aggregate villages, intensive maize agriculture and a patterned co-occurrence of skeletal pathologies. These commonalities do not necessarily result in similar health profiles. Certain recent studies of East Tennessee site samples have revealed particular inter-site variability in health status (e.g., presence/absence of sex differences, presence/absence of social role differences). Given demonstrable intra-regional ecological differences and perhaps sociopolitical heterogeneity, the intersite differences may vary by geography or culture context. A multiple site skeletal sample belonging to the same cultural phase (Dallas, AD 1300-1550) from three different geographical areas within East Tennessee was examined to determine if health differs significantly between local populations (intra-regional) and if those differences parallel inter-regionally with more distant populations in East Tennessee.

Six sites are surveyed from three reservoir locations totaling 1,073 skeletal remains. The sites are: Hiwassee Island, Sale Creek, and Hixon from the Chickamauga Reservoir; Citico and Toqua from the Tellico Reservoir; and Cox from the Melton Hill Reservoir. Health data collected consisted of cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia, and periostitis. These were scored for presence-absence and severity. Results indicated that pathological prevalence and patterning showed more significant differences within a reservoir than between reservoirs. Commonalities which transcended distance include site size, length of site occupation, and date(s) of site occupation. The results also suggest that sociopolitical

heterogeneity between the reservoir samples merits further evaluation.

#### Morphometrics in forensic science: Steps towards the development of population specific standards.

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The statistical quantification of error and uncertainty is inherently intertwined with ascertaining the admissibility of forensic evidence in a court of law. This issue was especially advocated in the 2009 National Academy of Science review of forensic practice. In the forensic anthropological discipline, the robustness of any given method and classification statistics should not only be evaluated according to its stated error, but also to the accuracy and precision of the raw data (measurements) from which they are derived.

Using a variety of traditional and novel approaches, we discuss here the results of statistical analyses assessing the validity of the raw data that is being used to formulate Australian forensic standards from 3D osseous landmarks acquired in CT-reconstructed bones. We then outline how 3D multivariate descriptors of size and shape can be used to estimate sex with a high degree of expected accuracy. We demonstrate the effect on classification accuracy when non-population specific vs. population-specific sexing standards are applied to an Australian sample. Assessing the relative magnitude of the different sources of errors is fundamental to providing robust and accurate data and results in the forensic sciences. This is especially true in Australia, where there is a general lack of population-specific morphometric skeletal standards for biological profiling, and forensic scientists therefore have little recourse but to apply standards from non-Australian populations that fail accurate representation of the modern Australian population, and thus introduce unacceptably high levels of error.

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#### How Mentawai Island primate characteristics affect hunters' prey choice.

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Hunters usually choose prey items based on prey characteristics. Qualities that hunters search for in prey include taste, size, availability, and capturability. In this study, these traits and their impact on local hunting of four nonhuman primates (*Hylobates klossii*, *Macaca pagensis*,

*Presbytis potenziani*, and *Simias concolor*) were examined on the Mentawai Islands of West Sumatra, Indonesia. All of the primates are endemic, endangered, and hunted to varying degrees.

Physical and verbal data were collected on hunting practices. All signs of human access to and use of three forest areas were recorded, 144 men who lived near the forests were interviewed, and primate densities were calculated from data collected during surveys of the areas.

The results indicate that a minimum of 263 primates were harvested from the three forests, and that they were not hunted randomly. The number of hunters who had successfully captured a macaque or a simakobu was significantly greater than the number of men who had not (*M. pagensis*: n = 52/76 hunters,  $X^2 = 10.32$ ,  $p = 0.001$ ; *S. concolor*: n = 50/76 hunters,  $X^2 = 7.58$ ,  $p = 0.006$ ). In contrast, there were significantly fewer hunters who had killed gibbons or leaf monkeys than would be expected (*H. klossii*: n = 27/76 hunters,  $X^2 = 6.37$ ,  $p = 0.012$ ; *P. potenziani*: n = 28/76 hunters,  $X^2 = 4.81$ ,  $p = 0.028$ ). It appeared that hunters chose prey items not only based on size, but also due to their ease of capture, taste, and density.

This research was generously funded by Primate Conservation, Inc. and the Wildlife Conservation Society.

#### Assessing the correlation between dermatoglyphics and genetic data in worldwide populations.

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Dermatoglyphic traits are often used as morphological proxies for genetic data to estimate population distances and population history. Using total ridge count (TRC), as opposed to individual digit ridge counts, studies on the genetics of dermal ridges have confirmed that total ridge counts are highly heritable. Based on the early development of skin ridges during prenatal development, characteristics such as ridge counts have been shown to be effectively selectively neutral. These phenotypic data have often been used as an estimate of genetic relatedness between groups, despite some suggestions that this may be misleading.

To determine if utilizing phenotypic distances would produce a significantly different result than using genetic distances, dermatoglyphic samples from continental populations were compared to corresponding genetic population sample data. Short tandem repeat (STR) data were obtained for worldwide populations using the Centre d'Etude du Polymorphisme Humain (CEPH) database. Genetic distances for these data were calculated using Slatkin's genetic distance, designed for microsatellite data (Slatkin, 1995). Ridge count data, consisting of 20 ridge count variables, were analyzed using Mahalanobis distances. A Mantel test was then applied to the results of both the phenotypic and genetic analyses to assess the differences between the two approaches. Preliminary results indicate that there is a

difference between analyses conducted using phenotypic distances versus genetic distances, but that the differences do not strongly alter the conclusions ultimately drawn from the analyses.

**Prevalence of Portuguese preschool obesity and associations with family characteristics and child behaviours.**

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Childhood obesity is a major health problem in Portugal. The aim of this study is to analyze the prevalence of childhood obesity in children aged 3.0-6.0 years old and the association of parental characteristics and child behaviors with child obesity.

A cross-sectional study was done in a sample of 8089 children, aged 3.0-6.0 y. Weight and height were measured. Overweight and obesity, using cut-off points as defined by the IOTF, were used. Data was analyzed using the chi-square test and the multivariate logistic regression analysis adjusted for age and sex. The prevalence of obesity (including overweight) in boys was 10.2% and in girls was 14.0%. The prevalence of obesity increased by time of TV viewing: < 2h, 23.2% and  $\geq$  2 h, 25.4%; decreased by active play < 2 h, 23.6% and  $\geq$  2 h, 28.6%; increased with breakfast skipping, yes 24.4% and no, 32.9%, increased with father obesity - father overweight, 26.9 and father obesity, 36.3% - and mother obesity, mother overweight, 31.1% and mother obesity, 38.2%; decreased with father educational level, 4 years, 29.0%, 6 y, 27.9%, 9y, 25.7%, 12y, 24.8% and > 12 years, 19.7% as well as mother educational level, 6 y, 30.1%, 6 y, 28.7%, 9y 26.2% 12y, 24.4% and > 12 y, 21.6%.

Portuguese schoolchildren showed a highest percentage of obesity what constitutes an important health problem in Portugal. Moreover, sedentary behaviors and unhealthy behaviors such as skipping breakfast were significantly associated with child obesity.

**Nutritional content of fallback and preferred foods in the diet of the Sanje mangabey (*Cercocebus sanjei*), Udzungwa Mountains National Park, Tanzania.**

GUILLAUME PAGES and CAROLYN L. EHARDT. Department of Anthropology, University of Texas at San Antonio.

This research evaluates theoretically derived predictions about the role of fallback foods in the diet of the Sanje mangabey (*Cercocebus sanjei*) through investigation of levels of antifeedants (condensed tannins CT and phenolics) and selected nutrients (crude protein, ether extract, NDF, ADF and ADL) associated with switching from preferred foods to fallback foods. A sample of 30 adult mangabeys from a habituated group was followed for 12 months, from December 2010 to November 2011, in the Mwanihana Forest, Udzungwa Mountains National Park. The mangabeys spent 50.6% of their plant diet feeding on ripe fruits, 29.6% on seeds, 6.8% on woody plant pith, 6.5% on

fungus, 3.1% on young leaves and 1.2% on flowers. A selection ratio was calculated to identify fallback and preferred foods. Fallback seeds and plant pith intake were found to be significantly negatively correlated with ripe fruit availability ( $\rho = -0.350$ ,  $\rho = -0.339$ ;  $p < 0.05$ ) and were also negatively selected for their high CT and phenolics levels ( $\rho = -0.448$ ,  $\rho = -0.414$ ;  $p < 0.05$ ). During periods of low ripe fruit availability, two fallback foods, seeds of *Parinari excelsa* and pith of *Aframomum* species, accounted for up 38.9% and 19.8% of feeding time, respectively, and contained 48.76% (DM) of lipid content and 25.01% (DM) of crude protein, respectively. This study confirms that plant secondary compounds influence dietary choice in frugivorous cercopithecines and that fallback foods with high lipid and protein content may be used to maintain dietary quality year-round, despite high content levels of condensed tannins and phenolics.

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**Paternity confusion or reassurance? Why pregnant Hanuman langurs (*Semnopithecus schistaceus*) are proceptive.**

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Anthropoid primates are unusual among mammals for their loss of estrus and for mating during gestation, which has been interpreted as a female counter-strategy to infanticide by males. If mating prior to conception is non-randomly distributed among males, after conception females may bias solicitations toward different males to confuse paternity and reduce the risk of infanticidal attacks. Under this tactic, males who join a group after a female has conceived should receive more solicitations than older resident males. Alternatively, pregnant females may solicit the same individuals to reassure males of paternity and encourage future protection of infants. We examined these predictions using proceptive behavior (i.e. solicitations of copulation via head shaking or presenting) before and after conception in Hanuman langurs from Ramnagar, Nepal. This species has no external signs of reproductive state, which may facilitate paternity confusion. Data were collected in ad libitum and focal animal sampling on two multimale, multifemale groups between 1991 and 1996. Groups had 4 to 15 adult females, and 2 to 9 adult males. A total of 2,542 proceptive events were included in the analysis. Post-conception, most females solicited different males (17 of 23 cases analyzed, 13 cases  $P < 0.05$ , chi-square test). Further, when males joined a group post-conception, the new males generally received a higher percentage of proceptive behaviors (8 of 11 cases, 6 cases  $P < 0.05$ ,

bootstrap analysis). These results support the hypothesis that proceptive behavior is aimed at paternity confusion. Future analysis will test whether proceptive behavior is indicative of the actual mating behavior.

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**Extending ethnoprimateology: an exploration of human/orangutan interactions in an urban zoological garden.**

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We present research on interactions between zoo-housed orangutans (*Pongo* spp.) and their caregivers at Auckland Zoo, New Zealand. Following the framework of ethnoprimateology, we use a combination of ethnographic, ethological and historical analyses to present a holistic picture of human-alloprimate interactions in this distinct setting. This approach facilitates our examination of the humans' understanding of orangutan behaviour and cognition, the social propensities of captive orangutans, and the ethics of keeping great apes in zoological gardens. Our ethological results confirm the existence of complex patterns of sociality among the orangutans, and suggest that individuals differ in their social propensities (e.g., time dyads spent in close proximity differed  $F_{(5,770)}=67.65$ ,  $p > 0.005$ ), and ethnographic data suggest that they differ in their inclination to interact with caregivers. Ethnographic data also suggest that although caregivers feel that they have close bonds with some of their orangutan charges, they expressed uncertainties about whether their practice of "reading" the orangutans' moods represents a valid husbandry approach. Furthermore, some caregivers struggled to reconcile their views of nonhuman great apes as moral persons with the realities of captivity. The portrayal of zoo animals as "martyrs" for their species was an emerging theme among the participants. Our study represents an extension of the ethnoprimateological research site into an artificial world well beyond natural ecological ranges. Despite this chasm, we develop tangible connections between our results and practical implications for orangutan welfare and conservation. As such, the robust utility of the ethnoprimateological approach is confirmed.

*This research has been approved by the Auckland Zoo's Animal Ethics Committee and the Human Participants Ethics Committee at the University of Auckland.*

**Enamel thickness in durophagous and folivorous primate species.**

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Enamel thickness in primates is hypothesized to be the selective product of several distinct constraints on feeding. Durophagy and lifetime dietary wear are known to be associated with thickened enamel caps, while folivory—or consumption of tough, sheet-like materials—is hypothesized to be associated with both thinner enamel and more heterogeneous thickness. The presumed thinner and more heterogeneous thickness of folivore enamel has been proposed as a mechanism for producing shearing crests, whereby thinner sections of enamel are worn more quickly, exposing the underlying dentine. Junctions between remaining enamel and exposed dentine form sharp blade-like edges which are functionally analogous to unguulate lophs. Indeed, folivorous primates are known to exhibit wear patterns that enhance the lengths of enamel dentine junctions (EDJs) on occlusal surfaces.

To determine whether heterogeneity in enamel thickness characterizes the teeth of folivorous primates, we collected enamel thickness data from unworn molars of three sympatric cercopithecids for which diets are known: durophagous mangabeys (*Cercocebus atys*) and two folivorous colobines (*Colobus polykomos* and *Procolobus badius*). Results indicate that colobines have thinner enamel overall ( $p = 0.008$ ); however, coefficient of variation measures reveal the three taxa do not differ in the variability of enamel thickness within crowns ( $p = 0.976$ ).

Based on our data we argue that heterogeneous enamel thickness is not necessarily associated with folivory in primates—and is therefore an unlikely mechanism for lengthening occlusal EDJ. We suggest that additional factors, such as enamel microstructure, and disparate occlusal surface usage are important in exposing enamel-dentine interfaces.

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#### Reconciling old maps with their curated collections: The implementation of technology to the riddle of curated commingled remains.

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This project seeks to re-examine a curated collection of commingled human remains and present a methodological technique in the application of contemporary technology to collections based research. In the Tennessee Valley, the Middle Woodland Period (A.D. 1 – 500) Copena mortuary complex is characterized by localized groups utilizing subterranean geologic formations and mound sites as interment locations. The depositional activities at many cave sites, which often consisted of simply inserting remains into the cave via an accessible opening, create a multilayered, commingled bone scatter. This research examined a single layer subsample from Lewis Jones Cave (1SC42), a Copena cave mortuary site in northern Alabama, and attempted to delineate both a Minimum

Number of Individuals (MNI) for the area and a cluster of associated elements in an effort to reconstruct individuals. We applied GIS and Adobe Photoshop to plan-view maps from the initial 1977 excavation to illuminate possible features in the two dimensional renderings that might assist our understanding of the collection. Reconstruction was aided by first isolating potential bone clusters on the digitized map and then applying collected metric, nonmetric, and patterned taphonomic data to delineate individuals based on these original clusters. The subsample rendered a conservative MNI of five by utilizing repetition of the left femora, while individual reconstruction was possible for two individuals. These preliminary observations will provide insight for further research of the Lewis Jones Cave site. Additionally, we believe the implementation of digitized maps will add considerable substance and contextual information to future collections based research.

#### Incremental growth lines in melatonin-deficient mice.

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Dentine- and enamel-forming cells secrete their respective tissues in rhythmic increments, resulting in the formation of successive growth lines. Experimental studies in primates and rodents have demonstrated that these lines are the result of daily secretory activity (circadian rhythms). In 2001, a Japanese team showed that the destruction of the master biological clock in mammals, the suprachiasmatic nucleus (SCN), resulted in the cessation of growth line formation in rats. Recently, researchers have hypothesized that melatonin (an endocrine hormone secreted with a circadian rhythm) may act as a messenger between the SCN and the developing teeth, and therefore may be a crucial component in the process of growth line formation. In order to test this hypothesis, we studied dental development in melatonin-deficient C57BL/6 mice. Six mice were given two (n=2), four (n=2), or five (n=2) injections of nitrilotriacetato lead (2 mg/kg Pb-NTA) at five day intervals from eight days of age to chronologically label the developing incisors. Following humane sacrifice, incisors were dissected, decalcified, sectioned, and stained in order to visualize the lead labels. Five growth lines were observed between consecutive lead labels, demonstrating clear daily incremental lines in C57BL/6 mice teeth, as in other rodents. These results suggest that melatonin may not have a principal role in the process of incremental line formation. Ultimately, further elucidation of circadian biology and its role in

incremental feature formation will allow more accurate estimations of tooth formation time, an essential tool for reconstructing primate life history.

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#### Mapping the spatial distribution of the mortuary remains at Neolithic Alepotrypa Cave, Greece.

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Neolithic Greece is characterized by significant variability in mortuary expression. Burial practices include primary single and multiple burials, secondary deposits in ossuaries, cremations, and various ritualistic processes. Apart from formal burial practices, Neolithic sites also contain scattered bone. While scattered bone is rarely studied, understanding its spatial order can inform us of the overall mortuary context, and the patterning of the secondary mortuary processing.

This work focuses on the Neolithic site of Alepotrypa Cave in southern Greece, in which all forms of funerary expression have been observed, in order to study prehistoric social relationships through the spatial distribution of mortuary expressions. In an effort to map the spatial distribution of the human osteological remains, the overall mortuary context of the cave was reassessed and scattered bone was restudied in conjunction with primary and secondary burials. All burial forms, with the associated grave goods, were identified within the context of a detailed map of Alepotrypa Cave, which was produced using GIS, with all human skeletal remains plotted and spatially situated within this system. The elements in scattered bone and their spatial distribution where compared against the respective ones from primary and secondary burial locations in order to determine if they are the byproducts of secondary burial processing or if their position is the result of a deliberate act of remembrance.

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#### Seasonal and social influences on androgen secretion in male geladas.

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Among male vertebrates, the challenge hypothesis predicts that seasonal patterns in androgen secretion vary in accordance with mating system, male-male competition, and paternal care. For example, in male primates competition for dominance rank is associated

with increases in androgen levels. For reproductive success, gelada (*Theropithecus gelada*) males must first overthrow a dominant leader for access to a unit of females ("takeover") and then, as the new leader of that unit, fend off rival males. Here, we examine the social and seasonal factors contributing to variation in male gelada androgen levels using noninvasive fecal samples (N=2730 samples and 133 males) collected over 6 years (2006-2011). We found a strong seasonal pattern in fecal testosterone metabolites (fT) for all males, with peak fT levels at the end of the rainy season when food is most abundant. Although leader males exhibited the highest levels of fT overall, bachelor males exhibited significantly higher fT levels across a few months each year characterized by a high rate of takeovers. Moreover, bachelors were more likely to engage in and escalate aggressive contests with leader males during this "takeover season". Our results suggest that bachelors may be maximizing the likelihood of a successful takeover by challenging leader males when their fT levels are lowest.

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#### **Patterns in the adult and subadult pathologies in the Late Prehistoric Hiwassee Island osteological sample from East Tennessee.**

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The site of Hiwassee Island (40MG31) was apparently a strategically important pre-Columbian aggregate settlement based on the episodes of occupation and its island location at the confluence of the Tennessee and Hiwassee Rivers (Chickamauga Reservoir). The site was one of few WPA Era salvage archaeological projects that merited a monograph (by T. Lewis and M. Kneberg). However, little bioarchaeological analysis has been undertaken on the human remains. The Late Mississippian component (Dallas phase, AD 1300-1400) (N=175) was examined for basic health markers (LEH, periostitis, cribra orbitalia [CO], porotic hyperostosis [PH], longitudinal growth) and assessed by age and sex. Two adult age-at-death cohorts (<30 years, 30+ years) were defined.

CO was evident in 56% of subadults, PH in 41%, and periostitis in 17%. The post-weaning age subadult data revealed age progressive chronic health stress in conjunction with compromised growth. Males had a higher overall prevalence of anemia (PH or CO) (86.7% versus 68.2%) but when controlled by age, the sex difference was not significant. The adult sample has a 66.7% raw frequency of LEH with no significant difference by sex. Young adult age at death co-occurred with higher a prevalence of LEH (63% versus 35%).

The overall prevalences of the pathologies assessed are markedly higher in the Hiwassee Island sample relative to other Dallas phase samples in East Tennessee. This may reflect the eco-geographic particulars of the island or may relate to the abrupt socio-political reorganization of the Dallas phase in the Chickamauga Reservoir after circa AD 1400.

#### **Dental pathology and indicators of environmental stress in the prehistoric population of the Atacama Desert.**

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The present investigation evaluates the biological impact of the occupation of different ecological niches over time in the Atacama Desert, North Chile. We compared skeletal samples from sites in Pica-Tarapacá and the Atacama oases from different cultural periods (Formative, Middle and Late Intermediate). Our goal was to explore differences over time in these two desert areas.

We analyzed dental pathology, including caries, occlusal wear and antemortem tooth loss in concert with the cultural context of the burials as a way of accessing diet during these times and between the two regions. Considering the significant environmental stress produced by desert climates, we also studied several osteological indicators of stress: linear enamel hypoplasia, cribra orbitalia and porotic hyperostosis.

Our results show a high prevalence in both sets of indicators. However, while there are pronounced differences in all dietary indicators between periods in the Atacama oases sample, Pica-Tarapacá shows significant differences only in antemortem tooth loss. Environmental stress indicators show no clear pattern of chronological or geographical differences. Nevertheless, the mortuary context and high prevalence of hypoplasia in most samples, suggests that these populations were subject to high levels of environmental stress.

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#### **Male reproductive senescence in the ring-tailed lemur (*Lemur catta*).**

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Although most studies of reproductive senescence focus on females, males also experience reproductive decline with increasing age. Among primates, males show decreased semen quality as well as declines in reproductive performance (e.g., sexual stamina) with aging. At present, quantitative data on the effects of aging on male sexual performance are only

available for humans and rhesus macaques. Such data are lacking in strepsirhines. Therefore, the goal of this multi-year retrospective study was to evaluate male ring-tailed lemur (*Lemur catta*) sexual behavior for evidence of reproductive decline. Data were collected across 11 mating seasons on St. Catherines Island, Georgia, USA. Data came from 60 different copulatory events that led to ejaculation involving 27 individual male *L. catta*. The oldest males in the study were 14 years of age. Results showed that older male *L. catta* did indeed exhibit a decline in sexual performance, because age was positively correlated with cumulative time spent in mounts before ejaculation was reached (Spearman,  $p < 0.05$ ) and with the total number of mounts needed to reach ejaculation (Spearman,  $p < 0.05$ ). Older males (those between 8-14 years of age) were also less likely than younger males to be the first mates of females entering estrus, which may signal a concomitant decline in the competitive ability of older males, as access to females is largely gained via physically aggressive intra-sexual competition in this species. These results demonstrate that strepsirhine males experience a marked decline in sexual performance with age, making this pattern of reproductive senescence ubiquitous across the primate order.

#### **A sensitivity analysis of the impact of household consumer-producer ratios on the hazard of out-migration among the Karen.**

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Household dynamics have important implications for human migration and mobility, perhaps especially in small-scale agricultural populations. However, studies that investigate the influence of household factors on human movement patterns have been rare, largely because relevant quantitative data are hard to collect. In this study we used longitudinal demographic data from ethnic Karen populations along the Thai-Myanmar border. These villages rely heavily on agriculture for subsistence. We used event history analysis to investigate the risk of out-migration with regards to the household consumer-producer (CP) ratio. In our study population(s), working-aged males are likely to engage in strenuous work during planting and harvesting seasons and may also consume more food during these times. However, during the off season, males may not contribute much labor at all. We therefore conducted a sensitivity analysis of our event history model, allowing for varying contributions by working-age males and females. Our initial model indicated a negative relation

between a household's CP ratio and the risk of a household member out-migrating. Our sensitivity analysis indicated that when male household members contribute more labor than females there is a decrease in the likelihood of out-migration in high CP ratio households. We interpret this finding to indicate that when there is a relative shortage of household 'producers' there is also a decrease in the likelihood that household members will migrate. Our study adds to the scant literature on migration in small-scale agricultural societies and has implications with regards to the use of CP ratios in demographic models.

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**Ad sanctos burial and markers of skeletal health in Medieval Asturias, Spain.**

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The purpose of this study is to investigate the relationship between Medieval mortuary status reflected in ad sanctos burials to markers of skeletal health, observed on individuals living in the predominantly rural communities of Medieval Asturias, Spain (~900-1800 AD). Ad sanctos burial, roughly translated to "in the presence of saints," refers to the Medieval Christian practice of mortuary status reflected by burial in proximity to saintly remains or Christian relics (Naji 2005). Theoretically, this differential status indicates differential access to resources. High status burials are considered to be those within the walls of a church, while the lower status individuals were buried outside the church walls in the cemetery.

In this study, human skeletal remains recovered from 13 different archaeological contexts within the region of Asturias, Spain, were analyzed to address ad sanctos burial's relationship to health. Potentially confounding issues of poor preservation and limited contextual information were resolved by aggregating the multiple small Christian church cemetery samples into a single regional sample representing the general Medieval Asturian population. Standard demographic information as well as typical indicators of skeletal health and disease such as: linear enamel hypoplasia, tibial periostitis, cribra orbitalia, porotic hyperostosis, other bony infections, and adult stature were evaluated on all available individuals.

Results show that while ad sanctos mortuary treatment was practiced throughout Spain during the Medieval period, health differences between individuals buried within churches and in the common church cemetery are not statistically significant.

**Hallucal reduction in sloth lemurs and morphological convergence on orang-utans by *Palaeopropithecus*.**

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It has been claimed that among primates *only* the orang-utan possesses a "rudimentary hallux", presumably related to its adaptations for antipronograde positional behaviors. To the contrary, we document here a steep morphocline of hallux reduction in a clade of strepsirrhines that includes living indriids and subfossil palaeopropithecids ("sloth lemurs"), culminating in a vestigial hallux in *Palaeopropithecus*. Hallucal metatarsals (Mt1) are described for the first time for *Babakotia radofilai* (n=4) and *Palaeopropithecus ingens* (n=1), and these are compared to *Indri*, *Propithecus*, *Avahi*, *Pan*, *Gorilla* and *Pongo*.

The Mt1 of *Indri* (< 10 kg body mass) is absolutely longer than that of both *Babakotia* (~20 kg) and *Palaeopropithecus* (~40 kg). Relative to the length of the fourth metatarsal in strepsirrhines and the third metatarsal in great apes, the Mt1 of *Babakotia* is much shorter than in all indriids (and the African apes). The Mt1 is also greatly reduced in orang-utans, but this reduction is exceeded by *Palaeopropithecus*. The prominent peroneal process seen in the Mt1 of living indriids (and other strepsirrhines) has been lost in both sloth lemurs. The diaphysis of the Mt1 is robust in *Babakotia* but is more gracile in *Palaeopropithecus*, and the head in *Palaeopropithecus* is small and flattened as in orang-utans.

Hallucal reduction reinforces other skeletal evidence (e.g., limb proportions and phalangeal curvature) that these two genera of large-bodied sloth lemurs were highly suspensory. Orang-utans are therefore not unique, but still serve as the best primate analogue for *Palaeopropithecus*, one of the most antipronograde mammals to ever evolve.

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**Convergent evolution of escape from hepaciviral antagonism in primates.**

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Evolution of our immune systems is shaped by their interaction with pathogens. We asked whether adaptive changes in immune factors serve as "memories" of past viral infections and whether these can provide insights into ancient viruses. We also sought to determine whether virus-driven adaptive changes in host factors affect their ability to restrict modern-day viruses.

Host factor MAVS is a central component of the viral RNA sensing pathway. Not surprisingly, therefore, many viruses antagonize it. Such antagonism places selective pressure on MAVS to evolve away from being inhibited. Indeed, our phylogenetic analyses suggest that MAVS has recurrently and rapidly evolved in primates, consistent with the

hypothesis that viral antagonism has shaped its evolution.

HCV is a modern-day virus that antagonizes MAVS. We sought to functionally determine whether adaptive evolution in MAVS has consequences for its ability to resist HCV antagonism. Indeed, we found that MAVS from multiple primate species have independently acquired adaptive changes at the same position that protect it from HCV antagonism.

In order to determine the nature of viral antagonists responsible for driving this evolution in MAVS, we functionally tested the ability of multiple HCV-like viruses from non-human primates to antagonize MAVS. Results from these experiments suggest that ancient hepaciviruses were likely responsible for driving MAVS evolution.

Thus, evolution of host immune factors can be used to gain insights into history of ancient viral infections. Our study also suggests that adaptations to ancient viruses likely have profound impact on host susceptibility to modern-day viruses such as HCV.

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**Comparative analysis of intercuspal dimensions and crown morphology between the deciduous second molar and permanent first molar within the same maxillary arcade.**

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The permanent first molar (M1) has received particular attention in anthropological studies because it is thought to most accurately represent the ancestral form of the molar field. Indeed, differences in M1 trait expression have been useful in assessing biological relationships among modern human populations and effective in discriminating among Plio-Pleistocene hominin taxa. The deciduous second molar (dm2) is considered the analogue of the permanent M1 and is thought by some to be more phylogenetically conservative and/or under stronger genetic control due to its early development. This study tests that presumption by comparing morphological and metrical variables of the maxillary dm2 (x<sub>dm2</sub>) and M1 (XM1) within the same individuals. The sample included 64 individuals representing several archaeologically-derived recent human groups. Traits included absolute and relative intercuspal distances, cusp areas, cusp angles, occlusal polygon area, and Carabelli's trait expression. Results show highly significant correlation between the XM1 and x<sub>dm2</sub> in all absolute and most relative dimensions and in Carabelli's trait expression. In addition, the relative areas of the occlusal polygon, protocone and paracone did not differ significantly between the two teeth. These results suggest that crown shape and cusp proportions are partially conserved in the XM1.

In contexts in which no permanent XMI1s are available, we propose that select traits in the xdm2 may be used as a proxy for XMI1 expression. However, while the XMI1 may be the most conservative of the permanent maxillary molar field, our results suggest that the xdm2 may better represent the ancestral molar morphology.

*Data collection by SEB was supported by the LSB Leakey Foundation. Data collection by KSP was supported by the National Science Foundation Graduate Research Fellowship No. 2011121784.*

**Multiple myeloma: How a contemporary Forensic Anthropology case can inform the past.**

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In collaboration with the District 20 Medical Examiner's Office, Naples, Florida we present a forensic anthropology case of a destitute adult, European American male exhibiting prolific lytic activity consistent with multiple myeloma. Our review of the osteological literature highlighted a dearth of contemporary cases of clinically confirmed multiple myeloma that lacked modern medical intervention. As such, this contemporary case provides data to help the differential diagnoses of ancient skeletal remains that exhibit the condition and becomes one of a few comparative standards that help biological anthropologists identify the condition. Furthermore, we present the myriad conditions eliminated via differential diagnosis.

Multiple myeloma, metastatic carcinoma, Langerhans cell histiocytosis, and mycotic infection exhibit overlaps in the distribution and morphology of the lytic lesions that identify these skeletal pathologies. However, we identified the skeletal pathology as multiple myeloma via macroscopic examination and radiographs which revealed bilateral osteolytic bone resorption that exhibited a 'punched-out' appearance and lack of osteoblastic activity. We validated our diagnosis by means of examination of the decedent's medical records and laboratory results. Specifically, the medical records revealed a clinical diagnosis of multiple myeloma affirming hypercalcemia, hyperproteinemia, elevated IgG levels, low IgA and IgM levels, and anemia of chronic disease.

**Population interaction during the Hungarian Early to Middle Copper Age: A biological distance study using dental metric and nonmetric traits.**

IAN C. PAWN. Southeast Archeological Center, National Park Service, Department of Anthropology, Florida State University.

This study examined population interactions on the Hungarian Plain using

frequencies of dental non-metric traits and dental measurements. Archaeological evidence had indicated intensified interaction, trade, and settlement dispersals during the Early to Middle Copper Age, but it was not understood how these cultural shifts affected gene flow between populations across the Hungarian Plain. Genetic variability can be used to infer the possible nature of interactions between populations. It was hypothesized that intensified population interaction resulted in increased gene flow and limited phenotypic variability between populations.

Seven cemeteries were sampled for comparison using biological distance statistics. Phenotypic differences in the dentition were used to examine genetic variability between and within cemeteries. Dental metrics were compared using Relethford-Blangero analysis, and frequencies of dental non-metric traits were compared using Smith's Mean Measure of Divergence. Phenotypic differences between males and females within cemeteries were also examined to infer possible post-marital residence patterns using comparisons of variance in dental metrics.

Phenotypic analyses revealed overall genetic homogeneity across the Plain, but there were subtle genetic differences between the cemetery samples. Only one cemetery exhibited higher than expected phenotypic variance. These data support a model of increased gene flow between populations during a period of intensified trade and interaction. The genetic differences between males and females within cemeteries were limited suggesting relatively equivalent amounts of gene flow among both sexes. No post-marital residence model could be proposed for these data. These data will provide valuable insight into Copper Age social relations taken in conjunction with archaeological data.

*This work was made possible through support provided by the National Science Foundation and Florida State University*

**The effects of locomotor category on the ontogeny of skeletal robusticity in two strepsirrhine species.**

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This project investigated skeletal development in nonhuman primates, specifically searching for locomotor and sex differences. We searched for a relationship between bone shape ("robusticity") and bone quality (density) in *Lemur catta* and *Propithecus verreauxi*. A compensatory relationship between bone shape and quality has been shown in humans and mice, whereby gracile bones maintain functional equivalence by increasing tissue mineral density, so we investigated whether it is also present in two species of lemur. Because the pattern has

been shown to be sexually dimorphic in humans, we tested for sex differences in adult lemurs, which are less sexually-dimorphic than humans in their body mass. Finally, since the pattern was seen in infant mice, indicating that it is genetic, rather than activity-mediated, we looked for the pattern in infant lemurs.

We microCT scanned eight bones from 11 *L. catta* and 10 *P. verreauxi*, which ranged from 0 to 96 months of age. We compared robusticity (i.e., total periosteal area / length) to the tissue mineral density of the bones. The variables were significantly positively correlated due to ontogenetic allometry, but due to small sample sizes, we could not identify the predicted inverse relationship within infants or adults separately. However, *Lemur* femora were consistently more gracile with higher tissue mineral density than *Propithecus* femora at all ages, but the reverse was true for the ulna. The site-specific, and at times age-specific nature of the relationship indicates activity patterns may be contributing to the development of both shape and quality aspects of bone strength.

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**Identifying traumatically induced brain injury (TBI) and disability in medieval England AD1066-AD1600.**

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Traumatic brain injury (TBI) is a major public health issue and is the most complicated affliction and management problem in modern medicine. It is the leading cause of death in people under 45, results in multiple disabilities and is among the earliest neurosurgical problems faced by ancient doctors. This indicates that TBI was recognised as a significant health problem from prehistoric times and is worthy of investigation.

The hypothesis tested was "TBI survivors demonstrate a variety of disabilities which evidence inequality of access to care and treatment". Non destructive macroscopic and radiographic methods of investigation were used to identify ill health and disability in TBI survivors and a control group of individuals. Recording methods followed acknowledged good practice standards and findings were compared with current clinical brain injury studies. The study populations came from the medieval cities of York, London and Norwich.

Current findings indicate survivorship of individuals who would not have been expected to survive their injury without modern medical intervention, variance of sharp and blunt force trauma injury patterning between the cemetery populations and the potential marginalisation of some individuals within their community.

In summary, studies of injuries to the cranium and the identification of disability in archaeology has been extensive but limited in scope. Consequently, little is known about the complex and potentially devastating impact TBI had on the victim and the wider community.

Therefore, this study of the outcomes of the survivors of TBI has the potential to move research into disability in past populations forward.

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#### **Patterns of sexual dimorphism in *Pan* and *Gorilla* limb bones.**

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While it is well-established that *Pan* and *Gorilla* differ in degree of size-based sexual dimorphism, less is known about their patterns of shape-based sexual dimorphism in the postcranium or about geographic variation in these patterns. Using a geographically diverse sample, differences between the genera in patterns of sexual dimorphism in the limb bones were investigated.

Forty-three linear measurements of ten limb bones were collected from *Gorilla* (n=266) and *Pan* (n=274) adults, size-corrected using geometric means, and analyzed using t-tests and principal components analyses (PCAs). Male and female *Gorilla* are best separated on PC2 and PC3, with high loadings for size-corrected lengths and midshaft widths and low loadings for size-corrected measurements of the proximal and distal ends. *Pan* sexes are not as strongly distinguished but are best separated on PC1 and PC2, on which size-corrected lengths, hand and foot bone widths, and elbow and knee measurements load most heavily. T-tests and PCAs of size-corrected measurements show greater shape differences between sexes in *Gorilla* than in *Pan*.

Examination of PCA plots by species, subspecies, and population, however, show that patterns of sexual dimorphism differ at each of these levels and do not simply reflect the genus-level pattern. For example, in *Gorilla*, the female distribution pattern varies among populations. In *Pan*, *P. troglodytes troglodytes* and *P. t. verus* display some separation of sexes, while little sexual dimorphism is apparent in the distributions of *P. t. schweinfurthii* and *P. paniscus*. Patterns of shape-based sexual dimorphism in limb bones exhibit geographic variation within each genus.

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#### **Exhibiting bodies: Confronting the human remains debate in public museums.**

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Museums largely serve as the venue for promoting anthropological research to the greater

public. These are dynamic institutions, however, that must respond to fluctuating social concerns. Currently, the field of physical anthropology is directly affected by the contentious museum climate regarding the display of human remains. To confront this issue, a multidisciplinary approach explores transitions in public perception and the evolution of museum practices associated with these materials. The contemporary examination of museums is achieved through qualitative research as well as a quantitative analysis of human remain displays. A survey of eleven English museums was implemented focusing on institutional characteristics, representations of human remain types, display features, and spatial and thematic trends. Within each of these categories a numeric scoring system was developed, allowing for statistical analysis to be completed both within and across fields. Although this survey approach was only used to assess permanent displays, trends in temporary exhibitions are also investigated. Results suggest that despite vocalized hesitations, displaying human remains can be completed in an educational manner which is both respectful to the content and its visiting audience. The prospects of such a conclusion are highly favorable to the discipline of physical anthropology. With a greater museums presence, more information can be spread to an already large audience therein promoting widespread knowledge as to the human existence and fostering further excitement in like forms of research.

#### **Multivariate analyses of trabecular bone structure in the proximal femur of living and extinct strepsirrhine primates.**

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The three-dimensional trabecular bone structure of the femoral head of strepsirrhines has been related to locomotor differences, particularly between leaping and non-leaping taxa. The goal of this study is to assess trabecular bone structural adaptation in the proximal femur of strepsirrhine primates by using multivariate discriminant function analyses to categorize extant species by locomotion and to predict locomotor behaviors in fossil primate species. The proximal femur of 37 individuals from six extant primate genera (*Microcebus*, *Cheirogaleus*, *Galago*, *Loris*, *Otolemur*, *Perodicticus*) and three extinct primate taxa (*Karanisia*, *Omomys*, *Shoshonius*) were scanned on a high-resolution computed tomography system with voxel dimensions below 0.04 mm. Trabecular bone structural features (bone volume fraction, degree of anisotropy, trabecular thickness, number, and spacing, and connectivity density) were quantified in two volumes of interest extracted from the articular region of each bone. These features were corrected for body mass and used in a multivariate

discriminant function analysis both to determine the suites of bony characteristics that differentiate locomotor and taxonomic groups and to predict the position of the three fossil specimens. Results for extant species show a strong separation of *Galago*, *Loris*, and *Perodicticus*, suggesting a distinct locomotor functional signal in the femoral head trabecular bone of these primates. Fossil specimens show clear similarities to specific locomotor groups with the basal lorisiform *Karanisia* plotting closest to the slow quadrupedal *Loris* and the larger-bodied quadrupedal leaping *Otolemur*.

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#### **Influence of angiogenesis on craniofacial bone morphology.**

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The bases of craniofacial skeletal size and shape variation within modern populations and across evolutionary history is extremely complex. A large number of genetic factors and epigenetic interactions guide the development of craniofacial bones. Given the critical role that blood vessel growth (angiogenesis) plays during skeletogenesis, we hypothesize that modification of angiogenic processes can produce novel evolutionarily relevant variation in calvarial bone morphology during fetal vault skeletogenesis.

The *Fgfr2<sup>+P253R</sup>* Apert syndrome mouse model with known craniofacial dysmorphology was studied because fibroblast growth factor (Fgf) and receptor (Fgfr) interactions are known to influence angiogenesis. Additionally, significant reductions in craniofacial bone size and bone density are associated with conditional Tek-cre based expression of the *Fgfr2 +P253R* mutation in vascular endothelial cells. Simultaneous Optical Coherence Tomography and Photoacoustic Microscopy (OCT/PAM) produced 3D images of blood vessels and tissue layers surrounding the developing left frontal bone of *Fgfr2<sup>+P253R</sup>* mutant mice and littermates at embryonic days 13.5, 14.5, 15.5, and 16.5. For some specimens, bones identified using micro-computed tomography ( $\mu$ CT) were registered to OCT/PAM images. Careful comparison revealed no clear differences in vascular patterns associated with early frontal bone skeletogenesis between mutant mice and unaffected littermates. Therefore, fetal modification of vascular patterns may not be the basis of previously measured abnormal calvarial bone dimensions associated with expression of this mutation in vascular endothelium. Further studies are required to explore other potential regulatory connections between angiogenesis and evolutionarily relevant craniofacial skeletal variation.

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**Ancient DNA genomics of Madagascar's extinct subfossil lemurs: *Palaeopropithecus ingens* genetic diversity.**

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With ~100 extant taxa, lemurs are one of the most diverse faunal groups of Madagascar. Yet lemur diversity was even greater prior to the arrival of humans on the island ~2,300 years before present (ybp). From unmineralized skeletal remains, we know of at least 17 "subfossil" lemur species that went extinct between 2,000 and <500 ybp. All extinct subfossil taxa were larger than any extant lemur; humans probably contributed to their extinction through hunting and habitat changes. We are using ancient DNA techniques and massively parallel sequencing to study subfossil lemur extinction biology by estimating genetic diversity and characterizing temporal changes in effective population size, and by making comparisons to extant lemurs. To date, we have sequenced the complete mtDNA genomes of four *Palaeopropithecus ingens* individuals from two sites. Surprisingly, our preliminary estimate of *P. ingens* mtDNA diversity ( $\pi=1.8\%$ ; accounting for DNA damage) is relatively high compared to our estimates for the largest-bodied extant lemurs, *Indri indri* ( $n=10$ ;  $\pi=0.5\%$ ), diademed sifaka (*Propithecus diadema*;  $n=10$ ;  $\pi=1.3\%$ ), and Milne-Edwards' sifaka (*Propithecus edwardsi*;  $n=10$ ;  $\pi=0.7\%$ ), each sampled from multiple sites. This difference cannot readily be explained by temporal variance among the *Palaeopropithecus ingens* samples, as all individuals were estimated to have lived within ~150 years of each other (1,486-1,330 ybp). While these results are preliminary, they suggest that the female effective population size of this subfossil species may have been higher than that of many extant lemurs. Thus, low historical population size may not be a principal extinction risk factor for lemurs.

**Aye-aye jaw adductors: Anatomy, architecture, and allometry.**

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With its specialized foraging style and distinctive craniodental complex, the aye-aye (*Daubentonia madagascariensis*) is a most unusual strepsirrhine primate. During extractive foraging, aye-ayes employ wide gapes and perhaps generate large incisive bite forces, two functional requirements that typically might be predicted to produce conflicting morphological demands in an evolutionary trade-off. Given these functional requirements, the jaw adductors of *Daubentonia* are expected to have long fascicles to accommodate wide gapes and/or great physiological cross-sectional areas (PCSA) to produce large bite forces. Thus far, the only published data on chewing muscle fascicle length and PCSA in *Daubentonia* are from a subadult specimen. The chewing muscles in that specimen had very long fascicles and unremarkable PCSA, supporting gape adaptation in the masticatory complex, but not force adaptation. Here we report the first data from an adult aye-aye. Relative to both body mass and jaw length, its total chewing muscle PCSA (2067 mm<sup>2</sup>) is significantly greater (three standard deviations) than the mean of a broad sample of strepsirrhines. Mean fascicle length (9.9mm) relative to both body mass or jaw length for the adult specimen is also high relative to the strepsirrhine mean, but within the second standard deviation. Taken together with the data from the subadult *Daubentonia* specimen, this suggests that aye-ayes might shift foraging mechanics through development, based on changing functional constraints, with juveniles using a wide-gape strategy and adults using large bite forces.

Travel funded by Johns Hopkins University and Pennsylvania State University.

**Impact of early life experience on fitness-relevant demographic outcomes in wild white-faced capuchin (*Cebus capucinus*) males in Lomas Barbudal, Costa Rica.**

SUSAN E. PERRY. Anthropology; Behavior, Evolution and Culture Program, University of California-Los Angeles.

My recent published work in this population has demonstrated that (a) males who spend their first 5 years of life in a group with a stable alpha male disperse later than males who experience alpha male turnover, (b) males who disperse later are more likely to become alpha males and start siring offspring early in life, (c) those males who achieve external takeovers disperse jointly rather than singly, and (d) co-migrants have a coefficient of relatedness of  $r=0.25$  on average. It is not entirely clear why there is a link between demographic stability early in life and success in achieving alpha status

later in life. Here I explore the demographic consequences of growing up in stable vs. unstable groups. The study includes demographic data from six groups of capuchins in Lomas Barbudal, Costa Rica from 1990-2011. 58% of 133 males who grew up in groups with alpha turnover during the first 5 years of life lived to age 5, whereas 78% of 32 males growing up in groups with no alpha male turnover during the first 5 years of life survived to age 5 ( $P=0.04$ ). Males who experienced no alpha turnover during the first 5 years of life co-resided, at age 5, with significantly more natal males within 5 years of their age than those males who experienced alpha turnover in the first 5 years of life ( $P=0.024$ ). These natal males could potentially serve as play and co-migration partners, aiding them in taking over other groups.

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**Investigating inter-laboratory variability in stable isotope data.**

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With the growing popularity of isotopic paleodiet and paleoenvironmental reconstructions, the question of whether data obtained in one laboratory are directly comparable to those obtained elsewhere becomes increasingly relevant. Differences in pretreatment and analysis could potentially introduce variability in isotopic results that would render data comparisons from different laboratories invalid. To address these issues and answer the pressing question of the validity of inter-laboratory comparability, we have undertaken a study enlisting the participation of over fifteen anthropology, biology, and geology laboratories that routinely analyze ancient bone collagen and apatite. From its inception, the goals of this study were to: (1) assess the degree of inter-laboratory variability associated with bone collagen and hydroxyapatite pretreatment and analysis, and (2) identify potential causes of this variability (e.g. chemicals used, treatment time). To accomplish these goals, participating laboratories received replicate samples from the same ancient <sup>14</sup>C-dated human bone, which they were asked to process and analyze following typical in-house protocols. Participating laboratories provided details on pretreatment and analytical methods, sample preservation assessments, and resulting isotopic data. Here we present the results of this inter-laboratory study. These results establish the comparability of stable isotope data obtained from different laboratories and provide insight into the nature, degree, and potential causality of inter-laboratory isotopic variability.

### Extensive convergence between giant panda and hominoid vertebral formulae.

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The vertebral column plays central roles in posture, stability, and locomotion. Its numerical composition is somewhat conserved across phylogenetic groups, which may result from developmental constraints and/or stabilizing selection. Deciphering the role of selection versus constraint in this complex anatomical system is therefore of interest in functional and evolutionary studies.

Compared to other vertebrates, mammals are relatively conserved in pre-caudal vertebral formulae. Hominoids are intra- and inter-specifically quite variable in vertebral counts, and because their vertebral formulae are derived relative to non-hominoid primates and many other mammals, an understanding of the forces that drove their evolutionary history may be aided by a comparative study. Using ARLEQUIN, we analyze a dataset of 5735 mammals from 648 species (435 genera), representing all major divisions of Mammalia. Following Pilbeam, we use a morphological analog of Nei's genetic identity index to quantify interspecific variation in vertebral formulae by creating a ratio of shared vertebral patterns between two populations to the total amount of variation in both populations.

Results demonstrate a significant case of convergence between giant pandas (*Ailuropoda melanoleuca*) and hominoids; in turn, giant pandas generate no similarity with other bears. Like hominoids, giant pandas demonstrate reduced trunks and numerically long sacra. Although more detailed analyses on the evolutionary morphology of ursid and hominoid vertebral columns are required, the observation that both groups demonstrate complex manual manipulation during upright feeding postures is intriguing. Whether or not this behavior played a selective role in their extensive convergence is a hypothesis that will require further testing.

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### On the ecology of leprosy: Tails from phylogenomics.

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The origin and ecology of leprosy, an ancient human scourge, remain poorly understood. *Mycobacterium leprae*, the causative agent of leprosy, exhibits a parasitic lifestyle based on extensive genome decay that happened millions of years ago, suggesting *M. leprae* may have been present in primates long before modern humans. In contrast, very limited genetic

variation among strains of distant geographic locations suggests a recent jump to humans. To explore the evolutionary history of leprosy, we sequenced the genome of an *M. leprae* isolated from a West African mangabey. Further, to assess whether other non-human primates are also affected by leprosy, we surveyed wild chimpanzees and ringtail lemurs using qPCR of DNA extracted from cheek swabs or wadges.

Our analyses show that the mangabey strain is closely related to human strains. Human West African and the mangabey strains are ancestral to Eurasian strains, supporting an Africa origin of leprosy. To determine the timeframe of disease spread, we calculated *M. leprae*'s substitution rate from the estimated divergence time between *M. leprae* and *M. tuberculosis*. The latter was obtained using 101 homologous proteins across 27 bacterial taxa and a Bayesian relaxed-clock framework calibrated with biogeochemical events. Our findings support the spread of leprosy from Africa to Europe and Asia around 10,000 years ago. The role primates play in the ecology of human leprosy remains unknown. New World nine banded armadillos that are infected with leprosy in their entire range, however, have been implicated as possible zoonotic source for human leprosy more recently.

### The depositional patterning of avian scavenged remains.

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Black Vultures (*Coragyps atratus*) and Turkey Vultures (*Cathartes aura*) are large diurnal birds that primarily feed on carrion such as road kill, but recent evidence has revealed that vultures will also feed on human remains. As scavengers of carrion and humans, vultures can play a critical role in the deposition of skeletal remains from both past and modern settings. Despite the importance of avian scavengers in an anthropological context, the depositional patterning of skeletal elements scatted by vultures and other birds remains under investigated. Knowledge on the depositional patterning of avian scavenged remains can benefit anthropologists during both archaeological and forensic investigations by aiding and promoting an awareness of where to search for remains that may have otherwise been overlooked. The goal of this study is to provide new knowledge on the depositional patterning of avian scavenged remains through the use of Global Positioning Systems (GPS), Geographical Information Systems (GIS), and Nearest Neighbor Analysis (NNA). This study used 16 deceased piglets in the fresh stage of decay to investigate vulture scavenging patterns in six different Central Texas locations. Spatial point data on pig skeletal elements scavenged by birds were analyzed using NNA to test the hypothesis that birds will scatter and deposit remains in a pattern that is random rather than in a pattern that is either clustered or more dispersed than by chance alone. Results reveal that avian scavengers, especially vultures, display a non-

random scavenging behavior that is reflected in the final deposition of the skeletal remains.

### Serum prolactin and social behavior of Kindas and other baboons.

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Prolactin, the "maternal hormone", is now understood to be more generally related to nurturing behavior, in males as well as females. We examined prolactin levels in male baboons (*Papio*) of three species: *P. anubis*, *P. hamadryas* and *P. kindae*. We predicted a difference in prolactin profiles, paralleling their distinct social behavior. Samples came from baboons captured in the Awash National Park (anubis and hamadryas) and in Kafue National Park (kindas). Mean adult male prolactin in kindas (X=10.6) did not differ significantly from hamadryas (X=7.94), but each was higher than anubis (X=5.74; p=0.002). In each species, prolactin levels increase from early sexual maturity (about 6 years) to young adulthood, but the trajectories differ. In anubis, mean prolactin concentration rises gradually, leveling at about 13 years. In hamadryas, prolactin concentration shows a marked, high peak between 8 and 11 years, when, as young adult bachelors, males often assume a mother-like role in carrying and caring for a female infant, as a first step toward One Male Unit formation. In kindas, prolactin levels rise until c 9 years, and remain high. We suggest that this may be related to the uniquely high frequency of male-female grooming interactions in which the male is the groomer (70%, vs. 13% in anubis), behavior reminiscent of the prolonged grooming of infant baboons by their mothers. Thus elevated prolactin levels in both hamadryas and kindas baboons when compared with anubis, may reflect species variation in behaviors that can be described as 'pseudo-maternal'.

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### Postmarital residence in Neolithic Anatolia.

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The Neolithic site of Çatalhöyük, Turkey (7400 – 5600 cal BC) is well-known for the female symbolic imagery discovered there, including the so-called goddess figurines. The

presence of such artifacts has led some researchers to conclude that Çatalhöyük engaged in a form of fertility worship with the female as the central figure. This type of worship coupled with the fact that Çatalhöyük was an early agricultural center has led others to argue that Çatalhöyük was a matriarchal society. However, archaeological studies of the site have shown that there is very little difference between the sexes in terms of diet, activity, and mortuary treatment. The present study tests the hypothesis of a female centered society through a post marital residence analysis based on dental metrics and morphology. Data were collected on adult dentition from Çatalhöyük and two other Neolithic sites in Anatolia: Aşıklı Höyük and Musular. Data from males and females were compared within Çatalhöyük and between the three Neolithic sites to assess dental phenotypic variation.

Within Çatalhöyük univariate variance differences indicate that females show more variation in dental size than do males. Between the three sites univariate tests of dental size found males to be largely different and females to be more similar. Dental morphology identified few differences within Çatalhöyük or between the three sites for males or females. Based on these results it appears that females were the more mobile sex, which is consistent with expectations of a patrilineal society.

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#### **Intra-household variation in anemia status and its relationship with self-perceived health in the Mexican Family Life Survey: Implications for Bioarchaeology.**

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The presence of porotic hyperostosis (PH) and cribra orbitalia (CO) in human skeletal remains is used as an indicator of chronic anemia caused by nutritional inadequacy (poor dietary intake or malabsorption) which can affect work capacity and quality of life. In the bioarchaeological literature, PH and CO are commonly used as markers of living conditions, status and an individual's well-being. However, the association between anemia status, living conditions and quality of life has not been fully tested among living populations. Using data from the Mexican Family Life Survey (MxFLS), we explored variation in anemia status among members of the same household, as well as its relationship with self-reported nutritional status. The rate of anemia in the sample was relatively high with 6,018 of the 32,144 individuals (19%) affected. Comparing adults and children living in the same home we found a high degree of incongruity, 73% of anemic children had non-anemic mothers. A similar degree of incongruity was found between spouses. In 92% of households with an anemic adult, the spouse of

that individual was non-anemic. Finally, while a higher incidence of anemia was associated with lower self-perceived nutrition, 12% of those who reported being very well or well-nourished were found to be anemic. These data suggest that caution should be taken when using PH and OB to reconstruct lifestyle due to the high degree of intra-household variation observed here. In addition, the data also suggest that the presence of anemia does not always correlate with individuals' self-perception of life quality.

#### **Scaling of distance from center of mass to condylar axis in primate mandibles.**

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To understand the evolution of primate feeding systems, we are studying the biomechanical determinants of the scaling of chew cycle duration in primates. This project quantified size-related changes in the distance from the mandibular center of mass to the condylar axis in 51 species of primates, 14 prosimians and 37 anthropoids. Center of mass location was calculated from CT scans using Amira. Relative density of the bone was estimated using Hounsfield numbers of the voxels and marrow space was assigned the density of water. The distance from the center of mass to an axis passing through the backs of the mandibular condyles was calculated. Jaw length was estimated as the distance from the condylar axis to infradentale. The scaling of the distance from the center of mass to the condylar axis relative to jaw length does not differ significantly from isometry in either anthropoids or prosimians. The two groups do not differ significantly from each other in scaling coefficients. Differences in mandible shape between anthropoids and prosimians do not result in differences in scaling of the distance from center of mass to condylar axis. Future work will incorporate more realistic estimates of the location of the axis of rotation.

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#### **Diminutive cercopithecine teeth from Kanapoi, Kenya, and implications for the evolution of body size and diversity in guenons.**

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In 2012 a team from the West Turkana Paleontology Project of the National Museums of Kenya uncovered two small associated unworn second and third molar teeth of a primate

from the *Australopithecus anamensis* type site at Kanapoi, dated to around 4.2 mya. These molars show typical cercopithecoid bilophodont, quadritubercular morphology. Metric and morphological comparisons reveal that they are indistinguishable from molars of the extant talapoin monkey (*Miopithecus talapoin*). This is the second oldest reported guenon fossil. Previously reported cercopithecine teeth from Koobi Fora, Kenya (minimally 3.4 million years ago) show similar morphology and size. Faunal and other analyses at Kanapoi suggests open woodland habitat with patches of grasslands. The specimen raises intriguing possibilities about the evolution of African guenons. Molecular phylogeny estimates place *Miopithecus* divergence at about 7-8 mya. If truly *Miopithecus*, the specimen extends the geographic range of these monkeys to East Africa in a dry, seasonal woodland habitat with open grasslands. The very small size suggests either that dwarfing occurred very early in this genus, or, if not *Miopithecus*, that there have been separate dwarfing events within cercopithecines. Alternatively, the specimens may suggest that primitive guenon body size was small, although this is contradicted by the fact that older fossil guenon teeth (5.4 mya) were larger. Whichever is the case, the new specimens suggest that the modern diversity in guenon body size arose early in the history of the group, and that diminutive size is not uniquely associated with current talapoin habitat.

#### **Craniofacial variation III: Efficient, landmark-free superimposition of head surface scans.**

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The now-familiar approach of landmark-based morphometric analysis is problematic for many anthropological (and other) data sets. Many structures of interest lack meaningful and repeatably identifiable landmarks. At the same time, it is becoming increasingly easy to collect data via surface scans for ever larger samples of specimens, making manual landmark placement for superimposition and other analyses impractically time consuming. One way to address this is through the use of landmark-free methods, such as the Iterative Closest Point (ICP) algorithm, to directly process the surface scans.

ICP relies on a nearest neighbor search (NNS), which is very computationally intensive. A simple NNS requires on the order of  $n^2$  operations, where  $n$  can reach easily into the hundreds of thousands. This poster presents a computationally efficient approach to ICP that yields a substantial reduction in computation costs. In this efficient method, we cluster the vertices in one scan into small groups, tracking cluster creation to form a spatial tree. Searches performed with these trees dramatically decreases the computational cost, to order  $n \cdot \log(n)$ . For instance, superimposing two scans

of 23,000 points using the new process was approximately sixty times faster than the naive method.

The algorithm has been demonstrated here by fitting a sample of 40 bald head scans, provided by the US Armed Services, to a reference template to show regional variability. While the ICP algorithm is dependent on initialization, the conventional coordinate axes in the scans provide adequate initialization parameters. This method is applicable to most landmark-sparse structures.

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#### **Exo- and endocranial ontogeny in hominoid primates.**

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Patterns of endocranial size and shape variability in hominins have attracted considerable attention as a potential source of information about evolutionary and developmental modifications of brain structure and function. Relatively little, however, is known about how changes in neuroendocranial morphology are brought about by changes in brain and viscerocranial morphology, respectively. To identify the role of each of these modules in shaping the braincase, we examine patterns of exo- and endocranial shape variation along and across ontogenetic series of great ape (*Pan troglodytes* and *P. paniscus*, *Gorilla gorilla*, *Pongo pygmaeus*) and human skulls. We use methods of dense surface sampling and geometric morphometrics to identify major modes of neuro- and viscerocranial variation and covariation. Results indicate that differences between taxa in endocranial shape are already present at birth, reflecting differences in brain morphology as well as in the way the viscerocranium is hafted to the neurocranium. Taxon-specific differences in postnatal endocranial ontogeny are mostly due to differential growth trajectories of the brain and the viscerocranium. Neuroendocranial globalization is likely to represent a shared hominoid pattern of early postnatal skull ontogeny.

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#### **Primate energy expenditure and life history.**

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Primates have slower rates of growth, reproduction, and senescence than other placental mammals. Classic life history theory proposes that primates' slow life history is a function of energy allocation, with resources shifted away from growth and reproduction, and toward somatic maintenance. Such energy-allocation models of life history variation assume that total energy expenditure, TEE (i.e., the energy budget, calories/day), is a fixed function of body mass, a view that is consistent with studies of basal metabolic rate showing broad similarity among placental mammals. However, basal metabolic rate is not strongly correlated with TEE, and might not accurately reflect energy budget size. Here, we examine new and published doubly-labeled water measurements of TEE (calories/day) among 15 primate species, including 7 wild and 9 captive populations, and test the hypothesis that primate life histories reflect variation in TEE rather than energy allocation. We show that TEE among primates are significantly lower than those of other placental mammals, in contrast to previous studies of basal metabolic rate. Further, primates' low TEE appears to explain their slow life history: rates of growth, reproduction, and senescence are similar among primates and other mammals when examined as a function of TEE rather than body mass. Notably, ANCOVA controlling for body mass revealed no difference in TEE between wild and captive primate populations, suggesting that TEE is a stable, evolved physiological trait rather than a labile response to activity level. We discuss the implications of these data for primate ecology, life history, and evolution.

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#### **From tug-of-war over reproduction to conflict over group membership: A theory of conflict and conflict resolution.**

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Conflict over reproduction is a fundamental problem of social evolution since it may impede the stability of social groups of animals. A multitude of theoretical studies have thus addressed this problem, a prominent class of models being so-called tug-of-war models. These models assume that natural selection may resolve reproductive conflict among group members owing to the negative impact of such conflict on

the contestants' fecundity. Reproductive conflict among primate males is often intense, and many researchers have concluded that the observed patterns of conflict are well described by tug-of-war models. Here, I argue that this conclusion is wrong. Tug-of-war models have been originally developed to address reproductive conflict among females. In their present form, however, they are not suitable to describe reproductive conflict among males (in primates as well as in other vertebrates), because the proposed tradeoff between reproductive effort and fecundity is far less important in males than in females. I show, however, how the models can be modified to address the tradeoff between reproductive effort and survival, which is deemed to be a more important determinant of fitness in males. Based on my current work, I further show how this approach can be used to also study the resolution of conflict over group membership. In summary, I highlight a common misconception in the application of tug-of-war models and outline a theory which is more suitable than current models to study reproductive conflict among male primates.

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#### **Environmental plasticity of intralimb indices.**

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Many studies have reported that human distal limb elements (i.e., tibiae and radii) display greater secular changes and positive allometry with stature than their proximal counterparts. This suggests that distal limb elements may be more environmentally plastic than proximal elements. If true, samples subjected to improved living conditions should exhibit a systematic change in intralimb indices.

This study tested the above hypothesis using osteometric data collected from five geographically different and temporally diverse population groups: recent American Whites, recent Portuguese, medieval Nubians, Point Hope Arctic Native Americans and Plains Native Americans. Within each population group, long bone lengths were collected from two samples exposed to contrasting living conditions (n total = 318). Relative living conditions were evaluated using previously published demographic, socioeconomic, and health information. Crural and brachial indices were calculated and compared across each (within-population) paired sample to determine whether there was a directional change in intralimb indices with relative living condition. Results showed no consistent trend in male or female intralimb indices across the sample comparisons. When populations were pooled, males and females displayed greater positive allometry in the distal limb elements relative to proximal elements. Within populations, however, relationships between distal and proximal elements did not significantly differ from isometry. These results demonstrate that the response of proximal and distal elements to living conditions may vary from those patterns that have been published,

and that further investigation is needed into the effects that specific extrinsic and intrinsic variables may have on limb lengths and proportions.

**Bioactive factors in milk: Comparisons across nonhuman primates and humans.**

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Milk is not just food, but also a means by which mammalian mothers signal biochemically to their offspring. Milk contains physiological levels of growth factors and other hormones; these signaling molecules have important effects on growth and development of neonates. We investigated whether commercially available assays designed to measure two growth factors (EGF and TGF- $\beta_2$ ), their receptors, and the metabolic hormone adiponectin in human biological samples were effective for non-human primate milks. Milk samples for gorilla (N=1), orangutan (N=1), baboon (N=9), and common marmoset (N=5) came from the Smithsonian National Zoological Park's Milk Repository; milk samples for rhesus macaque (N=59) came from individuals housed at the California National Primate Research Center. We performed parallelism and recovery tests to validate the assay kits (R&D Systems, Minneapolis). Longitudinal samples from the gorilla, orangutan and macaques allowed a comparison of the pattern of expression with previously published patterns in human breast milk. All analytes were successfully measured in gorilla; for other taxa one or more assays were not successful. Milk adiponectin declined across lactation in gorilla and orangutan, similar to humans, although adiponectin concentration was low compared to human breast milk (gorilla=4.8 $\pm$ 5 ng/ml, orangutan = 1.4 $\pm$ 1 ng/ml, human range = 5 – 80 ng/ml). Macaque milk adiponectin (6.9 $\pm$ 4 ng/ml) was higher than ape milk, and appeared to increase with infant age. Milk EGF concentrations were highest in gorilla milk (29.7 $\pm$ 9 ng/ml), followed by orangutan (7.8 $\pm$ 4 ng/ml) and macaque (2.9 $\pm$ 2 ng/ml); these values are all below those found in mature human milk (75 $\pm$ 12 ng/ml).

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**Evolutionary history of nocturnal galagids: new insights using a multilocus approach.**

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Galagids are probably "the least known of all primates" and their systematics is one of the most long-standing problems in primatology. Species diversity has likely been underestimated due to the lack of morphological variation, and most species have been described using bioacoustic data, leading to a large, but quite controversial, increase in species number. In the present study, I revisit the contentious relationships within African Galagidae by analyzing 20 nuclear loci (>13kb) and mitochondrial sequences from all major galagid lineages. Traditional phylogenetic methods (maximum likelihood and Bayesian inference) as well as a species-tree/gene-tree approach were used to analyze the dataset. Relationships among the main clades are well resolved and support the needle-clawed galagos (*Euoticus*) as the most basal genus, which thus represents a unique lineage within Strepsirrhines. *Galagoideis* is paraphyletic, suggesting the presence of two separate genera for the dwarf galagos: the Eastern forms (e.g., *zanzibaricus* complex) actually cluster closer to greater and lesser galagos than to the Western species (*thomasi/demidoff*). I propose that morphological and ecological similarities within dwarf galagos are likely a consequence of either convergence or plesiomorphic retentions. Molecular dating indicates deep evolutionary divergences within the family: the origin of crown galagids occurred in the early Oligocene and most extant genera were already present by the late Miocene. Such deep divergence within several lineages might also suggest the presence of multiple cryptic species, for which better geographic sampling is required. Finally, results are discussed in light of climatic and biogeographical events to explain galagid diversification in Africa.

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**Androgens and immune function in human and nonhuman primates.**

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As proximate drivers of reproductive effort in males, androgens play a crucial component in male life history strategies. Androgens act in a pleiotropic fashion to modulate energy balance between competing demands like immunocompetence and reproductive processes, and investment in competing functions vary according to environmental and social contexts. Testosterone in particular is well known for its hypothesized immunosuppressive properties. We review several studies that present evidence such as positive associations between testosterone levels and infection severity, negative associations between testosterone levels and some measures of immunity, and altered levels of testosterone

during infection. We also present conflicting data, illustrating that testosterone likely does not affect all aspects of immunity equally, and may in fact exhibit a phenotypic correlation with immunity in healthy individuals. The relationships between testosterone and immunity also likely depend on host energy flux in addition to other hormone levels. In particular, the adrenal androgen dehydroepiandrosterone has been implicated in immunological outcomes, and may in fact counteract some of the immunosuppressive properties of testosterone. Preliminary evidence also suggests that dehydroepiandrosterone may be elevated during immune activation. Given that one of the primary roles of dehydroepiandrosterone is to function as a reservoir for the synthesis of testosterone and other hormones, the relative differences in concentrations between these hormones may play an important role in immunological outcomes and life history trade-offs. A more cohesive understanding of the interactions between testosterone and dehydroepiandrosterone in varying social and ecological contexts may shed light on the larger aspects of male life history strategies.

**Locomotor diversity and midfoot mobility in gorillas.**

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The recent discovery and description of *Australopithecus sediba* from South Africa and the Butele partial foot from Ethiopia has renewed interest in the evolution of the foot in Plio-Pleistocene hominins, as their morphology suggests that early bipeds may have been more diverse in their locomotor repertoires than previously thought. Interpreting the fossil record depends on an accurate understanding of the relationship between bony morphology and locomotor function. Among extant hominids, gorillas are diverse behaviorally, ecologically, and in their locomotor habits, offering an opportunity to understand postcranial morphological diversity in closely related living taxa. Although all gorillas are primarily terrestrial knuckle walkers, western gorillas are characterized by a greater degree of arboreality than eastern gorillas. Here we use laser scans and a three-dimensional methodology to test the hypothesis that western gorillas have more mobile calcaneocuboid and cuboid metatarsal joints than eastern gorillas, increasing mobility in the midfoot and facilitating arboreal locomotion. Our comparative analyses of the calcanei and cuboids of 51 eastern and 29 western gorillas confirmed our functional predictions. Western gorillas have cuboids that exhibit statistically significantly more concave fourth metatarsal facets and larger calcaneal processes, and calcanei with correspondingly deeper cuboid facets than eastern gorillas. These results have implications for understanding

hominid pedal evolution and the ways in which natural selection alters bony anatomy in response to ecological, behavioral, and locomotor demands.

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**Comparison of endocranial and ectocranial “symmetry planes” and application to the virtual reconstruction of hominid fossils.**

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It is not entirely clear how the asymmetries of the skull and those of the brain relate to each other in hominids. However, in absence of well-defined landmarks on endocranial casts, it is common to use landmarks delineated on the skull to define a reference plane about which endocranial asymmetries are inferred, and to reconstruct a missing portion of an endocranial cast with its “mirror image”. The validity of these procedures is largely unknown. We investigate this question by defining and computing three different symmetry planes on several individuals. The first plane is computed by superimposing the outer (ectocranial) surface of the skull with its mirror image. This definition uses all the points of the surface, a probabilistic modeling of the latter, and the principle of maximum likelihood; the plane is ultimately computed using the expectation-maximization algorithm, and the whole procedure is fully automatic. The second plane is defined and computed in the same way, but using the inner (endocranial) surface of the skull. The third plane is the best-fit (using least squares regression) plane through a set of inter-hemispheric, endocranial, manually delineated landmarks. These planes are computed and compared in a quantitative way on two modern humans (young and adult), two modern chimpanzees (juvenile and adult) and one *Australopithecus africanus* (Mrs Ples, STS 5). Based on this study, a tentative virtual reconstruction of the endocranial of the Taung Child, whose left endocranial is mostly missing, is proposed.

**It's all in the wrist: manipulative dexterity in white-handed gibbons (*Hylobates lar*).**

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Manual complexity in great apes is considered to be an important facet of hand evolution, reflective of advanced cognitive skills, and is likely influenced by morphological adaptations in hand shape related to suspensory lifestyles. Relatively little is known about the manual abilities of the small apes, but they are generally assumed to have limited manual complexity because of their highly specialized hands. This study examined manual skill during foraging in wild small apes (*Hylobates lar*) compared with similar-sized, sympatric monkeys (*Macaca nemestrina*) with a broadly similar dietary profile at Khao Yai National Park, Thailand, in order to directly test whether differing manual abilities facilitate access to more or different (higher quality) foods, and whether small apes demonstrate enhanced manual complexity when handling foods similar to that seen in great apes. Sixteen months of videotaped hand use were recorded for eight gibbon groups (16 animals) and one macaque troop (9 animals). Results show that gibbons have a larger manual repertoire for precision skill than macaques, gibbons demonstrate a unique form of previously undocumented hand-foot bimanual coordination during foraging, and their sophisticated feeding skills are directly related to greater wrist mobility in varying hand positions during feeding, especially in the terminal branches. These critical differences allow gibbons to be more selective in reaching and choosing foods than is possible for pronograde quadrupedal monkeys.

**Determination of body surface area from a whole-body CT scan.**

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The estimation of the body surface area (BSA) has been a challenge in the past centuries. Current techniques like 3D laser surface scan and CT-scanning, may be expected to quantify the BSA in an easier and more accurate way. Whole body CT-scans were obtained of 54 male cadavers between 20 and 87 years of age. Only individuals with intact skin and without post-mortem bloating were included. 3D reconstructions were generated from CT-scans using Mimics software and the BSA were automatically extracted from the program. The resulting BSA was compared with 4 predictive equations. We found no statistically significant difference between our CT-scan based results and the results obtained using the predictive equations of Du Bois and Du Bois (1916), Mosteller (1987) and Livingston and Lee (2001); but significant difference was observed from between our equation and the equation of Yu et al. (2003). Using Bland and Altman (1986) plots, we assessed the agreement between our results and the Du Bois equation, which is the most widely used equation in clinical medicine. We found that the Du Bois equation underestimated

BSA for underweight cases and overestimated for overweight and obese cases. We conclude that care must be taken especially when BSA is calculated for overweight and obese persons and new equations may be needed for such persons.

***Australopithecus afarensis* probably lacks a midfoot break.**

DANIEL J. PROCTOR. Anthropology, SUNY Buffalo State.

The *Au. afarensis* MT 4 fossil A. L. 333-160 was analyzed using three-dimensional morphometrics to test the hypothesis that the proximal articular surface is flat as in humans rather than highly convex as in apes. A humanlike articular surface would suggest that *Au. afarensis* lacked apelike tarso-metatarsal flexibility associated with a midfoot break. A principal components analysis compared the proximal articular surface shape of A.L. 333-160 to *Pan*, *Gorilla*, *Hylobates*, and habitually shod and unshod humans. The hypothesis cannot be falsified. A. L. 333-160 has a flat articular surface that is indistinguishable from unshod humans and is similar to OH 8 (*H. habilis*) and StW 628 (possibly *Au. africanus*). The surface shapes represented by these fossils are all consistent with a rigid lateral midfoot. Articular surface size is significantly different between all groups except the unshod human group and *Pan*. Regression analysis revealed no significant relationship between size and shape for PC 1, which is the most important axis for distinguishing the shape differences between humans and apes. There is a significant relationship between size and shape on the PC 2 axis. This axis shows that *Hylobates* has extreme proximal surface curvature that extends to the dorsal side of the metatarsal. In this sample shod and unshod humans are significantly different in size, and significantly different in shape on the PC 2 axis. Though there is much overlap, some unshod humans have a marginally flatter surface. It is unclear whether this is due to size or being habitually unshod.

**Ancient Swahili origins: a mitochondrial study of ancient inhabitants of the Kenyan coast.**

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Many scholars have assumed that the ancestors of the Swahili were Bantu-speaking groups who entered East Africa from the west in the closing centuries BCE; however recent archaeological evidence suggests a more complicated situation. Over four field seasons, from 2008 to 2011, thirteen burial tombs were excavated in the cemetery located next to the central mosque at the Swahili site of Mtwapa on the southern coast of Kenya. Men, women and children were buried together in the tombs, and individuals were entombed laying on their right

sides, in an extended position, facing Mecca. The remains of at least 87 individuals were recovered, with an average of seven skeletons per tomb. To date, mitochondrial DNA (mtDNA) has been extracted from the teeth of 62 of those individuals. Sequence analyses of the first Hypervariable Region (HVRI) of the control region indicate the presence of mtDNA haplotypes of both West-central and East African origin. These preliminary results show a diverse population that likely included genetic input from Bantu-speaking and nonBantu-speaking groups.

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#### **Reconstructing human colonization of Polynesia using molecular data.**

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Oceania is an outstanding region to study human prehistory and evolution. Colonization of Oceania comprises the earliest movement of modern humans out of Africa with the subsequent settlement of Australia and Papua New Guinea about 50,000 years and the latest movement of people into Polynesia about 3,000 years ago.

However, many aspects of the colonization of Polynesia by humans, such as the sequence of settlement or the influence of Lapita or Micronesian cultures still remain unknown. Molecular data can shed light on some of this questions.

The study of human demographic history is currently on an inflection into a new era. New sequencing technologies, improved techniques to retrieve DNA from subfossil remains and new data analysis approaches (such as model-based analysis) will revolutionize our understanding of this complex human achievement.

Here we present results of National Geographic's Genographic project and other research projects in Oceania. In this studies we sampled DNA and genealogical information from several hundred individuals throughout Oceania. We sequenced complete mtDNA genomes and identified Y chromosome haplotypes to study population structure and population histories through-out Polynesia. Using classical as well as model-based analyses we reconstruct population histories and quantify support for or against different scenarios.

#### **Anthropological primatology: What field primatologists can contribute to the field.**

JILL D. PRUETZ. Anthropology, Iowa State University.

In the 1950s, Washburn's 'New Physical Anthropology' marked the beginning stage of modern primatological fieldwork. Moving from a focus on natural history studies of primates as models of early humans, primatologists in anthropology departments today have broadened their perspective and focus on hypothesis testing. Although technological advances have made the field primatologist's life easier, the basic methodology, as well as the ultimate goal of studying evolutionary adaptation within our scientific Order, remains the same. However, new analytical and theoretical possibilities combined with conservation and ethical concerns about the subjects of study require the field primatologist to adapt. I explore these changes using my research on savanna chimpanzee behavior and ecology at Fongoli, Senegal as an example, and I suggest future directions in arguing that the field primatologist provides an invaluable resource for an array of scientists within and outside of the field of anthropology. Primatological anthropologists occupy a unique niche, in providing established field sites where wild primates are habituated to observer presence as well as long-term data on specific individuals. Such a resource is invaluable to a range of disciplines. The Fongoli Savanna Chimpanzee Project has thus far collaborated with colleagues in genetic, parasitological, endocrinological, archaeological, isotopic and cultural anthropological studies. The challenge for anthropological primatology is to be at the cutting edge of theoretical development in addition to being a valuable resource for a multitude of scientific inquiries. In forming collaborative arrangements, the field primatologist can broaden their involvement at the forefront of scientific advancement.

#### **Automated approaches to geometric morphometrics.**

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Three-dimensional geometric morphometric (3DGM) methods for placing landmarks on digitized bones have become increasingly sophisticated, including algorithms that optimize the distribution of semi-landmarks within user-defined patches. One aspect that all 3DGM methods share is that initial landmarks must be designated by the researcher. Thus researcher interpretations of homology and correspondence influence, and are required for, representations of shape.

We present new algorithms allowing fully automatic placement of correspondence points on samples of 3D digital models representing bones of different individuals/species which can then be input into standard 3DGM software and analyzed with dimension reduction techniques. We test this

algorithm with a sample of 106 primate calcanei represented by 1,200 correspondence points per bone. For comparison, we generated a traditional 3DGM dataset on the same sample, placing 27 landmarks on each bone. Data were analyzed with morphologika2.5. Initial results show strong similarities between the shape spaces generated by the automatic and traditional methods. PC1 corresponded mainly to distal calcaneal elongation in both plots. PC2 corresponded visibly to position and size of the peroneal process. In both analyses PC1 and PC2 together account for ~50% of the total sample variance. In plots of PC1 with PC3, both datasets showed almost perfect separation of major primate clades. These results indicate that automatic quantifications can lead to shape space representations that are at least as meaningful as those based on observer landmarks, thus providing the potential to save time in data collection while also increasing completeness of morphological quantification and eliminating observer error.

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#### **A phylogenetic analysis of the hominin clade using postcranial characters.**

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The phylogenetic relationships within the hominin clade remain controversial, a state which can be largely attributed to the fragmentary nature of the fossil record. Currently, many species are represented only by craniodental fossils and, as a result, most phylogenetic studies on hominins have focused strongly on this more robust craniodental record. The use of postcranial morphological characters in phylogenetic analysis has the potential to make useful contributions to the current state of knowledge of evolutionary relationships within the clade.

Here, a phylogenetic analysis has been done using postcranial characters that are indicative of bipedalism. The most parsimonious tree was generated using the computer program MacClade and subsequently compared to an existing tree that was created using craniodental characters. The two trees differ slightly, most notably in the placement of *Homo floresiensis* and *Paranthropus robustus*. It has been hypothesized that *H. floresiensis* represents a sister taxon of *H. erectus*; this hypothesis is not supported by the analysis done here, which instead suggests that *H. floresiensis* is more closely related to the Australopithecines. The placement of *P. robustus* is more difficult to interpret due to the lack of confidently associated postcranial remains for other megadont archaic hominins. The largest problem with this, as with other phylogenetic analyses of hominins, is the lack of data; more fossils from both new and existing taxa need to be found to further elucidate evolutionary relationships within the clade.

**A bioarchaeological legacy: The academic family tree of George Armelagos.**

VENTURA R. PÉREZ and HEIDI BAUER-CLAPP. Anthropology, University of Massachusetts Amherst.

As a pioneer in the fields of bioarchaeology and biocultural anthropology, George Armelagos has had a profound influence on the sub-field of biological anthropology and, indeed, on the discipline of anthropology as a whole. His research and writing embody theoretical and methodological revolutions that have influenced scholars throughout the world. Armelagos influenced the careers of countless anthropologists and helped create and impact the work of the dozens of students he mentored. Armelagos's impact on the department of anthropology at the University of Massachusetts Amherst can still be felt. His work and his legacy can be seen in our bioarchaeological field school and in the research of our bioarchaeological faculty and graduate students. In this poster, we outline Armelagos's intellectual legacy in bioarchaeology and biocultural anthropology by tracing his academic "family tree," identifying students he mentored and following his influence through subsequent generations of scholars around the world. Our focus will go beyond the students he advised and will include co-authors, membership in groups, collaborations, concepts and diagrams, and long-standing arguments about specific theories, models, locales, and research programs. By tracing Armelagos's major research traditions, conflicts, and disagreements, we hope to present how he impacted the diversity of the discipline.

**Reconsideration of the mandibular mental foramen position in the genus *Homo*.**

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A placement of the mandibular mental foramen under the M1 occurs frequently in European Middle and Late Pleistocene Neandertal lineage specimens. These hominins are often described as showing a "more posterior" placement of the mental foramen, and this feature is often cited as a derived condition in Neandertals. The present study examines the position of the mental foramen in relation to the osteological marker gonion within the mandibular corpus in a taxonomically diverse sample of mandibles within the genus *Homo*. A very strong correlation ( $r = .991$ ) was found between the distance of the mental foramen to gonion and the gonial length of the mandible. An index relying on these two variables shows remarkable stability across the genus *Homo*, suggesting little movement of the mental foramen within the mandibular corpus. The Neandertal lineage specimens show a mental

foramen that is located only 3.3% (approximately 3.0 mm) more posteriorly, relative to gonial length, than in a pooled *H. sapiens* sample. However, this difference is insufficient to explain the change from a modal placement of the mental foramen under the P4 to the M1. Rather, than a posterior migration of the mental foramen within the body of the mandible, changes in the relationship of the dental arcade to the mandibular corpus seem to be a more likely explanation for the placement below the M1 in the Neandertal lineage sample. While this feature may still hold some descriptive value, the implications of the results for the identification of Neandertal derived traits is discussed.

**A variance component method for analyzing the effect of ancestry in admixed family-based genetic studies.**

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The appearance of similar regions of extended linkage disequilibrium (LD) found in pedigrees and created by admixture has been described previously and forms the basis of admixture mapping which can increase power to detect genes influencing normal or pathological traits that vary between parental populations. However, admixture LD has not previously been incorporated into methods which use the admixture present in many U.S. populations to increase power in family-based designs. This is achieved by the incorporation of shared ancestry information across multiple pedigrees by use of additional matrices of relatedness as calculated directly from biogeographic ancestry information found in dense genotype data. As currently implemented, this is an extension of the variance component methods utilized in SOLAR, but the theoretical basis could be applied to other methods. Depending on computing power, the ancestry-relatedness matrix can be calculated either as a genome-wide estimate or on a locus-specific basis, which will increase power for some traits. The utility of this method is illustrated by examination of Mexican American families enrolled in the San Antonio Family Study analyzed using both conventional linkage and association methods and with the inclusion of an additional ancestry matrix. As compared to studies of unrelated individuals, siblings, or nuclear families, the analysis of extended pedigrees greatly improves power by increasing the total number of contrasts that can be considered. The inclusion of an overarching relationship matrix based on shared ancestry provides a method for linking extended

pedigrees into a single meta-pedigree for a yet more powerful analysis.

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**Associations between metabolic hormones and macronutrients in human milk.**

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Despite considerable research looking at milk macronutrients, energy, and hormones in milk, there remains virtually no published data looking at macronutrients, energy, and metabolic hormones from the same milk samples. While many of these metabolic hormones, especially leptin, have been implicated in the establishment of feeding self control and satiety, there is no available research testing for an association between milk nutritional composition and the quantity of hormones such as leptin. This study hypothesized that as a satiety signal, milk leptin levels would be positively associated with fat, protein and energy and inversely associated with sugar in milk.

These proposed associations were tested in 135 milk samples from 103 individuals from Cebu, Philippines. Milk samples were collected as part of a larger study of reproductive health (Adair et al., 2011) and substudy of lactation and milk (Quinn et al., 2012). Individuals had been nursing from 7-1300 days. Milk fat, protein, and total sugars were measured using standard procedures. Milk leptin was measured in skimmed milk using EIA and was within the range reported for other populations ( $287 \pm 257$  pg/mL).

There were no significant associations between individual macronutrients and leptin in this sample except for total sugars ( $r = -0.35$ ,  $p < 0.005$ ). Milk leptin declined as milk sugar increased. As increasing milk sugar is usually associated with decreased caloric density of milk, this provides a new source of evidence linking milk leptin with infant satiety by providing an actual measure of the nutritional composition of the milk relative to leptin content.

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**Spatial analysis of fine-scale Y chromosome variation in Swahili and Yemeni males clarifies the expected distribution of genetic variation in societies with different post-marriage residence norms.**

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Different post-marital residence patterns are expected to produce clearly distinguishable distributions of genetic variation within and between populations. However, studies of genetic diversity at scales from the local to the global have recovered conflicting patterns. Most of these studies have been based on summary measures of genetic diversity that are better

suited to equilibrium conditions. Here, I directly examine the spatial distribution of Y chromosome microsatellite variation in individuals carrying a Y chromosome in the same haplogroup in two different samples: Yemeni and Swahili males. Ethnographies of both societies report a normative patrilineality, but they differ in post-marriage residence patterns. Post-marriage residence is typically patrilineal in Yemen, while post-marriage residence in Swahili communities does not perfectly fit any of the standard patterns. The results of this analysis show how the non-equilibrium conditions and deviations from normative residence patterns that generally prevail in human populations lead to deviations from the expected distributions of genetic diversity within and between populations. In particular, the fine-scale spatial distribution of Y chromosome variation in Yemeni populations fits a normative patrilocality, but there is also clear evidence of male migration – on the order of 1-2 males per generation – which leads to misleading results when the data are analyzed using summary diversity statistics. Similarly, the spatial distribution of Y chromosome lineages on the Swahili coast reflects the greater diversity of post-marriage residence patterns, but summary measures fail to recover patterns of connections among communities.

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#### **Activity type and level influence growth rate, remodeling, and diaphyseal geometry of cortical bone.**

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Cortical bone shape and microstructure are often used to reconstruct behavioral activities and life histories of individuals in the archaeological and fossil records, but much remains unknown about how exercise levels and the nature of activity influence cortical bone. Here, we used a mouse model to study the effects of activity on mechanical and microstructural properties of cortical bone development. Female wild-type mice (n=30) were subjected to three experimental activity patterns: sedentary controls, activity-wheel running, and activity-vertical climbing. During the experiment, each mouse was given three subcutaneous injections with fluorescent bone-labeling dyes at known intervals to allow for histological examination of bone growth rates and remodeling. After the experiment, two 100-

micron thick cross-sections of the humerus were prepared for microscopic and cross-sectional geometric analysis. The wheel-running mice, who exercised the most, had a significantly faster bone growth and showed higher proportions of fast forming tissue. Compared to them, the vertical-climbing mice, who climbed meshed cages an average of 140m each night, had a much slower bone growth but showed more histologic variation in bone remodeling, such as an increase in numbers of osteon and drifting-osteon. However, the differences in diaphyseal geometry between the activity groups were less pronounced than the differences in microstructure. The results of this study suggest that cortical anatomy is more sensitive than gross geometry to variations in the degree and type of activity, and may allow researchers to make refined inferences about activity and locomotor history from skeletal remains.

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#### **Understanding the colonization of the North American Arctic: The results of whole mitochondrial genome sequencing of Inupiat populations of the Alaskan North Slope.**

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Conventional understanding of North American Arctic prehistory identifies two successive colonization events in which populations rapidly moved eastward from the Alaskan North Slope to Greenland (at 4000 YBP and 800 YBP). The latter Neo-Eskimo migration (known as the Thule expansion) resulted in a complete replacement of the previous Paleo-Eskimo inhabitants, and formed the ancestral gene pool of all modern Inupiat/Inuit peoples.

To build on our understanding from previous studies of mtDNA hypervariable sequences, we sequenced 139 complete mitochondrial genomes from Inupiat populations of the Alaskan North Slope, the hypothesized geographic origin of the Thule culture. As expected, we found North American Arctic-specific haplogroups A2a, and A2b. We additionally found a previously undescribed A2 haplotype that does not match any published non-Arctic A2. We found several individuals belonging to haplogroup D4b1a2a1a1 (previously known as D3), with a possible back mutation at 16093. D2 was also found in the North Slope sample, but appears to be distinct from the Paleo-Eskimo Saqqaq D2, and in the hypervariable region more closely resembles Aleutian D2 haplotypes. Finally, we discovered two occurrences of the recently recognized pan-American founder haplogroup C4c1, which has

been hypothesized to be a post LGM expansion from Beringia. We apply coalescence methods to date these haplogroups, and discuss the implications of this unexpected genetic diversity for both the colonization of the Arctic and the earlier peopling of the Americas further south.

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#### **Cultural ecology and biological distance among Classic and Postclassic period American Southwest and Mexican populations.**

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A biological distance study using dental morphological traits was conducted to determine whether economic and ecological similarities correlated with phenotypic distances among Classic and Postclassic period Mexican populations. Samples represented populations from the American Southwest, the Valley of Mexico, the Gulf Coast of Mexico, and the Yucatan peninsula. Matrices of phenotypic distances were created using pseudo-Mahalanobis' D<sup>2</sup>, and compared with model matrices for geographic distance, shared migration history, shared subsistence patterns, shared trade items, and shared cultural affiliation. The results of the multiple regression analysis showed geographic distance (p=0.403), shared migration history (p=0.118), and shared subsistence (p=0.065) were not significantly correlated with the matrix of biological distances. However, shared trade items (p=0.006), and shared cultural affiliation (p=0.037) were significant at significance level 0.05. The R<sup>2</sup> value for the full regression model including all variables was 0.52. When the samples in the analysis were limited to Late Classic and Early Postclassic sites that overlapped in time, the regression results showed shared trade items (p=0.019) continued to be significant, and geographic distance (p=0.006) was also significant. Shared subsistence (p=0.091), shared migration history (p=0.894), and shared cultural affiliation (p=0.442) were not significant. The R<sup>2</sup> value for this regression model was 0.65. These results indicate that trade had an affect on phenotypic distances during the Late Classic and Early Postclassic periods of Mexico.

#### **Introducing new variables into morphometric body mass reconstruction.**

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The reconstruction of body mass has important ecological and physiological implications in paleontological and

archaeological studies. Morphometric equations regressing bi-iliac breadth and stature on body mass have been shown to have a stronger relationship with body mass than mechanical reconstructions based on weight-bearing skeletal elements. This research expands the morphometric approach of body mass estimation by investigating the anthropometric variables of transverse chest width and bi-acromial breadth as well as the aforementioned variables using individuals from the Hamann-Todd Collection (n=151). Bi-iliac breadth and transverse chest width correlated most strongly to body mass in both pooled and sex-separated equations while stature correlated most weakly to body mass. The addition of transverse chest width and bi-acromial breadth to bi-iliac breadth and stature improved the estimation of body mass in both males and females. Forward stepwise regressions ( $f\text{-to-enter} \leq .05$ ) also revealed that bi-iliac breadth and transverse chest breadth alone were selected to estimate body mass and performed better than the bi-iliac breadth and stature equations in both males and females. Additionally, these trunk and shoulder anthropometrics were chosen because, like bi-iliac breadth, similar measurements may be derived from the skeleton. We will investigate if clavicle length may be used to represent bi-acromial breadth and if transverse chest width may be represented by rib breadth, using a 2D morphometric approach to determine the maximum lateral value of the rib.

#### Searching for the invisible people in the African diaspora: Biocultural perspectives.

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African People and those of African descent have been dispersed throughout the world in the past both within the continent and abroad. The primary focus of this poster is the research approaches necessary to examine the lives and experiences of these past African and African descent communities in the western hemisphere. Although a daunting task if taken as a whole, it is important to understand that the diverse African origins, multiple European powers, varied political economies, and historical trajectories pose both intriguing biocultural studies of human adaptations as well as problematic issues of theory and method. Each population must be examined and explored within the context that they are discovered in, yet the experiences and effects of involuntary migration, enslavement, and post-colonial societies bind them together. The approaches to this African Diasporic work is informed by Armelagos' early ecological approaches to health and disease, his biocultural syntheses, and his commitment to seeing populations as people and not races. Several skeletal series (First African Baptist Church, Newton Plantation, Catocin Furnace, New York African Burial Ground, Cedar Grove) including enslaved, emancipated, and freedmen populations will illustrate the approach or identify demographic, paleopathological issues.

#### Effect of posterior curvature on the bending strength of maxillary canines in cercopithecoid monkeys.

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We previously reported (*AJPA* 138:218) that the geometries of cercopithecoid canines convey resistance to a variety of parasagittal loads by analyzing each canine as a tapered straight beam subject to the isostress condition (i.e., each canine maximally stressed to same degree at each section). Herein, we extend that analysis by considering the effects of curvature of the posterior aspect of each canine. If posterior radii of curvature are of the same magnitude as the anteroposterior dimension of the cross section, then accurate assessments of stress require a curved beam analysis.

We determined posterior radii of a sample of 15 permanent maxillary canines from males and females representing 8 West African cercopithecoid species. We acquired coordinates along the posterior aspect from the tooth base (i.e., enamel-dentin junction) to the tip with an approximate spacing of 0.5 mm between points using a digitizer. Bezier curves were fit through the data, and radii were determined from the fits using numerical differentiation and the calculus curvature formula.

We found radii of curvature to vary dramatically along the length of individual canines, often by an order of magnitude. The radii are of the same magnitude as the anteroposterior dimension of each cross section at nearly every location along each tooth. At the base, however, where parasagittal bending moments are greatest, radii were up to an order of magnitude less than the anteroposterior dimension. Curved beam effects must be present in anthropoid canines; failure to consider curvature will result in an overestimation of canine bending strength.

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#### Secular change in dental development in New Mexican females.

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Recent research has indicated a dramatic acceleration of dental development in 20<sup>th</sup> century European Americans in Tennessee and Arizona, resulting in developmental stages being reached at earlier calendar ages. In order to determine whether this change in rate is seen in New Mexico, Moorrees' developmental stages were recorded for mandibular canines, third and fourth premolars, and second molars, as well as maxillary canines and second molars in European American females. The sample

consists of two cohorts from the 1970's (n=87) and 1990's (n=81) between 5-11 years. Developmental stages with n<5 per cohort or n<10 combined were excluded, and the mean calendar age per tooth development stage was calculated for each cohort.

The average calendar age difference per tooth, for all developmental stages combined, ranges between 2 and 7 months. A paired t-test confirmed that the differences between the two cohorts are significantly different over all 17 developmental stages ( $p=0.0011$ ). By tooth between cohort, significant differences were seen in the maxillary canine ( $p=0.0327$ ) and mandibular third premolar ( $p=0.0200$ ). The only significant difference in development stage across teeth was root 3/4 complete ( $p=0.0124$ ). Contrary to previous findings, however, the calendar age of the 1990's cohort is older for 15 of the 17 developmental stages than the 1970's cohort. This runs counter to the general trend of acceleration in development observed in multiple systems.

#### Reassessing guenon craniodental morphology: Closer inspection reveals support for the arboreal and terrestrial clades.

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The guenons (tribe *Cercopithecini*) are a diverse radiation of arboreal and terrestrial monkeys distributed across sub-Saharan Africa. Traditional morphological estimates of guenon phylogeny have placed the origin of the guenon clade at 1-2 mya and suggested that terrestriality evolved multiple times within the radiation. Recent molecular studies, however, suggest that guenons originated approximately 11.5 mya and that committed terrestriality evolved only once, hypothesizing two major sub-clades, one largely arboreal, and the other terrestrial. This molecular arrangement renders the genus *Cercopithecus*, currently associated with taxa in both clades, paraphyletic. Considering this lack of congruence between morphological and molecular data, are there any morphological features in guenon anatomy that support the molecular findings? Although guenon postcrania have been examined, there are fewer analyses of craniodental traits. In this study, we analyzed the craniodental morphology of 10 guenon species using measurements collected from calipers and digital photographs. We compared several craniodental features found in the proposed arboreal guenon clade to the corresponding features in the proposed terrestrial clade. After controlling for body size, 11 of 18 characters analyzed were significantly different between the two groups (Mann-Whitney U,  $p \leq 0.05$ ). Terrestrial guenons exhibit features such as:

wider orbits, broader biorbital widths, and mesiodistally longer M<sup>2</sup>s. Arboreal guenons exhibit traits including taller mandibular rami and increased basicranial length. Thus, these results demonstrate that there are craniodental characters supporting the molecular groupings. Our findings also highlight the need for reevaluation of guenon morphological systematics and suggest that there is much more to understand about guenon craniodental diversity.

**Proceptive and attractive behaviors during female pregnancy in black and gold howler monkeys: Preliminary results.**

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Pregnant females are expected to avoid spending energy on mating. However mating behavior may serve other functions different from reproduction. We explored mating behavior of two *Alouatta caraya* pregnant females (during first half of pregnancy, 1-3 months) from two different groups during 30 days each one at San Cayetano (27° 30' S-58° 41' W) in northern Argentina. We recorded all proceptive behaviors (grooming, inspection of genitals, tongue flicking, mouth to mouth, tail intertwining, anogenital presentation) and attractive behaviors (grooming, inspection of genitals, mate guarding) in full-day follows during August and September 2011. We found that pregnant females copulated 27 times, 5% of the time with central males and 95% with non central males. Both proceptive and attractive behaviors preceded 63% of copulations, 33% were preceded by only attractive behaviors and the rest by only proceptive behaviors. The most common proceptive behavior was inspection of genitals (38%, n=15 observations) and the most common attractive behavior was inspection of genitals (67%, n=26 obs.). There was no difference in females solicitations towards central and non central males (Mann Whitney test U=70, p>0.05). Non central males performed more attractive behaviors toward females than central males (Mann Whitney test U=70.5; p<0.05). We suggest that mating behavior in pregnant howlers may represent a mixed mating strategy to decrease infanticide risk and increase affiliative bonds with resident males. Additional relationships between female mating behavior during pregnancy and distribution of within group social affiliative interactions are discussed. *Funded by American Society of Mammalogists, International Primatological Society, and Consejo Nacional de Investigaciones Científicas y Técnicas de Argentina (CONICET).*

**Variability in bone length and proportions of the arm and hand.**

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Traditionally, investigations of proportion in the limbs examine proximal and distal length differences by comparing brachial and crural indices. This approach, however, has only considered the bones of the arm or leg, and does not investigate variability throughout the entire limb. Do *all* the long bones of the limb decrease in stability proximo-distally, or is there a break between the patterns of variability in the arm versus those in the hand?

Bias-adjusted coefficients of variation were determined for the length of each long bone in the left arm and hand of 106 individuals. The variation of individual bones were compared, with the sum of the MC3, PP3, IP3, and DP3 lengths as a proxy for hand length (ray 3) to examine relationships throughout the entire limb. Significant differences were noted when a coefficient of variability diverged 3% or more from those of the adjacent bones. In males, the pattern of proximo-distal variability in the arm halts at the distal radius, then repeats again in the bones of the hand - the metacarpals are more stable than the radius and ulna. Females demonstrated a general proximo-distal decrease in stability throughout the entire arm, with no repeated pattern in the hands. Also, differences between rays 2-4 compared to rays 1 and 5 in both sexes support expected patterns developmental field division in the hand.

These findings may help uncover further developmental patterns evidenced in human arms and hands, allowing researchers a better understanding of limb proportion, health, and stress.

**Late Miocene hominin biogeography: Comparative analyses of eastern and southern African faunas.**

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Many biogeographic studies of fauna associated with Late Miocene hominin sites highlight the taxonomic similarities between hominin localities in central and eastern Africa, including those of the Middle Awash. Most studies, however, fail to include the Late Miocene Langebaanweg fauna, the only site sampling this time period in southern Africa, thus overlooking potential important biogeographic links with southern Africa that could elucidate how faunal communities, including hominins, were distributed across Africa through time.

Here, we include fauna from three discrete Langebaanweg communities in biogeographic analyses along with 15 other Late Miocene faunal assemblages sampling eastern and northern Africa and Eurasia. Updated lists of large mammal genera were included from each site, with regional Eurasian taxonomic lists based on those of Bernor, et al. (2009). For each pair of assemblages, the genus-level faunal resemblance indices (FRI) of Dice (Sokal and Sneath, 1963) and Simpson (1943) were calculated and compared. While previous studies like those of Bernor et al. (2009) highlight the faunal similarities calculated between the

*Ardipithecus* faunas and those of the Lothagam Nawata Member, our analyses instead result in a larger calculated FRI between the three Langebaanweg assemblages and those of the Middle Awash. Calculations also reflect strong links with other eastern and northern African hominin sites.

These results suggest that despite the lack of hominins in Langebaanweg assemblages, their taxonomic similarities with Middle Awash faunas suggest strong faunal interchange between southern and eastern Africa during the Late Miocene that likely influenced later hominin dispersal patterns in the Plio-Pleistocene.

**Of lice and men: The study of human evolution from a lousy perspective.**

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Human evolution is studied from many different perspectives, and recently much attention has been paid to the use of human parasites and pathogens as markers of human migration and human evolution. One particular parasite that has proven useful for studies of human evolution is the human head louse (genus *Pediculus*), which has been traveling on the lineage leading to modern human since it diverged from the lineage leading to chimpanzees. *Pediculus* was likely a parasite of every hominin that has existed. Because it cannot live on other hosts, it has journeyed with us, and its DNA contains a record of that journey. The mtDNA of head lice is for more diverse genetically than the mtDNA of modern humans, and the mtDNA of living lice dates back 2 million years unlike the much younger mtDNA coalescence of living humans. Our lab has just sequenced the full genomes of the chimpanzee louse (*Pediculus schaeffi*), as well as two deeply divergent clades of human head lice (*P. humanus*) whose mtDNA diverged 700,000 to 1.2 million years ago. These deeply divergent human lice offer a glimpse into our past evolutionary history. Our genomic studies suggest that the head lice of living humans originated on two different hominins living approximately 1 million years ago that remained isolated from one another until quite recently when admixture among the lice occurred. These results are consistent with the hypothesized isolation and recent admixture between Neanderthals and anatomically modern humans.

**African primate, carnivore and ungulate communities exhibit a proclivity toward random phylogenetic structure.**

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Numerous mechanisms have been proposed for contributing to the structure of primate communities, including historical circumstance, competition, climate, habitat, and resource limitation among others. Many researchers have analyzed community structure from an ecological perspective, but fewer studies have explored communities in the context of phylogeny. We analyzed 206 African large mammal communities, as well as three subsets: primates (135), carnivores (199), and ungulates (183) to derive net relatedness (NRI) and nearest taxon (NTI) indices. Significantly low NRI/NTI values (i.e. phylogenetic overdispersion) are indicative of past interspecific competition, resulting in competitive exclusion among closely related species. Alternatively, significantly high NRI/NTI values (i.e. phylogenetic clumping) would suggest that closely related species have similar ecological requirements, resulting in their coexistence. Communities may also exhibit phylogenetically random species compositions, yielding NRI/NTI scores not significantly different from zero. We found that in African large-mammal communities, 63% exhibited a random phylogenetic structure, 25% were overdispersed, and 12% were clumped. Within the taxonomic subsets, 86% of primates, 92% of carnivores, and 72% of ungulates exhibited random phylogenetic structure. Overdispersion accounted for 12% of primate, 4% of carnivore, and 21% of ungulate communities, while phylogenetic clumping only accounted for 2% of primate, 4% of carnivore, and 7% of ungulate communities. For primates, overdispersion occurs in mosaic habitats, whereas clumped communities are close to borders of biogeographic provinces. We suggest that past interspecific competition or habitat filtering has affected a relatively small proportion of African mammal communities, however, we also explore the differences in community structure among phylogenetic groups.

#### **Going out on a limb: Does Obesity have a systemic effect on limb bone morphology?**

NICOLE M. REEVES. Anthropology, University of Tennessee.

In studies of the effects of body mass on the human skeleton, an emphasis is often placed on the principle of bone functional adaptation, associating changes with local mechanical effects. However, it is known that systemic metabolic shifts occurring with obesity also influence bone turnover and cell signaling. Therefore, it is possible that obesity has systemic effects on bone throughout the skeleton, both due to increased loads and physiological effects, such as hormonal levels.

This study considers the interaction of these mechanical and metabolic effects. Previous anthropological studies have correlated severe obesity with changes in some cross-sectional properties of lower limb bones. This study adds further analyses by examining effects on the upper limb, which is subject to a different mechanical loading pattern than weight bearing

bones. All data were collected from high-resolution tomographic scans of modern individuals' skeletons (Bass Donated Collection, University of Tennessee). Cross-sectional properties were taken from multiple diaphyseal locations on the humerus, radius, femur, and tibia on human remains from people known to be within normal clinical weight ranges and people documented as overweight. Differences in cortical bone strength properties in the upper limb bones would be indicative of systemic effects of obesity on the skeleton. Preliminary results comparing the cross-sectional geometry of the midshaft femora of obese and non-obese individuals showed significant differences, while no differences were noted for the midshaft humeri. Further analyses will test for differences at different locations along the humeral and femoral diaphyses, as well as the radius and tibia.

#### **Ethical questions in human reproductive ecology.**

MEREDITH W. REICHES. Human Evolutionary Biology, Harvard University.

Human reproductive ecology is a sub-field of physical anthropology that investigates the evolution of human reproductive physiology and behavior as well as the importance of that physiology and behavior in the emergence of other uniquely human traits, such as our species-characteristic life history. In order to understand how human bodies respond to conditions of evolutionary relevance, reproductive ecologists frequently work in populations where women have limited access, for economic or cultural reasons, to reliable contraception. This practice must be examined from an ethical standpoint for two reasons. First, inequality in resource access between researcher and participant is a positive selection criterion for research populations, which introduces a significant power differential that may create barriers to informed consent. Second, the development interests of research community members may conflict with the researcher's ability to address questions of evolutionary relevance in the research community, leading to ambivalence in the researcher's relationship to development efforts. This paper synthesizes evidence showing that the absence of reproductive choice has significant health and economic consequences in the lives of women and children and invites us to consider how we can build dialog about reproductive values and freedoms into our relationships with research communities. Medical anthropologist Arthur Kleinman's cross-cultural illness questions are adapted to suggest the form that a conversation between researcher and prospective participant might take.

#### **Exploring the influence of suspension on ulna articular surface shape in anthropoid primates.**

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We examined the correspondence between ulna articular surface shape variation and suspensory locomotion. Researchers have identified skeletal adaptations to suspension in primates that perform high proportions of forelimb-dominated locomotion (e.g., brachiation). There are multiple influences, however, on the appearance of the limb skeleton, including the demands of limb activity, phylogenetic constraints, and size. Thus, it is important to take these potential influences into account when examining the relationship between skeletal morphology and suspensory behavior. In addition, geometric morphometric techniques allow us to explore variation of ulna articular surface shape in a wide range of extant anthropoids and potentially find new aspects of skeletal shape that correspond with suspension.

We collected 18 three-dimensional landmark coordinates on ulnae of 12 extant species using a Microscribe digitizer. We explored shape variation using principal components analysis and studied covariation between shape and potential influences on skeletal morphology (i.e., brachiation, phylogeny, and centroid size) using multivariate regression. The first and second principal components of variation, which represented different aspects of trochlear and radial notch shape and accounted for approximately 70% of the overall variation, grouped brachiating hominoids and platyrrhines. Furthermore, quadrupedal cercopithecoids and platyrrhines grouped together along these same two principal components. As confirmed by regression analysis, these aspects of ulna articular shape variation clearly correspond with differences in use of suspensory and pronograde quadrupedal behavior. However, overall articular surface shape variation did have a significant relationship with phylogeny and centroid size as well, illustrating the importance of incorporating these factors into functional analyses.

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#### **Shared space in a sacred forest: Habitat use by humans and Javan gibbons (*Hylobates moloch*).**

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Shared use of space between humans and non-human primates can be a source of conflict to both species and can have important conservation implications. In the sacred forest Cagar Alam Leuweung Sancang in West Java, Indonesia, humans enter forest inhabited by Javan gibbons (*Hylobates moloch*) for spiritual meditation and concentrate their activities to sacred areas, where gibbons also range. In this study, we use a combination of ethnographic observation and GIS analysis to explore the use of space by both humans and gibbons to

determine areas of potential space competition. Data were collected August 2010-June 2011. We collected GPS locations and behavioral data on both the humans (6,652 hours) and the gibbons (1,253 hours) in the forest using 10 minute instantaneous scan sampling.

Preliminary results indicate humans preferentially gather in certain areas of the forest ( $n=39917$   $df=7$ ,  $f=973.52$ ,  $p<0.0001$ ), with the most people gathering at the Cikajayaan waterfall, the most sacred spot in the forest (mean=4.195,  $sd=3.493$ ). Two gibbon groups' home ranges encompassed most of the sacred areas. Group B was less likely to be present as the number of people present increased ( $n=23780$ ,  $df=1$ ,  $\chi^2=288.082$ ,  $p<0.00001$ ), but Group C's presence was not affected by number of people ( $n=18873$ ,  $df=1$ ,  $\chi^2=1.589$ ,  $p=0.2075$ ). Thus some gibbons in the forest avoid using certain areas when humans are present. Understanding the effect of shared space on wildlife is necessary for informing conservation policy in human-visited forests because reduced or modified use of space due to human occupancy may be costly to the wildlife.

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**Specifying the nonspecific in paleopathology: A stable isotope investigation of metabolic disorders in North-Central Poland.**

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Diet is a risk factor for many pathological conditions, but the nonspecific nature of skeletal manifestations of pathology obfuscates the role of diet among other possibilities. This study explores the role of diet in the metabolic disorder rickets by comparing stable carbon and nitrogen isotope signatures of subadult skeletons with and without pathological changes associated with rickets from a medieval cemetery at Gruczno, North-Central Poland.

Rickets results from vitamin D deficiency in childhood, due to low sunlight exposure and/or dietary insufficiency. Some vitamin D-rich foods are mushrooms, fish, egg yolks and liver. Signs of metabolic diseases such as rickets and scurvy are uncommon among skeletons from Poland and Europe (usually <2%). In some populations they are more prevalent (8-10%). As part of broader investigations of skeletal health at Gruczno, we test the hypothesis that isotopic signatures of 3 subadults without skeletal pathological changes do not overlap with those from an unusual subadult showing severe rickets (long bone bowing, epiphysis deformation, bone porosity and periosteal reactions).

Studied individuals were 3-5.5 years old at death. Pathological lesions were examined and diagnosed macroscopically and by X-ray. Isotopic analyses were conducted using rib collagen.

Subadult  $\delta^{13}C$  values show little variation (range: -19.91 to -20.07‰).  $\delta^{15}N$  values range from 8.3‰ to 11.2‰. Although the difference is

small, the subadult with severe signs of bone metabolic disorder exhibits the highest  $\delta^{15}N$  value. In addition to nutritional content of this individual's diet, we consider the possibility of prolonged suckling, a known risk factor for rickets today.

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**Nonhuman primates and "others": Multispecies ethnography in the Dzanga Sangha Dense Forest Reserve (RDS), Central African Republic.**

Melissa J. Remis and Carolyn A. Jost Robinson. Department of Anthropology, Purdue University.

We use the Dzanga-Sangha Dense Forest Reserve (RDS) as a case study on the utility of multi-species ethnography as a theoretical framework for ethnoprimateology. The expansion of people and extractive practices in the tropics requires primatologists to situate their work within complex, human-dominated ecosystems. In 2002 the overall density of cercopithecoïd monkeys in RDS was 6.14 groups/km<sup>2</sup>; (park: 16.232 groups/km<sup>2</sup>, reserve: 4.65 groups/km<sup>2</sup> (Delta AIC = 0.09, AIC = 887.58, ESW = 19.56 m). In 2009 primates had become cryptic in response to increased gun hunting, and observations were too few to estimate densities. Encounter rates for gorilla nests on transects had declined from 0.98 nests/km to 0.39 nests/km. To further understand these results, we interviewed 77 BaAka hunters at RDS on their knowledge of primates and importance of human-animal relationships. From interviews we gained insights into primate behavior and the adaptive responses of hunters to shifting abundance and anti-predator responses. With increases in gun hunters, cross-bow hunting of primates has declined dramatically; it is a skill no longer transmitted to the younger generation (2012: 1 hunter, 2009: 4 hunters). Interestingly those who emphasized the symbolic importance of primates had previous experience as a cross-bow hunter or at primate research camps. We suggest the value of combining primatological and ethnographic approaches emphasizing the interconnectedness of nonhuman primates and "others." Examination of everyday interactions of people and primates provides researchers with avenues for studying declining populations and promoting the intrinsic and extrinsic valuations that form the core of successful conservation programs.

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**HOMINIDS agent-based model of Toro-Semliki wildlife reserve: Incorporating a modern mosaic habitat analogy into interpretations of the paleoenvironment and ranging behavior of *Ardipithecus ramidus*.**

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We use the agent-based, spatial simulation model HOMINIDS to evaluate hypotheses relating the foraging behavior of *Ardipithecus ramidus* to habitat structure. The hypothesized forest-grassland mosaic paleohabitat of *Ardipithecus* shares many characteristics with the current habitat of the Mugiri chimpanzee (*Pan troglodytes*) community, a relatively dry, heterogeneous habitat in western Uganda within the Toro-Semliki Wildlife Reserve. Similarities in brain size, morphology, and shared phylogeny of chimpanzees and *Ardipithecus* make it possible to test our model's accuracy against real life data and can be used to develop hypotheses for *Ardipithecus* behavior.

We use botanical records from Semliki to develop a virtual landscape suggested for *Ardipithecus* paleohabitat. Behavior of different agents in the simulations is determined by a synthesis of known dietary and locomotor attributes of Mugiri chimpanzees and published interpretations of *Ardipithecus* fossils. We first evaluate the utility of our model for simulating actual patterns of Mugiri chimpanzee food selection and ranging behavior in a virtual 80km<sup>2</sup> landscape, which approximates the estimated Mugiri community home range of ~96km<sup>2</sup>. A negative control investigates the influence of uniform vs. realistic habitat distribution on chimpanzee-agent ranging. Varied experimental conditions simulate the effects of published differences in locomotion and feeding efficiency between chimpanzee- and *Ardipithecus*-agents. Our model allows us to analyze the degree to which ranging and feeding behaviors of simulated *Ardipithecus* and *Pan* agents diverge within the same landscapes, and results suggest that further observations of the Mugiri chimpanzees will be useful for developing testable hypotheses for *Ardipithecus* behavior.

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**Comparison of the nutritional composition of foods consumed by howler monkeys (*Alouatta pigra* and *A. caraya*) in Mexico and Argentina.**

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Despite evidence of flexibility in the amount of monthly feeding time devoted to exploiting leaves, fruits, and flowers by howler monkeys, few studies compare inter-specific differences in howler feeding ecology in relation to nutrient concentrations of plant species and items consumed. We present data on the nutritional ecology of *Alouatta pigra* in Campeche, Mexico and *A. caraya* in Corrientes, Argentina. We conducted full-day focal follows of adult individuals belonging to two *A. pigra* and two *A. caraya* groups during 12 and 8 months, totaling 2,675 focal hours. We analyzed the nutrient content of 119 (*A. pigra*) and 143 (*A. caraya*) samples from feeding trees belonging to 32 and 26 species, respectively. While there are overall similarities in the nutrient composition patterns of the diets when considering general categories (i.e. leaves, fruits, flowers), foods consumed by *A. pigra* were more fibrous than those eaten by *A. caraya* (12-74.5% vs. 8-67.8% neutral detergent fiber [NDF]) and lower in crude [CP] and available protein [AP] (2.8-35.6% vs. 3.8-45.5% CP and 0.1-30% vs. 2-42.9% AP). Moreover, the protein-to-fiber ratios (AP:ADF) of both mature and young leaves differed (Mann-Whitney,  $p < 0.05$ ) between the two primate species (young leaves:  $0.44 \pm 0.3$  *A. pigra* vs.  $0.82 \pm 0.5$  *A. caraya*). The highest average AP content ( $15 \pm 6.9\%$ ) was found in inflorescences eaten by *A. pigra*, but for *A. caraya* it was young leaves that contained the most AP ( $20.7 \pm 7.3\%$ ). Our results highlight the importance of detailed nutritional information in comparisons of the feeding ecology of different primate species across their distribution.

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#### The biomechanics of power generation during human high-speed throwing.

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High-speed throwing is a distinctive human behavior and may have been an important mode of early hunting. However, the biomechanical bases of how humans produce high-speed throws are not completely understood. Using inverse dynamics analyses of kinematic data from 20 baseball players fitted with 4 different restrictive braces, each of which inhibits specific motions, we test a model for

how power is generated at key joints during the throwing motion.

We show that achieving high projectile speeds during throwing requires a combination of elastic energy storage at the shoulder, as well as the transfer of kinetic energy from proximal body segments to distal segments. We find that the largest power contributions during the throwing motion come from rotation of the torso. However, intervertebral brace restriction data suggest that this rapid, torso rotation motion (average peak  $\sim 850$  deg/sec) is powered almost exclusively (90%) by the large, hip rotator muscles. Further analyses show that this hip-driven, torso rotation motion accounts for between 30-50% of the power needed to internally rotate the humerus, extend the elbow, and flex the wrist during throwing.

These data suggest that evolutionary shifts in the hip rotator muscles, most notably the gluteals, would have significant effects on throwing performance. Fossil evidence for the expansion of the gluteals and for the rotational mobility of the spinal column suggest incremental shifts in torso mobility and power generation began in the australopiths and likely reached modern levels in *Homo erectus*. The adaptive contexts of these anatomical shifts are also considered.

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#### Age-at-death estimation of pathological individuals. A complementary approach using teeth cementum annulations.

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Recently, the value of cementum annulations (TCA) for age-at-death determination was confirmed for bioarchaeological research. Use of TCA for early Holocene specimens from India demonstrated systematic biases in the morphological methods, had a demonstrable impact on the age pyramid, and significantly changed paleodemographic statistics. While TCA may provide greater accuracy and precision for age estimation of skeletally healthy specimens, it is unclear the magnitude to which specific pathologies affect the accuracy of different techniques for age determination. We hypothesized that age determination methods based on gross morphological changes in the skeleton will not accurately predict age-at-death for individuals with bone growth pathologies (achondroplasia, osteomalacia, osteogenesis imperfecta). Conversely, for adult individuals with chronic and severe rhino-maxillary infections, acellular

cementum formation may be disrupted and thus morphological methods should be preferred. We compared age estimates from TCA with estimates made using standards for determination from the pelvis, fourth rib, dental attrition, and cranial stenosis. Results demonstrated that morphological techniques produce variable and inaccurate age estimates for pathological specimens in archaeology. Our results confirm the utility of cementum annulations for age estimation in bioarchaeology, particularly for pathological specimens, and suggest directions for additional research on the effects of pathology on the accuracy of various aging techniques.

#### DNA mini-barcodes as a tool for primate applied diagnostics and species identification.

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Increasingly identification of primate samples relies on molecular techniques. DNA barcoding, focussing on the mitochondrial cytochrome c oxidase subunit I, gains popularity as a universal species-identifier. Problems with conventional DNA barcoding include degradation in archival specimens and processed material (food products) and samples stored in DNA-unfriendly preservatives (formalin), preventing the recovery of PCR fragments  $> 200$  bp. Mini-barcodes may resolve these problems.

We test the validity of mini-barcodes as a way of identifying (archaic) human and non-human primates, based on 540 sequences of 87 species deposited in GenBank. A 648 bp section was selected and a series of mini-barcodes (108 to 324 bp) were generated. Neighbour-joining trees were compiled for each mini-barcode, relying on bootstrap values to assess accuracy of species identification. The full sequence provided unambiguous support (bootstrap values  $\geq 99\%$ ) for 68 (78.2%) species. Efficiency of mini-barcodes reached a maximum of 96.8% (mean  $96 \pm 1.11\%$ ) for the 324 bp barcodes, 84.8% (mean  $80.6 \pm 3.41\%$ ) for the 162 bp barcodes, and 78.8% (mean  $67 \pm 6.54\%$ ) for the 108 bp barcodes. Problem taxa, which did not provide unambiguous identification for any length of barcode, included those that frequently hybridise in nature, those close in evolutionary terms and those who have seen recent taxonomic change. The terminal 3' end performed marginally better than the proximal 5' end.

We conclude that mini-barcodes in the order of 160-300 bp can be effective in identifying primates, especially when focussing on the terminal end. Mini-barcodes provide a feasible option for DNA barcode analysis of museum samples and applied diagnostics.

#### Bioarchaeology and "disability": Using the present to inform interpretations of past impairment.

CHARLOTTE A. ROBERTS. Archaeology, Durham University, England.

This poster takes a theoretical approach to recognizing “difference” and reconstructing “identity”, an increasing area of study in bioarchaeology. It discusses the ways in which bioarchaeological data may be used to provide a perspective on how impairment affected our ancestors' lives. It argues that it is important to interpret our data within 'context', use multidisciplinary approaches, and the physical and mental experience of their impairment. People living with the mycobacterial diseases leprosy and tuberculosis, and associated signs and symptoms, will be used to support the discussion, but reference to competitors in the Paralympics (London 2012) will also be presented to show how impairment does not necessarily impact ability to function as a “normal” member of society. Evidence from ethnographic studies suggest that the level of impairment experienced depends on many variables, such as views of the body, sex, social status, ethnicity, the nature of the impairment (e.g. permanent or temporary, major or minor, congenital or acquired, visible or invisible, and how much support there is within the community. It is also argued that assumptions about how people coped with impairment in the past, using bioarchaeological data, are much more complex than has been previously recognised. This study advocates taking more of a clinical perspective to understand the challenges that people with impairments faced in the past by accessing medical anthropological studies of the impact of impairment on people. Humans are very adept at adapting to physical and mental challenges in their lives as the Paralympics 2012 in London have shown.

#### **Stress and affiliation in wild black-handed spider monkeys: Do females tend-and-befriend?**

MICHELLE A. RODRIGUES. Department of Anthropology, The Ohio State University.

Stress is an adaptive strategy that mobilizes the body for acute physical challenges, but chronic stress has detrimental effects. Thus, coping mechanisms are valuable in reducing stress. One such mechanism, the “tend-and-befriend” strategy, refers to affiliation between females as an adaptive strategy to deal with the effects of elevated stress after fight-or-flight situations. This mechanism is proposed to be a widespread strategy throughout the primate order, and one that underlies patterns of female bonding in humans. Although this strategy is utilized by matrilineal primates characterized by female kinship bonds, there has not been documentation of this strategy among unrelated females. Here, I examine the relationship between female affiliation and cortisol concentrations in 11 wild female black-handed spider monkeys. Time spent affiliating with females is significantly positively correlated with mean cortisol concentrations ( $r_s=0.829$ ,  $p=0.002$ ,  $df=11$ ). Time spent huddling ( $r_s=0.780$ ,  $p=0.005$ ), grooming ( $r_s=0.800$ ,  $p=0.003$ ) and playing ( $r_s=0.753$ ,  $p=0.007$ ) with other females are all positively correlated with mean cortisol concentrations. Contrary to predictions, females

that spend the most time affiliating with other females have the highest cortisol concentrations. However, in a separate validation study on a captive population, I found that cortisol peaks in feces 24 hours after a stressor. In my study of wild females, both fecal samples and behavioral data were usually collected on the same day. Thus the high cortisol of affiliating females suggests that females are using social interactions as a way of ameliorating spikes in cortisol concentrations. Female spider monkeys do appear to tend-and-befriend.

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#### **What's eating *Microcebus*? Endo- and ectoparasite ecology of *Microcebus griseorufus* at Beza Mahafaly Special Reserve, Madagascar.**

IDALIA A. RODRIGUEZ, EMI LIENNE RASOZANABARY and LAURIE R. GODFREY. Anthropology, University of Massachusetts, Amherst.

Prior parasitological surveys of lemurs at Beza Mahafaly Special Reserve (BMSR) in southwest Madagascar have documented a single species of tick, *Haemaphysalis lemuris*, and a single louse, *Trichophyloterus babakotus*, infesting lemurs. However, little attention has been paid to parasites infesting *Microcebus griseorufus*, which may serve as intermediate hosts to immature stages of haemaphysaline ticks, enabling adult ticks to preferentially parasitize larger-bodied lemurs. Because mouse lemurs at BMSR live in relatively high densities, often descend to the ground, engage in social grooming, and regularly consume insects, and because single tick species may infest multiple hosts in single forests, understanding the parasitic loads carried by these lemurs is very important.

By analyzing fecal samples collected during the dry season, we found *Microcebus griseorufus* at BMSR to host at least ten species of helminthes and protists. Additionally, over a period of 12 months, we collected two species of ticks, *Haemaphysalis lemuris* and *H. simplex*, and one sucking louse (possibly *Lemurpediculus verruculosus*) from the ears and pelage of *Microcebus*. Endo- and ectoparasite infestation patterns suggest that *Microcebus* does indeed serve as an intermediate host to immature haemaphysaline ticks; the synchronous development of immature ticks during the austral winter may pose a risk for vector-borne disease. *Microcebus* likely also shares certain endoparasites (*Hymenolepis* sp.) and ectoparasites (*H. simplex*) with introduced rodents (*Rattus rattus* and *Mus musculus*). The BMSR has experienced drastic changes in habitat and mammalian communities and these changes may have consequences for interspecific parasite transmission and for parasite ecology.

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*Conservation Inc. (PCI), and American Society of Primatologists (ASP).*

#### **Whole genome DNA sequence analysis of the kinda baboon (*Papio kindae*).**

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The goal of this study is to compare the complete genome sequences of wild-caught kinda baboons (*Papio kindae*) with equivalent sequences from all other species of *Papio*, as well as with other primates. As part of a larger multi-disciplinary field study, 76 kinda baboons in the vicinity of Chunga within Kafue National Park, Zambia were captured, bled and released. Blood samples (clots, buffy coats and whole blood) were frozen in the field, and transported to the US. DNA was extracted using standard methods. We then used the Illumina Hi-Seq platform to generate an average of 40x whole genome sequence coverage (approximately 120 gigabases of paired-end sequence reads) for each of three kinda individuals. To facilitate identification of variants and perform other comparisons, the kinda baboon sequence reads were mapped to the available baboon reference genome, a draft whole genome assembly from an olive baboon (*Papio anubis*) that was sequenced using a combination of Illumina, Roche 454 and Sanger platforms and assembled using CABOG, Atlas-Link and Atlas-Gapfill. Genomic comparisons among baboon species indicate substantial genetic differentiation at several levels. Pairwise sequence divergence across our sample of 15 individuals representing six *Papio* species ranges from 0.29% to 0.49%. Single base differences outnumber small indels more than 4:1. This presentation will summarize the amount and type of genetic differences between kinda baboons and other baboons. We will also describe within-species genetic variation in *P. kindae* and the other baboon species.

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#### **Multiple loci provide a more complete picture of Native American evolutionary histories.**

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Four First Nation communities in British Columbia volunteered to participate in a study that combines multiple lines of genetic evidence

for constructing evolutionary history. Each locus exhibits unique characteristics that provide a specific focus on evolutionary history. Many of these loci have been analyzed in Native American populations, except in the Pacific Northwest. Mitochondrial DNA (mtDNA) provides information on the evolutionary history of females, and Y-chromosomal DNA provides the evolutionary history of males in the Americas. Alleles at the ABCA1 gene exhibit functional phenotypic variation; some alleles are unique to the Americas. Lastly, the D9S1120 short tandem repeat (STR) is a non-coding, neutral locus, and the 9RA is unique to the Americas. We determined the mitochondrial haplogroup by sequencing the control region of the genome. We determined the Y-chromosomal DNA haplogroup by genotyping diagnostic SNPs using ABI Taqman assays and using the AmpFISTR® Yfiler® PCR Amplification Kit to examine the 17 Y-STR loci. We determined the ABCA1 autosomal allele that is unique to the Americas and analyzed alleles at the D9S1120 STR locus. In general, we found that mitochondrial haplogroups A, B, C, D, X, and H and Y-chromosomal haplogroups Q, C, and R were the most common. The ABCA1 results were the same for all individuals tested, and the 9RA allele was found in each population sampled. Our results provide DNA information on populations in the Pacific Northwest that can be used to infer various aspects of the evolutionary histories of Native Americans.

**More than the sum of its parts? Multivariate analysis of locomotor behavior in *Ardipithecus ramidus*.**

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Locomotor behavior in the Pliocene hominin *Ardipithecus ramidus* has been inferred to be primitive, comprising mainly above-branch palmigrade quadrupedalism, with infrequent vertical climbing and suspensory behaviors. By extrapolation, initial analyses have concluded that the last common ancestor of African apes and humans was also a generalized arboreal quadruped. If correct, this interpretation implies extensive homoplasy in the evolution of the African ape postcranial skeleton. However, this interpretation is based only on univariate or bivariate analyses of the postcranial skeleton in haplorhines, many using uncommon variables and/or size corrections. To determine whether postcranial morphology in *Ardipithecus* is indicative of generalized arboreal quadrupedalism, we used discriminant function analysis (DFA) to assess the degree to which appendicular skeletal morphology correlates with locomotor behavior in primates. Data include

segment lengths from stylopod, zeugopod and autopod elements of fore- and hindlimb in >800 specimens representing all extant primate groups, each assigned to locomotor categories based on published data.

The DFA accurately separates extant groups according to locomotor behavior based on postcranial morphology, correctly classifying >97% of cases. Among fossil taxa, *Proconsul* is unambiguously classified as an arboreal quadruped. In contrast, *Ardipithecus* occupies a unique morphospace intermediate between arboreal quadrupeds and vertical climbers/knuckle-walkers, although it is marginally closer in multivariate space to the latter. Our analysis indicates that *Ardipithecus* is not a typical arboreal, palmigrade quadruped. Instead, the total morphological pattern in its appendicular skeleton is consistent with frequent forelimb-dominated locomotor behaviors.

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**A reconstruction of the Sts 65 *Australopithecus africanus* pelvis with implications for birth in early hominins.**

JULIA ROMANO, ALEXANDER G. CLAXTON and JEREMY M. DESILVA. Department of Anthropology, Boston University.

Characterizing australopithecine pelvic morphology has been extremely difficult in part because of limited fossilized pelvic material. Sts 65, an undistorted, yet under-studied, adult right female ilium and pubis from Member 4 of Sterkfontein, South Africa, provides an opportunity to reexamine variation in the australopithecine pelvis. Here we digitally reconstruct the superior aspect of the Sts 65 pelvis with Autodesk Maya by mirroring the right ilium and articulating the two ilia using a scaled and mirrored digital model of the Sts 14 sacrum. Points along the arcuate line were used to properly orient the ilia to the sacrum. Both Sts 14 and Sts 65 exhibit similar overall morphologies: laterally flared ilia, small size, and an inferiorly directed pubis. However, the inlet shape of Sts 65 differs markedly in appearance, being more anterior-posteriorly elongated (Brim index: 79.5). As inlet brim indices can vary widely in modern human females, it is unlikely that Sts 65 and Sts 14 belong to different species or different sexes. The extremely large size of other australopithecine pelvises (such as StW 431) allow us to infer that Sts 65 is another female. By comparing the inlet dimensions to the cranial dimensions of a neonatal australopithecine (based on an ape model), we suggest that infant australopithecines would have entered the birth canal transversely and that the cephalopelvic ratio was human-like, not ape-like. These data imply a challenging, human-like birth process, though it is unclear whether a human-like rotational birth occurred in Sts 65.

**Modularity and shape variation of upper P4-M1 teeth in modern humans.**

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Recent studies on dental morphology in mammals have explored the genetic basis of phenotypic variation through morphometric integration. However, reports on metameric shape variation in humans are scarce. This study focuses on the geometric shape and size of upper P4-M1 in individuals of three geographic dispersed populations from Africa (Hutu, n = 11), Asia (Javanese, n = 13) and America (Inuit, n = 9). The covariation patterns among teeth were analyzed to test their degree of modular integration. Shape and size variation was extracted from landmark configuration, located at occlusal surface on digital images, using generalized least-square Procrustes superimposition for each tooth. Two-block partial least-squares analysis and vector correlation (Rv) coefficient were used to quantify the total amount of cross-covariance between two subset of landmarks corresponding to each tooth. Results show higher levels of tooth-shape complexity compared with size. We found non-significant covariation between P4 and M1 shapes but covariation was found in size of the three analyzed populations (Rv > 0.7; P < 0.01). This suggests independent shape variation in these two tooth classes whereas their size is integrated. In addition, Procrustes distances derived from canonical variates analysis among groups show higher morphological differences between Asian (P < 0.001) and African-American (P = 0.011) populations. Our findings suggest that upper P4-M1 complex develop from different morphogenetic fields which affect shape but not size in human populations, and secondly, that dental morphometric difference among populations could result by non-random processes, such as phylogenetic and/or ecological factors.

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**Orthodontist needed! Crooked teeth at the New Kingdom site of Amarna, Egypt.**

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The teeth of ancient people are usually free of malocclusion because large chewing forces stimulated jaw growth. One exception to this rule is the population of the ancient New Kingdom city of Amarna, Egypt, which was the capital of Pharaoh Akhenaten (c. 1349 – 1332 BCE). Although tooth wear was extensive, hence

mastication forces large, malocclusion was the rule and not the exception. 58 individuals with complete articulating maxillae and mandibles were chosen for occlusion analysis: 86% had some form of malocclusion; 70% had one or more displaced teeth; 68% had one or more rotated teeth; and 41% exhibited more serious malocclusion such as over-bite, cross-bite, *etc.* Because displacement and rotation of anterior mandibular teeth was the most common problem, 41 mandibles (mostly from the current excavation) were selected for detailed analysis during the following field season in Egypt: 70% had at least one anterior tooth displacement; 86% showed at least one tooth rotation; and the sum of incisor displacements ranged from 0 to 17.6 mm. Metric analysis shows the problem to be deficiency in anterior mandible growth before the canines began to wedge themselves between the premolars and incisors. This conclusion is supported by skeletal analysis which shows Amarna adults to be shorter than other Egyptian groups and subadult long bone growth delayed up to 23.7 months. Amarna mandibular malocclusion is certainly due to delayed growth associated with living conditions, rather than failure jaw grow because of insufficient mastication forces.

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#### **Anthropology in the age of phenomics.**

CHARLES C. ROSEMAN. Anthropology and Illinois Informatics Institute, University of Illinois.

Understanding the ways in which genes and environments interact to produce complex phenotypes is of fundamental importance for the study of evolution. Several distinct traditions have arisen in response to this need in a number of different sub-disciplines of anthropology, including bioarchaeology, paleoanthropology, and anthropological genetics. Here, I examine the ways in which evolutionary genetic models may be elaborated on and used to approach long-standing questions about human variation and evolution in a way that synthesizes these different traditions and alloys them with trends in evolutionary biology. Using a mouse model, I show one way in which problems in the human fossil record may be approached from a genomic perspective. I also use evolutionary quantitative genetic models to recast classic questions about the causes of human variation in comparative context. Results from these two different ways of looking at variation both point to the need to adopt nuanced models of the causes of variation and the evolution of phenotypes that have long been called for from all corners of anthropology. An anthropological phenomics perspective that unifies the study of genes, environments, and their interactions in the whole human organism could answer this call. This will require the adoption of a highly collaborative "big data" approach to problems in human variation that presents many moral and practical problems that will necessitate considerable changes to the way in which we practice the craft of anthropology.

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#### **Craniofacial variation among American, African and Diaspora populations.**

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Research into the genetic admixture proportions from different geographic areas in the United States through autosomal markers demonstrates a complex process with differences in the extent of European contributions to Southern and Non-Southern African Americans. Recent demographic shifts and migration have further increased this diversity. What contribution can 3D craniofacial morphometrics make to this discussion? The purpose of this project is to examine West African variation as it relates to African Americans and to examine if a more precise geographic origin can be identified. Data for five populations were collected as part of the *3D-ID, Geometric Morphometric Classification of Crania for Forensic Scientists* software and for *Research in Human Identification* initiative. Five samples from Diaspora populations including modern African Americans, West African (Angola, Ghana, and Nigeria) and African Slaves from Cuba are analyzed using eleven traditional anatomical craniofacial landmarks using the software MorphoJ. The plot of the Canonical Variates show a distinct cluster for the African American, African Slave and the Angolan sample, while the samples from Nigeria and Ghana cluster together. Interestingly, the Mahalanobis Distance results demonstrate that African Americans ( $D = 4.72$ ,  $p$ -value = 0.13) and the African Cuban slave ( $D = 4.43$ ,  $p$ -value = 0.09) sample do not differ significantly from the Angolan sample, while they are significantly different from the other two West African samples. These results suggest a stronger Angolan contribution resulting from the Trans-Atlantic Slave trade than other West Africans to New World Diaspora populations.

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#### **Finite element model of the *Cebus* mandible under different loading conditions.**

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Foods of different material properties elicit different feeding behaviors. How those behaviors impact mandible morphology depends on their associated patterns of stress and strain. Patterns of strain in the *Cebus* mandible were investigated using a finite element model (2.5

million tetrahedral elements) constructed from high-resolution CT scans. Material properties were assigned to trabecular bone, periodontal ligament, and teeth, and to 36 regions of the cortical bone of the mandible. Applied muscle forces were calculated from the PCSAs of the temporalis, superficial and deep masseters, and medial pterygoid muscles from the same individual. The models were constrained at single nodes at the center of each jaw joint: one model was also constrained at the right premolars, a second model on the first, second and third molars. The models were solved using the linear static solver in Strand7 and contour plots of von Mises strain compared under the two loading conditions. Under both models high strains are seen on the condylar heads and necks and on the buccal aspect of the corpus below the molars on both working and balancing sides: in the premolar biting model strain magnitudes are higher at these locations. The molar constrained model experienced higher strains on the lingual aspect of the symphysis and working side corpus. These results suggest that under different feeding behaviors may be reflected in differences in symphysis and corpus morphology.

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#### **Quantitative trait variation in purebred baboons and their hybrids.**

CHANTAL C. ROSSOUW and REBECCA R. ACKERMANN. Department of Archaeology, University of Cape Town.

Recent genetic studies indicate that contact and admixture occurred amongst contemporaneous hominins (e.g. modern Africans, Neanderthals, Denisovans) as they moved into new environments. However, the phenotypic effects of hybridization remain poorly understood, making it difficult to locate individual hybrids or hybrid zones in the fossil record. A more nuanced understanding of the effects of hybridization will also allow us to better understand the underlying evolutionary processes that have affected our lineage in the past. Here we report on a study of craniometric differences between known pedigree hybrid ( $n=72$ ) and purebred baboons (*P. anubis* and *P. cynocephalus*) ( $n=461$ ), as well as other baboon species (*P. hamadryas* ( $n=44$ ), *P. papio* ( $n=28$ ) and *P. ursinus* ( $n=220$ )). The hybrids were analysed in two different groups: (1)  $F1 = P. anubis \times P. cynocephalus$  first generation hybrids; (2)  $B1 = P. anubis \times F1$  backcross hybrids. Twenty-four (24) craniometric variables were compared. Results show that hybrids differ significantly from the other baboon taxa, including their parent taxa. Moreover, they are more variable morphologically than their parent taxa, with phenotypic variation at the limits of, and sometimes outside of, that seen in either anubis or yellow baboons. This supports previous studies indicating that differences between parent and hybrid baboon populations can be detected in traits affecting cranial morphology, and indicates that hybridization can have a substantial quantitative effect on baboon morphology, causing increased variation as well as transgressive phenotypes.

**Adult individual age: reliability of estimation using cementochronology.**

CLAUDE RUCKER. CNRS-CEPAM, UMR-7274.

Dental cementum, a mineralized tissue capturing in its successive incremental layers the fibers linking the tooth to the alveolar bone, seems to be considered a reliable age indicator. The protocol to estimate age-at-death includes several steps well described by numerous authors and tested with success in the majority of the published cases.

There are, however, a certain number of instances and under different geographic latitudes, where important discrepancies have been observed between observed and chronological age.

In order to understand these variations, this study looks at three crucial points: 1) the interactive system between cells from the Hertwig sheath and the fibroblastic cells under control of various factors developed during odontogenesis; 2) the adaptation of adult biochronology not native to the place where tooth samples have been taken; 3) various parodontal pathologies and their influence on cementum apposition.

A concordance between estimated age using cementochronology and civil age has been observed with a small (7%) error rate for a continental French population. A greater error rate of about 20% is notable for northern latitude samples.

**Structure of the Trinil *Homo erectus* femora.**

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The Trinil fossil femoral sample has played an important, although controversial role in discussions of the early hominin postcranial skeleton since discovery of the first specimen (Femur I) by Dubois in 1892. Here we report the results of new computed tomographic analyses of femoral shaft structure in Femora I-V from Trinil. Femora were scanned using a GE Lightspeed OX/I scanner, with a resulting voxel size of .39 x .39 x .6 mm. A semi-automatic threshold-based segmentation process with manual corrections was used to separate fossilized bone from any matrix; cortical contours were clearly visible at all levels. The resulting data were used to create virtual 3-D representations of all specimens, from which cross-sectional geometric properties (areas, second moments of area) and morphometric maps were derived. Comparisons were carried out with other Early and Middle Pleistocene

*Homo* femora as well as a sample of modern humans.

Although somewhat variable, Trinil Femora II-V exhibit key characteristics shared with other *H. erectus* femora, including increased mediolateral to anteroposterior bending rigidity in the midshaft and proximal shaft regions, and, in most specimens, relatively thick medial and lateral cortices in the distal shaft. Both of these characteristics are indicative of relatively increased mediolateral bending of the diaphysis, which is consistent with differences in hip structure (e.g., a relatively long femoral neck) associated with Early to Middle Pleistocene *Homo*. Femur I does not show this pattern, adding to evidence that it is not *H. erectus*, but rather derives from a more recent time period.

*Funding for this study was provided by the French MNHN and the Human Evolution Research Fund at the UI Foundation.*

**The interplay between behavior and disease: investigating pathogen transmission dynamics in wild chimpanzees with social network models.**

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Great apes demonstrate tremendous variation in social contacts, which epidemiological studies show can be crucially important for predicting pathogen spread. Wild apes are also vulnerable to several directly-transmitted respiratory pathogens that have caused major population declines. Network-based epidemiological models provide an effective approach for mathematically formalizing heterogeneous transmission pathways and can be a powerful tool for predicting outcomes of future pathogen introductions and disease control efforts. Using such models, we investigated how behavioral association patterns may affect pathogen transmission dynamics within the wild Kanyawara chimpanzee community (N=37) in Kibale Forest, Uganda. Specifically, we used association data from field observations to construct nine monthly contact networks on which we stochastically simulated epidemics to explore how outbreak sizes depend on i) pathogen infectiousness, ii) network position of the index case, and iii) the month of the outbreak. We then used generalized linear models to identify individual characteristics that influence outbreak size. We found that outbreak sizes were largest in the presence of estrous females due to an increase in mean network connectedness. Outbreak sizes were also greatest when the index case was a high-ranking male or a chimpanzee with a large family unit, as these individuals tended to be the most highly connected. Follow-up simulations of vaccination

strategies revealed that for a fixed level of coverage, epidemic risk could be greatly reduced by targeting these individuals relative to random vaccination. Overall, our work demonstrates how combining behavioral data with network models can offer practical applications for pathogen control of endangered wildlife species.

This study was funded by the US Fish and Wildlife Service, the ARCS Foundation, Morris Animal Foundation, the Margot Marsh Biodiversity Foundation, and Fulbright.

**Shifting the focus in primate community ecology: Utilizing patch focals to study unhabituated dry habitat chimpanzees.**

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Researchers studying primate community ecology have largely focused on primate species only, ignoring the interactive role that primates have within their larger communities. However, non-primate species (e.g., birds, bats, and other mammals) can greatly influence the socio-behavioral ecology of primates, especially by competing for food and habitat space. Shifting the focus of research to include these potential non-primate competitors requires a modification in methods as well. The common primatological method of all day focal follows captures detailed information about the study species, but overlooks important phenomena, such as indirect competition, that occur during the absence of the focal species. Patch focals, in which areas of habitat are monitored, allow for observation of all animals within a study area; capture resources that are not used by the study species; and are particularly well suited for unhabituated communities, where closely following fauna is not possible. Chimpanzees at the dry habitat site of Issa, Ugalla, Tanzania were expected to have broader resource use than forest chimpanzees, due to increased competition with other fauna for fewer available resources. Data were collected utilizing patch focals from October 2010 to October 2011. Dietary and habitat preferences were determined for chimpanzees and other fauna, resulting in a detailed analysis of chimpanzees within their larger faunal community. Understanding how fauna interact within their communities is extremely important for informing conservation efforts. For chimpanzees in particular, understanding their ecological role in varying extant environments can elucidate the role of early hominins in similar paleo-environments, when used as models.

**Functional morphology of proximal caudal vertebrae in nonprehensile-tailed primates.**

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Functional morphologists have devoted considerable attention to the structure and function of prehensile tails. By contrast, little attention has been paid to nonprehensile tails

despite the fact that this tail type characterizes the majority of mammalian taxa. Here, we compare proximal caudal vertebral anatomy among nonprehensile-tailed primates in the context of a comparative mammalian sample. We evaluate linear and angular measurements with known biomechanical significance against tail length in order to investigate the anatomical changes associated with tail loss/reduction. Preliminary results demonstrate that at the levels of the first and mid-proximal vertebrae, an increase in tail length is associated with craniocaudally longer vertebral bodies with more circularly-shaped proximal articular surfaces, longer spinous processes, and transverse processes that are more laterally expanded and point more caudally and ventrally. Prezygapophyseal orientation does not appear to change with respect to tail length at these vertebral levels. At the level of the transition vertebra, results (for features present) are similar to those of first and mid-proximal vertebrae, but the relationship to tail length appears weaker. Generally, comparisons of proximal caudal vertebrae among nonprimate mammals that vary in tail length confirm the trends observed for primates. These features likely afford longer-tailed mammals enhanced proximal tail flexibility, as well as greater surface area for attachment and improved leverage of tail musculature, compared to shorter-tailed mammals. Our findings provide an anatomical basis for future studies of nonprehensile tail kinematics and may contribute to our understanding of the anatomy associated with tail loss in primate evolution.

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**Influence of placental characteristics on birth weight and evidence for population differences in placental morphology: A preliminary report from Cebu, Philippines.**

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The placenta is the physical, metabolic, and endocrine interface between maternal ecology and the developing fetus; investigation of the functional-morphological properties of this organ can help us better understand not only what drives birth weight, but also how the intrauterine environment sets lifecourse health trajectories in motion. Here we present preliminary data on 1) the relationship between placental characteristics and birth weight of babies born to women who have been lifelong enrollees in the Cebu Longitudinal Health and Nutrition Survey in Cebu City, Philippines and 2) evidence for population differences in

placental characteristics. In contrast to findings in several populations, placental and birth weights were not correlated in our preliminary sample ( $n=10$ ,  $r=0.04$ ,  $p=0.91$ ), although lower birth weight neonates tended to have lower-weight placentas (451.67 g vs. 638.75 g;  $t=-1.944$ ,  $p=0.09$ ). We compared the Cebu sample to a similarly-sized sample of control pregnancies (i.e. not growth-restricted;  $n=9$ ) from Nottingham, UK. Cebu birth and placental weights were lower (though not significantly so) than the Nottingham sample, but Cebu placental villous surface area was significantly smaller (6.29 m<sup>2</sup> vs. 11.0 m<sup>2</sup>,  $p<0.01$ ). The Cebu placental villous surface area was similar to the Nottingham values for growth-restricted fetuses ( $n=5$ , 6.47 m<sup>2</sup>). Since this is the region of the placenta responsible for maternal-fetal nutrient transport, variation in this compartment has important implications for understanding population variation in fetal growth patterns, disparities, and developmental programming.

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**Human walking and developmental bone morphology: An integrated functional perspective.**

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The objective of this research is to examine how human locomotor development contributes to the pattern of ontogenetic morphological change in trabecular microarchitecture and adjacent cortical geometry. The hypothesis tested predicts that the pattern of ontogenetic within-tibial variability in trabecular and cortical bone is associated with age-related variability in gait kinematics. High-resolution CT scans were collected for the tibia from the Norris Farms #36 skeletal collection, ranging in age from neonate to adult. Resolution-corrected morphometric structural analysis of the 3D trabecular bone fabric structure was performed for multiple cubic volumes of interest from the proximal and distal tibial metaphyses using the BoneJ plugin within ImageJ. Cortical cross-sectional geometric parameters were calculated at 20% and 80% of whole bone length. Gait analyses were undertaken on 25 age-grouped children between the ages of 1 and 9 years to establish new data for joint kinematics/kinetics coefficients of variation (CV) across age classes. The results of this work demonstrate that individual CVs versus age for joint angles are significant in the medial/lateral axis at the knee and ankle with the greatest variability in the youngest. Multivariate analysis

supports the hypothesis of increased trabecular bone microarchitectural variability in the younger ages at both the proximal and distal tibia. Age-related cortical bone variability is significant in the proximal tibia, but not distal. Our conclusions from these data support the concept that the kinematic characteristics associated with the initiation of human gait contribute to skeletal microarchitectural and geometrical heterogeneity and differentiation.

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**Shape analysis of the human zygomatic bone – Data evaluation.**

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The zygomatic bone is an important element of the viscerocranium. Several muscles attach here, and its shape has a marked effect on facial appearance. As a consequence, shape variation of the zygomatic bone is crucial in forensic facial reconstruction, reconstructive surgery and evolutionary studies.

We analysed the shape of the zygomatic bone in 200 individuals, divided into four subgroups, representing females and males of Chinese and European origin. Our data consists of surface meshes extracted from CT-scans. First, eight manually placed landmarks provided a rough alignment of these meshes. Then, both rigid and elastic surface matching algorithms were applied, using iterative closest point matching and smoothed displacement fields. After the registration process, all vertices of the matched surfaces were corresponding throughout the sample. Based on this information, statistical shape analysis was performed, using 1000 mesh vertices.

Our results show significant shape divergences related to sex and population affinity. Sex differences are hardly distinguishable with the naked eye. A comparison in terms of origin proofs the average Chinese shape to be more robust than the European. The variation depending on population affinity concentrates on the orbital border of the zygomatic bone, with less variation at the temporal border.

**Integrating clinical perspectives and bioarchaeological interpretations: Case analyses from Neolithic Catalhöyük, Turkey.**

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It is well understood that bioarchaeological analyses of human skeletal remains require, at a minimum, an intimate knowledge of human osteology. Expertise in the fields of human physiology and soft tissue anatomy, however, along with the ways in which such knowledge might enhance our interpretations of health and lifestyle in the past,

are sometimes less appreciated among the bioarchaeological community. In this study, we seek to demonstrate the benefits of integrating information from the clinical literature into bioarchaeological interpretations using three examples from the Neolithic farming community of Çatalhöyük (9400-8000 yBP) in Turkey: 1) a young adult male with fusion of the second and third cervical vertebrae, 2) a young adult female with neuromuscular atrophy of the right upper limb and hand, and 3) a middle adult female with avascular necrosis of the right scaphoid. An understanding of the anatomical and physiological correlates of skeletal manifestations of trauma or pathology can provide insight into the underlying causes of these conditions. Furthermore, by interpreting such cases in light of the ways in which these conditions are prevented or treated among modern populations, as well as the problems that arise in the absence of medical intervention, bioarchaeologists can gain a better appreciation of the impacts these disorders may have had on the health and well-being of individuals in the ancient past. Bioarchaeologists have much to gain from integrating elements of archaeological context, paleopathology, and clinical anatomy in their analyses, and such syntheses provide an avenue for advancing the discipline as a whole.

#### **Ethical practice in biological anthropology: An introduction to the 2013 symposium.**

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This opening presentation for the 2013 symposium, Ethical Practice in Biological Anthropology: continuing the dialogue, will outline the goals of the symposium and propose possible steps for future symposiums (such as modules addressing topics of ethics in biological anthropology) to be considered during the forty-five minute discussion period. The goal of this symposium is to bring together researchers working in different specialties of physical/biological anthropology who can illustrate how the practice and discussion of ethics is relevant to our field.

In this presentation, we will highlight the history of ethics discourse within our field and address the need for continuing discussions of ethics in biological anthropology. We hope that this symposium will encourage others to discuss questions of ethics that have arisen during their fieldwork, research, and studies. Eventually we hope this will lead to new spaces for discourse in the field and the generation of additional reference materials for students, professors, and researchers. Ultimately, we hope this symposium will offer critical new view points on ethical issues, while simultaneously building on the work that has come before it.

#### **Validation of bone apatite purification protocols for stable isotope analysis in bioarchaeology by Solid-State Nuclear Magnetic Resonance spectroscopy .**

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Stable isotope analysis is commonly used to study diet and residential mobility of past populations. The reliability of isotopic values of the mineral fraction of bones found in archaeological context is regularly questioned because of potential isotopic effects caused by the diagenetic alterations and the chemical treatments of bone apatite.

The aim of this study was to test the validity of two different apatite purification protocols by solid-state Nuclear Magnetic Resonance spectroscopy (NMR) of hydrogen (<sup>1</sup>H) and carbon (<sup>13</sup>C) nuclei that consist on: first, elimination of organic matter in bone by sodium hypochlorite treatment during 48h; and second, elimination of exogenous carbonate by two apatite purification methods using 0.1M acetic acid during 4h *versus* 1M acetic acid during 1h.

NMR <sup>1</sup>H and <sup>13</sup>C spectra were obtained under magic angle sample spinning (MAS) for: (1) untreated bone, (2) bone after sodium hypochlorite treatment, (3) bone after 0.1M acetic acid treatment, and (4) bone after 1M acetic acid treatment.

This study was performed on 10 archaeological human samples having different states of preservation: 5 from the catacomb of Saints Peter and Marcellinus (1<sup>st</sup>-3<sup>rd</sup> century AD, Rome) and 5 from Saint Benedict cemetery (18<sup>th</sup> century AD, Prague).

Primary results in <sup>13</sup>C NMR spectroscopy showed that, despite the sodium hypochlorite treatment, small amounts of organic residues were still present in some samples. The <sup>1</sup>H NMR spectroscopy also showed differences in the elimination of exogenous carbonate according to the protocol used. Isotopic effects were established according to concentration and immersion time of acetic acid.

#### **The function of long calls in western gorillas (*Gorilla gorilla*): Behavioral flexibility in ape communication.**

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Animals often use long calls to regain contact and reestablish proximity with group members. Although both gorilla species use long calls, only among western gorillas are

individuals occasionally separated by more than 200 m from other group members, thereby requiring some mechanism to restore group cohesion. Here we test whether their "hoots" function as long contact calls, in which case they should be individually distinct, given by both males and females when separated, and result in reduced inter-individual distances. We collected behavioral (1,458hr), spatial (simultaneous GPS points = 268) and acoustic data (643 call segments), during simultaneous 2h-focal follows of the male and an adult female (rotating among 4 females) in one group of wild western gorillas, at Mondika Research Center, Republic of Congo. Hooting bouts (sequence of hoots, n = 89) were given every third day on average and lasted nearly an hour. Discriminant function analysis confirmed individual distinctiveness of hoots. When hooting bouts began, at least one female (or the male) was absent from the main party, and the average distance between the separated individuals (216±83 m) was significantly greater than their mean daily proximity (51±15 m). Both the male and females initiated and responded to hoots, and the distance between separated individuals decreased significantly by the end of the hooting bouts. We conclude that hoots, used only by males during inter-group encounters in mountain gorillas, are used by both sexes in western gorillas to promote group cohesion, suggesting flexible usage of homologous calls by closely related species.

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#### **Analysis of archaic introgression in Ötzi the Tyrolean Iceman, a 5300 year-old prehistoric modern human.**

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The contribution of Neandertal populations to present-day peoples illuminates the process of recent human evolution. The Neandertals were a relatively peripheral population that occupied western Eurasia from roughly 150,000 to 30,000 years ago. Nuclear genomic evidence has been recovered from several later Neandertals, after 50,000 years ago (Green et al. 2010). Neandertal genomes are more similar to living people who trace most of their recent ancestry to regions outside Africa. By contrast, sub-Saharan African people today have less Neandertal genetic similarity. These comparisons show that in addition to deriving more than 90% of their genetic heritage from ancient Africans, most present-day people outside Africa derive a fraction of their ancestry from the Neandertals (Green et al. 2010).

These comparisons leave unanswered questions. Was population mixture with Neandertals limited to non-African populations, or do today's Africans also have some Neandertal ancestors? Did mixture occur as a

singular event, or was there a long process of population interaction? Did populations who succeeded the Neandertals in Europe have a higher fraction of Neandertal ancestry?

We carried out a series of comparisons to address these questions. By examining the Neandertal similarity of individuals from the 1000 Genomes Project, we have substantially expanded the sample of Neandertal-human comparisons. We also examined the genome of the Tyrolean Iceman, a European from approximately 5300 years ago. This is the first comparison of Neandertal genomes to the genome of a prehistoric modern human individual.

#### **Orangutan sleep architecture: A comparison between orangutan, chimpanzee and human sleep behavior.**

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Of the extant primates, only twenty nonhuman species have been studied by sleep scientists. Notable sampling gaps exist, including large bodied hominoids such as gorillas (*Gorilla gorilla*), orangutans (*Pongo spp.*), and bonobos (*Pan paniscus*), for which data have been characterized as high priority. Here, we report the sleep architecture of three female and one male orangutan (*Pongo spp.*) housed at the Indianapolis Zoo. Sleep states were identified by scoring correlated behavioral signatures (e.g., respiration, gross body movement, muscle atonia, random eye movement, etc.). The behavioral analysis differentiating sleep states were scored in one-minute epochs, at 8x real time speed. The captive orangutans were focal subjects for a total of 42 nights (535.9 h) recorded. We found that orangutans slept an average of 9.20 h (range: 5.93-10.8 h) nightly and were characterized by an average NREM of 8.17 h (range: 5.47-9.9 h) and REM of 1.04 (range: 0.43-2.07 h) per night. In addition, to assess whether the orangutan species typical sleep architecture (STSA) is within the human range, we compared previously published values of human sleep architecture (HSA) to that of the data generated in this study. NREM % and REM % were significantly different in both chimpanzees and humans when compared against orangutans—chimpanzee values being intermediate between that of orangutans and humans. With increased stability, habitually terrestrial hominins may have benefited from higher quality sleep compared to the vagaries of arboreal sleep. This suggests that the advent of HSA was coincident with the emergence of *Homo erectus*.

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#### **Addressing the osteological paradox using high resolution stable isotope analysis.**

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The “osteological paradox” posits that the evaluation of health in archaeological populations is complicated by three factors: fluctuating demographic patterns, selective mortality, and variable susceptibility to illness among individuals. Selective mortality, for example, refers to the obvious reality that a skeletal sample comprises deceased individuals and underscores the potential difficulty of accurately describing the living population at any given age. Stable isotope analysis offers a potential means to address this problem by permitting both cross-sectional and longitudinal approaches. Stable isotope analysis is commonly performed on bone collagen and plotted against age at death to build a picture of dietary change and life history events such as the weaning process. In much the same way that enamel growth disruptions reveal childhood stress episodes in individuals that survived into adulthood, stable isotope analysis of teeth can provide information about survivors as well. Here, we present new high resolution stable carbon and nitrogen isotope profiles in dentine collagen of early forming permanent teeth in a sample of adults from the Medieval Nubian site of Kulubnarti. We compare these longitudinal data to cross-sectional data obtained from rib collagen to explore the relationship between survivorship and childhood diet. Results suggest that survivors had variable dietary histories, but did not follow the pattern obtained from the cross-sectional analysis. A sharp drop in nitrogen isotope ratios between the ages of 4 and 5 years evident in the cross-sectional data was not apparent in any of the survivors.

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#### **Revisiting the social brain hypothesis: Incorporating within-species group size variation into a comparative analysis.**

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The social brain hypothesis proposes that the complex social environments of primates selected for increased brain size over time (Dunbar, 1992, *Journal of Human Evolution*, 20: 469-493). While managing multiple social relationships may require an increase in neocortex size, past comparative studies have neglected to account for the effect of within-species variation in group size on brain size. Data from studies of multiple populations of the same primate species provide an opportunity to investigate whether within-species variation in group size influences the relationship between

group size and brain size. In this paper, we implement a re-sampling procedure with phylogenetic generalized least-squares (PGLS) regression to capture within- and between-species variation. Specifically, we tested whether species averages in group size obscured the relationship between group size and brain size. We compiled data on group size from the literature for multiple populations of 26 monkey and ape species from Dunbar's (1992) sample. We re-sampled group sizes from each species and then conducted 10,000 PGLS regressions to examine the relationship between group size and neocortex ratio. A majority of the regressions was significant, suggesting that group size is correlated with neocortex ratio after controlling for the effect of within-species variation. This result is consistent with the social brain hypothesis. Our procedure accounts for within-species variation and should be used in future phylogenetic comparative studies.

#### **Infectious diseases, beliefs and treatment before antibiotics: Examples from Portuguese culture and skeletons.**

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Despite the scarcity of post-medieval skeletal evidence of infectious diseases in Portugal, written records indicate that these diseases were a common cause of morbidity and death. This study aims to acknowledge the social experiences of patients with infectious diseases in Portugal from the 16th to early 20th centuries. Thus, two types of research were conducted: (1) macroscopic and radiological assessment of bone infection, namely bony evidence of tuberculosis and osteomyelitis, in individuals from the Coimbra Identified Skeletal Collection; (2) medical texts and other publications were researched in order to understand the evolution of medical knowledge and folk beliefs about the scourge of infectious diseases. Findings indicated that skeletons of 3 non-adults with tuberculosis as cause of death mainly presented bone lesions in the vertebral column and lower limbs, while 4 cases of osteomyelitis showed signs of surgery affected the limbs. Historical documents indicate that tuberculosis was considered highly contagious. Sanatoria, good climate and a highly nutritional diet were recommended by physicians while home remedies spread. Lack of morality in society was seen as responsible for the spread of tuberculosis. Young patients expressed their pain in poetry referring to lung dilation, and referred to having feelings such as a mixture of love and hate, and imminence of death. Bone destruction and bone recession from surgery, namely in osteomyelitis, led to disability. Together, osteological data and historical research demonstrate that these diseases were both a social and biological scourge and shaped economic classes by leaving many patients poor and without social support.

**Changes in long bone strength correspond to shifts in locomotor behavior during development in chimpanzees (*Pan troglodytes*).**

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Changes in locomotion are likely to be reflected in bone strength and shape since stress placed on bone through habitual behaviors during early development can cause significant responses. Previous research has shown that when humans go through the abrupt shift in locomotion from crawling to walking at about one year of age, there is a corresponding increase in femoral to humeral strength. Chimpanzees likewise go through a locomotor shift during development, transitioning (albeit gradually) from primarily suspensory behavior to predominantly quadrupedal knuckle-walking. It is therefore predicted that in chimpanzees, initial forelimb usage will increase humeral diaphyseal strength over that of the femur, and that later, hindlimb loading during quadrupedalism will lead to greater femoral strength.

This hypothesis was tested using skeletons of wild-caught individuals from museum collections. Long bone geometric properties were derived from micro CT scans of the midshaft of the humerus and femur. Principal Moments of Area (i.e.  $I_{max}/I_{min}$ ) and Second Moments of Area ( $J, Z$ ) were calculated from the images using BoneJ (version 1.3.2).

As predicted based on locomotor data, this study found that very young chimpanzees have stronger humeri than femora with a trend of increasingly stronger femoral to humeral second moments of area over time. Changes in femoral to humeral strength were more subtle compared to the trend found in humans, but this corresponds to a more gradual shift in locomotion, and nonetheless illustrates a comparable relationship between behavioral and morphological development.

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**The interaction of DISH and obesity on a pathological anterior pubis.**

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Diffuse idiopathic skeletal hyperostosis (DISH) is a systemic disorder of unknown etiology affecting the axial and appendicular skeleton. The most recognizable feature of DISH is fusion of the anterolateral vertebral bodies with preservation of the intervertebral disc space. While the clinical and paleopathological literature infrequently discusses attendant fusion of other bony sites or skeletal areas, literature has posited that obesity may play a role in the formation of DISH.

The skeleton of an obese white female (+400lbs) at Texas State University-San Marcos presented with fusion of the vertebral column

and multiple costovertebral joints typical of DISH, along with unusual skeletal outgrowths affecting the left and right pubic symphyseal faces. In order to document the prevalence of this pubic bone defect, 84 individuals from the William M. Bass Donated Skeletal Collection were examined. Inclusion criteria comprised of differential diagnosis of DISH or ankylosing spondylitis and/or obesity (>250lbs). One white male (+400lbs) had similar skeletal manifestations on the pubic symphysis with associated vertebral and unilateral sacroiliac fusion indicative of DISH. These two individuals demonstrate the potential interaction of DISH with obesity and the various skeletal outgrowths that may result.

**Short-term consequences of intergroup aggression among tufted capuchin monkeys: Implications for long-term coexistence among unevenly-matched competitors.**

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Recent studies of intergroup aggression suggest that location-dependent dominance permits small groups to stably coexist with larger neighbors. Among Argentine tufted capuchin monkeys (*Sapajus [Cebus apella] nigritus*), however, the outcome of intergroup aggression is determined by relative male group size, suggesting that group extinctions and home range displacement should be more frequent. Here we investigate the consequences of intergroup aggression on subsequent use of contested areas for three capuchin monkey groups at Iguazú National Park. During all-day group follows, we recorded the location of the group's center at 15-minute intervals. We used linear mixed models to examine the effect of intergroup encounters ( $N = 47$ ) on intervals between revisitations to one hectare quadrats ( $N = 814$  revisits), controlling for seasonal availability of fruit resources and relative intensity of use across seasons. In the absence of intergroup encounters, groups return more rapidly to areas with either high densities of seasonally-important fruit resources or intensive use throughout the year. Regardless of the quality of the area, intergroup encounters occurring in intensively-used areas do not affect return times; however, responses to encounters that occur in infrequently-visited portions of the range depend upon local resource availability. Both wins and losses in low-quality areas significantly increase revisitation intervals, whereas – in high-quality areas – patch return times decrease following an encounter. These results support a learning-based mechanism for home range maintenance, wherein territorial expansion by dominant groups is constrained by interaction costs imposed by subordinate groups

that persist in using familiar areas despite repeated defeats.

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**A man's face reveals his body height: A GMM approach to ontogenetic and static allometry.**

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A large number of studies investigated which facial features lead to dominance attributions and other social inference, whereas separate studies assessed the role of body height in sexual selection. Facial allometry might link these approaches, but has received surprisingly little attention. To start with, we predict the presence of size cues in the adult face and relate them to the postnatal growth pattern.

Our sample comprises 44 frontal photographs of Austrian boys (6–11 years) and men (17–33 years) together with their body height. On each photo 35 anatomical landmarks and 34 semilandmarks were digitized.

We estimated allometry via regressions of facial shape on log centroid size and body height in the full ontogenetic sample as well as in the subsample of adults only. The ontogenetic regressions were very similar, reflecting the high correlation between facial size and body height during ontogeny ( $r = 0.83$ ). The static regression pattern of adult facial shape on body height resembled the ontogenetic pattern with an overall elongation of the mid- and lower face, a relative decrease in eye size as well as a thickening and lowering of the eyebrows. By contrast, the relationship between adult facial shape and facial size was less pronounced and not statistically significant.

These results show that there are substantial shape cues to body height in the adult male face (with taller men having the more mature features). This might operate as confound in studies of facial masculinity, leadership, and mate preferences.

**The signature of language and geography on the genetic structure of human populations in Africa.**

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Recent evidence shows that the serial founder effects model is the best portrait of human genetic variation on a global scale. The model provides less insight into genetic variation in Africa, from which the founding population

for the rest of the world arose. To help fill this gap, we studied the genetic structure of African populations in relation to geography and language. We examined 652 autosomal microsatellite loci from 2413 individuals in 118 African populations collected and made publicly available by Sarah Tishkoff (Science, 2009 324:1035). We analyzed correlations and partial correlations between matrices of Nei's genetic distance, geographic distance, and linguistic distance. For all pairs of populations, we used great circle geographic distances, and a linguistic distance based on positions of languages in a standard classification (*i.e.*, languages in branches, in subgroups, in groups, in primary branches, and in families). Geography independently accounted for 12% of the variation in genetic distance ( $p=0.0000$ ). Language independently accounted for 9% of the variation in genetic distance ( $p=0.0000$ ). To explore the role of language further, we partitioned the linguistic distance into components defined at each level of the classification. We found that language family membership alone accounted for nearly all of the correlation between linguistic and genetic distance, with modest additions from primary branches and groups. It appears in this light that language groups reveal genetic signatures of ancient divisions in African populations. The correlation of genetics and geography, independent of language, reveals more recent gene flow and population movement.

#### **Preliminary report on the anthropology of 15 X STR loci.**

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A total of 535 chromosomes from US European (132), SW Hispanics (155), African Americans (118), West Africans (primarily Ghana and Nigeria)(30), Ethiopia (34), SE Asia (32) and Siberia (34) were tested for 15 X chromosome STR loci (DXS8378, DXS9902, DXS6795 [LG1], DXS7132, DXS6803, DXS6789, DXS7424, DXS101, GATA172D05, DXS7130, GATA165B12 [LG2], HPR1TB [LG3], GATA31E08, DXS10147 and DXS7423 [LG4]), yielding 144 alleles using two multiplexes developed at AFDIL for forensic purposes. The loci were individually analyzed by  $F_{ST}$  analysis across the seven populations, and aggregated analyzed using PCA followed by hierarchical cluster analysis. All probability values were corrected for multiple tests using the Bonferroni correction.

The results of the  $F_{ST}$  analysis indicated that 11/15 loci had  $F_{ST}$  values  $>0.05$ , 9 of which were significant at the  $\alpha=0.05$  level, however only 4/15 were significant after Bonferroni correction. PCA analysis yielded six Eigen vectors which accounted for 100% of the variance, and generated highly discriminating factor scores for the seven populations.

Cluster analysis using Ward's Method on a Squared Euclidean distance matrix generated an anthropologically expected tree with African Americans clustering with West Africans on a deep root, East Asian and Europeans on a separate branch, with the Siberian and SE Asians separated by a relatively deep root as expected. An unexpected result was the Europeans and SW Hispanics (admixed) clustering, and the Ethiopians also clustering in this group indicating commonality with Europeans. These results support the use of these markers as tools in the investigation of the origins of modern human populations.

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#### **Hybridization or exploitation? Bioarchaeological evidence for the nature of Corinthian colonial interactions in Albania.**

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Traditional explanations regarding the nature of Greek colonization embrace a model of Hellenization—the one-sided flow of Greek culture from core to periphery. Colonial interactions are described as imbalanced with the native peoples quickly subjugated and local resources strongly regulated and controlled. However, newer models define colonial relationships in terms of hybridization—variation in colonial response and transformation of identity for both interacting populations. Motivations for colonization may even have involved the establishment of friendly relations throughout the Mediterranean creating a system of reciprocity. We use bioarchaeological evidence to contribute to this discussion, and test the hypothesis that Corinthian colonial interactions were largely friendly. Specifically, we hypothesize that there was no change in skeletal stress or trauma following colonization at the Corinthian colony of Apollonia, Albania (c. 600 B.C.). This is supported by historical sources indicating colonial interactions at Apollonia were friendly and initiated through non-violent means.

At Apollonia (n=228), prevalence of skeletal stress (porotic hyperostosis, cribra orbitalia, enamel hypoplasia) showed nonsignificant increases while the frequency of periostitis and trauma decreased following

colonization. At Corinth (n=85), prevalence of skeletal stress (porotic hyperostosis, cribra orbitalia, oral health) decreased. Although these data support the assertion that colonial interactions were nonviolent, relations were not necessarily mutually beneficial to Corinthians and their colonies. Though Corinth received benefits from colonization resulting in improvements in skeletal health for their populace, skeletal health declined at Apollonia, likely in response to urbanization, poor sanitation, and exposure to new pathogens through increasing interaction with Mediterranean traders.

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#### **Dendritic morphology of pyramidal neurons across the visual stream: A direct comparison of chimpanzees and humans.**

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The morphology of pyramidal neurons in human and chimpanzee cerebral cortex has previously been demonstrated to increase in dendritic complexity and spine density in cortical regions of increasing neural integration, such as prefrontal cortex. The role of brain size scaling on the elaboration of dendritic arbors has been difficult to interpret, however, in part because of the wide diversity of regions previously studied. The present study examines variation in the dendritic morphology of pyramidal neurons between humans and chimpanzees within a functionally-related processing stream of ventral visual regions. Cortical samples from three different visual regions representing increasing integration (V1, V2, and fusiform gyrus) from two chimpanzees and two humans were stained with the rapid Golgi technique. Ten neurons from each region of each individual were traced with NeuroLucida software, for a total of 120 neurons.

The following measures were analyzed: soma area, total dendritic length, mean dendritic segment length, dendritic segment count, dendritic spine number, and dendritic spine density. Univariate analyses indicated that many measures of dendritic complexity increase along the processing hierarchy in both species; however, a repeated measures ANOVA revealed there were no significant species differences in the pattern of regional variation according to any of these measures ( $F=0.005 \leq x \leq 2.035$ ,  $P=.077 \leq x \leq .975$ ). These findings suggest that the pyramidal neuron morphology underlying neural integration along the levels of the ventral visual stream of the neocortex is similar in humans and chimpanzees.

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**Shape analysis of the human zygomatic bone - surface registration.**

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In Geometric Morphometrics, most methods are applied on sparse sets of homologous landmarks, manually placed on the structures to be analysed. The drawbacks of manual landmark placement are evident: though modern digital imaging provides very accurate surface representations of biological structures, there are few landmarks that are well-defined and reliable in terms of homology and observer error. As a consequence, the rich information contained in the digital information is poorly exploited. Many approaches to overcome these shortcomings (e.g. sliding semi-landmarks), still rely more or less on manually placed landmarks, thus being subject to observer error. We are presenting a method using smoothed displacement fields to register an atlas surface onto all other surfaces in our sample. Hereby, manual interaction is only required to place reference points establishing an initial, coarse spatial correspondence. To test the performance of our proposed method, we choose a rather complex geometric structure: the human zygomatic bone. In our study, we apply our registration method to 200 surface meshes extracted from CT-scans in order to evaluate population- and gender-specific surface shapes. 8 landmarks provide information for the surface meshes to be coarsely aligned, followed by an enhanced iterative closest point rigid body registration. The aligned surfaces now are iteratively matched onto each other using a locally smoothed displacement vector field. Finally, all surfaces are represented by meshes, consisting of corresponding vertices. Vertices within the region of interest can be processed, using the well established methods of Geometric Morphometrics.

**Microwear texture analysis of mandibular molars recovered from four Medieval sites in England and Ireland.**

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Excavation of the Medieval ecclesiastical site at Kiltasheen (Co. Roscommon, Ireland) recovered the skeletal remains of 131 individuals, which demonstrate poor dental health and significant physiological stress at the site. Historical records suggest the site was a stronghold for the O'Conor Kings of Connacht from the mid-7<sup>th</sup> to 14<sup>th</sup> centuries, but little is known about the subsistence patterns practiced by its residents. This study uses white light scanning confocal microscopy and scale-

sensitive fractal analysis to quantify the occlusal microwear fabric of 32 adult mandibular molars from Kiltasheen and three other Medieval sites in England and Ireland in order to elucidate potential differences in subsistence practices at each of the sites. Results indicate a smaller enamel surface *scale of maximum complexity (smc)* at Kiltasheen than at All Saint's church (York, England) ( $p=0.009$ ), which suggests that wear-causing particles may have been smaller at Kiltasheen than at York. Historical records suggest similar diets among sites, but potentially different food preparation techniques: grain with a higher moisture content in Kiltasheen likely required longer milling times to process than in York, leaving behind finer non-food abrasives. The results of this study show promise in the utilization of DMTA along with historical records and environmental information in contributing unique knowledge to the challenging task of utilizing human remains to infer the diets of past populations.

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**Multiple, distinct biological populations in Iron Age Mongolia: The Xiongnu elite cemetery of Borkhan Tolgoi (Egün Gol valley) reveals an ancestral Turkish component.**

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Building on previous research, this study explores the prehistory of Mongolia during a time when nomadic tribes created the world's first steppe empire in Inner Asia. These aggregated tribes, known as Xiongnu, ruled from the 3rd century BCE to the 2nd century CE. They came to define steppe polity construction later used by the Mongol Empire. These nomads moved extensively over the eastern steppe and interacted with peoples from Siberia to Xinjiang. However, the Xiongnu as a people are relatively unknown to scholars and their origins remain obscure.

This study attempts to elucidate questions of the Xiongnu's population history and structure by examining craniofacial diversity using geometric morphometrics. Using a suite of multivariate statistical analyses, this study explains the origins of the Xiongnu in a biological context and makes inferences about genetic exchanges. A quantitative genetic model (Relthford-Blangero) is used to test group relationships and infer levels of gene flow between groups.

Results indicate the Xiongnu were composed of at least two biologically distinct groups. One sample from an elite cemetery in northern Mongolia (Borkhan Tolgoi) shares their ancestry with a Bronze Age population from Mongolia (Chandman), and possibly, to a later migration of Turks. The Xiongnu also evidence biological similarity with nomads who composed the Mongol Empire, modern-day Mongolians, and Siberian groups. These results are similar to ancient genetic studies while also achieving consensus with models of steppe polity formation proposed by archaeologists. The

Xiongnu nomads are a significant part of Mongolia's past with links to its modern peoples. *This work was partially supported through a National Science Foundation Doctoral Dissertation Improvement Grant (BCS #1028773).*

**Genetics and development of obesity in captive vervet monkeys (*Chlorocebus aethiops sabaeus*).**

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Obesity is a growing problem the world over, with a high cost to public health. This research investigates a baseline genetic predisposition to obesity during development in a genetically well-characterized model system: the vervet monkey (*Chlorocebus aethiops sabaeus*). We used basic measures taken thrice yearly on body size and composition such as BMI and waist circumference (WC) in a captive population of 657 monkeys measured from 2008 through 2012, to search for heritable patterns in obesity. We found that 43 (10% of adults) were chronically obese (obese during at least three successive measurements) with obesity defined as having an adult WC above 40.5 cm. Loess regressions and k-means clustering of longitudinal WC and BMI measures from 2000 to 2012 reveal stark differences in growth trajectories between chronically obese and non-obese colony members: whereas non-obese WC and BMI growth levels off just after attaining full adult size, obese colony members appear to maintain a pubertal growth slope up to a decade after puberty has passed. Analyses of estimated additive genetic heritability using SOLAR show that BMI, WC, and chronic obesity are all highly heritable (BMI:  $h^2 = 0.65$ ,  $p = 1.1 \times 10^{-09}$ ; WC:  $h^2 = 0.61$ ,  $p = 1.6 \times 10^{-10}$ ; chronic obesity:  $h^2 = 0.64$ ,  $p < 0.01$ ), at levels much higher than those seen in previous studies of NHP populations, with significant covariates represented by age and sex. This preliminary study suggests that more comprehensive examinations of growth may elucidate previously unknown patterns in the development of obesity.

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**Cross-species parasite patterns: Pinworm prevalence in captive lemurs.**

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Parasite infection in primates is thought to be costly and to have shaped behavioral and physiological adaptations of hosts and parasites. Assessing patterns of infection will inform our understanding of the interactions between parasites and their primate hosts and the adaptations that mitigate costs of infection. Ten years of parasite occurrence data in 14 diurnal lemur species with outdoor access were extracted from routine veterinary visit records at the Duke Lemur Center. These data were combined with demographic information on the individuals sampled to facilitate cross-species comparisons.

The most prevalent parasite across this population was a pinworm from the family Oxyuridae. A G-test showed that pinworm ova appeared significantly more frequently than did stronglylid ova ( $p < .0001$ ), which were the second most frequently found ova. Based on the contact and airborne transmission routes of species within Oxyuridae, it was hypothesized that lemur species housed in larger groups would have increased exposure risk and would be more frequently diagnosed with pinworms. This hypothesis was not supported by the data, which show that pinworms were significantly more frequently diagnosed in eight *Eulemur* species, which are housed in small groups, than in *L. catta*, *P. coquereli*, *V. rubra*, and *V. variegata*, which are housed in larger groups. Future analyses will integrate age, sex, and more detailed housing data to determine whether the observed pattern can be further explained by these parameters. Articulating the risk factors for parasites provides the framework in which adaptations to minimize infection or pathogenesis in lemurs can be understood.

#### ***In-vitro* analysis of nutrition in Hadza tubers using Hadza simulated cooking techniques.**

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Cooking is widely recognized as a highly significant step in human evolution because it possibly facilitates increased availability of nutrition. Cooking mechanically and chemically changes food, which can increase digestibility. This is particularly important for starchy foods because heat causes starch to absorb water and lose its otherwise highly resistant crystalline structure, a process called gelatinization. Gelatinization makes starch more digestible in the small intestine and increases the bioavailability of nutrition. However, some have questioned whether gelatinization of starch is the main goal of cooking. The Hadza hunter-gatherers of Tanzania roast their wild tubers for only a few minutes on an open high-flame fire. The same tubers are also often consumed raw. These observations led us to propose a series of questions regarding the Hadza tubers: What does brief fire roasting do to the starch? Does the starch require cooking for salivary  $\alpha$ -amylase

activity? Are there differences in nutrient bioavailability between cooked and uncooked tubers *in-vitro*? Our results show that tuber starch remains mostly unchanged after brief fire roasting and there is subsequently little difference between cooked and uncooked tubers in nutrient bioavailability *in-vitro*. We make inferences as to why a subsistence-based population such as the Hadza would practice thermal food processing behaviors that do not seem to alter the nutritional elements of the food itself. In particular, we hypothesize that brief roasting enables faster peeling and ease of chewing of Hadza tubers.

#### **Stable Isotopic Analysis of Human Diet in the Cape Region of Baja California Sur.**

THERESA M. SCHOBBER. Department of Anthropology, University of Florida.

Explorer accounts from 1533 on document populations in the Cape Region, Baja California Sur, Mexico as maritime foragers with varying descriptions of leadership, rank and occupational specialization within language groups. The antecedent and concurrent Las Palmas Culture (A.D. 1200 to 1700) was originally defined by William Massey based on excavation of small exclusive-use burial caves. Each cave held one or two primary interments and several secondary bundle burials representing both sexes and all ages. Skeletal elements in bundle burials were often painted with ochre before being wrapped in sewn palm fiber mats or occasionally animal hides. Both burial types have produced a diversity of largely perishable grave offerings.

Preliminary analysis of stable carbon and nitrogen isotope ratios of human bone collagen previously demonstrated marine protein contributed substantially to local diets and that while variability was evident, differential mortuary treatment offered little explanatory value. The present study builds on this earlier research with analysis of carbon isotope ratios of bone apatite carbonate and collagen from 81 individuals interred in nine cave burial and three open-air sand dune sites dating between A.D. 800 and A.D. 1650. Gender differences in whole diet and dietary protein intake outweigh differences observed by burial context, mortuary treatment or grave offerings. However variability between isotopic signatures and patterning between burial caves supports their use as markers of resource territories. Additional variability is accounted for by macronutrient shifts during weaning observed more clearly in bone apatite carbonate to collagen spacings than nitrogen isotope values of bone collagen alone.

#### **Skhul V segmentation and Broca's region asymmetries in Neandertal endocasts.**

P. THOMAS SCHOENEMANN<sup>1</sup> and RALPH L. HOLLOWAY<sup>2</sup>. <sup>1</sup>Anthropology, Indiana University, <sup>2</sup>Anthropology, Columbia University.

One of the endocranial hallmarks of modern *Homo sapiens* are observable

asymmetries over Broca's regions (BA 44, 45, 47) of the brain that are presumed to be related to motor aspects of speech production and language. CT scans and segmentation procedures have made it possible to quantitatively measure asymmetries of these regions in fossil hominins. Here we demonstrate the patterns of asymmetries in the endocasts of La Chapelle-aux-Saints, La Ferrassie, La Quina, Saccopastore, as well as the Middle Eastern Skhul V endocast from Mt Carmel, Israel, which has not been shown before. The Skhul V endocast shows a left-handed association of petalial features, and a right Broca's cap prominence. The French and Italian Neandertals demonstrate a different endocranial shape, and a mix of right and left-handed petalial associations, as well as asymmetry of the Broca's cap region. These observations are consistent with the view that Neandertals from both Europe and the Middle East had brains very similarly organized as those of modern *Homo sapiens*.

#### **Reproductive competition in male white-faced capuchin monkeys (*Cebus capucinus*): Variation in testosterone, DHT, and glucocorticoid production.**

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In many wild primates, male dominance rank is correlated with reproductive success. However, not all males compete successfully, suggesting that the costs of obtaining and maintaining high dominance are significant. Testosterone (fT) and dihydrotestosterone (fDHT) are androgens that facilitate male aggression and sexual behavior. Glucocorticoids (fGC) are associated with the stress response and mobilization of energy stores, but chronically elevated levels are associated with immunosuppression. We investigated the hormonal mechanisms underlying reproductive competition in alpha and subordinate male white-faced capuchin monkeys (*Cebus capucinus*) across female reproductive phases. From July 2008–October 2009, we collected weekly fecal samples (N=989) from all adult and subadult males (N=14) residing in three habituated groups in the Santa Rosa Sector of the Area de Conservación Guanacaste, Costa Rica. Fecal samples were also collected from females to identify periovulatory phases (POP) using progesterone and estradiol assays. Males responded to the presence of ovulatory females with increases in fT, fDHT, and fGC regardless of dominance status (GLMM, fT:  $F=70.352$ ,  $P<0.001$ ; fDHT:  $F=8.474$ ,  $P<0.001$ ; fGC:  $F=8.474$ ,  $P=0.004$ ), suggesting that all males experience increased competition and stress during POPs. Alpha males had higher fT, fDHT, and fGC than subordinate males independent of female reproductive state (GLMM, fT:  $F=161.313$ ,  $P<0.001$ ; fDHT:  $F=78.774$ ,  $P<0.001$ ; fGC:  $F=1.367$ ,  $P<0.001$ ). These findings suggest that while alpha males may benefit from increased competitive ability associated with

elevated fT and fDHT, high fGC levels indicate that there are also costs associated high dominance status.

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#### Investigating activity at the Third Cataract (Nubia): Enteseal remodeling at Kerma and Tombos.

SARAH A. SCHRADER, Department of Anthropology, Purdue University.

The ancient city of Kerma was once capital to the Kerma civilization, otherwise known as Kush, which thrived in Upper Nubia from ~2,500-1,500 BC. However, this prosperity ended when the Egyptian Empire conquered Nubia with the emergence of the New Kingdom Period (1,550-1,069 BC). Archaeological evidence suggests the town of Kerma was abandoned as the Empire began implementing various methods of consolidation, such as the construction of temple towns, the promotion of local administrators, and socioeconomic reorganization. Located 10km north of Kerma, Tombos is an example of an administrative center that was created at the beginning of the New Kingdom (~1,550 BC) and was cohabitated by both Egyptians and Nubians. It is not possible to determine if any of the Tombos inhabitants were from Kerma, however, the proximity and chronological relationship between the two presents an interesting point of comparison.

This study examines enteseal remodeling, as a proxy for physically strenuous activities, studying the variation between the Kerma and Tombos samples. Evidence suggests both males and females of Kerma were engaging in significantly higher levels of manual labor than the people of Tombos, despite age and body size controls. This supports the idea that Tombos served the Third Cataract region as an administrative center during the New Kingdom. Furthermore, this investigation also indicates that the inhabitants of Kerma were engaging in relatively rigorous physical labor and, thus, the transition to imperial power might not have been as detrimental to local lifeways as once thought.

This research was supported by the National Science Foundation Doctoral Dissertation Improvement Grant (#1128950) and the Global Synergy Grant (Purdue, University).

#### The effect of sibling birth on parent-offspring relationships in lemurs.

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Parent-offspring conflict theory proposes that parents will redirect investment to subsequent offspring when the benefit of investing in the current offspring is less than that of investing in new offspring. The current offspring, however, seeks continued investment from the parent, and the theory thus predicts conflict between the parent and offspring when new siblings are born. To date, empirical support for parent-offspring conflict theory is limited.

We examined parent-offspring conflict in a group of ring-tailed lemurs (*Lemur catta*) at the Duke Lemur Center from October 2010-February 2012. In October 2010 the group consisted of three recently weaned juveniles and three adults (including both the mother and father of each juvenile). In March 2011 three infants were born, such that each juvenile had at least one new sibling. We predicted that mother-juvenile affiliative behavior would decrease after sibling birth while aggressive behavior would increase. We conducted scan sampling at 2-minute intervals, recording the activity and nearest neighbor of each juvenile and adult, for 108 total hours of observation.

Juveniles were nearest neighbor with their mother significantly more before sibling birth than after their birth. Similarly, juveniles huddled with their mother significantly more before sibling birth than after. While overall aggression was rare, all instances of parent-juvenile aggression occurred after the birth of new siblings. Before sibling birth juveniles spent significantly more time with their mother than father, while after they spent equal amounts of time with each parent. These results suggest a shift in maternal investment coinciding with sibling birth.

#### Broader social impacts: Physical Anthropology and the K-12 classroom.

CAITLIN M. SCHREIN, School of Human Evolution and Social Change, Arizona State University.

The role of physical anthropology in the K-12 classroom has not been examined in the context of student learning. To better understand the influence of PA education on students' academic interests, professional goals and decision-making, a mixed-methods analysis including questionnaires and interviews of 44 undergraduate students was conducted. The results demonstrate that students who have a relatively high exposure to PA in K-12 are more likely to be interested in engineering or science (including health and medicine) majors and/or careers and demonstrate clearer decision-making skills regarding some socioscientific issues than students with less exposure to PA. These results hold regardless of the students' religious background or level of acceptance of evolution.

We know, however, that approximately 20% of public high school biology teachers do not teach about evolution. Some reasons for this include a lack of knowledge of the subject and/or

a lack of resources for teaching. In 2012, a new AP Biology curriculum and the Next Generation Science Standards were released and each includes expectations that teachers will teach about evolution. To assist teachers in adapting to and creating new curricula, physical anthropologists at universities, colleges, and museums are encouraged to engage in outreach programs that foster best practices for teaching evolutionary biology and integrate human examples into classroom lessons. Such activities can affect the quality of K-12 science education, cultivate student interest in science, and benefit researchers by establishing programs by which they can meet the broader social impacts criteria of granting agencies.

#### Reconstructing phylogenetic relationships and evolutionary processes in early *Homo* evolution: Genetic drift or selection?

LAUREN SCHROEDER and REBECCA R. ACKERMANN, Department of Archaeology, University of Cape Town.

The discovery of the somewhat *Homo*-like *Australopithecus sediba* has fuelled a growing number of debates surrounding the phylogenetic relationships in the *Homo* lineage. These discussions are complicated by our partial understanding of the underlying evolutionary processes acting to produce the diverse morphology characterizing this time period, fundamental in determining and understanding different potential evolutionary scenarios.

Here we apply statistical tests developed from quantitative evolutionary theory to estimate the causal factors (genetic drift vs. selection) behind morphological divergence during the early evolution of our genus. Analyses are performed on 3-D scan data collected from cranial and mandibular specimens of early *Homo* from eastern and southern Africa, *A. sediba* and *A. africanus*. If drift is rejected, selection vectors are then reconstructed to understand the magnitude and direction of selection.

Results from all analyses reject drift when investigating morphological divergence between southern and eastern early *Homo*, *A. sediba* and *A. africanus*. Estimated selection vectors and morphological responses for each analysis show that the selection required to produce east and South African early *Homo* from *A. sediba* is straightforward in direction and magnitude, whereas *A. africanus* to early *Homo* is more complex. However, genetic drift may explain the divergence between the earliest *Homo* specimens and later early *Homo*. Overall, these results suggest that the selection needed to change from *A. sediba* to *Homo* is a more likely adaptive scenario than one including *A. africanus*. However, a transition from the earliest *Homo* specimens (Hadar, Uraha) to later *Homo* is arguably a simpler evolutionary pathway.

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**Females select mates that are less related than expected among the Gombe chimpanzees.**

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In chimpanzees, females typically disperse at adolescence and must integrate into a new group in unfamiliar surroundings, often facing substantial aggression from resident females, before reproducing. This unusual pattern for mammals likely occurs because male chimpanzees benefit in cooperating to defend a large territory, forcing female dispersal to prevent inbreeding. However in the Kasekela community in Gombe National Park, Tanzania half of all females remain in their natal group allowing for direct comparisons of inbreeding risk and avoidance between immigrant and natal females. We genotyped 129 chimpanzees at 8-11 microsatellite loci and calculated relatedness (R) between each dyad using Co-ancestry.

As expected, natal females were more related, on average, to the adult males in their community than were immigrant females, and thus faced a higher risk of inbreeding. However, among 41 conceptions over 24 years, natal females, overall, were not more related to the sires of their offspring than immigrant females, despite two instances of close inbreeding. Furthermore all females, on average, conceived with a sire that was significantly less related to them than non-sires. These results suggest that chimpanzees are capable of detecting relatedness, and thereby can decrease, though not completely eliminate, the risk of inbreeding. Whether inbreeding avoidance occurs through behavioral mechanisms or post-copulatory, cryptic female choice is not yet known.

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**Mandibular premolar morphology is correlated with mechanically challenging diets in sympatric primates.**

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It has been suggested that megadont mandibular premolars in fossil hominins is an adaptation for the consumption of mechanically

challenging food items. This study used an extant primate model to test the hypothesis that megadont premolars correlate with diets that are especially hard or tough. We investigated several mixed-sex groups of closely-related, sympatric primates (e.g., *Callimico-Saguinus*, *Cebus sp.*, *Cercocebus-Lophocebus*, *Hylobates-Pongo*, *Macaca sp.*, *Papio-Theropithecus*). Although there is significant overlap in the dietary items these sympatric primates consume, they differ in their mandibular postcanine morphology. Standard metric and 2D geometric morphometric analyses were conducted on the mandibular postcanines of these taxa in the collection of the NMNH. Even when the effects of differences in body size are taken into account, relative premolar size is significantly and consistently larger in taxa that consume harder diets than closely-related, sympatric taxa. Relative premolar size was not consistently larger in taxa that consume tougher diets than closely-related, sympatric taxa. These results indicate that relatively large P<sub>4</sub> crown areas may be an adaptation that allows taxa to shift to diets with higher percentages of mechanically challenging food items, specifically hard food items. The results of this study have implications for reconstructing the dietary ecology of sympatric *Paranthropus* and early *Homo* and may be evidence of character displacement in the evolution of the postcanines of early hominins.

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**Reflections on an education in Biocultural Anthropology at Emory University.**

THEODORE G. SCHURR. Department of Anthropology, University of Pennsylvania.

In this presentation, I will briefly summarize the numerous contributions that George Armelagos has made to Biological Anthropology, particularly with regard to the issues of human biological diversity and race, human osteology, and epidemiological transitions, as well as discuss his influence on me as a scholar. While a doctoral student at Emory University, I had the pleasure of working with George during my graduate studies there. Like many students, I was attracted to the biocultural approach to anthropological research that Emory was developing in the early 1990s, and benefitted greatly from working with the Biological Anthropology faculty who instigated this program of study, especially George. Through our discussions, I came to greatly appreciate his contribution to human skeletal biology and paleopathology, his efforts to move beyond typological thinking in describing human diversity, his consideration of the role of both biological and cultural factors in shaping human dietary practices and disease history, and his use of insights from evolutionary anthropology to broaden public health understanding of different epidemiological issues. His work is a clear testament to the value of an interdisciplinary approach to the understanding of human biology, diversity and disease, an approach that I have attempted to infuse into my own research, and provides an important counterpoint to post-

modern critiques of holistic and positivist approaches to studying anthropological phenomena.

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**To wean and to die: Childhood life course differentials in Middle Bronze Age Sidon.**

HOLGER SCHUTKOWSKI and CARA THOMAS. School of Applied Sciences, Bournemouth University.

The period of weaning is considered to be one of the most stressful and potentially harmful phases of early life history, as it is nutritionally, immunologically and psychologically disruptive. Patterns of weaning in past populations therefore reveal important insight into resource availability, differential parental investment and childhood health. We present here the first data of this kind for the prehistoric eastern Mediterranean.

A total of 46 infant and child remains from a Middle Bronze Age site at Sidon, Lebanon, were analysed for age, sex, pathological lesions and collagen isotopic ratios of carbon and nitrogen, using standard assessment techniques, respectively. There was a consistent preponderance of male mortality in children between two and six years of age, while earlier and later stages of childhood showed no significant differences. Weaning began from one year onwards and was generally completed between age three to four, a pattern commonly found in natural populations. There seems to be no indication of parentally biased feeding behaviour during weaning, i.e. no significantly different weaning pattern between the sexes. However, some boys died in a comparatively marginal nutritional status, suggesting clear differentials within the society in terms of access to high-quality food items. These individuals also display severe carious lesions already in the deciduous dentition, suggesting continued high carbohydrate dietary supply post weaning.

The findings are consistent with current interpretations of Sidon as a thriving, highly stratified and diverse urban society, where wealth differentials and social inequality result in very different prospects for development through the life course.

**The ultrastructure of bone: two new levels of hierarchy revealed by transmission electron microscopy (TEM).**

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Bone is widely recognized to be a hierarchical structure, ranging in scale from macroscopic anatomic features (epiphyses, trabeculae, etc) through microscopic (osteons, lamellae, osteocytes, etc.) to nanometer-scale features dominated by collagen fibrils and associated mineral phases, visualized using transmission electron microscopy. The mineral component, which makes up approximately 60 wt% of bone, is generally believed to be hydroxyapatite, and is believed to be found principally inside the fibrils, in gaps between collagen molecules. Using TEM images of ion-milled sections of bone, we have shown that about 80% of the mineral occurs outside the fibrils in the form of polycrystalline "mineral structures" 100's of nanometers (nm) long, and 6 nm thick. These are stacked around the fibrils and form a self-supporting network inside all bone. Using dark-field imaging we show that the component crystals of the mineral structures are themselves up to 6 nm thick, filling out the entire thickness of the mineral structures, and averaging  $28 \pm 19$  nm long in the plane of the mineral structures. Some appear to be composite, homoaxial crystals meeting along planes parallel to the thinnest dimension of the mineral structures; such 2-3 nm thick crystals are consistent with low-angle X-ray scattering data. The mineral itself is an OH-free apatite which we show to contain hydrogen phosphate ( $\text{HPO}_4$ ) and carbonate ( $\text{CO}_3$ ) ions, but which converts to hydroxyapatite when heated to 600 °C.

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#### **Treponematoses in pre-Columbian Denmark: A paleopathological, archaeometric and historical approach.**

SUSANNE SCHWARZ. Graduate School Human Development in Landscapes, Christian-Albrechts University Kiel.

A pre-Columbian existence of the *Treponema pallidum pallidum* bacterium in the Old World is still controversial. While single findings of possible syphilitic lesions were made all over Europe, syphilis is not mentioned in historical records before the return of Christopher Columbus in 1493. The aim of this paper is to investigate new cases from Denmark that emerged during a study of more than 1000 skeletons from both German and Danish medieval cemeteries. Six pre-Columbian individuals from three different Danish burial sites on Funen, Jutland and Zealand suggest an infection with treponematoses. Two of the skeletons show cranial lesions, i.e. stellate depressions on the right and left parietal bone, the other three only display periosteal reactions of varying degrees on the postcranial skeleton. None of the 247 examined subadult individuals showed signs of congenital syphilis. Computed tomography scans showed focal obliteration of the periosteum on long bones as well as on the affected skulls. Radiocarbon dates indicate that three of the four analysed skeletons predate AD 1493 at a level of 95% confidence. Considering

climate and geography of the findings, venereal syphilis might be the treponemal disease causing pathologies among these skeletal remains. However, regarding bone lesions, their prevalence and the historical research, it all points to a less aggressive, maybe non-venereal form of treponematoses. Consequently the pre-Columbian theory could be rejected.

#### **Forensic anthropometry: Reconstructing body dimensions of partially hidden persons in CCTV surveillance images.**

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Identification of offenders and victims of a crime from images recorded by video security systems is becoming a new area of application of biological anthropology in forensics. A body, as represented in a 2D image is subject to optical distortions – rectilinear, curvilinear and angular – and to video compression artifacts. Collaboration between image analysis experts and anthropologists is required to retrieve maximum information about bodies of persons shown on surveillance images. We tested the accuracy of reconstructing body dimensions from different surveillance videos of known and unknown individuals using geometric video metrology techniques to obtain body heights and dimensions of body parts (e.g. head and neck height – suprasternale to vertex). Once accurate measurements are obtained from images, it is possible to use anthropometric regressions to reconstruct body heights from body part dimensions of individuals whose complete body is partially obscured in CCTV images. In a series of 93 consecutive video frames showing a walking person of known body height, two reconstructions of body height, independent of fluctuations of the vertex position during gait, were within 24mm (1.3%) and 65mm (3.5%) of the actual height. In a sample of 30 males and 30 females of unknown heights, the two geometric methods provided height differences within 24mm. Body heights reconstructed from head and neck heights fell within 14-23mm of the direct geometric height measurements. Therefore it is possible to use modern metrology techniques to obtain both direct measurements and reliable reconstructions of anthropometric dimensions from poor quality surveillance images.

#### **The health and status of children from the Middle and Late Mississippian periods in the Tennessee.**

REBECCA SCOPA KELSO. Department of Anthropology, University of Tennessee, Knoxville.

This research examines the visibility of the effects of hypothesized population disruption from the Middle Cumberland "Vacant Quarter" on eastern Tennessee Mississippians during the

Middle and Late Mississippian periods. Previous analyses on archaeological sites have indicated increased conflict toward the Late Mississippian in eastern Tennessee. Skeletal studies demonstrating declining health status and increased trauma among adults have reflected this archaeological evidence. Unlike previous research, this study analyzes mortuary practices and biological health of children, using Mississippian archaeological sites throughout eastern and central Tennessee. The skeletal remains of children are the most effective way to assess a past population's overall health, as children are more susceptible than adults to environmental stressors, especially nutritional stress.

Overall, children from the Middle Cumberland and eastern Tennessee show few morphological differences. As a whole, there is no significant difference in estimated stature, body mass estimations, robusticity, or various skeletal measurements between the two regional groups. When divided into age categories—fetal-birth, 1-4 years of age, 5-10 years of age, and 11-17 years of age—the two regional populations are still statistically similar except in the 1-4 years of age group. Within this age category, maximum femoral length and femoral midshaft measurements are significantly different, with taller statures and greater robusticity in the Middle Cumberland sample. These femoral dimensions are indicative of differences in activity level, as well as health status. Further analysis will compare nonmetric traits associated with stress and overall health between the two groups, and will increase sample sizes to improve statistical power.

#### **Neolithic transition in central and south-eastern Italy: An isotopic approach.**

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The arrival of agricultural and breeding practices at around the X millennium BC had prominent repercussion on culture, economy, demography and settlement patterns of Old World and still represents a fascinating and challenging subject matter amongst scholars.

In this work, the question of Neolithic transition was faced in dietary terms with the aim to investigate the subsistence strategies at Neolithic times. For this purpose bone collagen carbon and nitrogen stable isotope analysis was applied to 73 bone remains (27 human, 46 animal) collected from Early Neolithic sites of central and south-eastern Italy. Collagen of satisfactory quality was obtained from 27 humans and 42 animals; the remaining 4 animals were excluded since no collagen yields or C:N > 3.6.

Since complexity and uncertainty in the interpretation of stable isotope values, mixing model software (MixSIR\_1.0.4) was used to better interpret the contribution of different sources to diet. The results seem to highlight a significant dietary variability amongst farmers letting suppose a geographical differentiation between inland and coastal Early Neolithic sites.

To understand the economic implications, i.e. the extent of the shift from hunting and foraging to farming, the results obtained were compared to the data of Mesolithic and Palaeolithic sites. A significant dietary variability was highlighted between farmers and hunter-gatherers letting suppose a temporal differentiation.

On the basis of the geographical and temporal variability observed, we can suppose that the introduction of agriculture resources was associated with the adaptation by Neolithic inhabitants to exploit different environments and landscapes.

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#### **Burying the child in post-medieval Poland: Prenatal vs. postnatal remains .**

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Until recently, fetal remains have often received less consideration in bioarchaeological analyses. Accordingly, less is known and understood about how past societies viewed perinatal deaths (6 months *in utero*–1 month postnatal), including stillborn infants, *vis-à-vis* post-neonatal (1 month–1 year) and early childhood (1-3 years) deaths. A post-medieval (17<sup>th</sup> – 18<sup>th</sup> centuries) Polish cemetery has well preserved perinatal and post-neonatal remains, providing an opportunity to assess the mortuary context of each as well as to learn more about fetal identity within the culture. The purpose of this study is to specifically assess the burial context of perinatal infants to determine whether they were treated differently than postnatal infants and young children in terms of location in the cemetery, use of coffins, burial inclusions, and other aspects of funerary rites.

A sample of 47 subadult remains (n=15 perinates, n=15 post-neonates, n=17 young

children) was assessed for various aspects related to burial context. Results indicate that perinatal infants received the same mortuary treatment as post-neonates and young children, indicating that this society viewed preterm infants as synonymous with those that died some time after birth. Perinatal and post-neonatal remains were not segregated in the cemetery and were interred in coffins regardless of age. The inclusion of copper coins, which were believed to afford the deceased with some protection from evil spirits, was found in all age categories. Arguably, these results suggest that the fetal identity was not distinguishable from that of post-neonates.

#### **Further studies on dental calculus as a proxy for stable carbon and nitrogen isotopes: extraordinarily high levels of $\delta^{15}\text{N}$ in prehistoric samples from Chile correspond to findings on traditional biomaterials.**

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A recent study of a Basque sample from northern Spain demonstrated that dental calculus might serve as a new proxy for estimating stable carbon and nitrogen isotope ratios. The next step is to analyze calculus from samples at the other end of the dietary spectrum compared to Europeans. Toward this end, calculus was collected from 35 prehistoric human skeletons from northern Chile for stable carbon and nitrogen isotope analysis. Samples were selected from seven prehistoric collections associated with coastal and valley sites dating from the Archaic period (~4000 BC) to European contact (AD 1476). Results produced  $\delta^{15}\text{N}$  compositions between +17.8 and +33.1‰ (mean = +24.1) and  $\delta^{13}\text{C}$  compositions between -14.4 and -21.8‰ (mean = -17.8). Despite the unusually high values for  $\delta^{15}\text{N}$ , results are consistent with previous isotope studies in northern Chile using traditional biomaterials (collagen, hair, fingernail, muscle). This provides an additional line of support that dental calculus can be used as a proxy for obtaining stable isotope signatures in bioarchaeological research. The causes underlying the heaviest  $\delta^{15}\text{N}$  compositions in northern Chile are not definitive, but they may involve a combination of desert aridity and a significant dietary component influenced by the use of isotopically-heavy guano as a crop fertilizer during later periods. Nitrogen values also suggest marine resources were a significant dietary component for all time periods.

#### **It's the time of the season for extra chewing: temporal variation in diet and phenotypic plasticity in masticatory elements.**

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Recent discussions of australopithecine feeding adaptations have focused on the extent to which the masticatory systems of these species were influenced by seasonal variation in dietary properties. This issue is typically framed in terms of reliance on nonpreferred, mechanically difficult-to-process fallback foods at certain times of the year. Here, we report preliminary results from an ongoing animal-model-based diet-manipulation experiment designed to examine this issue. We obtained 40 weanling white rabbits (five weeks old) that were assigned to three dietary cohorts: pellets only (control); pellets supplemented with hay cubes (“annual”); and pellets supplemented with hay cubes for only part of the 48-week experimental period (“seasonal”). Each subject was imaged longitudinally every two weeks using microCT. From these scans we obtained bone cross-sectional areas in the coronal plane at four sites involved in force resistance during biting and chewing: the mandibular symphysis, condyle, and corpus, and the hard palate. Measurements were size-adjusted using maximum cranial length. At ten weeks into the experiment, annual rabbits had significantly ( $P < 0.05$ ) greater relative cross-sectional areas than control rabbits at the corpus, palate, and condyle. Seasonal rabbits, which received hay for only the first six weeks, differed from control rabbits and were similar to annual rabbits in all variables except corpus cross-sectional area; in the latter variable, annual rabbits were significantly larger. These results confirm previous findings regarding organism-level responses (i.e., phenotypic plasticity) to variation in dietary properties and suggest that such responses are site specific and sensitive to experimental conditions that mimic seasonal variation in diet.

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#### **Paleoenvironmental change in Pliocene eastern Africa as inferred from dental microwear texture analysis of fossil Bovidae.**

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Environmental hypotheses of Pliocene hominin evolution state that key ecological adaptations of early hominins are directly linked to shifts in local or regional climate. In order to determine relationships between climate change and human evolution, it is first necessary to reconstruct the habitats in which early hominins lived. This is especially important for Pliocene sites, as increasing bipedality has been linked to

a shift from closed woodland forests to more open, arid habitats. Many techniques have been used to refine our understanding of the Pliocene paleoenvironments of eastern Africa; however these have not led to consensus reconstructions. Here we present a new, independent dataset for the inference of diet, and by extension, habitats of individual bovids in the days before death. This study applies dental microwear texture analysis to reconstruct the diet, and therefore ecological contexts, of specimens from Kanapoi, Allia Bay and Laetoli. The microwear signatures of the fossils are interpreted using a comparative database of 25 extant species of African Bovidae and are compared to previously published data on the bovids from the Hadar hominin site in Ethiopia. Results indicate that the fossil bovid assemblages from all four sites include both browsing and grazing taxa, suggesting access to a wide variety of resources. The earlier sites include higher proportions of browsing taxa, suggesting more closed habitats on average. In general, the results presented here indicate that all four sites were mosaic and primarily composed of semi-closed habitats like woodland and bushland, with incursions of open savanna grassland.

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#### **Masticatory and non-masticatory spatial explanations for mandibular symphyseal morphology in extant *Homo sapiens*.**

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The chin is considered a uniquely derived feature of *Homo sapiens*; however, causal explanations for its presence are debated. While adaptive dynamics related to masticatory biomechanics have been used to explain the presence of the chin, recent preliminary studies on extant *H. sapiens* have demonstrated an inverse relationship between chin size and facial prognathism, indicating that the size of the chin likely results, at least partially, from differential growth of the maxilla and mandible.

This study tests two sets of hypotheses that have been proposed to account for chin prominence: (1) masticatory biomechanics, and (2) craniofacial spatial dynamics. For the two sets of hypotheses, it was predicted that (1) both symphyseal shape and orientation will affect the strain caused by both lateral transverse and vertical bending stresses in the symphyseal region, and (2) chin prominence should be associated with the relative anterior-posterior placement of the maxilla and dentoalveolar complex. Coordinate landmark data were collected from 3D laser scans of associated Euro-American crania and mandibles, and data were analyzed in MomentMacrof, Morphologika, and R.

Symphyseal shape and orientation were associated with the strain caused by both lateral transverse and vertical bending stresses. Furthermore, chin prominence was positively associated with the anterior-posterior position of the dentoalveolar complex and maxilla. This suggests that chin development in extant *Homo*

*sapiens* is, in part, a function of both masticatory stresses experienced at the symphysis, as well as lower anterior maxillary growth reduction, both of which may influence chin morphology across the wider range of *Homo*.

#### **Assessing the population of Proboscis monkeys and threats to their survival in Balikpapan Bay, East Kalimantan, Indonesia.**

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Few data exist on proboscis monkeys in the mangrove forests of Balikpapan Bay in East Kalimantan, Borneo. In order to ascertain the current population levels of *Nasalis larvatus* in the bay, a boat survey was undertaken encompassing 15 different rivers over a three month period from May-July 2012. Over 180h of observations were recorded and resulted in an encounter rate of 341 individuals and 57 groups. When compared to a similar study in 2007, this translates to a 30% decrease in proboscis groups over the past five years. The bay was divided into two subpopulations, the north (6.67±4.179) and south (2.43 ± 1.40) (t(11)=2.373 P= 0.56), and this study found there was no significant difference in encounter rates between these subpopulations. Population density was 0.33 groups/km<sup>2</sup> and 2 individuals/km<sup>2</sup>. Spearman's rank was used to see if there was any relationship between group population and the distance to the nearest industry or settlement (rs=0.1973 N= 15 p= 0.47) and it appears to be negatively correlated. Due to the methods used and lack of further habitat analysis, these data cannot be extrapolated, but this study highlights that Balikpapan Bay still represents one of the largest populations of proboscis monkeys in Kalimantan. It is important that these findings are made available in order to further research in the area and to afford the current population protection against the destructive anthropogenic activities occurring within the bay.

#### **Religious and medical healing in Medieval Irish society.**

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Consideration of emic concepts of disease allows bioarchaeologists to go beyond the identification of diseases in the past to an understanding of the lived experience of afflicted individuals. Disease ideologies encompass not only the causes of illness and the social meanings attributed to certain diseases but also the options for care. This paper integrates historical, archaeological, and human skeletal data to investigate healing practices and health seeking behaviors in late medieval Ireland (c. AD 1200-1550).

Documentary sources (saints' lives, annals, law tracts, and medical texts) indicate two models of disease causation and cure: religious and naturalistic. While assistance from the saints could be sought through prayers, charms, and relics, medical practitioners prescribed certain herbs and foods and performed physical procedures. Archaeological survey and excavation yield information about actual practices that occurred at places of healing, including pilgrimage routes, holy wells, and hospitals. Last, analysis of human remains and their mortuary contexts reveals the treatment choices of particular people. For example, personal badges in burials identify individuals who went on pilgrimage, and skeletal evidence for trepanation and set fractures testify to medical intervention. Although modern scholarship often distinguishes between religious and medical responses to disease in the medieval period, these are better interpreted as a continuum than as exclusive categories. In their search for relief from their ailments, ill individuals most likely used all available options, turning to both the saints and medical practitioners.

#### **A study of postcranial indices, ratios and body mass versus eco-geographical variables in an assessment of phenotypic adaptation to climatic conditions.**

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Human body size and shape exhibit considerable global variation. According to Bergmann's and Allen's rule, populations in cold climate exhibit larger body and smaller/shorter extremities than populations in hot climate. As such, skeletal limb size proportions may shed light on human evolution and climatic adaptation. In this perspective, we investigate ecogeographic significance of human postcranial diversity.

We used brachial-cranial indices; femur head breadth-femur length ratio; femur head breadth-lower limb length ratio; and body mass as indicators of phenotypic climatic adaptation among 11 historic and recent sample groups from Africa, Europa, South Asia, East Asia, and North America.

Data were subjected to principal components analysis and Manly's non-parametric correlation tests. The non-parametric correlations were tested between pc scores, indices, ratios, body mass, and ecogeographic variables: latitude, longitude, minimum temperature, and maximum temperature. Significance was calculated after 10,000 permutations in a two-tail test ( $\alpha = 0.05$ ).

Principal components plots exhibit geographic clines from South to North. The first principal component scores (loadings especially for body mass and femur head breadth to femur length ratio) shows weak but statistically

significant correlations with latitude and minimum temperature, and a very weak but statistically significant correlation with maximum temperature. Only crural index shows a strong and statistically significant correlation with latitude when variables are tested separately. All significant weak correlations between the regressions of PC scores and latitude, minimum temperature, and maximum temperature indicate some trends in the data for a potential selective mechanism or adaptive pathway occurring in the indices, ratio and body mass.

**The descent of Christianity: Religious conversion and social change in Medieval Nubia.**

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The rapid spread of Christianity around the Old World was frequently accompanied by dramatic changes in social structure. Such social developments may have biological correlates that are archaeologically observable as alterations in the relationship between the biological affinity of individuals and their spatial patterning within a mortuary site. To assess whether such changes in social structure accompanied the introduction of Christianity to Upper Nubia, a principle components analysis was conducted using dental cervical measurements of 26 adults (570 teeth) from the Ginefab School Site, upstream of the Fourth Cataract of the Nile River. Both mortuary practices and radiocarbon dates indicate that interments at this site span the introduction of Christianity to the region. Component scores were subjected to an average-linking hierarchical cluster analysis. These results were then used to investigate the relationship between biological affinity and spatial location within the cemetery as well as whether or not such patterning exhibited diachronic change.

Results suggest that, during the post-Meroitic period (AD 350-550), biologically related males were interred in proximity to one another. During the subsequent Christian period (AD 550-1400) this structuring principle was relaxed and biologically related individuals of both sexes were interspersed throughout multiple burial clusters. Although sample size in this study is small, results suggest social reorganization coincident with the Christian conversion of Upper Nubia and complement findings from an analysis of cranial nonmetric traits in a larger sample from this cemetery. This study also illustrates the utility of intrasite kinship analyses for clarifying processes of social transformation.

*This skeletal collection derives from fieldwork directed by B. J. Baker under licenses granted to Arizona State University by the US Department of Treasury, Office of Foreign Assets Control (Nos. SU-1897 & SU-2122), with support for fieldwork and lab processing provided by the Packard Humanities Institute (Award Nos. 07-1391, 07-1424, & 08-1472 [OFAC license No. SU-2071]) and The Regents of the University of*

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***Ardipithecus ramidus* proximal capitate morphology is most consistent with a locomotor ancestry of palmigrade arboreal clambering.**

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We have previously argued that the total morphological pattern of *Ardipithecus ramidus* is consistent with an ancestry of palmigrade arboreal clambering (PAC). The chimpanzee-human ancestor was therefore likely primarily adapted to PAC as well, but only chimpanzees underwent further specialization to committed vertical climbing (CVC) (*sensu stricto*, cf., Fleagle et al 1981), ultimately leading to knuckle walking (KW).

Two proximal capitate features possibly suggestive of PAC ancestry are capitate head position and midcarpal articular surface size. The former was previously cited as evidence for PAC ancestry in *Ar. ramidus*. Our broad anthropoid sample demonstrates a clear phylogenetic pattern. Cercopithecoids have more dorsally positioned capitate heads, while those of ceboids are more palmar. Humans, *Australopithecus afarensis*, *Ar. ramidus*, and Asian apes have more palmarly positioned heads than those of African apes, likely reflecting the ontogeny of KW kinematics in the latter. The capitate head's palmar position in *Ar. ramidus* suggests habitual palmigrady during arboreal climbing.

In great apes, humans, and *Au. afarensis*, the dorsal midcarpal articular surface extends approximately as far distally as the palmar, suggesting similar degrees of flexion and extension. This ratio in cercopithecoids and ceboids suggests a dominance of dorsiflexion. The *Ar. ramidus* (ARA-VP-6/500) range exceeds that of other anthropoids, but is most like ceboids, consistent with an unusually high range of midcarpal dorsiflexion. Taken together, these data support the earlier conclusion that *Ar. ramidus* evolved from a PAC ancestor and that hominids were never adapted to CVC.

**The neuroendocrinology, behavioral pharmacology and frontal neuroanatomy of dopamine in mother-reared and nursery-reared rhesus monkeys (*Macaca mulatta*).**

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The behavioral consequences of early maternal deprivation often evoke human psychopathologies and dementias involving a defective neurotransmission of dopamine. Therefore, we investigated the impact of maternal deprivation on brain dopaminergic pathways during three multidisciplinary and comparative studies of nursery/peer-reared (NR, n=6) and mother-reared (MR, n=6), male, juvenile rhesus monkeys. First, basic neuroendocrine functioning was determined through cerebrospinal fluid (CSF) samples of serotonin, dopamine, and the dopamine metabolites homovanillic acid (HVA), and 3,4-dihydroxyphenylacetic acid (DOPAC). Then, to measure dopaminergic tone, serum prolactin, as well as testosterone and cortisol, were sampled before and after dopamine receptor-2 (DRD2) antagonism with the drug Raclopride. Second, the behavior-pharmacological effects of agonizing or antagonizing DRD2 or dopamine receptor-1 (DRD1) were assessed by treatment with the drugs SKF81297, SCH23390, Quinpirole, and Raclopride. Third, relative densities of DRD1 and DRD2 in the prefrontal cortex and basal ganglia were quantified in postmortem brain specimens from similarly reared, juvenile, male rhesus monkeys (NR, n=6; MR, n=6). Compared to MR, NR monkeys exhibited lower dopaminergic tone, altered sensitivities to the pharmacological manipulation of DRD1 and DRD2, as well as reduced densities of orbitofrontal DRD1 and medial-prefrontal DRD2. Furthermore, some behavioral outcomes of nursery-rearing were associated with either low dopaminergic tone or altered levels of CSF dopamine metabolites. Consequently, brain dopamine systems are significantly influenced by early maternal deprivation and thus likely underpin the social and emotional deficits typically observed following early adversity in primates.

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**A quantitative approach for late Pleistocene hominin brain size.**

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As a general rule, brain size has experienced considerable increase from *H. habilis* to anatomically modern humans (AMH). Nevertheless, it is often stated, especially in popular science, that Neanderthals had the largest brains. We evaluate whether the Neanderthal's endocranial volume is significantly larger than that of AMH and if the

differences in body mass (BM) and endocranial volume (EV) are related to latitude (LAT) and/or time (TIME).

We created a database containing 411 individuals of whom 43 are Neanderthals and 339 Pleistocene (161) and Holocene (207) AMH.

The results of our study show that Neanderthals have smaller brains than the Pleistocene AMH despite the fact that the latter are smaller in body mass. However, the Holocene AMH (7 populations) have smaller brain sizes than those of Neanderthals. Nevertheless, both taxa have brain size ranges that overlap substantially (>45.22%), and their means are therefore indistinguishable from a statistical point of view. On the other hand, while the AMH's body size seems to fit ecogeographic assumptions (Bergmann's rule) [ $\log\text{LAT}$  on  $\log\text{BM}$  ( $R=0.258$ ;  $p<0.001$ )], Neanderthal size variability seems to respond rather to a temporal pattern of increase [ $\log\text{EV}$  on  $\log\text{TIME}$  ( $R=0.604$ ;  $p<0.001$ ) and  $\log\text{BM}$  on  $\log\text{TIME}$  ( $R=0.579$ ;  $p<0.002$ )]. The most recent populations of AMH have smaller brain sizes. This fact could be linked with genetic variations, such as *Microcephalin*, a specific regulator of brain size, because this gene has continued evolving beyond the emergence of AMH.

#### Examining life and community history with 19<sup>th</sup> century bioarchaeological remains from Pontiac, Michigan.

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The recovery and analysis of desecrated human remains from the Oak Hill Cemetery in Pontiac, Michigan, provided an opportunity to study the life history of a family of pioneers and contrast it to the current social climate of this city. Desecrated human remains and artifacts were recovered from the Southard family mausoleum by the Anthropology Department of Wayne State University during a community restoration project on the property. The human remains were inventoried and pathologies and body modifications were noted. A review of historical data pertaining to these individuals was completed and examined within the context of the bioarchaeological remains. The results of this study include an interpretation of the repeated, long-term desecration of these individuals, as well as personal aspects of the lives and health of this elite family as told through the combination of written and bioarchaeological data. When viewed within the present-day social context of the City of Pontiac, it was found that even though there have been demographic and political changes since their lifetimes, the data collected in this study indicate that many of the same ideologies pertaining to race, religion, and politics persist today.

#### The Bronocice Sheep Project: The use of ancient mitochondrial DNA analysis of sheep to infer human social interactions during the middle Neolithic in southeastern Poland.

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The archaeological site of Bronocice in southeastern Poland provides archaeological evidence of a large village that was a regional center involved in long distance trade. Two smaller sites involved in the study, Zawarza and Niedzwiedz, located within a day's walk from Bronocice, potentially existed within the larger site's interaction sphere. This study uses mitochondrial DNA (mtDNA) analysis to determine the genetic relatedness of sheep within and between each site inferring how humans manipulated sheep movement and breeding practices. These communities directly impacted the genetic composition of sheep both to maintain the health of their herds and as a means of human social exchange. The sheep samples in the study focus on two defined occupational phases between 3650 BC-3100 BC. This would indicate that there is a potential change in the genetic composition between different temporal phases further explaining changes in human interactions over time. A total of 40 samples were extracted, ten samples from each of the sites and each phase from Bronocice. Using four primer sets spanning the targeted mtDNA region of positions 15496 through 00015 chosen for comparison with existing published sheep sequences. Successful sequencing results were obtained from each site and time period providing sufficient evidence of a human influence over the movement and breeding of sheep.

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#### Dietary variability yields novel dental microwear textures for geladas.

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Geladas (*Theropithecus gelada*) are regarded as extreme dietary specialists owing to their heavy reliance on grass, a unique adaptation among primates. Consistent with this view, molar microwear analyses have revealed gelada enamel surface features to be highly anisotropic and low in complexity. Further, low variation in

complexity, anisotropy, and heterogeneity among individuals has implied dietary homogeneity at the population and species levels. Two weaknesses of these earlier studies are the absence of dietary information for the specimens and their association with heavily degraded habitats. Here we present new molar microwear texture analyses on gelada specimens from an ecologically-intact Afroalpine grassland in Ethiopia, the Guassa Plateau. The dietary ecology of this population is diverse (including grasses, herbs, and invertebrates) and variable across seasons and age-sex classes, with elevated consumption of underground storage organs during low rainfall periods. To test whether this dietary variability is recorded on enamel surfaces, we analyzed dental microwear textures from Facet 9 of M<sub>1</sub>s from four specimens (three juveniles and one adult). The specimens show lower mean anisotropy, higher mean complexity, and greater variation in heterogeneity compared to previously published results for geladas. These patterns could be linked to (a) the frequent consumption of quartz grains, both from soil-borne grit and heavy seasonal dust accumulation on above-ground vegetation, and/or (b) the seasonal consumption of fallback resources with challenging mechanical properties. These results illustrate a diversity of microwear textures for geladas despite highly specialized anatomical adaptations for graminivory. Implications for interpreting hominin dietary ecology from microwear are discussed.

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#### A preliminary quantitative comparison of the internal trabecular architecture of the ilia of chimpanzees and orangutans by high-resolution x-ray computed-tomography (HRXCT).

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Analyses of the pelvis typically focus on its function as a lever, giving less consideration to its role in support and resistance to stresses generated by muscles. These forces also shape the internal architecture of the innominate, which can also be used to illuminate function. This project is a preliminary comparison of the trabecular structure of the ilia of chimpanzees and orangutans. Differences in trabecular density and anisotropy are predicted between the two, based on their locomotor modes. Regions of greater loading are predicted to have denser and more anisotropic trabecular bone. Orangutans tend to load their ilia in all directions, via arboreal quadrumanous clambering, while chimpanzees typically have a more directionally-constrained locomotor mode. Thus, the chimpanzee ilium should have denser, more anisotropic trabecular bone. HRXCT scans of chimpanzee and orangutan ilia were analyzed with ImageJ and Quant3D for trabecular density (bone volume fraction) and anisotropy (star volume distribution, SVD). Volume of interest (VOI) selection was complicated by the irregular

shape of the innominates. Here a series of VOIs proceeding from the level of the posterior inferior iliac spine (PIIS) toward the acetabulum were used. They were scaled by the geometric means of measurements of each ilium, to facilitate comparison of homologous regions. Bone volume fell in both ilia as the scans proceeded inferiorly, likely due to the relief of this region from the actions of the gluteal muscles. No differences in SVD were found. Bone volume was higher in the chimpanzee than in the orangutan, consistent with the prediction.

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#### **An examination of pubertal development in human skeletal remains from medieval England.**

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In societies where date of birth was rarely formally recorded, the perception of individuals as children or adults was inevitably dependent on the physical process of puberty, but this subject has to date received little attention in bioarchaeology. Based on modern data, it is possible to identify specific dental and skeletal maturation events that closely correspond with the external changes of puberty: the development of the mandibular canine, hamate, hand phalanges, iliac crest, cervical vertebrae and distal radius. This paper presents the results of an application of these methods to two large skeletal collections from Medieval England: St Peter's Church, Barton-upon-Humber and St Mary Spital, London. Examining pubertal development alongside chronological age in these two very different populations provides an insight into the possible environmental and social factors that affected this maturation process in the past. In both populations, the onset of puberty appears to be occurring at a similar age to 20<sup>th</sup> century adolescents, but the later stages of puberty were significantly delayed, in some cases by four or five years in comparison to modern standards. Age at menarche also seems to have been affected, particularly in the urban group. This analysis suggests that the timing and progress of puberty in medieval England was being influenced by environmental factors including nutrition, exposure to infection and physical labour.

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#### **The evolution of brain size and longevity in mammals.**

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Large brains are metabolically expensive and require extended developmental periods,

resulting in increased risks of offspring mortality and delayed sexual maturity. Despite this, encephalization has occurred many times independently in mammals. Hypotheses to explain the evolution of encephalization must account for its adaptive value in spite of the associated costs of a longer period of development.

One hypothesis (cognitive buffer) to explain the association between brain size and longevity argues that encephalization would allow more behavioral flexibility to respond to ecological challenges, thus reducing extrinsic mortality and allowing for the evolution of an extended lifespan. An alternative hypothesis (delayed benefits) argues that the costs of delayed reproduction can be outweighed by benefits later in life. If the opportunity to evolve and develop a large brain is available, it might be acted upon despite its costs because the learning it allows provides obvious fitness benefits later in life. Accordingly, long-lived organisms have more to gain from investment in a large brain.

To test these competing hypotheses, we analyze a large dataset of average, sex-pooled brain and body masses and maximum lifespan records from 792 mammalian species. We calculate encephalization and longevity quotients using OLS regression on body mass. T-tests are then conducted when z-standardized  $EQ-LQ > |1.96|$ . Results demonstrate that while high LQs are associated with significantly high EQs, the reverse is not true. Results remain unchanged even when potentially problematic orders are removed, suggesting that increases in longevity precede encephalization as a general rule in mammals, thus supporting the delayed benefits hypothesis.

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#### **Sub-adults in the Middle and Late Mississippian: Mortality, fertility and growth rates.**

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Sub-adult skeletal remains provide an under-utilized source of information about mortality, fertility, and demographic variation in prehistoric populations. In this study, we examine diachronic patterns of fertility and mortality in the transition from Middle to Late Mississippian periods in Missouri; we then compare them to similar analyses from Woodland and Mississippian populations in west-central Illinois, Arkansas, and Tennessee. We utilize the D0-1/D19+, D5-19/D5+, D30+/D5+, and D1-5/D-10 proportions as relative indicators of population birth, growth, and death rates. Fertility indices (5-19/5+, and 30+/5+) are proxy measures of fertility, and have been demonstrated to be strongly correlated ( $r^2 = .971$  and  $.877$ ) with life-table estimates of crude birthrate and growth rate, respectively. The juvenile death proportion (1-5/1-10) reflects childhood survivorship and is strongly correlated with childhood death rate and crude birth rate. We

then examine the relationship between linear enamel hypoplasias, porotic hyperostosis, and cribra orbitalia on sub-adult longevity and survival.

Age-at-death for sub-adults was estimated using dental eruption, epiphyseal fusion, and long-bone length. Death ratios exhibit considerable variability between sites and through time, but temporal trends indicate low but consistent population growth throughout time, before experiencing a population decrease during the Late Mississippian period. Increasing rates of LEH, cribra orbitalia, and porotic hyperostosis through time, combined with Kaplan-Meier survival curves and log-rank tests emphasize the importance of the relationship between sub-adult fertility and mortality in response to changes in subsistence, disease, and social environments.

#### **C-reactive protein, early life, and growth in the Gambia.**

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In recent years researchers have investigated the potential of lasting effects from early life environments on later human health and immune function. Here, we add to this growing research body (Moore et al. 2001; McDade et al. 2010), and report on the relationships between CRP and early life variables, current investment in growth, and other markers of immune function in a population of adolescent females in the Gambia.

In preliminary analysis in our sample ( $n=55$ ), we find a negative correlation between CRP and ponderal index ( $t = -2.28$ ,  $p = 0.03$ ) and a negative trend with infant growth ( $p = .08$ ), in regressions accounting for current age and BMI. Longitudinal data allows us to ask if CRP is predictive of weight or height gain over the next 6 months, and unlike studies with children (McDade et al. 2008), it does not appear that elevated CRP is predictive of growth. In Western populations the adipokine leptin has been positively related to CRP, independent of BMI (Shamsuzzaman et al. 2004). While CRP does display a positive relationship with leptin in our population, this relationship appears to be entirely mediated by the effects of BMI. Additional analysis will further explore these relationships.

There is considerable evidence connecting early life conditions to later life disease, yet it is not clear how these relationships are formed. Early life influences on immune phenotype have been postulated, and evidence for this is growing. This research suggests that birth size, and potentially early life growth, are related to later life inflammation.

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### Dental microwear profilometry of African non-cercopithecoïd catarrhines of the Early Miocene.

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The early Miocene of Kenya has yielded the remains of many important stem catarrhine species that provide a glimpse of the anthropoid primate radiation at a time of major faunal turnover in Africa. These taxa have been subject to innumerable studies, yet there is still no consensus on their diets. Here we report on an analysis of dental microwear textures of non-cercopithecoïd catarrhines from the Early Miocene of Kenya. High-resolution casts were made of all molar specimens with undamaged occlusal surfaces at the National Museums of Kenya, Nairobi. Scanning confocal profilometry revealed 83 individuals with unobscured antemortem microwear of the genera *Dendropithecus*, *Micropithecus*, *Limnopithecus*, *Proconsul*, *Kalepithecus*, *Nyanzapithecus*, and *Rangwapithecus*. Scale-sensitive fractal analysis was used to generate texture attributes (complexity, anisotropy, scale of maximum complexity, textural fill volume, and heterogeneity of complexity) for each specimen, and the fossil taxa were compared using conservative non-parametric statistical tests. This study revealed no significant variation in microwear texture among the fossil taxa, which is consistent with results from a previous feature-based microwear study using smaller samples. This suggests the taxa often consumed foods with similar mechanical properties despite morphological differences. However, statistical analyses of microwear texture data do separate the Miocene fossil sample from several extant anthropoid primate genera such as *Alouatta*, *Cebus*, *Cercocebus*, *Colobus*, *Presbytis*, *Semnopithecus*, and *Theropithecus*. This suggests that the African non-cercopithecoïd catarrhines of the Early Miocene had generalist diets and had not yet specialized to the degree of many modern taxa, despite variation in tooth form.

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### Hierarchical analysis of population structure by isonymy in the city of Binghamton, NY.

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Surname analysis affords biological anthropologists the ability to understand population dynamics analogous to genetic relationships. Recent developments in the field of surname genetics include the application of random isonymy calculation to multiple levels of population subdivisions within towns, villages and municipalities. Such methods are useful in examining the historical impact of immigration on population structure, since available census data typically includes country of origin as well as surname.

This study examines the surname structure present in the 1925 New York State Census of the city of Binghamton in Broome County, NY. Random isonymy (Ri) and consanguinity (Ri/4) via head of household were calculated for the entire city and for 13 wards within the city. These values were compared to the percentage of immigrant heads of household for each ward. The Ri value for the entire city of Binghamton was 0.00070111, and varied between a high of 0.00211528 in the 5<sup>th</sup> Ward and a low of 0.00042 in the 1<sup>st</sup> Ward. The 1<sup>st</sup> Ward had the highest percentage of immigrant heads of household (65%), well above the city average of 22%. However, in general there was a slight positive correlation between Ri and percentage of immigrant heads of household by ward. This project was conducted as part of the Binghamton Neighborhood Project and the Evolutionary Studies (EvoS) program of Binghamton University.

### Evolutionary biology offers an effective tool for changing high school students' attitudes about healthy food choices.

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The pilot study presented here involved an "intervention experiment" whereby evolutionary biology was used as a tool for changing high school students' attitudes and preferences about healthy food choices. The study aimed specifically to address: Does knowledge of human evolutionary biology make a difference in students' understanding of health consequences related to their dietary choices? Is this knowledge sufficient to effect behavioral changes?

Students were recruited from a high school biology class in Cambridge, MA and randomly assigned to attend one of two nutrition workshops for approximately one hour. Informed consent by parent or guardian was obtained prior to participation in the study. Group A received instruction in dietary physiology alone. Group B received instruction in dietary physiology coupled with human evolutionary biology. This allowed for isolating and testing the value of exposure to evolutionary biology as a means of effecting behavioral change. Documentation of students' perceptions, attitudes and food choices before, during, and after the experiment involved the use of food diaries, questionnaires, and film

interviews. Film interviews yielded qualitative findings -- enabling students to express thoughts, feelings, and attitudes in an open-ended way.

Although sample size was small, the results showed unequivocally and unanimously that exposure to evolutionary biology shifted students' perceptions of healthy food choices. Knowledge of evolutionary biology also led to precise dietary changes students intended to implement immediately. These findings indicated that the emergent field of evolutionary medicine holds potential as an untapped yet effective public health intervention strategy regarding the dietary choices of youth.

### Quantitative genetic analysis of morphometric data: Challenges and considerations.

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The characterization and quantification of craniofacial form has long been a primary interest of comparative anatomists. While modern morphometric techniques are proving very successful at describing craniofacial shape, the dissection of the genetic determinants of that shape is more elusive. The current research seeks to elucidate the genetic underpinnings of variation in the complex craniofacial and dentognathic regions.

When approaching the genetic analysis of a complex shape, consideration must be given to the mode of acquisition of phenotypic characters with the ultimate goal of the genetic analyses. While simple methodologies may provide only a cursory description of shape compared to more sophisticated geometric techniques, the former may outperform the latter in elucidating the genetic underpinnings influencing trait variation. Comparisons of differing morphometric techniques, and their relative power in subsequent quantitative genetic analyses, illustrate the challenges encountered when trying to maximize the strength of both the morphologic descriptors and the genetic signal.

If the primary goal of statistical genetic analyses is to identify the genes influencing variation, the likelihood of achieving that goal is related to the number of genes involved and the effect size of those genes. It is typically more difficult to localize and identify the genetic influences of polygenic traits because each gene, by itself, may exert a relatively small influence. With proper consideration, the goals of both the maximal description of biological shape, and the dissection of the genetic architecture influencing that shape, can be accomplished.

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### Growing up in Akhetaten: A Bio-cultural approach to childhood growth.

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The childhood growth of the children from the South Tomb cemetery at Tell el-Amarna is examined. Tell el-Amarna is the site of Akhetaten, the ancient Egyptian capital of the Pharaoh Akhenaten. No previous city or temples existed at Tell el-Amarna prior to Akhenaten building his capital (c. 1346 BCE) and it was abandoned shortly after his death. The skeletal population of the South Tomb Cemetery represents a brief period of time (15 to 20 years) in Egyptian history. The South Tomb cemetery has the shortest adult stature reported in Egypt suggesting extensive childhood stress.

Two hundred forty-nine individuals have been excavated from the South Tomb cemetery. Sixty-five individuals ranging in age from 4.5 months to 16.5 years were used in this analysis. Growth was assessed using long bone lengths in relation to bio-cultural life stages that were extracted from the historical ethnographic records of ancient Egypt and human life history patterns. Maresh mean long bone lengths for age were used as the optimal standard in the analysis.

Individual  $\delta$ mean values indicate that 90.8% of the subsample falls below the line of unity and that 70.8% of the subsample is below 0.90. The children of Amarna appear to be suffering from both an early (between 1 to 3 years) and possible later juvenile/adolescent (after 8.5 years) growth disruptions that are associated with specific bio-cultural life transitions at Akhetaten. Results of the growth analysis indicate that the children of Akhetaten on the whole are not reaching their growth potential.

### A head for cranial analysis: 3D investigation of endo- and ectocranial sex dimorphism.

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A novel 3D method was used to explore size and shape sex dimorphism in modern American crania and improve sex estimation using endo- and ectocranial measurements.

Three-dimensional models were constructed from cranial CT scans from the William Bass Donated Collection (n=222). These models were used to create statistical bone atlases of the endo- and ectocranium. A bone atlas is a template that captures the primary shape variation in a skeletal element and facilitates computer-automated measurements and shape analyses from large datasets. An exploratory analysis of the atlas principal components was used to pinpoint areas of high sexual dimorphism. Linear and angular measurements were extracted, focusing on areas

highlighted by the PCA. Linear discriminant analysis with variable selection was used to determine the most effective discriminators.

Results indicate that, while size is a significant component of cranial sex dimorphism, shape plays a role, as well. The PCA showed significant size differences in cranial length and facial breadth and shape differences in the glabellar, zygomatic, occipital, and mastoid regions. Important size-related variables captured by the discriminant analysis were bizygomatic breadth, maximum cranial length, cranial base length, and mastoid height. Vault thickness is also a sexually dimorphic feature, with females having thicker vaults than males in the frontal region, and males having thicker vaults in the occiput. An 11-variable model achieved 97.3% and eight variables classified 95.5%. Glabella projection index alone achieved 82.4%, bizygomatic breadth 83%, and basion-nasion length 82%. These accuracy rates are higher than those currently reported for the American population.

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### A comparison of visual and radiographic methods for detecting oral pathology in a skeletal sample from Ban Non Wat, Thailand.

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Traditionally, the diagnosis of oral diseases in bioarchaeology has relied solely on visual examination. This may result in an underestimation of dental disease occurrence because some oral lesions are undetectable macroscopically. Radiography is commonly used in clinical and epidemiological studies of oral disease, particularly dental caries, but few bioarchaeological studies employ this method, even though it has the potential to improve detection rates. The purpose of the study is to assess the value of radiography to the study of oral health in archaeological remains by comparing visual and radiographic methods for detecting oral pathology. The dental remains of adults (n=80) from the prehistoric site of Ban Non Wat, Thailand, were examined both visually and radiographically. The permanent teeth and supporting structures were radiographed using a portable dental X-ray system equipped with a digital sensor. Dental caries and periapical cavities were evaluated using standardised radiographic diagnostic criteria and compared with evidence from visual observations. The results show that radiographic examination significantly increased the detection of oral lesions. Specifically, radiographic examination (1) detected dental caries that were either invisible or obscured upon visual inspection, in particular interproximal lesions; (2) showed dental caries lesions may be more extensive than what is observed visually; and, (3) identified periapical lesions, indicative of conditions such as abscesses and granulomata, that would otherwise remain undetected. These results indicate that supplementing visual assessment of

oral pathologies with radiography provides a more precise and accurate representation of oral health.

### Investigating the relationship between mandibular skeletal form and Stafne's defect using geometric morphometrics.

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Stafne's static bone defect (SSBD) is a small lesion that can develop in one or both sides of the human mandible, usually in the area below the mylohyoid ridge in the submandibular fossa. In this study, 25 cases of SSBD were observed in a large archaeological sample of ancient skeletal remains from across California (n=855), spanning temporal periods from early human occupation to European contact. The observed SSBD frequency of 2.9 percent is consistent with previously reported frequencies for North Amerindians, but observed frequencies in certain regional subsamples are considerably higher, i.e. 6-7 percent. The cause of SSBD is unknown, although salivary gland size has been suggested as a predominant factor in geographic patterning of SSBD prevalence. The potential influences of size, shape, and asymmetry of the mandibular bone have so far not been examined. To investigate these factors, we here used a geometric morphometrics (GM) approach to analyze 134 mandibles with and without SSBD from three regions of California. Landmarks and sliding semilandmarks along a transverse cross-section of the lower mandible were digitized and aligned with Procrustes superimposition. Statistical analyses of centroid size and symmetric/asymmetric shape data did not show overall differences between mandibles with and without SSBD, although some shape differences were evident among mandibles from the Santa Barbara Channel region. The results indicate that skeletal form alone is not a primary determinant of SSBD formation or frequency. However, between-group variation in submandibular morphology may be one of multiple factors in its pathogenesis and geographic distribution.

### Phenotypic plasticity in humans: Lessons from the immune system.

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The polymorphic nature of many immune genes often influences the serum levels of the immune proteins themselves. During the last two decades, the amount of data on immune gene polymorphisms (IGP) has increased dramatically, with a growing number of studies suggesting an effect of those polymorphisms on immune disease susceptibility. However many studies have failed to show significant association between IGP and particular diseases.

We proposed that the existence of high levels of phenotypic plasticity (PP) should be considered before making any conclusions when linking IGP, the corresponding protein expression, and disease susceptibility. To address the hypothesis of high levels of PP, we conducted an *in vitro* study on human peripheral blood mononuclear cells (PBMC) from healthy donors (n=25, Caucasians), testing the effects of pathogenic antigens on the expression phenotypes for different cytokines when cytokine genetic information is taken into consideration. The cytokine polymorphisms analyzed were: TNF $\alpha$  (-308A/G); TGF $\beta$ 1 (codon 10T/C, codon 25C/G); IL-10 (-1082 A/G, -819T/C, -592A/C); IL-6 (-174C/G); and IFN $\gamma$  (+874 T/A). PBMC were stimulated *in vitro*, with either lipoarabinomannan-LAM (lipopolysaccharide from *Mycobacterium* wall) or lipopolysaccharide-LPS (general proxy for bacterial infection). Cytokine expression was measured by ELISA and Luminex technology. Preliminary results show that despite similar genotypic backgrounds for some cytokine polymorphisms, cytokine production varied among donors and sex, suggesting significant PP among humans when exposed to the same pathogenic antigens. We suggest that this plasticity is the legacy of differential exposure to and co-evolution with infectious diseases over the course of human evolution.

#### Survey of lemur diversity in Mahavavy-Kinkony Wetland Complex, North-Western Madagascar.

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The Mahavavy-Kinkony Wetland Complex (MKWC), North-Western Madagascar gained protected status in January 2007. Remaining forests are highly fragmented yet the complex covers most of the range of two highly threatened lemur species, *Propithecus coronatus* and *Eulemur mongoz*. The IUCN Lemur Specialist Group suggested *E. mongoz* be updated from Vulnerable to Critically Endangered based on rapid habitat loss. Thus, new data from MKWC are crucial for conservation action planning in this area. Lemur surveys were conducted in MKWC between May-June 2008 using nocturnal/diurnal strip transects in five fragments and presence/absence data from an additional three fragments using rapid diurnal surveys. *Propithecus coronatus*, *Propithecus deckenii*, *Eulemur rufifrons*, *Eulemur mongoz*, *Microcebus* sp and *Lepilemur* sp were encountered. Compilation with previous research produced updated distribution maps for MKWC and *Eulemur mongoz* densities were compared over time. *Eulemur mongoz* densities in Anjamena decreased at a rate of 85% over 13 years. Although not significant (p=.65), nested analysis (T=0.02) suggested *E. mongoz* as the most vulnerable to fragmentation of the diurnal/cathemeral lemur species surveyed. During the surveys, the species was not found in any fragments less than 250ha although representatives of all other species were still present. This research supports the IUCN Lemur

Specialist Group's suggestion to update the status of the *E. mongoz* and highlights the urgent need for conservation planning in the MKWC.

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#### The past as prologue: Changing disease ideologies surrounding HIV/AIDS in Zimbabwe.

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The lion's share (some 67%) of those currently living with HIV/AIDS resides on the African continent where the advent of the disease has simultaneously challenged as well as undergirded existing explanatory models. Based on interviews with Zimbabwean traditional healers (n=200), archival research, and analysis of secondhand literature IV/AIDS on the African continent, this poster takes a historical approach to understanding how contemporary conceptions of the disease fit into longstanding explanatory models of disease that are at once material and social. As such, this poster explores changing cultural definitions of illness and disease and, by extension, the individual's place in society, the human body and its parts, and healing practices. Seen in this way, changing disease ideologies/etiologies surrounding HIV/AIDS emerge from (and respond to) systemic practices and processes of political and economic control and provide interpretations of a rapidly changing world.

Data demonstrate, for example, that healers link HIV/AIDS to past disease outbreaks such as the 1918 influenza pandemic as well as biological warfare during Zimbabwe and South Africa's battles for independence. The disease has also been linked to historical indigenous afflictions such as runyoka and rukombe—both of which are “sent” sicknesses that require the intervention of traditional healers. Other examples throughout Zimbabwean history will also be discussed. This research suggests ways of identifying disease in the past that integrates multiple lines of evidence—particularly archival and life histories—that may assist bioarchaeologists in cultural interpretations and physical manifestations of disease and disability in the archaeological record.

#### Why do knuckle-walking African apes knuckle-walk?

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Second only to bipedalism, knuckle-walking is perhaps the most unusual means of terrestrial locomotion known in mammals, regularly practiced only by living chimpanzees, gorillas, and anteaters. While knuckle-walking was traditionally considered to be a shared

primitive adaptation of extant African apes, it is now recognized to have been acquired independently by chimpanzees and gorillas. There are many similarities in body form among orangutans and African apes, yet orangutans lack any adaptations to knuckle-walking most likely due to their infrequent terrestrial travel. Several characters specific to the knuckle-walking phenotype have been identified, but a functional explanation of the adaptation remains elusive. Here, we describe a model of knuckle-walking that integrates various characters of the torso and forelimb anatomy shared by the African apes. We argue that the digital and wrist flexors act to ameliorate impact loading by eccentric and isometric contraction during terrestrial locomotion in large bodied hominoids and thereby reduce irreversible cartilage and bone damage in forelimb joints. The primary adaptive changes to knuckle-walking appear to be changes in the volume and geometry of the antibrachial musculature as well as the narrowing of the upper thoracic cage. Unlike the common assumption that metacarpal and carpal geometry plays a significant role in restricting motion during KW, the characteristic osteological signature of knuckle-walking most likely results from each chondral element's loading history during ontogeny. These forelimb characters provide compelling functional explanations of the locomotor parallelisms in chimpanzees and gorillas.

#### Integrative aspects of the hominoid mandible.

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Despite being phenotypically distinct, hominoids have a common pattern of cranial integration. That is, coordinated variation among developmentally and/or functionally related cranial components is similar among hominoid species. While there have been several studies on morphological integration in the cranium, few have focused solely on the hominoid mandible. A better understanding of mandibular integration patterns can provide insight on factors that generate morphological constraints in the hominoid skull. This study examines ontogenetic integration in 140 sub-adult and adult humans, chimpanzees and bonobos to assess how integration patterns in the mandible compare to those of the cranium. A total of 29 3D landmarks were collected on the entire mandible and subsequently divided into developmental modules (alveolar region and ramus) to examine integration. Procrustes-based geometric morphometrics and two-block partial least squares analysis were conducted to quantify and examine integration patterns. PLS1, which accounts for 66% of the total covariance in the dataset, shows that *Pan* and *Homo* have a common pattern of integration, with the juvenile chimpanzees and bonobos clustering with the adult humans. Shape changes show humans to have a short alveolar region associated with a short and broad ramus, compared to an elongated alveolar and tall ramus in *Pan*. PLS2 (16.2%) separates humans from *Pan*, and accounts for shape changes mainly along the symphysis and

inclination of the ramus. Overall results suggest that morphological integration in the cranium and mandible is similar among these taxa; however, species-specific integration patterns are more distinct in the mandible than in the cranium.

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**Maintaining pair-bonds in red-bellied lemurs (*Eulemur rubriventer*): A preliminary captive study at Duke Lemur Center, Durham, NC.**

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Red-bellied lemurs (*Eulemur rubriventer*) are one of few nonhuman primate species known to exhibit obligatory pair-bonds. We know very little about how *E. rubriventer* initially form pair-bonds or how these pair-bonds are maintained once established. Most pair-bonded nonhuman primates (e.g., indris, titis, tarsiers, and gibbons) are marked by their use of *song*—vocal duets between bonded individuals and their offspring—in maintaining pair-bonds and defending territories. Red-bellied lemurs are unique because they do not use song. We aim to elucidate the ways in which *E. rubriventer* use tactile, olfactory, and auditory signals other than song to maintain pair-bonds.

From June-August 2012 (N=70 hours), we observed occurrences of 1) prolonged physical contact and grooming (i.e., tactile signals), 2) affiliative scent marking, wherein the male and female pass over each other applying scent directly to the recipient's body (i.e., olfactory signals), and 3) auditory interactions using close-distance contact calls (*grunts*) in four established pairs of red-bellied lemurs. We recorded all instances of these behaviors and vocalizations during hour long sampling sessions. The use of touch, scent, and sound was analyzed to determine frequencies of occurrence within and across groups, providing a preliminary picture of how *E. rubriventer* maintain pair-bonds. Across groups, the most frequently used signal was the close-distance contact call, distantly followed by olfactory and tactile signals. Prolonged physical contact was most often maintained during sustained rest periods. Future observations of wild *E. rubriventer* will further advance our understanding of how these lemurs form and maintain pair-bonds.

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**Relationship of internal and external condylar morphology to feeding behavior and diet in Tai Forest monkeys.**

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Advances in our understanding of how forces are transmitted through the temporomandibular joint supports the tenet that the size, shape, and material properties of the mandibular condyle are functionally linked to ingestive and masticatory loading environments. This linkage was explored by examining elements of both internal and external mandibular condylar morphology in four sympatric species from the Tai Forest Côte d'Ivoire known to differ in diet and feeding behavior: *Colobus polykomos* (n=6), *Procolobus badius* (n=6), *Cercocebus atys* (n=6), and *Cercopithecus diana* (n=4). *Cercocebus atys* exploits hard objects and insects, *C. diana* is primarily frugivorous, and the colobine species are more folivorous, with *C. polykomos* presumably exploiting a greater quantity of tougher foods than *P. badius*. We explored variation in condylar trabecular density using mean grayscale values from six areas of each condyle on posteroanterior digital radiographs. Condylar and mandibular dimensions were also recorded.

The species do not differ significantly in mean grayscale values. Most grayscale variance is accounted for by individual variation (49%) or location within the condyle (31%). In all taxa, the lowest grayscale values (i.e., least dense trabeculae) were observed on the lateral aspect of the condyle, an unexpected result considering that the lateral side is thought to be more heavily loaded than the medial side. While the species do not differ in anteroposterior thickness, both colobine taxa exhibit significantly greater mediolateral width compared to the cercopithecines. We propose that this variation in condylar width might reflect masticatory mechanics associated with tougher diets in the former taxa.

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**Modern morphometrics 101.**

DENNIS E. SLICE. Scientific Computing, Florida State University.

The introduction of the geometric morphometric (GM) approach in latter decades of the twentieth century produced a fundamental shift in the way much shape analysis is done. These methods, future directions of their development, and examples of their application were presented in a symposium entitled "Modern Morphometrics in Physical Anthropology" at the 2002 meeting of the AAPA in Buffalo, NY. The content of that symposium was expanded and published in an edited volume of the same name.

Now in 2013, we revisit the subject with Modern Morphometrics in Physical Anthropology II, a symposium dedicated to the memory of Dr. Robert R. Sokal. In this poster, I review some of the fundamental methods of GM for those who may be less familiar with the field to facilitate their appreciation of the other research presented in the symposium. Of fundamental importance is the Procrustes superimposition that removes variation in

landmark coordinates due to location, orientation, and size so that the resulting transformed coordinates can be subjected to familiar forms of multivariate dissection. Important extensions of this include the method of sliding landmarks, asymmetry analysis, partial least-squares analysis of shape modules and non-shape variables, and enhanced graphical representations of results made possible by the use of coordinate data and the retention of geometric information throughout an analysis.

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**What happened to Wilma? Demonstrative evidence in an FBI cold case.**

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One of the last forensic cases worked on by Karen Ramey Burns concerned the recreation of events leading up to the unsolved murder of Wilma June Nissen, a 23-year-old woman whose body was discovered in 1978. Burns worked in cooperation with a forensic engineer, the Body Donor Program of the University of Utah, and her graduate students to design a novel method of crime scene reconstruction, abrasion simulation. The decomposed remains of Wilma Nissen were found in a roadside ditch beside a gravel road in Lyon County, Iowa in 1978. The remains were unidentified until 2006, when fingerprints retrieved from the body were matched to a set taken during a prostitution arrest in the 1970s. Wilma's body was exhumed in 2007 for genetic identity confirmation and further evidentiary analysis. Examination of the skeletal remains uncovered an unusual patterned abrasion to the bones of both elbows. The Federal Bureau of Investigation requested that Brent Benson, a forensic engineer, design a mechanical model to explain the etiology of such skeletal lesions. Dr. Benson contacted Dr. Burns and together they developed an experimental research design to simulate conditions that could have caused the trauma. Fleshed arms were dragged at varying speeds across a large rotating disc surfaced with varying gravel grades to test the distance and pressure under which Wilma's elbows would have to have been dragged to effect the observed skeletal trauma. The study resulted in compelling evidence that Wilma had been alive when the injuries were sustained.

**Integrating geometric morphometrics and biomechanics.**

AMANDA L. SMITH and DAVID S. STRAIT. Department of Anthropology, University at Albany.

Recent years have seen the increasing integration of geometric morphometrics (GMM) and finite element analysis (FEA), an engineering method that can be used to address questions in evolutionary biomechanics. These efforts represent important methodological advances, but a full integration lies before us. The fundamental question needing to be answered is when given a sample of finite element models (FEMs), how can we determine whether or not the stress and strain patterns preserved within them are similar or different? More specifically, how is it possible to move beyond either qualitative assessments of FEMs or simple quantitative assessments based only on a miniscule fraction of the stress and strain data contained within them? A statistical framework for doing so will enable analysis of vast amounts of stress and strain data while incorporating spatial information, yet serious methodological and conceptual problems confront us. This problem is illustrated through FEA of chimpanzees and fossil hominins. GMM methods were used to identify six *Pan troglodytes* crania falling at the extreme ends of variation within the species. FEMs were constructed of these individuals, and of crania of *Australopithecus africanus* and *Paranthropus boisei* following virtual reconstruction using GMM. When loaded to simulate molar and premolar bites under conditions that control for size, the chimpanzees exhibit strains that vary in magnitude but that appear broadly similar in distribution. Strains in *A. africanus* are broadly chimpanzee-like, while those in *P. boisei* are not. However, these assessments are not based on a statistical analysis. Could they be?

*This project was funded by a grant from the National Science Foundation Physical Anthropology Hominid program (NSF BCS 0725126).*

#### **Secular change in the length and breadth of the bones of the upper limb.**

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While much of the secular change literature to date has focused upon long bone length as it relates to stature, limited research has dealt with changes in bone breadth. The aim of the present study was to determine the changes that occur both in the breadth of upper limb long bones as well as their lengths.

The study utilized thirteen measurements in the humerus, radius, and ulna of 600 individuals from the Huntington and Terry collections and the Forensic Data Bank. The data was separated by sex and analyzed by decade of birth using a Pearson's correlation analysis with a 2-tailed t-test.

The results indicated that while all lengths exhibited positive growth in males and females, the same could not be said for breadths. Specifically, in males, four of the nine breadth measurements exhibited no significant change, while three resulted in a reduction in size. Similarly, in females, three measurements

resulted in no change, while four exhibited a reduction. The humeral epicondylar breadth and the transverse diameter of the ulna were the only breadth measurements to result in positive growth in both sexes. Finally, while the transverse diameter exhibits a positive growth, the dorso-volar diameter exhibits an equally negative growth in both sexes, suggesting a "rounding" of the ulna.

The results of this study suggest that while the length of the long bones increase over time, breadth has not necessarily changed in a proportional manner.

*This project was funded, in part, by the Program in Forensic Anthropology at Boston University School of Medicine in Boston, MA.*

#### **Madeline Kneberg and the birth of Biological Anthropology in Tennessee.**

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The name of Madeline Kneberg is synonymous with archaeological research in Tennessee as she teamed with T. M. N. Lewis to bring systematic archaeological research to the Tennessee valley and the University of Tennessee. Kneberg was trained as a classical four-field anthropologist at the University of Chicago and was groomed by her mentor, Fay-Cooper Cole, for research in biological anthropology. Given her background, Kneberg assumed the lead in interpretation of the skeletal remains from archaeological sites, and these remains were critical elements in the overall interpretation of these sites and the pre- and proto-history of the Tennessee valley and its tributaries. Kneberg's approach to skeletal analysis focused on basic demographic parameters but is characterized by attempts to explain the biology of these people in a broader context of adaptation and population movement. While her work does reflect the influence of the typological perspectives typical of the time, she clearly rejected strict typologies and embraced the importance of normal population variation in analysis. In addition, Kneberg established biological anthropology as an integral component of the anthropological curriculum at the University of Tennessee starting in 1940. This included teaching human evolution during the era of the Butler Act. Although sometimes overlooked, Kneberg's pioneering efforts paved the way for the establishment of a strong tradition of biological anthropology at the University of Tennessee.

#### **Subsistence considerations based on the community health in the late prehistoric Thompson Village site from west-central Tennessee.**

MARIA O. SMITH and GERMAINE M. MOSHER. Sociology and Anthropology, Illinois State University.

Thompson Village (40Hy5) is a Late Mississippian Period (AD ~1300-1400) site from

west-central Tennessee in what is now the Kentucky Lake Reservoir. The health parameters examined in this sample (N=184, 132 adults, 52 subadults) are porotic hyperostosis (PH), cribra orbitalia (CO), periostitis, treponemal disease and, as Thompson village was arguably a maize-intensive agricultural community, a cursory survey for caries presence was also undertaken. Consistent with the agricultural subsistence economy, approximately half of all adults have caries. At least 3% of the adult sample have treponemal disease (sabre shins). Adding individuals diagnostically consistent with it (e.g., nodular expansion) elevates the prevalence to 8%. Some degree of non-diagnostic periostitis is present in the 0-5 age cohort (13%) and 14% of all adults. At least a quarter of the adult periostitis is a sequela of traumatic injury.

Twenty-two percent of subadults under the skeletal age of five display CO and 19% exhibit PH. Scurvy was observed in the sample and 15.4% of subadults and 4% of adults are identified as scorbutic. The 2 to 5 year-old cohort is particularly affected (28%) and likely synergistically relates to the frequency of periostitis. The prevalence of scurvy in these age cohorts is almost twice that reported from East Tennessee samples. Thompson Village inhabitants were evidently differentially stressed with respect to at least one aspect of diet and continued paleopathological assessment is merited.

#### **A study of cribra orbitalia over time and space in the ancient Nile Valley.**

NICOLE E. SMITH. Department of Anthropology, University of Arkansas.

Cribriform orbitalia is one of the most common skeletal lesions noted in ancient human skeletal remains excavated from the Nile Valley. Although its etiology remains under debate, recent research suggests that cribra orbitalia is caused primarily by hemolytic anemia. Research indicates that hemolytic anemia caused by malaria results in increased cribra orbitalia. Further, several independent researchers, using aDNA sequencing of ancient Egyptian mummies, found direct evidence of *Plasmodium falciparum* malaria. This direct evidence verifies the presence of malaria in antiquity, but the prevalence and spread of the disease remains unknown. As some models have pointed to the Nile Valley as the pathway of malaria from Africa to Europe within the time frame of Dynastic Egypt, variability in levels of cribra orbitalia should provide a way to track the spread of this disease. This study surveyed cribra orbitalia frequencies at 29 ancient Nile Valley sites, representing 4,760 individuals ranging from prehistoric to Christian periods (4400 BC – 1500 AD) and situated between upper Nubia and the Nile delta. Results showed generally high cribra orbitalia rates between 10.8% and 78.7% of the total population affected, with an overall mean of 42.8%. Over time and geographical location, the data showed no significant correlation, suggesting that high levels of hemolytic anemia affected individuals in the Nile Valley equally from pre-dynastic to Christian

periods. These findings, together with the aDNA evidence, support the hypothesis that malaria was already widespread and endemic in the Nile Valley long before the beginnings of Dynastic Egypt.

#### **Analysis of cytosine methylation in Native American ancient DNA.**

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Cytosine methylation of CpG dinucleotides is an important epigenetic mark that regulates gene expression in humans. While methylation patterns in extant populations have been widely studied, few studies have attempted to analyze methylation in ancient DNA. Indeed, it was only recently shown that methyl groups can be preserved in ancient DNA. However, it is unknown whether methylation patterns can be recovered from all (or most) ancient samples with preserved nuclear DNA. If they can, it may ultimately be possible to directly infer patterns of gene activity in ancient populations.

In this study, we assessed the preservation of cytosine methylation in ancient DNA from the remains of 25 prehistoric Native Americans from California, Illinois, Kentucky, and Mexico. These samples were previously shown to contain endogenous mitochondrial and nuclear DNA. We analyzed the cytosine methylation states of CpG-rich retrotransposons, which are epigenetically inactivated by cytosine methylation in humans. Unmethylated cytosines were converted to uracils by treatment with sodium bisulfite. Bisulfite products were pyrosequenced, and C-to-T conversions at potentially methylated CpG dinucleotides were quantified. We found that cytosine methylation is readily recoverable from human remains with preserved nuclear DNA from a variety of localities over the time depth tested (~6000 years). This study presents the first direct evidence of cytosine methylation in ancient human remains, suggesting that it may be possible to analyze patterns of gene activity in the distant past. This study also provides a diagnostic tool for assessing whether epigenetic marks can be recovered from ancient samples of interest.

#### **Conflicting evidence of warfare in Mycenaean Athens, Greece: Bodies versus bronzes.**

SUSAN KIRKPATRICK SMITH<sup>1</sup> and MARIA LISTON<sup>2</sup>. <sup>1</sup>Geography and Anthropology, Kennesaw State University, <sup>2</sup>Anthropology, University of Waterloo.

Cyclopean walls, bronze weapons, boars tusk helmets, military iconography – the evidence of militarism in Bronze Age Greece cannot be disputed. Burials have provided us with abundant evidence of military equipment in the form of bronze weaponry, yet the skeletons from burials have not always been adequately assessed in conjunction with the grave goods. There is ample evidence of violent injuries on

skeletons from Greece and other countries, and often these injuries can be linked specifically to military activity. Recent research on skeletons from Mycenaean Athens have suggested that there is an weak inverse relationship between weaponry in burials and injuries resulting from interpersonal violence. In this study, we expand this analysis to two additional Mycenaean Athenian chamber tombs to assess whether the previous pattern would be supported, and indeed it was. For Mycenaean Athens, the lack of a relationship between burial with weapons and skeletal evidence of trauma related to interpersonal violence holds.

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#### **First molar eruption and life history in living wild chimpanzees.**

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Understanding dental development in chimpanzees, our closest living relatives, is of fundamental importance for reconstructing the evolution of human development. Most early hominin species are believed to show rapid ape-like patterns of development, implying that a prolonged modern human childhood evolved quite recently. Yet chimpanzee developmental standards are uncertain because they have never been based on living wild individuals. Furthermore, although it is well established that molar tooth eruption (movement into the mouth) is broadly correlated with the scheduling of growth and reproduction across primates, its precise relation to solid food consumption or nursing behavior is unknown. To address these concerns we conducted a photographic study of subadult chimpanzees in Kanyawara, Kibale National Park, Uganda. Five healthy infants erupted their lower first molars (M1s) by or before 3.3 years of age, nearly identical to captive chimpanzee mean ages (~3.2 years, n=53). Kanyawara chimpanzees showed adult patterns of solid food consumption by the time M1 reached functional occlusion, spent a greater amount of time on the nipple while M1 was erupting than in the preceding year, and continued to suckle during the following year. Estimates of M1 eruption age in australopithecines are remarkably similar to the Kanyawara chimpanzees, and recent reconstructions of their life histories should be reconsidered in light of these findings. First molar emergence in early fossil hominins may be more informative about feeding behavior than about weaning age or maternal reproductive status.

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#### **A methodological comparison for stable carbon and nitrogen isotope analysis and applications to diet reconstruction.**

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Stable isotope analysis of bone collagen is a useful tool for dietary reconstruction, with several extraction methods currently in use. Often, the results obtained are assumed to be equivalent, but it is not clear whether differing methodologies in fact yield analogous results. In order to test the effect of collagen extraction methods on stable isotope analysis,  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  ratios were obtained from the mandibles (n=15) of individuals interred at the Byzantine (5<sup>th</sup>-7<sup>th</sup> c. AD) St. Stephen's monastery in Jerusalem, using methodologies developed by Ambrose and Schurr. These procedures were hypothesized to (a) produce statistically similar collagen yields and isotope ratios, and thus (b) generate the same interpretations with regard to diet.

There was no statistically significant difference between the two methods for collagen yield (Wilcoxon: p=0.7), or for carbon or nitrogen stable isotope ratios (Wilcoxon:  $\delta^{13}\text{C}$  p=0.5;  $\delta^{15}\text{N}$  p=0.7). Mean  $\delta^{13}\text{C}$  values (Ambrose:  $-18.7 \pm 0.4\%$ ; Schurr:  $-18.6 \pm 0.6\%$ ) were consistent with a primarily C<sub>3</sub>-based diet, while average  $\delta^{15}\text{N}$  ratios (Ambrose:  $9.1 \pm 1.2\%$ ; Schurr:  $9.2 \pm 1.2\%$ ) suggested some influence of animal and/or marine protein but represent an incomplete trophic level increase relative to faunal data. This comparative study indicates the Ambrose and Schurr methods are comparably effective for diet reconstruction of archaeological samples and that the differences in procedure do not affect subsequent interpretation.

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#### **Health research in biological anthropology: Integrating evolutionary and biocultural approaches.**

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Over the past several decades, the study of population-level health by biological anthropologists has become increasingly sophisticated as a result of growth in both evolutionary and biocultural approaches. Despite these advances, studies are often framed as either evolutionary or biocultural, foregrounding either an adaptive approach focused on ultimate

causation or one that emphasizes proximate factors such as political, economic, and historical processes. This is unfortunate because biological anthropology is uniquely positioned to understand the mechanisms responsible for distinctive population-level health outcomes by: 1) utilizing integrative models that incorporate proximate and ultimate factors; and 2) integrating theory and methods from other anthropological subfields and sister disciplines such as epidemiology, human physiology, and the social/behavioral sciences.

The present paper illustrates the utility of this multidisciplinary approach through a discussion of research by the Indigenous Siberian Health and Adaptation Project among the Yakut (Sakha), a high-latitude herding group from northeastern Siberia. This project combines research into metabolic adaptation to cold stress with an investigation of the health effects of economic and social change on native Siberians in the post-Soviet period. Results indicate important links between metabolic elevation and chronic disease pattern, which helps explain the distinctive health changes experienced by indigenous Siberians in the context of globalization (i.e., high rates of hypertension yet relatively favorable lipid profiles). These findings highlight the importance of considering regional adaptive patterns when investigating global health variation and, more broadly, underscore the need for biological anthropology models that integrate environmental exposure with underlying differences in susceptibility.

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#### **How trade networks impact phenotypic variation among an archaeological population from the Preclassic Maya site of Colha.**

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Excavations of the Maya site at Colha began in the 1970s. Located in present day northern Belize, Colha has been discussed in the archaeological literature because of its important role in the large-scale production of chert tools. The excellent raw material found around Colha allowed knappers to produce tools in mass quantities. The city was part of a regional distribution economic network that encompassed present day northern Belize and parts of Guatemala during the Late Preclassic period through the Late Classic, 300 B.C. to 800 A.D. This economic activity meant that Colha would have experienced a great deal of migration from throughout the region. This movement of people would be reflected in the phenotypic variation of individuals from the area. While the site was occupied through the Late Classic, skeletal remains have only been found from the Middle and Late Preclassic.

This study utilizes regional biodistance analysis to examine migration patterns in a population from the Late Preclassic. Nonmetric cranial traits were observed on the skeletons and recorded. Regional biodistance analysis is a technique used to analyze levels of relatedness between archaeological populations. In particular, intracemetery analysis, a type of regional biodistance analysis that examines level of relatedness within an archaeological population, was conducted on skeletal material from approximately 30 comingled individuals from Colha. Statistical analyses were conducted to determine possible familial relationships among the individuals buried in this site. The results of this study shed light on how cultural practices like trade influenced phenotypic variation among the Preclassic Maya.

#### **Anticipatory stress, territoriality and hunting in wild chimpanzees.**

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Territoriality and hunting are energetically and psychologically demanding aspects of male chimpanzee behavior that have significant reproductive consequences. The discrete nature of territorial and hunting competitions permitted us to investigate anticipatory urinary hormone secretion associated with these behaviors in the Ngogo chimpanzee community, in Kibale National Park, Uganda.

The stress response allows an individual to quickly alter its physiological and behavioral profile in response to acute changes in its social and physical environment. Here, we investigated the correlation between cortisol, a stress hormone, territorial and hunting aggression. Our results indicate that hunting and territoriality are facilitated by increases in adrenal activity and cortisol production in wild chimpanzees, as cortisol levels are high during and shortly after engaging in these behaviors. Additionally, these data showed that cortisol does increase before any aggression transpires. Our earlier results indicate that male chimpanzees also display anticipatory increases in testosterone in advance of territorial behavior but not hunting. This suggests that chimpanzees are physiologically differentiating between these events. The potential cues chimpanzees use to anticipate these behaviors are unknown. Therefore, we investigated two correlates of hunting and territorial behavior, large male party size and location in territory, which could be potentially responsible for these anticipatory increases. However, neither could explain the anticipatory increases in cortisol. Being on the periphery of their territory was not associated with elevated cortisol levels, while cortisol levels were higher when males were in smaller groups. The potential cues that explain the observed anticipatory increases in cortisol are still unknown.

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#### **Craniofacial variation II: Head shape prediction from anthropometric measurement and ancestry.**

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Over the years a large sample of whole-head surface scans has been collected. These scans could provide valuable information on head-shape variation for the design of protective and therapeutic head gear. Unfortunately, hair often obscures the vault of the head, which makes it difficult to identify the vault surface with certainty. Thus, a model to predict the obscured data would be extremely valuable. Here, we examine the extent to which anthropometric variables and self-reported ancestry can predict cranial index as a first step toward developing more sophisticated models utilizing landmark coordinates, anthropometric variables, ancestry, and other information.

All data were taken from the United States Army's Anthropometric Survey II for Hispanic and White males (N=61/ancestry). Linear models were developed to predict cranial index based on hand length and horizontal foot breadth. These variables were selected as the best predictors of cranial index from seven candidate measurements via a backward stepwise algorithm using AIC as a criterion. This model was compared to a comparable linear model that included ancestry.

There was no significant difference in cranial index between ancestries (p=0.1199), and, although both models had significant fits (p<0.005 for both), the addition of ancestry did not significantly improve the fit (p=0.529) and yielded a higher leave-one-out RMSE (3.795517 versus 3.821896). Although linear models based on anthropometric data can predict cranial index, ancestry data does not always improve the predictive power of such models, and therefore, ancestry may not play a large role in future models.

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#### **Early to Late Christian burial practices at Mis Island: Religious community and the concept of identity.**

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This research focuses on a sample of 407 individuals from two medieval Nubian Christian

cemeteries on Mis Island at the Fourth Cataract. Cemetery 3-J-11 dates to approximately AD 300-1400 and cemetery 3-J-10 to approximately AD 1100-1500. Arc-GIS spatial maps and statistical methods were used to analyze mortuary patterns according to cemetery chronology, age, sex, and to determine whether mortuary practices reflected communal, familial, or individualized social structures.

Results demonstrate significant differences in spatial organization and distribution of burials between the sites. Cemetery 3-J-11 was organized into multiple clusters, each with a mixture of pre-Christian, transitional, and Christianized burial patterns. It is possible that family or corporate-based spaces established in the pre-Christian or transitional period continued to be used, even as the community began to adhere to Christian burial practice. Conversely, cemetery 3-J-10 was homogenous without detectable burial clusters. Instead, distinctions in burial practice were reliant upon membership within age cohorts. Young subadults (<13) were spatially segregated to the edges of the cemetery, had more variable burial patterns, and were more likely to be buried with personal adornment. Alternatively, adolescents (13-19) and adults (>20) were located within the core of the cemetery in an extended-supine position, and without grave inclusions.

In conclusion, the homogenized mortuary patterns at cemetery 3-J-10 demonstrate that membership within age cohorts and the larger Christian community became more important than membership within specific family or status groups. Thus, 3-J-10 may have been consecrated to demonstrate a more Christianized identity in the Late Medieval Period at Mis Island.

#### **Of monkeys and Maya: Primate species identification from classic Maya iconography.**

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Understanding the interaction between humans and nonhuman primates is fundamental to primate conservation issues, and the meaning and importance humans place on different primates can dramatically affect the health and survival of primate populations. However, relatively little is known about the relationships between humans and their nonhuman primate neighbors through prehistory. This study examines the ways the ancient Maya depicted monkeys on ceramic materials. Iconographic elements and primate imagery provide important clues in understanding the ways primates were viewed by the Maya, and when the individual species can be identified, this information is critical in considering how people classified and assigned meaning to what they encountered in nature. There are three species of monkey currently found throughout the Maya region: *Alouatta pigra*, *Alouatta palliata*, and *Ateles geoffroyi*. Using both painted and incised images on Maya pottery dating largely to the Classic period (AD 250-800), we identified the species depicted, when possible, employing attributes

used by primatologists to distinguish primate species, including pelage color, facial markings, limb length and proportion, hand morphology, tail position, and positional behavior. Results indicate that the Maya not only distinguished between the genera *Alouatta* and *Ateles*, but also viewed the species differently on a symbolic level by associating them with different behaviors and activities. Focusing on primate symbolism provides insight into how the Maya interacted with animals living in their natural environment, what they understood of their behavior, and the ways in which symbolism was transmitted through the representation of these animals.

#### **Changes in skeletal CSG robusticity and sociopolitical changes in central Italy Sannites (800-200 BC).**

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The purpose of this research is contrasting the inferences on past physical activity inferred from grave goods composition with actual humeral, femoral, and tibial mechanical properties. CSG properties were estimated in Sannite individuals (n=315) from the necropolis of Bazzano (L'Aquila, Abruzzo, Central Italy) belonging to the Orientalizing-Archaic period (O-A; 800-600 BC, n=122), the V<sup>th</sup> century (V SEC; 500-400 BC, n=40), and the Hellenistic period (ELL; 400-100 BC; n=111). The three periods correspond to generalized shifts in grave goods composition: in the O-A, male burials contain weapons such as swords and spears; in the V SEC, grave goods are rare; in the ELL, weapons virtually disappear and grave goods recall the Greek symposium tradition. At a sociopolitical level, it is believed that those cultural changes accompanied a transition from a paramount chiefdom to a democratic republic. We expected to find a diachronic decline in male humeral bilateral asymmetry, considered a proxy for unimanual weapon use. Results show a diachronic decrease in humeral asymmetry in males, with the O-A and V SEC males significantly more lateralized than ELL males (P<0.01). In absence of subsistence changes, we can associate the diachronic decrease in male bilateral asymmetry with a generalized decrease in the use of unimanual weaponry. Interestingly, there are no historical accounts of large scale warfare waged by Sannites until the Hellenistic period. In this case, high lateralization seems to be correlated more with the symbolic importance of the warrior figure rather than the actual occurrence of large scale warfare.

*Hibben Foundation - University of New Mexico.*

#### **A camera trapping study of orangutans in the Wehea Forest in East Kalimantan, Indonesia.**

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Great apes are difficult to count directly and indirect signs, such as nests, are frequently used to census their populations. However, substantial time and effort are required to provide reliable population density estimates from nest surveys. Camera traps offer a potential alternative and have become a popular tool for assessing mammal populations. Recent camera trap studies of chimpanzee and gorilla populations have produced promising results, but to our knowledge this method has not been used to census populations of another great ape, the orangutan. Here we report on a camera trapping study of Bornean orangutans (*Pongo pygmaeus*) in the Wehea Forest in East Kalimantan, Indonesia (01°32'46"N, 116°46'43"E). This study was conducted from June 2011-January 2012 and April 2012-present for a total of 12 months to-date. We deployed 13 camera trap stations in 2011 and 42 stations in 2012 over a total survey area of ~50 km<sup>2</sup>. Camera trap stations consisted of a pair of Bushnell or Reconyx cameras placed 2-3 ft off the ground. During this study we obtained 403 photos of orangutans over 50 independent capture events (photos taken >1 hour apart). At least 9 individuals are represented in these photos with some individuals captured at more than one station. Furthermore, these photos indicate that Bornean orangutans may travel on the ground more than previously thought, even in areas of relatively contiguous forest cover. These results suggest that camera traps, perhaps in combination with other methods, could be a useful tool for surveying and studying orangutan populations.

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#### **Defining postmortem changes in west Central Montana.**

JESSICA R. SPENCER and TORY N. HUEY. Anthropology, University of Montana.

Research conducted by forensic anthropologists on the rate and sequence of human decomposition can assist law enforcement with estimates of time since death for remains from the forensic context. Preliminary research conducted in western Montana indicates that decomposition does not follow the patterns found in other geographic locations. The purpose of this study is to better define west central Montana's unique environmental factors that affect the rate and pattern of decomposition by documenting changes in mature pigs (*Sus scrofa*) employed as human proxies. The pigs were placed at different times throughout the year and analyzed by comparing the following variables: ambient temperature, relative humidity, weather patterns, internal temperature, external temperature, bloat, odor, color, entomological activity, and other visual observations.

The results from this study indicate that regardless of time of year, mummification of external tissues occurs and is persistent for at least a year in the absence of animal scavenging. Additionally, at a specific point in the decomposition process cold weather induced stasis occurs, directly affecting the rate and sequence of decomposition. The remains deposited in the fall (October) and winter (December) stayed in stasis throughout the winter and showed a slower rate of decomposition after the thaw. The pig placed in the spring (May) decomposed at a quicker rate and reaching mummification of external tissues more rapidly. The ultimate result of this study is to contribute to building a baseline data set for documenting decomposition in western Montana's highly variable and unpredictable weather.

**Assessing the forensic utility of the zygomaxillary suture in ancestry estimation.**

ALEXANDRIA N. SPORLEDER, CASEY E. BURNS and SCOTT D. MADDUX. Department of Pathology and Anatomical Sciences, University of Missouri.

The zygomaxillary suture is widely employed in cranial assessments of ancestry, with most individuals of Asian/Native American ancestry suggested to exhibit "angled" sutures (where the lateral-most and inferior-most points along the suture are coincidental), and most individuals of European ancestry believed to possess "curved" sutures (distinct lateral-most and inferior-most points). The proportions of zygomaxillary suture configurations in other populations, such as those of African ancestry, are less well known, but are generally assumed to be less diagnostic. In this study, zygomaxillary suture curvature was assessed through the evaluation of a continuous series of 3D landmarks traced along the suture. The lateral-most point along the suture was identified by assessing the mediolateral deviation of each landmark from the midsagittal plane. When the inferior-most landmark was also the lateral-most, a specimen was scored as "angled." Conversely, specimens with more superiorly positioned lateral-most landmarks were coded as "curved." Landmarks were collected on a total of 341 human crania from five geographic regions: Sub-Saharan Africa (n=58), North American Arctic (n=71), Northeast Asia (n=60), aboriginal Australia (n=75), and Europe (n=77). Our results support a high percentage of angled sutures among Native Americans, with 86% of our Arctic sample exhibiting this configuration. Interestingly, only 50% of our Asian sample exhibited angled sutures, refuting the common assumption of sutural similarity between these two groups. Our European sample, however, did not exhibit a high proportion (55%) of curved sutures, rather, it was our African (81%) and aboriginal Australian (77%) subsamples which exhibited the highest incidences of this configuration.

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**The African diaspora: Assessing cranial secular change using geometric morphometrics.**

M. KATHERINE SPRADLEY. Anthropology, Texas State University.

Previous studies have explored cranial morphological changes in American Blacks that have taken place since the forced emigration of West Africans to the American colonies, known as the African Diaspora. This research builds on the previous research by using larger sample sizes and a parental population along with groups from the U.S. that have experienced European gene flow. The purpose of this presentation is to explore changes in craniofacial morphology resulting from the transplantation of West Africans to the U.S. using geometric morphometric methods. Studies such as these are informative because gene flow and environmental variation can result in changes in the craniofacial morphology.

Twenty-three cranial landmarks were collected from 179 individuals including West African, Early Historic American Black, Late Historic American Black, and Recent groups. The data were subjected to a GPA followed by a Canonical Variate Analysis in order to explore morphological changes between the groups. The West African group is contemporary with the African Diaspora, the Historic groups come from archaeological excavations in the U.S., and the Recent group is from the Forensic Anthropology Data Bank. Results indicate that the West African and Recent groups are most differentiated and both Historic Groups are most similar to the West African group. However, the Recent group and West Africans show higher cranial base values than both historic samples, which may be an indicator of childhood stress. The results will be discussed within the context of reconstructing gene flow and differences the environmental conditions among the four groups.

**Clavicular curvature and locomotion in anthropoid primates: A 3-D geometric morphometric analysis.**

NICOLE SQUYRES. Functional Anatomy and Evolution, Johns Hopkins University.

As an essential component of the primate shoulder, the clavicle should reflect locomotor adaptations. While previous work has generally focused on measurements of clavicular length and torsion, the shape of clavicular curvature may better distinguish taxa and provide additional information about upper limb use in locomotion.

In this study, sliding semi-landmarks were placed on clavicles of 10 Anthropoid primate species (total n=96) that display a range of locomotor behaviors. Landmarks (k=37) were chosen to capture the overall curvature of the clavicle in three dimensions. Procrustes superimposition and principal components analysis show separation among taxa and several patterns of shape change in clavicular curvature that appear to be associated with locomotion and relative scapular position.

A superior curvature in the lateral part of the clavicle is related to the relative position of the scapula and sternum (e.g., extreme curvature in *Alouatta* associated with an enlarged vocal apparatus, and very little in *Homo* associated with the relatively low position of the scapula). An inferior curvature of the medial clavicle is found only in Hominoids and brachiators. This curvature could help stabilize the shoulder and prevent superior dislocation of the clavicle in suspension. Finally, the degree of anterior bowing in the clavicle represents a gradient from most-bowed in suspensory genera (brachiators and *Pongo*) to least-bowed in frequently terrestrial genera (*Papio* and *Gorilla*). This curvature may allow an increased range of craniodorsal movement without the clavicle impinging on the thoracic outlet. Clavicular curvature successfully distinguished among taxonomic and locomotor groups.

**Macroevolutionary comparisons of ecological disparity and craniodental disparity in platyrrhine and strepsirrhine primates.**

ELIZABETH M. ST CLAIR. Evolutionary Anthropology, Duke University.

Morphological distances are sometimes used in macroevolutionary analyses as a proxy for adaptive variation, but morphological differences between species may not always closely represent ecological or adaptive differences, considered relative to other sources of variation such as phylogenetic history or body size. This investigation compares ecological and morphological distances in 28 species of platyrrhine primates and 23 species of strepsirrhine primates, using field data for diet and activity profile to capture ecological variation and 24 craniodental measurements to capture morphological variation. Analyses were conducted in R, and include direct comparisons of the distance matrices, analyses of the phylogenetic structure of disparity among subclades (disparity through time), and a bootstrap analysis to identify unusually diverse clades at the family level.

Comparisons of the distance matrices using both standard and partial Mantel tests with a phylogenetic distance matrix indicate significant associations between morphological and ecological distance matrices (standard Mantel: platyrrhine p=0.013, strepsirrhine p=0.001). In both clades, high ecological distances were paired with low morphological distances in some instances, but the reverse was found less frequently. When platyrrhines and strepsirrhines were contrasted, analyses of the phylogenetic structure of disparity among subclades were relatively consistent between ecological and morphological datasets. Clades identified as possessing unusually high disparity were not consistent between the two datasets, with high ecological disparity in cheirogaleids, and high morphological disparity in lemurids. These mixed results suggest that the degree to which morphological disparity represents ecological variation may be dependent on the type of macroevolutionary analysis performed.

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#### **Bioarchaeological analysis of dental health and diet in Tonga.**

CHRISTINA STANTIS. Department of Anatomy and Structural Biology, University of Otago.

In this study, a general census of dental health (caries, periodontal disease, macrowear, dental chipping, calculus, and antemortem tooth loss) is carried out in 77 individuals excavated from the 'Atele mounds of Tongatapu, Tonga (~1000-1700 C.E.). From these 77 individuals, 1056 teeth/tooth sockets and 975 interalveolar septa are examined. The aim of this study is to create a holistic picture of subsistence and dietary practices using dental markers of diet.

Caries rates are relatively high for a Polynesian population; 11.9% of permanent teeth had carious lesions; 61.4% of adults had at least one carious lesion. By-tooth analysis of periodontal disease indicated a relatively low prevalence of septal changes (61.7% healthy), but no adult individuals had all septal areas healthy; general periodontal reactions occurred in almost the entire population. Men showed significantly higher rates of periodontitis than women ( $p \leq 0.001$ ). The degree of macrowear follows general age trends, but there are no significant sex differences. Of the 743 adult teeth examined for chipping, significantly more anterior teeth were chipped than posterior teeth ( $p = 0.013$ ), indicating a greater focus on incisal shearing and anterior tooth-tool use compared to chewing. Calculus is present in almost all adults. Antemortem tooth loss was relatively rare; only 8.2% of adult teeth were lost before death. Intra-population trends regarding age and sex are presented, as are inter-population comparisons between other Polynesian samples. The results are discussed against a background of ethnographic and archaeological literature, which suggest a typical Tongan diet was centered on well-cooked, carbohydrate-rich root vegetables.

#### **The quantification and assessment of mortuary practices at Morton Shell Mound (161B3).**

JESSICA C. STANTON and NICHOLAS P. HERRMANN. Department of Anthropology and Middle Eastern Cultures, Mississippi State University.

Morton Shell Mound is a Late Woodland Ossuary on the Louisiana Gulf Coast. Excavated in 1968-1972 by Robert Neuman, the skeletal collection consists of approximately 24,900 commingled human bone fragments. The original osteological report did not include a site-wide distributional analysis, and the assessment of minimum number of individuals (MNI) represents a provenience specific summation

resulting in an MNI of 275 individuals. In order to better assess the mortuary program and number of individuals present at Morton, we inventoried the collection using methods and technology unavailable to the original researchers. We give each fragment (or set of fragments) a unique ID in order to evaluate overall MNI, fracture patterns, and spatial distribution.

Because the collection is so fragmented, traditional methods of MNI assessment are not applicable. A landmark-based approach and a GIS-based method are used to assess MNI. The landmark method is applied to 17 major elements and the GIS method is applied to every placeable femur, humerus, and temporal fragment. The fracture characteristics of femoral and humeral fragments are assessed to distinguish between early stage postmortem (ESPM) and late stage postmortem (LSPM) fractures. After the fragments are inventoried, cross unit refits are identified in an effort to assess vertical and horizontal distributional patterns. These data are used to estimate the number of individuals present in the sample and aid in the interpretation of postmortem treatments of the Coles Creek burials at Morton Shell Mound as well as early Mississippian Period mortuary patterns across the Gulf Coast.

#### **Childhood physiological stress and longevity.**

RICHARD H. STECKEL. Economics, Anthropology and History, Ohio State University.

This paper examines the extent to which childhood markers of physiological stress found on skeletal remains affected the age at death of approximately 16,000 individuals who were buried in Europe from approximately 250 AD to 1900 AD. The raw data were assembled as part of the European phase of the Global History of Health Project. The childhood markers are linear enamel hypoplasias, porotic hyperostosis, cribra orbitalia, and femur length. The paper estimates a logistic model of survival to age 30 and to age 40, given survival to young adulthood (indicated by a fused femur), sex and site characteristics. These childhood markers of stress imposed substantial penalties on survival, which is consistent with the idea that high stress environments intensify the aging process as proposed under the childhood origins hypothesis of adult health.

*Data collection for this project was funded by the National Science Foundation, grants BCS-0527658 and SES-0138129.*

#### **Is the fit right? Lemur species-area curves in a fragmented landscape.**

TRAVIS S. STEFFENS and SHAWN M. LEHMAN. Department of Anthropology, University of Toronto.

Habitat fragmentation continues to increase in Madagascar. The 2012 IUCN Red List reports 91% of lemur species are now threatened. Determining how lemurs respond to habitat fragmentation is critical to improve

conservation efforts. Documenting species-area relationships in Madagascar will allow us to determine how species richness is impacted by alterations in habitat size.

In forest fragments, the species-area relationship is expected to follow a sigmoidal pattern with an upper asymptote. The shape of the sigmoidal curve is due to the total number of species (upper asymptote) and the small island effect, where species richness is affected by factors other than area, creating a j-shape in the lower portion of the curve. However, most studies have fitted data using the power model which does not have an asymptote or account for the small island effect.

The objective of our study is to determine how habitat fragmentation affects lemur species richness. We surveyed 42 forest fragments ranging in size from 0.23 ha to 117.70 ha on the western edge of Ankarafantiska National Park, Madagascar. The landscape is characterized by homogeneous stands of tropical deciduous dry forest surrounded by savannah. We found six out of the eight potential species and fitted five species-area models to our data using non-linear least squares regression analysis. Using Akaike information criterion we determined that the power model rather than candidate sigmoidal models best fit the data. This study will determine minimum fragment sizes needed to preserve the majority of lemur species.

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#### **Trabecular bone architecture in the thumb of recent *Homo sapiens*, *Pan*, and Late Pleistocene *Homo*: Taxonomic differences and evidence for handedness.**

NICHOLAS B. STEPHENS<sup>1</sup>, TRACY KIVELL<sup>2</sup>, N. HUYNH NGUYEN<sup>2</sup>, DIETER H. PAHR<sup>3</sup>, THOMAS GROSS<sup>3</sup>, JEAN-JACQUES HUBLIN<sup>2</sup> and MATTHEW M. SKINNER<sup>1,2</sup>. <sup>1</sup>Skinner Lab, Department of Anthropology, University College London, <sup>2</sup>Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, <sup>3</sup>Institute of Lightweight Design and Structural Biomechanics, Vienna University of Technology.

Evidence for species-wide handedness in non-human apes and when during the Pleistocene the right-hand bias of humans evolved are unresolved issues in paleoanthropology. External skeletal asymmetry is often used as a proxy for hand preference in humans. However, in non-human primates or fossil taxa where samples are small and handedness data are ambiguous or absent, more accurate measures of bone loading are required. Trabecular bone remodels during life and *in vivo* studies demonstrate that trabecular structure reflects changes in loading.

Therefore, to investigate handedness we quantify the trabecular structure in the first metacarpal (MC1). We compare paired

(left/right) metacarpals of *Pan troglodytes* ( $n=7$ ), *P. paniscus* ( $n=2$ ), modern *H. sapiens* ( $n=14$ ) and Late Pleistocene *H. neanderthalensis* ( $n=1$ ) and *H. sapiens* ( $n=1$ ). All metacarpals were micro-CT scanned at a resolution of  $\leq 30$  microns and relative bone volume, anisotropy and stiffness of the complete trabecular structure in the metacarpal head and base were quantified using MedTool®. We investigate (1) species differences between *Pan* and *Homo* and (2) intra-individual asymmetry in trabecular structure within each species.

Our results indicate that *Pan* is characterized by significantly greater bone volume but decreased trabecular organization compared to recent and fossil humans. Average absolute asymmetry in relative bone volume is 4.1% and 3.7% in human MC1 heads and bases, respectively; and 1.5% and 1.6% in *Pan* heads and bases, respectively. *Pan* displays a leftward bias, while humans and fossil humans confirm a rightward bias. The implications for interpreting behavioral loading in the hominine clade are discussed.

*This research was supported by the Max Planck Society.*

#### **Determination of the postmortem interval in western Montana: A preliminary study on perimortem and postmortem characteristics in blunt force fractures.**

ELIZABETH R. STEVENS. Anthropology, University of Montana.

Determining the postmortem interval is one of the most important and fundamental aspects surrounding a person's death that a forensic anthropologist must determine. The goal of this experiment was to determine a transition point between those observed perimortem and postmortem features within the associated blunt force fractures. Approximately 130 deer bones were procured through a deer processor and were set out in the Montana environment for a total of 24 weeks. At one week intervals, five bones were broken by a 5 pound weight at a drop height of 2½ feet, after being weighed in order to account for moisture loss. Variables recorded were the fracture type, fracture angle, fracture line appearance, coloration of the fracture line, the presence of bone marrow, color of bone marrow and odor distinction. The first variable to exhibit a sign of postmortem change occurred at Week 12 (PMI= 77), where a rough appearance appeared at the fracture margins. Ultimately the bones showed complete postmortem characteristics after a PMI of 133 days. This study in comparison to others regarding the same context (e.g. Wheatley, 2008; Weiberg and Wescott, 2008), produce similar patterns regarding overall fracture types and fracture margin appearances, but differ in time frames. The results of this study shows bones determined to be perimortem or postmortem. However, it also shows bones that are in an intermediary stage with a mixture of both perimortem and postmortem fracture characteristics, which could ultimately represent a transition point between the two gross time frames.

#### **Form variation in human long bone joints: A comparative geometric morphometric analysis of variation in the knee and elbow.**

SALLY D. STEVENS and UNA S. VIDARSDOTTIR. Anthropology, Durham University, UK.

Analyses using geometric morphometric techniques have demonstrated significant population specific variation in the morphology of the bony elements of the human knee joint (distal femur and proximal tibia). Research also indicates an atypical morphology in the knee, particularly the tibia, in the post-medieval population from Spitalfields, London UK (Stevens, 2005; Stevens & Vidarsdottir, 2012). This study compares and contrasts data from eight human populations, including two further British samples, to that of Spitalfields. It also includes data from the elbow (distal humerus and proximal ulna) to compare with the atypical knee, which ensures a degree of standardization against any systemic disorder in the Spitalfields postcranial morphology. Right-sided data are included from 257 femora, 245 tibiae, 222 humeri and 207 ulnae, largely from the same individuals. Results show that when compared to the additional British samples, the Spitalfields knee appears less morphologically distinct although the Procrustes distance between the Spitalfields sample and the other two samples remains statistically significant. In contrast to both femur and tibia, variation in the shape of the elbow is small between the geographically distinct groups, including Spitalfields, although the three British samples continue to cluster more closely together. However, like the knee, results for the elbow also show statistically significant distance between all groups. Our results indicate that what seemed at first to be unusual variation in the Spitalfields lower limb morphology is likely to be indicative of a more general British morphology, including other areas of the articular skeleton.

#### **Applying the Belmont principles to physical anthropology.**

SARA STINSON. Anthropology, Queens College, CUNY.

Respect for persons, beneficence, and justice are the three basic ethical principles discussed in the 1978 Belmont Report. These principles were the foundation of human subjects' regulations in the United States and continue to guide IRBs and researchers. This paper explores how the Belmont principles can be used by physical anthropologists and considers how the application of the principles is complicated by some of the unusual characteristics of physical anthropology research.

Physical anthropologists regularly employ the principle of respect for persons when they obtain voluntary and informed research participation and give additional protections to vulnerable populations such as children. But physical anthropologists may need to widen this principle beyond its original description, for example when they work with groups where the individual is not considered autonomous or with

populations that have little understanding of what research is. Beneficence entails protecting research participants from harm. Physical anthropology research does not commonly involve the possibility of physical harm, but our research can present emotional, social and psychological risks. The principle of justice calls for the fair distribution of the burdens of research. An important illustration of a situation where this principle is relevant to physical anthropology is research with disadvantaged populations. As the authors of the Belmont Report noted, the application of the three principles does not always lead to clear resolution of ethical questions, and this is certainly evident in physical anthropology.

#### **Sex estimation of juvenile human crania Using 3D assessment of craniofacial architecture.**

MICALA K. STOCK<sup>1</sup>, DAVID REYNOLDS<sup>2</sup>, ARI J. MASTERS<sup>3</sup> and TIMOTHY G. BROMAGE<sup>4</sup>. <sup>1</sup>Department of Anthropology, New York University, <sup>2</sup>Department of Anatomy, University of New South Wales, <sup>3</sup>Melbourne Dental School, Melbourne University, <sup>4</sup>Hard Tissue Research Unit, Department of Biomaterials and Biomimetics, New York University College of Dentistry.

Sex determination is fundamental to the construction of biological profiles in archaeological and forensic settings, however sex estimation remains difficult.

Using Enlow's mammalian craniofacial architectural relationships, Bromage (1992) demonstrated that such relationships discriminate female from male juvenile chimpanzees. In this study, Bromage's methodology developed from critical landmarks derived from in vitro human juvenile CBCT scans to discriminate sex determined profiles have been applied; thus with the precision of 3D imaging, we test whether modern human facial skeletons may be similarly distinguished.

A pilot sample of Cone-beam CT scans derived from Australians 6-16 years of age were analyzed ( $n=10$  males and  $n=10$  females). 3D landmarks for 70 craniofacial architectural points were independently identified by MKS and DR using Analyze 11.0 software. Points that could not be agreed upon within 1.6 mm—or 4 voxels on the 0.4 mm/voxel image—were discarded from analysis.

The craniofacial angle at the central semicircular canal, described by lines passing through the center of the orbit and the inferior greater palatine foramen, showed significant differences between the sexes at a 90% confidence interval. The angle at the junction of the anterior and middle cranial fossae (specifically at foramen rotundum), with lines passing through the aforementioned points, is significant at an 80% level.

We demonstrate the utility and efficacy of 3D evaluations of craniofacial architecture to discriminate juvenile female from male humans, having utility in forensic identification and potential for modern and fossil primate sex determination.

### **Narrative, meaning and the future of bioarchaeology.**

CHRISTOPHER M. STOJANOWSKI. Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University.

It is only within the last few decades that bioarchaeology emerged from its origins as a largely descriptive science. Since then, the field has witnessed tremendous growth and now applies evolutionary, social, and biocultural theories to the study of past peoples. Perhaps uniquely among disciplines represented within the AAPA, bioarchaeology developed dually from the "New Physical Anthropology" and the "New Archaeology". This talk discusses the tensions inherent in this developmental trajectory (the "bioarchaeologies") and attempts to define future directions of outreach, collaboration and research engagement. In particular, function-oriented consideration of past research highlights a basic question that is infrequently drawn to the surface: What is important for everyone (including the public) to know about the past? Bioarchaeology's approach differs from other disciplines that have a unifying historical narrative (paleoanthropology), produce general knowledge about biological systems (organismal biology), or engage the historical aspects of evolutionary research. In such cases "meaning" and relevance are easily conveyed, both to other researchers and to the general public, by virtue of an existing narrative super-structure. However, bioarchaeology's emphasis on context (archaeological and ethnohistoric) engenders a particularistic, historically-contingent focus. This both frees and constrains the field as it adjusts to the changing US academic landscape with increasing emphasis on the production of general knowledge and use-oriented research. Building on a tradition of biocultural, health-related studies, emerging emphases define a more humanistic bioarchaeology which may further contribute to the field's "identity" crisis. Cues from social media and the blogosphere suggest a way forward for the discipline.

### **Is fatter sexier? Male reproductive strategies in squirrel monkeys, *Saimiri sciureus*.**

ANITA I. STONE. Biology, Eastern Michigan University.

Squirrel monkeys (genus *Saimiri*) live in large social groups and are seasonal breeders. The unique reproductive physiology of males is suggestive of sexual selection. Males show weight gain during the mating season, which produces a "fatted" appearance in the upper arms and torso. Although much is known about the physiology of fattening, its evolutionary function remains unknown. Here I present data on wild *Saimiri sciureus* studied in Brazil, in order to describe male mating investment in the species, and to examine the hypothesis that male fattening is a product of sexual selection. Males were observed via focal animal sampling during four mating seasons. Male behaviors such as branch sniffing, genital sniffing and "draping" were observed. Compared to less robust males, fatter

males spent significantly more time near females ( $F_{2,72}=5.62$ ,  $p=0.005$ ) and less time alone ( $F_{2,72}=4.27$ ,  $p=0.01$ ), and more time engaged in mating activities ( $F_{2,63}=3.95$ ,  $p=0.02$ ). The 2-month mating season accounted for 62% of all male-male agonism observed over 12 months. These results are suggestive of male-male competition for females. On the other hand, males did not coerce females to mate and females affiliated more with fatter males ( $F_{2,18}=11.2$ ,  $p=0.005$ ). These results are also suggestive of female choice. It is possible that male fattening in *Saimiri* is a product of both intra and intersexual selection. Continuing genetic analyses will address whether higher male fattening leads to increased paternity.

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### **DNA analysis of ancient pathogens.**

ANNE C. STONE. School of Human Evolution and Social Change, Arizona State University.

The revolution in genome-wide and targeted sequencing technologies has provided access to large amounts of data from ancient DNA samples, including ancient pathogens. These data promise to provide new insights into the evolution of pathogens over time, their geographic patterning, and host-pathogen coevolution. In this introduction to this symposium, some of the technological innovations that are being used to investigate ancient pathogen genome data will be reviewed, and the opportunities and challenges of these analyses will be examined. This will be framed using research on ancient tuberculosis as an example. In particular, I will discuss the results of using quantitative PCR to assess the presence of the pathogen in over 100 bone samples ranging in age from 100-5000 years BP and the challenges of developing assays that are species specific (and do not amplify often unknown environmental species) as well as some of the methods of DNA capture and sequencing that we are using to investigate the biogeography and evolution of tuberculosis in the Americas prior to, during, and after European colonization.

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### **Were calories really a problem for the Classic Maya of Copan and K'axob? Evidence from paleopathological indicators.**

REBECCA STOREY. Comparative Cultural Studies, University of Houston.

As George Armelagos has long taught, one has to look at paleopathological indicators of stress in a population framework using a biocultural framework. He also was interested in the effects of social inequality on health in complex societies. The Precolumbian Maya of Mesoamerica have a high prevalence of pathological indicators during the cultural apogee of the Classic period (circa 250-900 CE). The morbidity burden indicated by this

prevalence should be due to the interaction of diet and hygienic environment, both considered to be substandard in this population. Poor nutrition affects immunological competence. Elite individuals should have evidence of a more buffered lifestyle. However, diet was thought to be a stressor for the Maya, even for the elite, because of the lack of animal protein and the high dependence on maize, beans, and other vegetables and fruits. Calories could be lacking, especially as the diet has traditionally been thought to lack fatty foods. The recent evidence for the use of palm and cottonseed oil, by both elites and commoners, and the increased presence of root crops to provide calories, makes nutrition potentially less of a contributor to stress. The difference in prevalence of paleopathological indicators in the Classic period Maya of K'axob, Belize, and Copan, Honduras, by status are minimal. One explanation is the archaeological evidence that diet did not vary greatly by social status, especially in access to caloric-dense foods.

*The Copan and K'axob studies have been supported by the World Bank, Fulbright Foundation, and the University of Houston.*

### **Craniofacial variation IV: Visualization of surface variation derived from whole head scans.**

DETELINA K. STOYANOVA<sup>1</sup>, BRIAN CORNER<sup>2</sup> and DENNIS E. SLICE<sup>1</sup>.  
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A defining feature of geometric morphometric methods is their capacity to produce concise and informative visualizations of population variation, between-population differences, and other multivariate results. With the increasing availability of surface-scan, it is necessary to extend the graphical capabilities of the geometric morphometric paradigm to this type of data. Elsewhere, we report on an efficient method for the superimposition of scan samples. Here, we present methods and associated tools for the visualization of that method and its results.

The software we have developed shows the head scan data divided into contiguous regions identified by our scan-fitting algorithm by coloring them differently. In addition, it can generate a color map that represents the differences between two head scans and has the capacity to visualize the magnitude of variability across regions of the skull in a sample of scans fit to a reference. The color and intensity used in the color map correspond to the actual numeric values of the differences between two skulls over the surface or the magnitude of variability over a region for a sample fit to a reference.

Beyond our own immediate needs and interests in advancing research in the design and evaluation of safety equipment, straightforward extensions to our software would make it a useful component of research in other areas, such as studies of modularity and its evolution.

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#### Geometric morphometrics as a tool in evolutionary biomechanics.

DAVID S. STRAIT. Department of Anthropology, University at Albany.

Geometric morphometrics (GMM) is the leading approach to quantitatively describing variation in shape and form in biological structures. GMM can be used in functional morphology insofar as shape and form influence function. However, if the key mechanical parameter of a given anatomical system can be measured simply, then a GMM analysis will not add to a functional interpretation. Rather, GMM will enhance the testing of functional hypotheses when applied to complex anatomical systems that defy simple mechanical explanations. In this regard, GMM is an excellent complement to finite element analysis (FEA), an engineering method used to examine how objects of complex geometry and material properties respond to complex loads: GMM provides information about variation but does not provide mechanical information, whereas FEA provides mechanical information but is not well designed to assess variation. Yet, both methods rely on similar inputs (3D coordinate data).

GMM and FEA can be integrated in several ways: GMM can be used to 1) identify a few individuals near the mean or extremes of variation, such that when they are modeled in FEA, they will provide an assessment of the mechanical consequences of intrataxon variation; 2) virtually reconstruct damaged or distorted fossil individuals that will be analyzed mechanically using FEA; 3) warp a given FEA model into alternative shapes/forms, allowing a virtual mechanical experiment; and 4) describe the differences in shapes produced in a given finite element model when subjected to different loads or boundary conditions.

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#### Histomorphometric differentiation of human and nonhuman bone.

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In both bioarchaeology and forensic anthropology, histomorphological differentiation of human and nonhuman bone is often utilized as a cost effective method for distinguishing species from fragments that cannot be categorized by gross morphology alone. Often, this involves observation of either osteon banding or plexiform bone as an indicator of nonhuman animals. When only secondary osteons are

visible, however, histomorphology alone cannot differentiate between human and nonhuman bone. This study tests two recently published histomorphometric methods that use osteon area (On.Ar) and/or osteon circularity (On.Cr) variables to differentiate human and nonhuman bone. A diverse sample of nonhuman mammalian bone (n=20) was compared with human femora and rib samples (n=50). Standard protocols for histomorphometric data collection were followed. The variables were measured for a maximum of 50 osteons per cross section and an average value for each sample was calculated. The first method used the On.Cr variable in a regression equation, while the second used both On.Ar and On.Cr in a discriminant function analysis (DFA). Results show that using On.Cr alone provided 100% correct classification for nonhuman bone, and 52% correct classification for human bone. Using both On.Ar and On.Cr in the DFA, however, separated human from nonhuman bone with 61% correct classification for nonhuman bone and 100% correct classification for human bone. The results of this study indicate that combining On.Ar and On.Cr as discriminating variables not only improves the ability to distinguish human from nonhuman bone, but is a more conservative approach that does not risk misclassifying human bone.

#### Does she or doesn't she: Change in osteon size with age and sex.

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Numerous studies have reported on the age associated change in mean osteon size (On.Ar mm<sup>2</sup>) in human cortical bone. While some report a decrease in On.Ar with age, other studies have found no change. The purpose of this study was to examine the correlation between On.Ar and age in a variety of bones: metacarpals (74), clavicles (n=22), ribs (n=102), tibias (n=27) and femurs (n=38). All bone samples and data were obtained from a variety of sources; archaeological excavations, dissecting room cadavers, autopsies and forensic cases. On.Ar was quantified in the mid-shaft cortex of at least 50 osteons in each bone at 200x magnification using the point count method. Recently, a study of Euro-Canadian second metacarpals determined that there was no correlation between age and On.Ar. In this study On.Ar in a sample of Inuit second metacarpals was also found not to decrease with age (r=.10). Data from clavicles (r=.29), tibias (r=.32), ribs (r=.52), and femurs (r=.72) show a negative correlation between On.Ar and age. The strength of the correlation varies from low (clavicles) to

strong (femurs) and appears to be bone specific. Sex based differences are also evident with the strongest, negative, correlation between On.Ar and age in the females of each bone group. Based on our data, a decrease in osteon size with increasing age is bone specific and appears to be most evident in females.

#### Do biological anthropologists have an ethical obligation to identify themselves as anthropologists? Reflections at the AAPA x AAA intersection.

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Many biological anthropologists identify more strongly with subfields in the biological sciences than they do with other areas of anthropology. This affinity with biology reflects longstanding similarities in our theoretical perspectives and methodological approaches, which are quantitative and comparative and permit us to engage in the empirical testing of falsifiable hypotheses. Yet despite references to "the sciences" and "anthropological science" in the current (May 2011) version of the Long-Range Plan of the American Anthropological Association (AAA), biological anthropologists do not flock to the AAA like they do to the AAPA. For some this is due to limited time and financial resources that preclude participation in yet another professional society of interest, but for others it is demonstrative of a pervasive skepticism about the relevance of non-scientific anthropology to biological anthropology in general. Nonetheless, the AAPA Code of Ethics is based on that of the AAA, suggesting that at least some shared standards of conduct have persisted amidst the ongoing tensions within anthropology and the array of alternative responses that have been adopted to reduce these tensions. All of these responses have consequences for our undergraduate majors and graduate student training, and ultimately, for the future of biological anthropology as a discipline and the ethics by which we abide.

#### Introduced mammal predation of wild lemurs at Bezà Mahafaly Special Reserve, Southwestern Madagascar: An assessment of predator scat samples.

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The lemurs of Madagascar rank among the world's most endangered primates, due in part to two millennia of human activity. An understudied aspect of human actions on lemur survival is the role of introduced predators. Domestic dogs and cats, in addition to the Indian civet, have been known to prey upon the lemurs at Bezà Mahafaly Special Reserve (BMSR). To date, the impact of introduced predators has not been systematically studied at this site.

To assess the impact of introduced predators on this faunal community, monthly scat samples were collected October 2008 through June 2009, spanning both wet and dry seasons. Scats ( $n = 37$ ) were identified to predator by size and morphology of the fecal specimen. Samples were dissected using a binocular scope with remains identified to broad faunal categories. Wild cat scats were most prevalent (68%), followed by civet and dog. Vertebrate prey (including rodents and lemurs) was more frequent in the dry season, with insects and plants being common across both seasons. Cats show higher counts of vertebrate prey than the other predators, with one cat sample containing a femoral distal epiphysis from an immature ring-tailed lemur.

Given the existence of *Lemur catta* remains in the samples we can infer that introduced predators are impacting the ecology of primates at BMSR, especially during the dry season. The presence of young lemur material indicates the potential threat of introduced predators on immature lemurs in particular, corresponding with previous observations of predation events by felids at BMSR.

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#### **The dietary competitive environment of early Eocene euprimates in North America.**

LAURA K. STROIK. Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University.

The earliest Eocene marked the appearance of the first North American euprimates. Despite the fact that leading hypotheses assert that traits involved in food acquisition underlie euprimate origination and early diversification, the precise role that dietary competition played in establishing euprimates as successful members of mammalian communities is unclear. This is because the degree of niche overlap between euprimates and all likely mammalian dietary competitors ("euprimate guild") is unknown. This research determines the temporal pattern of niche overlap within an Eocene euprimate guild and elucidates the nature of dietary competitive interactions surrounding the earliest euprimates in North America.

To evaluate the validity of using dental morphology to reconstruct dietary niche overlap, a discriminant function analysis was performed on nineteen 3D molar measurements in two extant euprimate guilds (Balta, Peru; Mindanao, Philippines; 106 species). Results showed that dietary niche reclassification rates were high (87%). Thus, a PCA of these molar measurements from an Eocene euprimate guild (Bighorn Basin, Wyoming) was conducted, and multidimensional polygons, each representing a species' dietary niche, were derived from this analysis. Calculation of an F-statistic using Euclidean distances associated with these polygons revealed that dietary niches of Eocene euprimates overlapped with some, but not all,

contemporaneous non-euprimate species ( $p < 0.05$ ). Furthermore, correlation analyses of polygon distributions demonstrated that patterns of competition changed over the duration of the Wasatchian. This suggests that the dietary competitive environment of the earliest North American euprimates was complex, and thus that diet had a variable effect on the course of this euprimate radiation.

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#### **Secular changes in robusticity of limb bones in Americans.**

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Secular changes in limb bone lengths over time have been studied extensively by anthropologists over the last few decades. Curiously, secular changes in skeletal robusticity have been largely ignored; instead, robusticity is generally studied to infer the level of activity in prehistoric populations. Over the last two hundred years, the trend towards a more sedentary lifestyle suggests significant changes could have occurred.

This study analyzed several measurements taken from the femur, tibia and humerus collected from the Terry Collection and the Forensic Data Bank to bridge the gap in our understanding of secular changes in robusticity. The sample was subdivided based on sex and ancestry. All individuals were born between 1828 and 1995. Long bone lengths, breadths, and robusticity indices were regressed on birth year using loess curves. Inflection points of 1900 or 1940 were discerned in the groups and used with parametric and nonparametric tests to determine statistical significance. All  $p$  values were adjusted for multiple comparisons.

Nineteen of the 48 comparisons showed significant secular changes ( $p < 0.02$ ). All limb bones increased in length over time, with the exception of the white male humerus. Also, all four groups show a decrease in lower limb bone breadths, which, coupled with an increase in length, decreased robusticity. Concurrently, the shorter humerus in white males and the increase in the other groups' epiphyseal breadths increased upper limb robusticity. Of the four groups analyzed, black males demonstrated the greatest secular changes in robusticity.

#### **Non-metric cranial and pelvic traits as a measure of sexual dimorphism in a modern South African population.**

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The current study combined the Walker (2008) and Klaes et al. (2012) methods to score non-metric cranial and pelvic traits on modern white and black South Africans. The contributions of genetics and the environment has led to population-specific distribution of non-metric traits (Garvin 2012). Krüger et al. (nd), demonstrated that the Walker (2008) method is applicable to a modern South African sample; however, the degree of expression is unique to the population. Similarly, high classification accuracies are noted on modern South Africans for non-metric pelvic traits for Klaes et al. (2012) (Kenyhercz 2012). The purpose of this study was to combine non-metric data from 71 corresponding skulls and innominates to examine the degree of sexual dimorphism in a modern South African sample as well as to examine correct classifications derived from these non-metric traits. Depending on the statistical analysis and variables employed, correct classifications ranged from 82-100%. The traits from the innominate consistently provided higher classifications than traits from the skull, even outperforming a combination of skull and innominate traits, thus indicating greater sexual dimorphism in the innominate as opposed to the skull in modern South Africans.

#### **3D retrodeformation of paleoanthropological fossils based on biomechanical simulation.**

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Plastic taphonomic deformation is a major problem in studying paleoanthropological fossils. In general, paleoanthropologists retrodeform the fossil manually according to the position of anatomical landmarks or based on symmetry planes. Another method is to analyse the change of shape of a simple anatomical structure as the orbit in order to compute strain parameters and infer the magnitude and orientation of the deformation. This is particularly interesting as it does not only allow one to retrodeform the fossil but it also gives information about the taphonomic process, which may be correlated with geologic measurements.

We propose to extend this method by analysing the deformation of the complete fossil. We used the open-source SOFA software framework targeted at real-time biomechanical simulation. The fossil is modelled as a linear homogeneous stiff material which is plunged into a linear homogeneous soft material which represents the surrounding geological layers. We apply a directional force on the surrounding material and simulate the 3D deformation of the

virtual fossil. We compute then a quality factor which is based on the correspondence or the symmetry of deformed and non-deformed landmarks. We search for the direction and magnitude of the force which maximizes the factor quality and we get a retrodeformation force and a 3D retrodeformed version of the fossil.

We performed experiments on the highly-distorted lower face STS 52a (*Australopithecus africanus*). The quality factor is based on the alignment with the corresponding mandible STS 52b which is assumed weakly deformed. The results are consistent with the paleo-anthropological observations.

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#### Cost of male mate competition in bonobos.

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Cortisol excretion in males of group living species is often associated with social rank and competition for estrous females. Rank-related patterns of cortisol levels can be used to study mechanisms of rank maintenance and costs associated with mate competition. Bonobos (*Pan paniscus*) are interesting because males form a linear dominance hierarchy but are not dominant over females and therefore aggressive male-male competition over access to females alone is not considered to be a successful reproductive strategy. In this study on social correlates of urinary cortisol in wild male bonobos, we investigated the relationship between cortisol levels and several aspects of mate competition, including male rank, aggression rates, and association time with estrous females. We found that cortisol levels correlated positively with dominance rank when estrous females were present, but not when they were absent. This result indicates that aggressive behaviour plays a minor role in maintenance of high rank. While aggression received from males and females explained within-individual variation in cortisol levels, it was the time spent in association with estrous females that best explained between-individual variation in male cortisol levels. The observed increase in male cortisol may be associated with spatial proximity to estrous females and could result from anticipated aggression from other group members, reduced feeding time in the males, or a combination of both.

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#### Synchrotron light identifies the biogenic uptake of metacinnabar in a bone sample from an Antigua, West Indies, Royal Naval Hospital Cemetery (1793-1822).

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Mercury is a heavy metal that exists in three categories of species: elemental mercury, inorganic mercury, and organic mercury. Elemental mercury and inorganic mercury compounds have been used for centuries to treat ailments such as syphilis and yellow fever. As part of a larger study on lead poisoning in colonial Antigua, a mass spectroscopic analysis (ICP-MS) of bone elements from 17 individuals once buried in a Royal Naval Hospital cemetery (1793-1822) revealed a high level of mercury in one individual. Analyzing trace elements that are identified within an archaeological context has been a challenge due to the difficulty of determining whether the element was present in the environment or associated with a biological event during life. Synchrotron radiation X-ray fluorescence (SR-XRF) was employed to determine whether the mercury was present in the bone as a result of environmental contamination or due to biogenic uptake. The SR-XRF study revealed an osteon with mercury-labelled lamellae, which is indicative that the mercury was biogenic. The synchrotron radiation X-ray absorption spectroscopic (SR-XAS) technique of X-ray Absorption Near Edge Structure (XANES) was used to determine that the mercury was present in the bone tissue as an inorganic mercuric sulfide in the beta structural form otherwise known as metacinnabar. While this inorganic form is not as toxic as organic mercury, there may have been an impact on the individual's health.

#### Explorations in paleodemography: An overview of the Artificial Anasazi agent-based modeling project, with new observations on demographic estimation.

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Population settlement, growth, expansion and eventual abandonment of ancestral Pueblo sites in the Four Corners region of the United States have posed enduring questions for bioarchaeologists and paleodemographers, including the respective roles of drought, conflict, disease, and intrinsic demographic factors in the abandonment of the region. In order to better understand the role of these factors, the Artificial Anasazi (AA) Project was initiated. The central component of this project is an agent-based computer model that uses extensive archaeological and environmental data to simulate the rise and fall of populations in the

Long House Valley, located in northeastern Arizona.

Data from this valley, coupled with archaeological estimates of growth and change, provide a baseline to compare to simulation outcomes. The simulations allow us to reproduce settlement decision-making and demographic behaviors of households in each Pueblo period, and to compare these with the observed archaeological record. The advantages of agent-based simulation include the ability to test a wide variety of fertility and mortality rates and ascertain the most realistic and probable set of "fits" to the observed Long House Valley data. We demonstrate that, using only the environmental opportunities and constraints as a first approximation, simulated population trajectories can be produced that are strikingly similar to the archaeological trajectories. Additionally, we present new results on the range of vital rates underlying these trajectories, discuss their fit in terms of fertility and mortality data from anthropological populations, and examine how the AA model can further explore the impact of these underlying vital rates.

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#### Ancestral estimation using E.A. Marino's analysis of the first cervical vertebra applied to three modern ethnic groups.

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Ancestry identification in forensic anthropology is vital for the medico-legal field. Forensic anthropologists have long sought to develop ancestry determination methods using complete and fragmented skeletal elements. Ancestry is most commonly assessed using cranial traits. Post-cranial methods for identifying individuals are needed in the field because cranial elements are broken and incomplete. Examining other elements can increase the likelihood of identification of the individual in question. Eugene Marino developed a method for estimating ancestry from eight measurements of the superior and inferior articular surfaces and vertebral foramen of the atlas from individuals of European and African descent. These specimens were from the Terry and Hamann-Todd collections. This study applies Marino's method to post-1950s individuals who are self-classified as Hispanic, Caucasian, and African-American. Two hundred and fourteen specimens were measured from the William Bass Skeletal Collection, the Pima County, Arizona's Coroner's Office, and the Maxwell Museum at the University of New Mexico. Each measurement was obtained using sliding calipers. The measurements taken from this study were analyzed using Statistical Package for the Social Sciences (SPSS) to establish a discriminant function that distinguishes Hispanic individuals from members of other populations. The analysis supports Marino's results in prediction of African-Americans and Whites with 60-72% accuracy. This study also concludes that a

discriminant function to predict ancestry between African-Americans and Hispanics with a 69-72% accuracy. This study concludes that the atlas can be used with a relatively accurate prediction to determine ancestry of Hispanics.

#### Reconstructing australopithecine midstance using femoral condyle curvature.

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Although it is universally agreed that australopithecines were bipeds, the exact nature of their bipedalism continues to be debated. Some researchers argue that australopithecines engaged in a modern form of bipedalism, while others suggest that these early hominins would have walked with deeply flexed knees and hips. This project examines the curvature of the medial femoral condyle among mammals, finding that regions of low curvature correlate with knee midstance angles during walking.

Sixty femora representing 16 mammalian species were surface scanned creating virtual surfaces models. Medial and lateral condyles were trimmed from the rest of the distal femur, and condyle profiles relative to the axis of knee flexion/extension were extracted as coordinate landmarks. These landmarks were treated as sliding landmarks in a geometric morphometric analysis. Species-average medial condyle profiles were created and a region of low curvature was identified. The position of the region of low curvature was quantified using a novel metric termed the angle to low curvature. Kinematic knee angles were collected from the literature and were regressed against the angle to low curvature metric at one percent increments of the gait cycle.

The highest correlation ( $r = 0.77$ ) between the angle to low curvature metric and knee angle occurs at 29% of the total gait cycle, which is midstance for most mammals. The resulting regression equation predicts a midstance knee angle of 166 degrees for humans and 125 degrees for chimpanzees. It also predicts knee midstance angles of 171 and 164 degrees for two australopithecine distal femora.

#### Raccoon modification of human skeletal remains.

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Bone modification by the raccoon (*Procyon lotor*) has not yet been described, despite it being an opportunistic scavenger that is a potential modifier of human remains deposited in either a modern forensic setting or our recent archaeological past. There are two phases to this research. Phase one used motion and heat-triggered digital video and still photography to record the nocturnal feeding behavior of raccoons as they scavenged surface-decaying human bodies ( $n=8$ ) at the University of Tennessee's outdoor decomposition facility. Additional data collection was in the form of near daily field notes and photographs during

camera operation and sporadic documentation up until the date of skeletal collection. Phase two documented raccoon bone modification in the William M. Bass Donated Skeletal Collection. Seven complete skeletons were examined under oblique light with the aid of 10-20X magnification. All skeletons represent individuals that were closely monitored as they decayed at the facility: abundant notes and diurnal photography were available for seven individuals and nocturnal photography was available for six.

Bone modification occurred secondary to soft tissue feeding. Thus, raccoons scattered but did not transport away skeletonizing body parts or bones. Tooth-mark morphology resembles that of other carnivores, but bone destruction is comparatively less severe. Raccoon modification of human skeletal remains may be characterized by a high frequency of tooth-marked bones of the hands, feet and ribs, with minimal destruction of long bone ends—a pattern unlike that of canids and felids. Pattern recognition will enable more accurate interpretations of body deposition and skeletal trauma.

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#### Membrane-plate transition in leaf development may influence feeding by Southern Muriquis (*Brachyteles arachnoides*, ATELIDAE, PRIMATES).

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Frugivorous Southern Muriquis fall back on leaves when fruits are unavailable. How do they decide what leaves to eat? Color and toughness are important, but while color is salient at long-distance, perception of toughness requires biting. This leaves a substantial sensory gap in efficient foraging for the most nutritious leaf. A possible intermediate characteristic is whether a leaf supports itself against gravity. Inability to do so (floppiness) is visible at short distance. Although floppiness can result from turgor loss (wilting), it is universal in flushing leaves because they lack a venation capable of self-support. Here we hypothesize that (a) leaves pass through a floppy membrane-to-stiff plate transition as they mature and (b), muriquis prefer membranes. Mechanical and color data were collected for leaves of two tree species (*Nectandra oppositifolia*, Lauraceae and *Guapira opposita*, Nyctaginaceae). Prior to testing, each leaf was marked for whether muriquis consume that leaf stage or not. A critical value of  $\lambda$ , calculated from blunt indentation, differentiated membranes ( $\lambda > 350$ ) from plates ( $\lambda < 350$ ). Results show turgid leaves of both species decreasing from  $\lambda = \sim 8000$  to  $\sim 30$  during development. Significant correlations with both colour and toughness support its potential role in leaf selection. Muriquis

appeared to select membranous leaves: for *N. oppositifolia*, mean  $\lambda = 2060.1$ ; Mann-Whitney  $U = 113$ ;  $p < 0.012$ ;  $n = 45$ ; for *G. opposita*, mean  $\lambda = 437.7$ ;  $U = 166.0$ ;  $p < 0.009$ ;  $n = 49$ . These findings emphasize the importance of mechanical properties in leaf foraging.

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#### Shape as a predictor of intermembral index.

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Researchers often attempt to use limb proportions to ascertain the locomotor repertoires of fossil hominins, but this approach can be problematic as few skeletons in the fossil record preserve both a full fore- and hindlimb. Consequently, estimates of full limb lengths are typically associated with substantial error. More frequently, the fossil record yields fragmentary remains of proximal and distal articular regions, but shape is sometimes considered to be less useful than indices for functional analyses. This study tests the hypothesis that the shape covariance between upper and lower limb elements is a good predictor of intermembral index, a more typical metric used in functional analyses.

Three-dimensional landmarks were collected on proximal and distal upper and lower limb elements of extant great apes and humans. Two-block partial least squares analyses were used to examine covariation between forelimb and hindlimb elements in these primates, and mean scores for each taxon were regressed against intermembral index to assess the correlation between these metrics. Results indicated that there is a high degree of covariation between fore- and hindlimb segments in the mixed species sample, particularly in the proximal ulna, distal humerus, and proximal/distal femur, and that shape covariation is significantly correlated with intermembral indices. Posthoc tests of the relationship between intermembral index and PC scores based on a single segment were statistically insignificant.

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#### Molar development and life history in four macaque species.

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In 1989 Holly Smith demonstrated that dental development is correlated with life history traits such as gestation length, weaning age, age at first reproduction, and interbirth intervals (IBIs) in a taxonomically broad primate sample.

These patterns have been extended to reconstruct hominin life histories, although the robusticity of this pattern within primate genera remains largely untested. Other scholars have suggested that folivorous primates show more rapid development than frugivorous species, or that smaller primates show faster development than larger ones. In order to investigate these associations, we compare molar calcification and eruption in 64 known-aged juvenile macaques (*Macaca arctoides*, *Macaca fascicularis*, *Macaca fuscata*, and *Macaca mulatta*) using high-resolution micro-CT scanning and conventional histology. We find that *M. mulatta* and *M. fascicularis* have the most rapid molar development, which is consistent with their short gestation lengths and short IBIs (both taxa), less frugivorous diet (*M. mulatta*), and smaller body size (*M. fascicularis*). Despite differences in the degree of frugivory and body mass between these two species, there were no marked differences in molar development. In contrast, *M. fuscata* shows a more prolonged dental development, which is consistent with their slower life histories and larger body mass. *Macaca fuscata* initiates molar calcification and completes root formation later than the other three species. While we find some support for primate-wide associations between dental development and life history, these associations may be influenced by ecological and physiological factors such as diet, reproductive seasonality, and body mass, even within a relatively closely-related group of primates.

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#### Health and disease: Exploring the consequences of infection on nutritional status.

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Infectious disease, such as diarrheal disease, respiratory infections, and parasitic infections are an important source of nutrition and energetic stress in many populations. Although infection may not always result in overt disease, frequent exposure to infection has been shown to have a negative effect on child growth. The goal of this paper is to explore the association between infectious disease, illness, and both short- and long-term markers of nutritional status among children and adolescents. In 2007, anthropometric measurements, health and parasitological surveys were collected for nearly 350 2-16 year old children and adolescents living in lowland Bolivia as part of the Tsimane' Amazonian Panel Study. Fifty of these had also participated in a similar study conducted in 2002 and make up a longitudinal sub-sample. Microscopic examination revealed high levels of parasitic infection, with 68% of children positive for at least one helminth species (64% of girls and 72% of boys). Associations between a person's reported illnesses, the presence of a helminth infection, their nutritional status were overall

weak and mixed. While height-for-age was not associated with a current infection, body fatness and muscularity were weakly associated with the presence of a current infection. The associations were stronger in communities closer to the regional market center. This paper argues that considering associations between infection and nutrition in contemporary populations helps provide a comparative landscape to examine the connections between stress and health across time.

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#### The scaling of jaw-muscle fiber architecture in anthropoid primates.

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The jaw-closing muscles are responsible for generating the forces and movements associated with chewing, biting and display behaviors. Addressing size-related trends in the force and excursion capabilities of these muscles is fundamental for testing various scaling hypotheses and for understanding the functional and evolutionary significance of departures from these theoretical predictions.

We measured fiber lengths (Lf) and pinnation angles and computed the physiological cross-sectional areas (PCSAs) of the masseter and temporalis muscles in adult males and females for 42 anthropoid species (n=19 platyrrhines; n=16 Old World monkeys [OWMs]; n=7 hominoids). We used Lf to estimate maximum muscle excursion/contraction velocity and PCSA to estimate maximum muscle force-generating potential. We employed reduced major axis regression to evaluate scaling relationships of Lf and PCSA relative to jaw length and condyle-M<sub>1</sub> distance (load-arm estimates for anterior tooth biting and postcanine mastication, respectively). Correlations with load-arm estimates range between 0.61-0.97 and are all significant (p<0.05). Relative to both load-arm estimates, masseter and temporalis Lfs scale with negative allometry in platyrrhines but positive allometry in OWMs and hominoids. PCSAs scale with negative allometry in platyrrhines and with increasingly positive allometry from OWMs to hominoids. Thus, we observe clade-specific allometric differences underlying potential shifts in the excursion- and force-generating capabilities of the masseter and temporalis across anthropoid clades. Superimposed on these size-correlated trends among clades are differences in jaw-muscle stretch and force estimates that correlate with variation in feeding behavior and diet in platyrrhines and with variation in gape associated with display behaviors in some OWMs.

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#### Dental microwear texture analysis and ecological plasticity in *Alouatta belzebul*.

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Howler monkeys occupy a wide range of habitats and have a diet that includes leaves, fruits and flowers. As a result, they readily adjust to major habitat changes and are often among the first platyrrhines to move into secondary forests. With this in mind, museum samples of *Alouatta belzebul* from two areas of tropical rainforest in northern Brazil were analyzed using dental microwear texture analysis: Fazenda Taperinha (specimens collected during the first half of the 20th Century), and UHE-Tucuruí at the Tocantins River (specimens collected during the 1980's after deforestation). Both sites are located in the Pará State.

All specimens used in this study are housed at the Museu Paraense Emilio Goeldi (MPEG) in Belém, Brazil. Three-dimensional point clouds were generated from high resolution epoxy casts of Phase II facets from M<sup>1</sup>s or M<sup>2</sup>s of 60 individuals using a white-light confocal profiler. Microwear texture attributes (complexity, anisotropy, textural fill volume, scale of maximum complexity, and heterogeneity of complexity) were produced using scale-sensitive fractal analysis. Despite differences in microwear texture variables between the *A. belzebul* samples from MPEG and other primate species, conservative statistical analyses failed to reveal significant differences between the howlers from Fazenda Taperinha and UHE-Tucuruí. This implies that these primates found foods with similar material properties at the two sites despite the habitat differences. This might, in turn, be a clue as to how howlers cope successfully with habitat modification.

This research was supported by The Leakey Foundation.

#### Habitat disturbance and fecal cortisol metabolites in a folivorous strepsirrhine, *Propithecus edwardsi*.

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The cort-fitness hypothesis proposes that individuals with high cortisol levels will experience reduced fitness because of the maladaptive effects that prolonged, elevated levels can have on long-term functions. Previous research in primates indicates that habitat disturbance can result in elevated levels, or a

muted response with little fluctuation. Furthermore, habitat disturbance may differentially impact species with different diets. We investigated whether cortisol levels in a folivorous lemur differ in disturbed ( $n=2$ ) and undisturbed ( $n=1$ ) habitats. We predicted that, in the disturbed sites, mean cortisol levels would be higher, and the response to environmental challenge (increased food scarcity and aridity) would be stronger. 1059 fecal samples from 10 females and 11 males were analyzed using solid phase extraction and enzyme immunoassay. We used linear mixed models with fixed factors age, sex, site, and group, and random factors monthly rainfall and food availability. Site differences approached significance,  $F(2,49.28)=3.012$ ,  $P=0.058$ . Fecal cortisol levels in the most disturbed site were significantly lower than in the undisturbed site ( $P=0.018$ ), contrary to findings for folivorous monkeys (*Alouatta pigra*), but similar to findings for frugivorous lemurs (*Eulemur rubriventer*). These results confirm that lower cortisol levels can occur in disturbed habitats, and that a muted response may be adaptive in a harsh environment.

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#### Reconstructing stress episode chronology and periodicity among Late/Final Jomon period foragers using incremental microstructures of enamel.

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This study reconstructs stress episode chronology and periodicity among Late/Final Jomon period (5000 through 2300 BP) foragers from Honshu and Hokkaido using linear enamel hypoplasia (LEH) defects. Age-at-defect formation was calculated by dividing each tooth into deciles and placing each LEH defect into a chronological framework based on 6-month intervals. Periodicity was calculated by counting the number of perikymata between successive LEH defects and multiplying this number by a constant associated with perikymata formation. On Honshu, median age-at-defect formation was 3.4 years, while 66% of all LEH defects were estimated later than 2.9 years. On Hokkaido, median age-at-defect formation was 3.1 years, while 61% of all LEH defects were estimated later than 2.9 years. Modal stress episode periodicity on Honshu was 0.1 years (35.1%), while modal stress episode periodicity on Hokkaido was 0.2/0.3 years (26% each). Average stress episode periodicity on Honshu (0.2 years) was significantly lower than average stress episode periodicity on Hokkaido (0.3 years). Average ages-at-defect formation are associated with tooth crown geometry for both samples, though LEH defects occurring after 2.9 years may reflect weaning stress in accordance with nitrogen isotope analysis. The shorter periodicity of stress episodes found among prehistoric Jomon foragers from Honshu suggests repetitive stress cycles that may not be traced to seasonality, and instead, may reflect random nutritional insufficiencies. In contrast, Jomon foragers from Hokkaido appear to have

experienced stress episodes along approximately 3-month intervals, which may track with accentuated seasonal shifts in this region.

#### Intrasexual competition and size dimorphism among polygynous primates.

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Intrasexual competition exerts a strong influence on the evolution of secondary sexual characteristics. It has long been theorized that the evolution of large male body size in mammals is correlated with the intensity of physically aggressive intrasexual competition that males experience. Despite the predictions of sexual selection theory, when monogamous species are removed from analyses, a number of studies have found no relationship between sexual size dimorphism (SSD; ratio of male-to-female body size) and the intensity of physically aggressive male-male competition, while others have found the expected positive association. This lack of convergence among studies is in part due to difficulty in finding a measure of intrasexual competition that reflects its potential to influence sexual selection. Since the temporal availability of females has a strong influence on the monopolization potential of males, estrous synchrony should be included in any measure of the potential for male-male competition over access to females. Thus, here I present a new formulation of the operational sex ratio (OSR), which incorporates estrous synchrony and the adult sex ratio (ASR). Using phylogenetic generalized least squares regression (PGLS), I find that among polygynous primates, there is no relationship between SSD and the potential for physical intrasexual competition. This indicates that polygynous primates represent an exception to the general rule that intensity of intrasexual competition leads to evolution of large male body size. Possible explanations include use of alternative mating strategies by polygynous males, and reduced reliance on physical competition due to formation of complex social relationships.

#### Renewed paleontological investigations in the Olteț River Valley of Romania and the new paleontological locality of Râpa.

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Present evidence suggests that neither intrinsic nor extrinsic hypotheses can fully explain the initial hominin dispersal out of Africa in the early Pleistocene, although paleoenvironmental data suggest this dispersal

may have been facilitated by climatic changes. Though the earliest hominins appear at Dmanisi, Georgia at ~1.85 Ma, well dated European hominins have not been recovered before 1.2 Ma (Sima del Elefante, Spain). Is this a true absence, perhaps due to ecological restrictions, or have hominins not yet been found in earlier European deposits despite their presence in this region?

To address these questions, we review existing data for early Pleistocene Romania and report the results of an initial survey of the Olteț River Valley. This valley is the location of the richly fossiliferous early Pleistocene site of Grăunceanu. Fossils recovered at this site include the fossil papionin *Paradolichopithecus arvernensis*, which has been reconstructed as highly terrestrial and may have inhabited a niche similar to that of *Australopithecus*. Mode 1 stone tools are also reported from this area, though their validity is questionable, and interpretation of both paleontological and archaeological remains from this region is hindered by lost excavation records and poor dating. Our preliminary surveys identified a new site (Râpa) containing in situ fossils, including a partial mammoth skeleton. These remains, in addition to a new stratigraphic profile, allow us to document the context of fossil deposition in this valley, through which we assess whether hominin dispersal through this region during the early Pleistocene would have been possible.

#### Moving beyond genetic race: Developmental contributions to human variation in New Zealand.

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While it is well-known that social inequalities are important contributors to health disparities across groups varying in ethnicity or self-identified race, there is growing interest in the possibility that these experiences can transcend the current generation, thereby resulting in a multi-generational pattern of adverse health. As one example, it has been hypothesized that a woman's experience of stress or discrimination prior to or during pregnancy could modify the stress physiology of her developing offspring, thus influencing health outcomes in the next generation. However few studies have tested this hypothesis. Here we evaluate whether reports of racial discrimination contribute to biological difference among an ethnically diverse cohort of pregnant women and their infants in Auckland, New Zealand. Consistent with our model we found that women reporting having experienced ethnic discrimination had elevated evening cortisol in late pregnancy ( $p < 0.01$ ), even after controlling for socioeconomic status. Among their offspring, newborns with a lower birth weight had a blunted cortisol response to vaccination at six weeks of age ( $p = 0.04$ ). Together these data suggest that the maternal social environment, including experiences of racial discrimination, induces durable modifications in maternal and fetal biology. These findings help explain why

biological patterns of health and disease tend to map onto socially defined categories such as ethnicity or race.

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#### 8,000 year old case of thalassemia from the Windover, Florida skeletal population.

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Thalassemia is a congenital blood disorder in which the body destroys red blood cells at a faster rate than they are produced, resulting in anemia. Historically, this disease is found more often in Old World populations, such as Middle Eastern, Chinese, and Southeast Asian depending on the affected globin sequence (alpha or beta). The earliest reported skeletal evidence of thalassemia comes from the eastern Mediterranean (Atlit-Yam) and is correlated with early agriculturist's exposure to the malarial parasite *Plasmodium falciparum*. While there has been little to no skeletal reports of thalassemia in prehistoric Native American populations, among the individuals from the 8,000 year old hunter-gatherer site of Windover, Florida there is a single potential case of the disease. A 22 year old female (Individual #76) exhibits bilateral foreshortening of the humeri with indications of premature epiphyseal fusion. The proximal aspects of both humeri are medio-laterally compressed, the gleno-humeral joint surfaces exhibit medial deformation, and the internal distribution of bone shows expansion of the medullary cavity with increased cancellous bone growth. These characteristics have been reported as indicators of thalassemia in both clinical and archaeological contexts. Alternate diagnoses such as, congenital dislocation or injuries during child birth are considered but fail to account for the full set of characteristics shown. Individual #76 may represent the oldest reported case of thalassemia from a native North American skeletal population.

#### Were the sacrifices in Mound 72 at Cahokia nonlocal? A new perspective from the dentition.

ANDREW R. THOMPSON. Anthropology Department, Medical Sciences Program, Indiana University, Bloomington.

Interpretations of Mound 72 at the Cahokia site have relied heavily on the treatment and organization of burials within the mound. Disparity in burial goods and burial context indicates that a marked degree of social inequality existed between individuals buried in Mound 72. This has led researchers to organize and group the various burial features in a hierarchical manner. Previous skeletal analyses demonstrate an appreciable level of biosocial difference between these groupings. Most notably, isotopic and dental morphological studies suggest that those prescribed to the sacrifice category were nonlocal to Cahokia proper. This conclusion has been integrated into

the way we currently view not only the activities surrounding the construction of Mound 72, but also the larger role Cahokia played in early Mississippian sociopolitical dynamics.

This study aimed at reinvestigating biological variation within Mound 72 using updated data collection standards for dental morphological traits, as well as odontometrics. Results from both indicators suggest that, phenotypically, the sacrifice group is very similar to the high- and mid-status burials. The group designated as the lowest status, Feature 229-lower, was dissimilar to all others in Mound 72. Based on this finding it is suggested that the sacrifices were likely drawn from the Cahokia population, whereas individuals in Feature 229-lower were nonlocal to the area. This conclusion is consistent with the aberrant burial context associated with Feature 229 and highlights the need for some aspects of Mound 72 to be reconsidered.

#### Too hot, too cold, or just right: Thermal challenges facing mantled howling monkeys (*Alouatta palliata*) in a dry tropical forest.

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Free-ranging mammals are confronted with the challenge of maintaining an energetically neutral body temperature within a thermally dynamic environment that changes daily, seasonally, and annually. While many laboratory studies have been conducted on primate thermoregulation, we know comparatively little about the thermal pressures primates face in their natural, evolutionarily-relevant environment. We examined thermoregulation of free-ranging mantled howling monkeys in a lowland tropical dry forest in Guanacaste province, Costa Rica. We recorded subcutaneous ( $T_{sc}$ ) and near-animal ambient temperature ( $T_a$ ) from 11 animals at 10 min intervals over 1606 sample hours. We found significant positive daily cross-correlations between  $T_a$  and  $T_{sc}$  (average  $r=0.70\pm 0.17$ ) with a modal (44% of days) lag time <10 min.  $T_{sc}$  increased with higher  $T_a$ , but plateaued at  $T_a > 41^\circ\text{C}$ . Similarly, 95% of dry season cases with  $T_a > T_{sc}$  occurred at  $T_a > 38.1^\circ\text{C}$ , which implies that howlers use a cooling response to prevent rising temperatures over a threshold  $T_a$ . However, this cooling response was relatively infrequent, with  $T_{sc}$  being below  $T_a$  in only 14% of dry and <1% of wet season samples. The magnitude of cool vs. warm stress differed as well, showing a maximum deviation of  $4.8^\circ\text{C}$  when  $T_a > T_{sc}$ , vs.  $15.4^\circ\text{C}$  when  $T_a < T_{sc}$ . Our data support a hypothesis that, despite inhabiting a dry tropical environment, howling monkeys experience more 'cool' than 'heat' stress. This suggests that cool temperatures may be a prevalent thermoregulatory challenge for primates,

particularly smaller primates living at higher latitudes and/or altitudes.

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#### Aye-aye population genomics: Signatures of natural selection.

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Aye-ayes are highly specialized extractive foragers, with the largest species distribution of any lemur. Across this distribution, they inhabit divergent forest types – from humid primary forests to relatively dry and deciduous forests. Such extensive habitat variation raises the possibility of population-specific ecological adaptation that may have left genomic signatures of selection. To detect such signatures, we collected whole genome sequence data from 12 wild aye-ayes from three geographically distinct areas in Madagascar (East, West and North regions). We estimated population differentiation for each detected SNP using the  $F_{ST}$  statistic. Extreme  $F_{ST}$  values in gene coding regions may reflect a history of region-specific positive selection, because the frequencies of adaptive alleles may have been subject to rapid increase. Indeed, we observed a relative excess of high  $F_{ST}$  nonsynonymous (amino acid changing) SNPs in the East population compared to the North and West populations. The genes containing high  $F_{ST}$  nonsynonymous SNPs include *CLGN* ( $F_{ST} = 0.82$ ), which is necessary for the production of fertile sperm, and two genes involved in eye development, *ADAM9* ( $F_{ST} = 0.82$ ) and *HMCN1* ( $F_{ST} = 0.67$ ). *ADAM9* mutations are associated with human cone-rod dystrophy, and knockout mice exhibit reduced photoreceptor responsiveness. *HMCN1* is expressed in retinal cells and mutations in this gene have been associated with macular degeneration. Though additional study is needed, these results may be interesting with respect to the aye-aye's nocturnal activity pattern and potentially strong selective pressures associated with low-light foraging.

### Three-dimensional head kinematics in chimpanzees and humans: Implications for the study of semicircular canal morphology.

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Semicircular canal morphology is thought to be indicative of locomotor capabilities in primates. Among hominids, humans are unique in possessing relatively larger radii of curvature of the anterior and posterior canals. This morphology has been associated with habitual bipedal behavior, which is predicted to entail greater angular head motions during locomotion. In this study, we test the hypothesis that humans have larger head angular velocities than chimpanzees during overground locomotion.

Head movements of humans and chimpanzees (*Pan troglodytes*) were collected using a four-camera motion capture system (Xcitex Inc., Boston, MA). A three-dimensional head marker set was used to calculate pitch, yaw, and roll angular velocities (maximum and root mean square) in space about anatomical axes of the skull over a full stride cycle. Data were collected from human normal and bent-hip, bent-knee (BHBK) walking, and from chimpanzee quadrupedal and bipedal walking.

Initial results indicate that humans experience significantly smaller head angular velocities than chimpanzees engaged in either quadrupedal or bipedal walking ( $P < 0.05$ ). In addition, while the angular velocities for normal and BHBK walking in humans are similar, chimpanzee bipedal walking produces higher angular pitch velocities than quadrupedal walking. Additional kinematic data from other locomotor modes will lead to a clearer picture of how habitual head movements are linked to semicircular canal morphology, and will ultimately allow for more accurate interpretations of canal morphology in extinct hominins.

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### Great expec-toe-tions: divergence, convergence and emergence of the modern hallux.

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The adduction of the first pedal ray in humans, such that the hallux is incapable of functional opposability, is a major feature of the evolution of the hominin foot (e.g. Darwin 1863, Haeckel 1879). Analysis of a large sample ( $n > 100$ ) of radiographs taken from the dorsal aspect of living human feet elucidates the relationship between osteological measures and the magnitude of hallucal adduction, which is a product of both hard- and soft-tissue anatomy (Lovejoy *et al.* 2009). I describe the correlation of hallucal convergence with first metatarsal posterior articular facet morphology, which allows inference of hallucal convergence in the absence of the medial cuneiform. I report

parameters of modern human hallucal convergence variation and offer insight into the hominin fossil record. I infer that the hallucal convergence of the recently reported specimen from Burtelle (BRT-VP-2/73) falls within the range of living human variation, inconsistent with the interpretation that this hominin retained the ability to grasp arboreal substrates with its great toe (Haile-Selassie *et al.* 2012). Of the fossil hominin first metatarsals surveyed, all fall within the range of living human variation, consistent with previous research on medial cuneiform (McHenry and Jones 2006) and first metatarsal (Berillon 1999) morphology. The small sample size of fossil hominin first metatarsals dooms statistical evaluation, though it appears that reduction of medial obliquity of the first metatarsal's joint surface with the medial cuneiform followed reduction of medial obliquity of the medial cuneiform's articular surface with the first metatarsal as argued by Berillon (1999).

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### Mandibular kinetics of gnawing in the aye-aye (*Daubentonia madagascariensis*) and biomechanical modeling of anterior tooth use.

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Many primate species show remarkable morphological adaptations to anterior tooth use, but the mechanics of this activity are poorly understood. Currently, *in vivo* data on bite force generation during anterior tooth use in primates are restricted to isometric bite forces on a force transducer and one study of bite kinetics for the mandible during wood-gouging in *Callithrix jacchus*. This research expands this area by collecting data on mandibular bite reaction forces from two aye-ayes gnawing an instrumented hardwood block. Subjects produced peak superior-inferior (SI) bite reaction forces of 23.6N (SD=9.3), peak anterior-posterior forces of 35.5N (SD=16.4), and peak resultant bite reaction forces of 43.7N (SD=11) during 41 gnawing cycles. Gnawing in *Daubentonia* occurred at a rate of 3.1Hz (SD=0.6), with peak AP forces preceding peak SI forces by 3.8ms (SD=5).

Gnaws recorded for *Daubentonia* are significantly larger than gnaws reported for *Callithrix*, which had average peak resultant forces of 28.0N (SD=3.6). *Callithrix* was reported to use only 50.3% of its maximum SI bite force (measured from isometric transducer bites) during wood-gouging. Transducer bites are unavailable for *Daubentonia*. Estimates of maximum SI bite force derived from published jaw adductor rPCsAs suggest that *Daubentonia* may use 10% or less of its vertical bite force capacity during gnawing. These findings suggest that wood-gnawing, like gouging, does not require relatively high bite forces. Further research on the metabolic costs of gnawing and seed predation in *Daubentonia* are planned to further elucidate the mechanical role of bite force

generation and resistance during anterior tooth use.

### Living on the seashore: A consideration of lifestyle among Formative Period fisherpeoples of northern Chile.

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Recent archaeological work at three contemporaneous looted cemeteries (Michilla 2, Punta Gualaguala 1, and Punta Gualaguala 4) located north of Chile's Mejillones Peninsula have revealed the fragmented remains of numerous individuals who lived during the Late Formative Period (AD 1-500). Here we present a study of the 32 individuals whose remains were in condition for bioarchaeological and chemical analyses. We considered a series of general health and body use indicators and conducted radiogenic strontium and stable carbon and nitrogen isotope analyses. Together these should provide a sense of the quality of life for these coastal residents.

Our results show an adult population with moderate to high enthesal remodeling scores. The few mostly complete individuals displayed low incidences of health indicators and trauma. A few non-specific stress indicators were visible, primarily osteoperiostitis. The only occurrences of trauma were two healed fractures on the cranium of a middle-aged female. Radiogenic strontium analyses of enamel from 23 individuals revealed a mostly homogenous population with a coastal origin. Carbon and nitrogen stable isotope analyses of bone from 32 individuals suggest a protein diet predominantly based on marine foodstuffs ( $\delta^{15}\text{N}$ : +21.6% to +27.1%). Interestingly, there was substantial variation within sites that may reflect idiosyncratic patterns of carbohydrate consumption.

When the different data sets are combined, we see a pattern that indicates an arduous coastal lifestyle involving hunting, gathering, fishing, and deep-sea fishing. Not surprisingly, this is in line with the mortuary context, which revealed ample fishing equipment, marine mammal bones, and shells.

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### Caries prevalence in ancient Egyptians and Nubians, ca. 14,000 BCE-1,400 CE.

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A total of 26,786 teeth belonging to 1,065 Egyptians and 777 Nubians (18 and 15 samples, respectively) of mixed sex and age

were observed for caries. 820 (0.03%) teeth belonging to 404 individuals (21.9%) show at least one carious lesion. The most common lesion is the occlusal type and the most commonly affected teeth are the molars (449 in 820 teeth, or 54.7%). From the 449 molars with carious pathology, 298 (66.3%) belong to the lower jaw.

There are no statistically significant differences in caries prevalence between males and females [ $t$  (1467) = - 4.09,  $p < 0.05$ ], or between Egypt and Nubia [ $F$  (1, 1840) = 2.72,  $p < 0.05$ ]. Significant differences occur in the interactions of caries frequencies with sex, region, period, and economy. Univariate ANOVA tests indicate that significant differences exist between Upper Nubia, and Lower Nubia/Lower Egypt. Upper Nubia exhibits both the least caries occurrence and the least sexual dimorphism in caries of all the regions in the study. Prehistoric h/g show unusually high caries frequencies. In most periods, males retain a non-significant lead in caries over females.

In view of the above, the present study can promulgate further research in the direction of 1) understanding the cultural/ecological context of what appears to be a unique dietary profile for Upper Nubia, 2) a re-evaluation of the carbohydrate component in prehistoric Nubian diet, and 3) a re-evaluation of current understanding of sexual caries dimorphism in agricultural populations.

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#### **Periodontal health and post-reproductive tooth loss among Mogollon women.**

ALEXANDRA C. TUGGLE and JAMES T. WATSON. School of Anthropology, University of Arizona.

Recent research has identified the importance of considering hormonal fluctuations over the life-course of women with regard to periodontal health and tooth loss. The primary goal of this study was to test the relationship between periodontal health, age, and sex in a prehistoric skeletal sample to identify if the influence of life-long hormonal fluctuations could be extrapolated from dental remains. Depth of periodontal resorption (from the CEJ to the alveolar crest) was measured on posterior teeth from two prehistoric samples from west-central Arizona (the Mogollon archaeological culture) to identify if periodontal disease impacted females greater than males in the samples. The results demonstrate that post-reproductive females have significantly higher resorption rates than males at both sites and that these differences increase significantly over time among the Mogollon. This study utilizes a life-history approach to identify that women experienced poorer periodontal health than men and suggest that it may be associated with an underlying biological phenomenon that deserves

further consideration (hormonal fluctuations) in future studies of prehistoric oral health. The results further indicate that temporal differences in periodontal health may have been exacerbated by external environmental (non-physiological) factors such as social tension and stress within these communities.

#### **Spatial analysis of bone recovered from FxJj 20 AB, Koobi Fora, Kenya with implications to early hominin behavior.**

MORGAN A. TUPPER and SARAH K. HLUBIK. Anthropology, Rutgers, the State University of New Jersey.

The importance of fire in human society is widely recognized though the timing of controlled use of fire by humans is a subject of great debate. The site complex of FxJj 20 on the Karari Escarpment along the eastern margin of the Koobi Fora basin in northern Kenya has been hypothesized to preserve evidence of ancient humanly-controlled fires since its discovery in 1973. The site of FxJj 20 AB, within the complex, is preserved in undisturbed floodplain silts and shows no evidence of sorting on the site. Excavations on the site took place in 1973, 2010 and 2012. The current study aims to test the use of fire by hominins at FxJj 20 AB through spatial analysis of the faunal bone recovered from the site. Burned bone investigated through a spatial framework can rule out alternative explanations for sites with evidence of fire, such as those in the FxJj 20 site complex. Approximately 650 specimens of bone, recovered in situ during the 2010 and 2012 field seasons, were used in the study and classified based on the size, type and potential alteration (i.e burning) of the bone. Spatial analysis studies are being used to compare the different categories of bone. Preliminary results of these analyses indicate segregation of bone by classification categories. In conjunction with other work being done on the project, this study provides evidence supporting hominin processing activities in conjunction with fire.

#### **The talo-crural joint: Interface of genome and use.**

KEVIN TURLEY and STEPHEN R. FROST. Department of Anthropology, University of Oregon.

Can geometric morphometrics identify the relationship of post cranial form and function? The current study examines the appositional articular morphology (AAM) of the talo-crural joint exploring this question.

408 matched tibiae and tali from 245 adult (M3) and 163 subadult (M1-M2) from 12 catarrhine taxa, 6 hominoid and 6 cercopithecoid (*H. sapiens*, *G. gorilla*, *P. troglodytes*, *P. paniscus*, *Pongo spp.*, Hylobatidae, *M. fascicularis*, *M. mulatta*, *M. thibetana*, *P. hamadryas*, *C. guereza*, *N. larvatus*) were studied. Landmarks were placed on the articular surfaces and edited using Landmark Editor software. Generalized Procrustes analysis, principal component analysis, multivariate regression and singular warps analysis were used to examine differences in joint shape.

Important features differentiate terrestrial and arboreal taxa that provide flexibility and stability on horizontally placed irregular surfaces of different textures in the former, and medially placed curvilinear surfaces with irregular surface movement in the latter. Trochlear facet and trochlear shape and plane, medial malleolar and medial talar facet shape and orientation, and trochlear crest and facet groove shape and displacement, differentiate the arboreal and terrestrial forms in adults (M3). In arboreal taxa these features provide increased range of dorsiflexion and inversion and increased flexibility, and in terrestrial taxa they increase stability in dorsiflexion and allow increased angular excursion.

A behavioral effect was observed. Adult articular shape sorted by substrate preference across superfamily. When the AAM subsets were examined, arboreal subadults and adult clustered, while terrestrial taxa separated, changing in shape from subadult to adult across superfamily, possibly reflecting change in substrate use.

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#### **"From man's sweat and God's love, beer came into the world": The significance of beer and brewing in reconstructing the health and nutrition of ancient agriculturalists.**

BETHANY L. TURNER<sup>1</sup> and MATTHEW J. LIVERMORE<sup>2</sup>. <sup>1</sup>Department of Anthropology, Georgia State University, <sup>2</sup>191 Peachtree Center Ave, Atlanta.

Thirty-three years ago, Armelagos and colleagues published the first evidence of antibiotic use among Sudanese Nubian agriculturalists (*Science* 209(4464): 1532-1534) through the consumption of tetracycline in beer contaminated with *Streptomyces* bacteria. The corpus of research stemming from this initial discovery highlighted the significance of brewing in agricultural production as a delivery system for therapeutic antibiotics; it also helped to bring greater visibility to fermented grains as significant components of ancient agricultural subsistence regimes. This study continues this line of inquiry, reviewing archaeological and historical evidence for different brewing traditions throughout the ancient world. Employing a biocultural perspective, we assess the respective impacts of these various brews on the diets, nutrition, and overall health of populations in associated cultures, inferred from osteological and biochemical data. Depending on other constituents of the diet, beer consumption is an important variable to account for in reconstructing diets and inferring nutritional status. Recent isotopic and microwear-based reconstructions of diet at Machu Picchu by Turner and colleagues demonstrate this and are discussed here, revealing subtle differences in diet likely due to differential consumption of *chicha* beer. In general, we find that the nutritional content of beers varies significantly depending on the grain(s) and fermentation procedures utilized. Similarly, the extent to

which microbial colonization (beneficial or harmful) can be surmised depends substantially on the grains themselves and the surrounding local ecology. Thus while there is no empirical support for the enduring hypothesis that beer spurred incipient agriculture, beer remains central to understanding paleonutrition in agricultural societies.

**Ethical discourse in Biological Anthropology: Some things borrowed, something new.**

TRUDY R. TURNER. Anthropology, University of Wisconsin-Milwaukee.

Professional ethical codes provide a framework for informed choices. They generally set forth broad guidelines or a common consensus for behavior of practitioners. Professional codes are derived from theories of applied ethics and general principles that have been discussed for well over a hundred years. Biological anthropologists have borrowed extensively from these discussions and from other disciplines in establishing a code of ethical conduct for our discipline. Our framework is derived from the major ethical documents of our time: Nuremberg, Helsinki, NIH, CIOMS, the Belmont Report and numerous United Nations documents. The current AAPA code of ethics derives in large part from the American Anthropological Association code of ethics. But does this document serve our current needs? We are at a point in the evolution of our discipline where we need to do more than integrate the ethics of closely allied disciplines such as archaeology, animal behavior and medical research. For example, bioethics is a vital component of our ethical discussion since its principles define the ways in which we engage with human subjects both as individuals and as populations. Emerging technologies, such as those in genetics, population databases and biobanks are leading to a redefinition of both informed consent and privacy. We also need to review ethical discussions of professionals who are not necessarily traditionally aligned with biological anthropology such as archivists, librarians and museum curators as we seek to codify our obligations with respect to collections of materials and the sharing of data.

**Locomotor anatomy of gray langurs (*Semnopithecus entellus*).**

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Gray langurs (*Semnopithecus* sp) thrive in a wide range of habitats throughout the Indian subcontinent and have been the focus of numerous studies on social behavior and ecology. Locomotor behavior described by Ripley (1967, 1977) and Grand (1976) was used to analyze "arboreal" and "terrestrial" abilities compared to the sympatric macaques and *Presbytis senex*; leaping is only one aspect of langur locomotion and includes fast and slow

movement, and use of firm, flexible, continuous or discontinuous substrates in canopy or subcanopy. Few anatomical data are available on the langur locomotor system.

Based on whole body dissection this study presents data on the musculo-skeleton of 5 adult male and female langurs. As with other Old World monkeys, langur forelimbs are lighter than hindlimbs relative to total body mass: 11-12% and 20-24%, respectively. The tail is 3.8% of body mass and exceeds body length. However, langurs differ from other monkeys (patas, vervet, macaque) in the distribution of mass within limb segments, for example, the thigh segment is lighter (62% vs 66.5-67%), whereas leg (27% vs 23-25%) and foot segments (11 vs 9-10%) are heavier. Similarly, the langur forelimb has a lighter arm segment and heavier forearm segment. The heavier and longer forearm (brachial index: 108, range 105-114) contributes to effective climbing and grasping, as does the heavier leg and foot segments.

For this relatively large-bodied colobine (9-18 kg) the total configuration of body proportions, segment mass and limb lengths contribute to the locomotor versatility observed under natural conditions.

**Incisor microwear and gouging in callitrichines.**

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All callitrichines feed on exudates. However, marmosets actively stimulate the flow of exudates by gouging trees, while tamarins rely on exudates released by insect damage or other injury to trees. These behavioral differences have been correlated with an assortment of morphological differences between these taxa, but the potential impact of these behavioral differences on dental microwear has never been examined.

The purpose of this study was to test the idea that incisor microwear textures differ between museum samples of marmosets and tamarins, and between museum samples of zoo and wild-collected specimens. Expectations were that, compared to tamarins, marmosets would have more complex and variable surfaces with larger features, as would wild compared to zoo specimens.

High-resolution replicas were made of labial surfaces of lower incisors from wild-caught marmosets ( $n=22$ ) and tamarins ( $n=9$ ) at the Goeldi Museum (Belem), and from zoo specimens ( $n=8$ ) at the Smithsonian (Washington, DC). Scanning confocal profilometry and scale-sensitive fractal analysis were used to generate microwear texture

attributes for each specimen. Central tendencies and variances were compared between taxa and between wild versus zoo specimens using non-parametric ANOVAs and Levene's tests respectively.

With appropriate sample size caveats, results showed marmosets have marginally higher and significantly more dispersion in texture complexity than tamarins. Wild callitrichines have higher complexity, lower anisotropy, and higher textural fill volume as well as higher variance in textural complexity and heterogeneity than captive individuals. These results raise the possibility that future analyses might help document the practice of gouging in fossil primates.

This project was funded by the L.S.B. Leakey Foundation.

**The determination of sex and ancestry of patellae and calcanei from the Hamann-Todd Anatomical Collection.**

PATRICIA S. URDZIK. Anthropology.

At times, physical anthropologists are requested by law enforcement agencies to construct a biological profile which will assist in the personal identification of an unknown individual. Key factors of the biological profile are sex and ancestry. Few U.S.-based osteological studies concerning the determination of sex or ancestry focus on patellae or calcanei, despite the high incidence of recovery of these bones from crime scenes. This poster discusses the first U.S.-based study which combines both the examination of sex and ancestry with measurements obtained from individuals from a well-documented osteological collection. Data was collected from 221 individuals from the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History, Cleveland, Ohio, and was analyzed by SPSS v. 20. The 12 discriminant functions generated can provide investigators with reliable methods that can be used to aid in the construction of a biological profile using either whole or incomplete patellae and/or calcanei of an individual. Functions were created using all variables as equal for cases where all measurements are able to be collected from each bone. Stepwise analysis was conducted to determine which measurements are best utilized when analyzing bones which may be only partially intact. This study shows that sex can be correctly determined for 80.8% of females and 87.1% of males, with a total sexing accuracy rate of 83.7% for all individuals. Also, ancestry can be correctly determined in 77.7% of American blacks and 74.3% of American whites, with a total accuracy rate of 76.0% for all individuals.

**Intra-individual changes in major bone constituents studied by Solid State Nuclear Magnetic Resonance Spectroscopy.**

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PACEA Anthropologie des Populations Passées et Présentes, CNRS, Université Bordeaux 1, <sup>2</sup>Military Health Service, Forensic Sciences Institute of the National Gendarmerie, <sup>3</sup>Institut National de Recherches Archéologiques Préventives, Grand-Est – Nord, <sup>4</sup>UMR 5248 CBMN Institute of Chemistry & Biology of Membranes & Nanoobjects, CNRS, Institut Polytechnique Bordeaux, Université de Bordeaux, <sup>5</sup>UMS 3033 Institut Européen de Chimie et de Biologie, CNRS, Université de Bordeaux.

Bone study by Nuclear Magnetic Resonance spectroscopy (NMR) of hydrogen and carbon atoms allows the identification of bio-hydroxyapatite and exogenous calcite, the characterization of aminoacids contained in collagen. This tool, yet weakly used in physical anthropology purposes, requires few quantity of materials (80 to 150 mg of bone powder) and no chemical treatment.

During this study, many variables were considered: (1) the reproducibility of the results obtained on different bones of the same individual (femur, tibia, humerus, vertebra, rib); (2) the influence of the burial condition (directly in the ground vs. coffin) for two individuals whose death are contemporary (20th century). These results are compared with those obtained on fresh bones.

Primary results showed the presence of collagen whatever the bone studied or the burial conditions were. For the same individual, differences are observed depending on the kind of bone: long bone, such as femur, present a better conservation of the organic matter associated with an upper relative quantity of collagen than bone with a thinner cortical bone (vertebra, ribs). At the same time, we found difference in amino acid composition between the individual directly buried in the soil and the one in the coffin whatever the bone studied are.

NMR spectroscopy gives rise to the differential degradation of the organic fraction according to bone type. For NMR analysis, we have to give priority to bone with thick cortical bone which are more resistant to external contamination.

#### **The developmental and evolutionary significance of occipital bunning: A comparative morphometric study.**

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The occipital bun has long been cited as a diagnostic Neandertal trait, but a degree of bunning can also be found on some anatomically modern human crania. Scholars have proposed many explanations for the development and significance of occipital bunning, including hypotheses about variation in nuchal musculature attachment, posterior brain growth mode and tempo, and aspects of craniofacial integration. Because occipital bunning corresponds, at least in part, to underlying growth in the occipital lobe of the brain, this

feature may provide insight into brain growth and development in past populations.

This study incorporates both fossil and extant human comparisons in order to better understand the timing and significance of occipital bun development. Morphometric data were obtained from Neandertal, early modern human, and recent modern human crania. Major landmark points and data streaming measurements of the occipital region were taken to capture surface curve data. Cranial capacity and cranial base measurements were also taken to assess cranial integration hypotheses. These morphometric data show a clear differentiation between Neandertal and modern human bun morphology.

Posterior cranial shape in extant modern humans was also assessed using cranial radiographs from the Iowa Growth Study, allowing a true longitudinal study of occipital bone growth. Preliminary analysis of these radiographs shows that bun morphology, when present, appears early in childhood, becoming more defined with age. Evidence of a posterior cerebral growth spurt is not supported by these data. Instead, bun development in extant humans appears to be a slow, uniform process occurring into late adolescence.

#### **Effects of fruit odor on fruit consumption and seed dispersal by *Microcebus murinus* and *M. ravelobensis* in a tropical dry forest in northwestern Madagascar.**

KIM VALENTA, RYAN J. BURKE, SARAH A. STYLER, DEREK A. JACKSON and SHAWN M. LEHMAN. Anthropology, University of Toronto.

*Microcebus spp.* are potentially important seed dispersers in the uniquely depauperate frugivore communities of Madagascar. Numerous studies have demonstrated the importance of fruit morphology, including color and size, in diurnal primate foraging decisions, though data are lacking on morphological characteristics of fruits consumed by nocturnal primates. Here, we examine the effect of fruit morphology on fruit consumption and seed dispersal by *Microcebus ravelobensis* and *M. murinus* in northwestern Madagascar. Because *Microcebus spp.* are small nocturnal dichromats, we hypothesize that fruit odor will drive variation in *Microcebus spp.* fruit consumption and seed dispersal.

Over a three month period (May – July, 2012), we offered 676 ripe fruits of 15 plant species to wild-trapped *Microcebus* (N = 99) and identified and counted all seeds contained in feces collected from traps. We quantified fruit odor for each fruit species using volatile odorant-adsorbent filters (XAD, Sigma-Aldrich) and gas chromatography-mass spectrometry (GC-MS). We determined total volatile organic compound (VOC) emission intensity for each fruit species by integrating under GC-MS chromatograms.

Together, both *Microcebus spp.* dispersed seeds of the fruit of nine species intact, and did not consume the fruit of six species. The surface-area scaled odor intensity of unconsumed fruits

is significantly lower than that of consumed fruits (t-test:  $t = 3.34$ ,  $p = 0.01$ ).

This is the first study to compare quantitative measures of fruit odor to fruit consumption and seed dispersal by a nocturnal primate and supports the hypothesis that fruit odor drives some variation in *Microcebus spp.* fruit choice.

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#### **Integrating data in paleoanthropology: The future role of prehistoric fossils in the genomic present.**

ADAM P. VAN ARSDALE. Anthropology, Wellesley College.

Technological developments in genetics have opened up vast new sources of data to address evolutionary hypotheses about humans, greatly broadening our understanding of human evolutionary history. As the recent publications of genomes from Neandertals and the archaic human remains from Denisova attest, genetic data now dominate the consensus narrative of human evolution. This shift should be welcome, rather than a source of anxiety for paleoanthropology, as these new data allow for greater resolution of hypotheses and aid in problems of equifinality. The complementary nature of genetic and fossil data, including the informational properties of the data, creates a mutually beneficial scientific synthesis. This relationship will be demonstrated by contrasting the portrait of human evolution at the end of the Pleistocene derived independently from the two sets of data.

Paleoanthropology's efficacy within this partnership is undermined, however, by a lack of openness and data access. The field of genetics has benefited from a massive expansion in the amount of readily accessible data. While paleoanthropological data is generated on a different scale than genetic data, the field is in the midst of a remarkably productive era of new, often unexpected, fossil discoveries. The increased rate of discovery and changing patterns of publication have not, however, led to dramatically increased access to data. Efforts to create open access systems in paleoanthropology have increased, but remain limited. This talk concludes with a basic functional framework, cost estimates and goals for an open access paleoanthropological fossil database.

#### **The health of Early *Homo*.**

LINDA VAN BLERKOM. Department of Anthropology, Drew University.

It is now apparent that human ancestors encountered many infectious agents even before the Neolithic. This paper reconstructs what some of these agents may have been, based on analysis of microbial, viral, and human genomes. A review of this research suggests that hominins of 2-3 Mya experienced selection mediated by

trypanosomes, hominoid malarial, bacterial infections of infants and newborns, viruses such as arboviruses, retroviruses, and hepatitis viruses, and bacteria involved in sepsis, as indicated by polymorphisms found in the human genome. In addition, genetic studies of pathogens and parasites have shown that many DNA viruses, tuberculosis, tapeworms, and bacteria such as *Helicobacter*, *Shigella*, and *Salmonella* were ancient health problems predating human migration from Africa. The many opportunistic pathogens found in the human microbiome suggest that these, too, are probably long-standing co-habitants and occasional causes of disease. Thus infectious disease was an important evolutionary force during human evolution.

#### The biological impact of cultural transformations and economic differences in Ancient Nubia.

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Patterns of skeletal robusticity are compared among four ancient Nubian populations. Two from Wadi Halfa are separated by time as well as political/economic conditions. The earlier Meroitic population (300 BCE-350 CE) represents a time of centralized political authority and complex economic interactions. The later (350-550CE) Ballana population represents a time of political and economic fragmentation. The two populations from Kulubnarti represent contemporaneous (742 +/- 81 CE) communities – one a landed peasantry and the other a community of landless, itinerant laborers.

Our results show significant ( $P < .05$ ) sexual dimorphism in both the Meroitic and Ballana populations of Wadi Halfa. Ballana males are also slightly (3%) but significantly ( $P < .05$ ) more robust than their Meroitic counterparts. There are no differences between Meroitic and Ballana females. These data suggest that the Meroitic-Ballana transition likely had little impact on overall health with a slight increase in male physical activity.

There are no ( $P > .05$ ) community differences between either the males or the females at Kulubnarti. Patterns of sexual dimorphism do however reveal an interesting difference. The landed peasantry are sexually dimorphic ( $P < .05$ ) while the itinerants are not. This singular (relative to all four communities) loss of sexual dimorphism within the itinerant community is consistent with skeletal and demographic evidence attesting to the poorer health, reduced growth, and increased mortality among their infants and children. It would appear therefore that social stratification at Kulubnarti had a greater impact than the political-economic transition at Wadi Halfa.

#### Dental microwear texture analysis at Tell Dothan.

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The site of Tell Dothan has been occupied continuously from the Neolithic to Hellenistic periods. In addition to biblical and historical accounts, archaeological material suggests an agricultural subsistence strategy. However, diet, the food that is actually consumed, must be determined osteologically; therefore, Dental Microwear Texture Analysis is employed. Epoxy-resin casts of permanent lower second molars are examined with a white light confocal profiler at a magnification of 100x. Microwear patterns located on Phase II are analyzed using scale-sensitive fractal analysis software. Three variables are selected for comparison: anisotropy (epLsar), surface complexity (Asfc), and textural fill volume (Tfv); the results for Tell Dothan are: 1.22, 0.0033, and 38532, respectively. The results are compared to data from foragers and farmers collected through the DENTALWEAR project for geographical and subsistence-related context. These sites include several from Israel (Natufian: 12,500-10,250 bp and Neolithic: 10,250-7,500 bp) and other areas (including the Bronze through Iron Age from England; Mebrak, Nepal: ~2,000 bp; and Middle Woodland, United States: ~2,000-1,500 bp). Tell Dothan exhibits a somewhat high complexity and a somewhat low anisotropy, but is distinct from foragers. Microwear at Tell Dothan is similar to early agriculturists, who have less processed and/or more heterogeneous diets than later agriculturists.

#### Variation in the Neandertal pelvis.

CAROLINE VANSICKLE. Department of Anthropology, University of Michigan.

The Neandertal pelvis has been used to claim that Neandertals differed from modern humans in the way that their bodies were shaped, in the way that they walked, and in the way that they gave birth. Previous studies have focused on the more complete pelvis in the Neandertal sample, especially the nearly complete male, Kebara 2, and the most complete female on record, Tabun C1. While these pelvic remains are useful for identifying Neandertal features, a sample of two fails to account for variation within Neandertals. Additionally, the female Neandertal sample, which is essential to any discussion of birthing methods, is so fragmentary that it is usually overlooked in favor of using Tabun C1 because her pelvis is better preserved. I test the null hypothesis that there is no identifiable variation in pelvis form within the Neandertal sample. I analyze metric and nonmetric data, which I have collected on nearly every Neandertal fragment in the fossil record, including the overlooked fragmentary females.

This is the first systematic analysis of Neandertal pelvis form based on the current fossil record. When my observations are compared across all Neandertals, several patterns emerge that suggest the null hypothesis can be rejected, and that there is formal variation in the pelvis of Neandertals. My discussion will explain which of these patterns may be due to sexual dimorphism, and which may result from population differences. My results will provide an important basis for analyzing future hypotheses that interpret Neandertal pelvic form.

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#### Is there a role for color-sensitive foraging in folivorous sifaka (*Propithecus verreauxi*)?

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While polymorphic trichromacy is well-documented in platyrrhines, recent work suggests it is also common among lemurs. In this form of color vision, allelic variation at the X-chromosome M/L opsin locus results in separate green- and red-sensitive cones in heterozygous females (trichromacy) but a single M/L cone type in homozygous females and males (dichromacy). Although polymorphic trichromacy is thought to be selectively advantageous in foraging, platyrrhine field studies have generally failed to identify any significant effect of color vision phenotype on foraging behavior. However, these studies have focused on insectivorous-frugivorous species. We examined the influence of color vision phenotype on foraging in a folivorous diurnal lemur, Verreaux's sifaka (*Propithecus verreauxi*). Previous work identified a polymorphism in *Propithecus* causing either "green-sensitive" (543 nm) or "red-sensitive" (558 nm) alleles. We collected genomic DNA from 50 individuals (28 females, 22 males) across 8 social groups at Kirindy Mitea National Park, a dry, deciduous forest in Madagascar. Using a custom assay, we performed real-time polymerase chain reactions to genotype each individual. Approximately 540 hours of foraging data were collected over 12 months on 10 focal individuals.

We detected evidence of polymorphic trichromacy in this population. Six (~21%) females were heterozygous for green- and red-sensitive alleles. The red-sensitive allele had the highest frequency (84% of 71 chromosomes). However, preliminary analyses of foraging behavior did not identify a significant relationship between color vision phenotype and plant parts consumed in *Propithecus*. The evolutionary significance of polymorphic trichromacy therefore remains uncertain, but may benefit from further studies of strepsirrhines.

**Co-variation between dietary toughness, chewing efficiency, and dental wear in a wild population of geladas.**

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Numerous studies have shown that primates generally avoid hard and tough foods when possible. Hard foods can cause catastrophic damage to the dentition, while tough foods might be fractured less effectively, reducing nutritional input during digestion. Consequently, the notion that the primate dentition is adapted to crack and/or tear mechanically challenging fallback foods has received much support from recent behavioral and morphological studies. Here we explore the mechanistic basis of particle breakdown by examining the relationship between dietary toughness, dental macro-wear, and chewing efficiency (as measured by fecal particle size) across wet and dry seasons in a sample ( $n=11$ ) of wild geladas (*Theropithecus gelada*) from an ecologically-intact Afroalpine grassland in northern Ethiopia. A matched-pairs  $t$ -test revealed that mean fecal particle size (MPS) was significantly higher during the dry season ( $t=-8.0225$ ,  $df=10$ ,  $P<0.0001$ ), indicating that individuals chew food less efficiently during this time. The difference corresponds to a shift from habitual short grass consumption during the wet season to consumption of underground storage organs and other vegetation with challenging mechanical properties during the dry season. MPS for older individuals is higher than expected on the basis of body size alone, implicating dental senescence as a contributing factor. Indeed, values for  $M_2$  relief index and shearing crest length were lowest in older individuals. These results support the long-held assumption that the dental morphology of the *Theropithecus* clade is associated with consumption of tough foods. The relationship between differential chewing efficiency and seasonal body conditions and mortality rates is discussed.

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**Stress, social inequality, and growth retardation: Exploring the multidimensionality of stature variation in past populations.**

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Variation in stature is commonly attributed to differential stress-levels during development. However, the osteological paradox indicates that overall tall stature in a population may be more indicative of high selective pressures during growth than of positive life conditions. This paper examines stature data in a broader biocultural context and draws parallels between bioarchaeological and living populations to explore the multidimensionality of stature variation in the past. Specifically, two research questions are addressed: (1) is tall stature associated with low or high stress (inferred from skeletal indicators) in past populations? and (2) what can we learn about stature variation by comparing living and past populations? Stature and skeletal stress indicators (cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia) were estimated using standard methods in two medieval bioarchaeological populations: Giecz, Poland ( $n=66$ ) and Trino Vercellese, Italy ( $n=52$ ). Stature data and biocultural information were gathered for comparative living samples from South America. Results indicate significant ( $p<0.01$ ) differences in stature between groups exposed to different levels of skeletal stress. However, the relationship between early stress and growth is confounded by several biocultural factors, including cultural buffering and socioeconomic status. Thus, interpretations of early life conditions based on the relationship between stature and stress should be advanced with caution. Additionally, comparisons between past and living populations indicate a striking difference in the prevalence of stunting (with ~50% stunting in the living populations and no stunting in skeletal samples). Different selective pressures, differential mortality, catch-up growth, and stressors of different nature and duration may explain this disparity.

**Living on the edge: Patterns of habitat use in *Saguinus midas*.**

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Genus *Saguinus* is widely noted as "preferring" or "thriving" in edge habitats (Hershkovitz, 1977. Garber, 1980. Porter, 2001.). Data collected over a two month period in a lowland secondary forest in the interior of Suriname supports this hypothesis. These data also demonstrate regular, daily troop movements from the edge in the early morning, towards sites deeper in the interior for the bulk of the day. These regular movements reflect a preference for sleeping sites located in the edge, coupled with a preference for interior forest for feeding. Possible explanations for this behavior include (but are not limited to), an increase in foliage cover as protection from diurnal predators (primarily various raptor species), foliage cover

used as relief from excessive temperatures, or an increased density of food resources. Further study at this site would likely provide clearer motivations for daily patterns of habitat use, and an extended period of study would be required to record whether these patterns hold through the change of seasons, or vary due to the seasonal shifts in weather patterns, as well as the possible seasonality of preferred food resources.

**The original analysis of the manual and pedal phalanges from the Drimolen hominin site, South Africa.**

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Numerous studies have analyzed Plio-Pleistocene manual and pedal phalanges to evaluate tool-related behaviors and locomotion in early hominins. We analyze here nine undescribed phalanges from the fossil hominin site of Drimolen, South Africa. The manual specimens consist of one proximal (DNH 9), two proximal pollical (DNH 116 and DNH 119), four intermediates (DNH 48, DNH 63, DNH 65 and DNH 66) and one distal pollical phalanx (DNH 13). There is one pedal proximal phalanx (DNH 117).

As at Swartkrans, assignment of postcranial elements is hampered by the fact that two hominin species have been found at the site, namely *Paranthropus robustus* and early *Homo*. To analyze the specimens, multivariate statistics (PCA and CVA) were conducted on the specimens using raw and size-adjusted data. This was done within the context of a large extinct and extant dataset to compare size and shape data.

In general, PCA and CVA yielded similar results but only the raw data was useful in discriminating between taxa. There was poor discrimination in the analyses based upon size-adjusted data because of the huge degree of overlap between fossil and extant taxa. Consequently, results were not diagnostic and it wasn't possible to assign specimens confidently to either *Paranthropus* or *Homo*. This is exacerbated by the isolated nature of the remains, the presence of two hominin taxa and taxonomic uncertainties of several Swartkrans phalanges. Despite these difficulties, these specimens do provide insight into the degree of morphological variation present in the phalanges from the Plio-Pleistocene of South Africa.

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**Applying anthropological shape analysis techniques to archaeological research: Overcoming problems and exploring possibilities.**

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The last two decades have seen geometric morphometrics (GMM) revolutionise anthropological studies of morphological variation. Their statistical power and ready visualisation have allowed the teasing apart of complex causes of morphological variation, explaining them in readily interpretable ways, even to non-specialist audiences. This revolution in bioanthropology has been accompanied by similar revolutions in other fields of morphological research, including primatology, biology, and palaeontology. Despite this, it is relatively recently that archaeology, which shares many of the same materials and methods as bioanthropology, has started exploring the use of GMM.

In this paper we discuss the possibilities and problems faced when applying anthropological methods to archaeological data, using a number of case studies from our Anth/Arch morphometrics group at Durham University. The studies cross the boundaries of these disciplines and illustrate research questions in palaeopathology, migration studies, and zooarchaeology. Can GMM help us quantify disease processes? Can they aid interpretation of human migration and social change on large and local scales? What can animal remains tell us about the human past, and the potential problems when studying species undergoing artificial selection of domestication, and/or used for human consumption?

Through the results of multiple bioarchaeological studies, we show that GMM have the potential to increase our understanding of the past in terms of aetiology of disease, and morphological affinities of both humans and their domesticates. We also highlight limitations to their application in archaeological contexts, and questions which are not readily answerable even with these advanced methods.

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#### **Middle Cumberland regional relationships and the Mississippian geopolitical landscape.**

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This paper explores the population structure in the Middle Cumberland Region (MCR), Tennessee, during the Mississippian period and expands this information to reconstruct the region's geopolitical landscape. Using population genetic modeling, we examine geographic and socio-political parameters that may have affected gene flow within the region and with external populations. Thus far, no studies have examined the population structure

of the MCR and this paper examines the biological relationships of this prehistoric population with information about geographic distances and the natural environment, such as soil productivity and terrain visibility.

Cranial measurements and non-metric traits from 249 and 574 individuals, respectively, were analyzed from 14 sites in the Middle Cumberland Region to reconstruct the population structure using minimum genetic distances and the Relethford-Blangero method of heterogeneity for cranial measurements. In addition, Geographic Information Systems (GIS) methods provided data regarding spatial distance between sites and visibility, site density, and the natural environment around the sites. Mantel matrices tested for correlation between biological distances and geographic distances and the natural environment.

The results indicate that biological affinities do not correlate with geographic distances suggesting the isolation-by-distance model may not apply to this region and the island model may be more appropriate. Further, there is no correlation with the tested natural landscape factors. These results suggest equal gene flow within the region and few socio-political factors, such as conflict, or environmental factors which precluded population movement around the region. As such, the MCR socio-political landscape was one of balanced control over resources and power.

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#### **Immigration and diet in Montreal during the 17<sup>th</sup> and 18<sup>th</sup> centuries: An isotopic analyses of archaeological populations.**

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End of the 17<sup>th</sup> century, Montreal was the organizational center of the fur trade in New France and an expanding colony. Many persons were passing by or settling in, coming from Europe, other parts of the colony, inland territories and New England. Among other things, what they encountered once arrived in Montreal, was a shift in their diet.

During my master project, isotopic analyses were carried out on 90 teeth (58 premolars and 32 molars) and 45 bones, excavated from Notre-Dame's cemetery, dating from 1691-1796, in order to obtain data on collagen ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) and apatite carbonate ( $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$ ). The results on oxygen show that these individuals were mainly born in Montreal (N=30) or coming from a region with slightly lower  $\delta^{18}\text{O}$  (N=8), possibly inland territories or northern villages. Immigrants from regions with higher  $\delta^{18}\text{O}$  (N=20), France for example, would have travel during their adulthood: only 6 individuals showed a mobility pattern indicating mobility before the age of 16. The diet in Montreal was diverse; the combination of  $\delta^{13}\text{C}$  from collagen and from apatite carbonate in the linear model of Kellner and Schoeninger (2007) shows two patterns of consumption: people consuming a good part of C<sub>4</sub> plants (with  $\delta^{13}\text{C}_{\text{carbonate}}$  around -11‰ vs. VPDB) among their

intake of C<sub>3</sub> plants, C<sub>3</sub> fed meat and fish, as well as people consuming few or none of C<sub>4</sub> food (with  $\delta^{13}\text{C}_{\text{carbonate}}$  around -13‰ vs. VPDB). Comparison with a sample from France provides new insight on the changes occurred in these migrants' diet.

#### **Genetic diversity in indigenous populations from Central Mexico and its implications for the peopling of the Americas.**

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Home to the Aztec Empire, Central Mexico was the most densely populated area of Mesoamerica in the 16<sup>th</sup> century. Today, more than half a million indigenous people from numerous ethnic groups still inhabit the region, including the Otomi and Chichimeca (Oto-Manguan languages), the Nahua (Uto-Aztecan language), and the Tepehua (Totonocan language). To assess the genetic diversity of indigenous Mexicans and infer prehistoric patterns of interactions amongst them, we analyzed genetic variation in 536 individuals from twenty-three communities in Guanajuato, Hidalgo, Morelos and Queretaro states. Mitochondrial DNA (mtDNA) diversity was characterized through control region sequencing and coding-region SNP genotyping; Y-chromosome diversity through SNP and STR genotyping; and autosomal diversity through SNP genotyping. MtDNA analyses revealed a high frequency (>98%) and considerable diversity of the four major Native American haplogroups (A2, B2, C1 and D1), along with the presence of D4h3 among the Otomi. Y-chromosome analysis also showed a high frequency (~60%) and haplotype diversity for indigenous haplogroups Q-M3 and Q-L54 among these four populations, while autosomal SNP analysis revealed a high percentage (>80%) of indigenous markers across all ethnic groups. We used these data to examine genetic differentiation and gene flow amongst ethnic groups, and to assess genetic diversity within their different language families. Overall, the high frequency and great diversity of indigenous mtDNA and Y-chromosome haplotypes in Central Mexico suggests the region may have been a center for population growth and expansion for many millennia. Our data further suggest that indigenous Mexican populations have experienced relatively limited historic admixture.

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**Global patterns of ABO polymorphism suggest strong balancing selection and very low effective population size after the human colonization of America.**

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The ABO blood group locus in humans is characterized by elevated heterozygosity and apparently stable allele frequencies within most populations. One exception to this rule occurs in Native Americans, since A and B alleles are uncommon in North America and rare in South America. While the maintenance of A, B, and O alleles suggests some form of balancing selection, the loss of diversity in Native Americans supports recent population bottlenecks of uncertain magnitude. Using knowledge of ABO protein function, we modeled asymmetric negative frequency dependent selection and genetic drift to determine the range of  $N_e$  values that produce patterns of ABO polymorphism observed in the Americas. Populations must be moderately small to lose either the A or B allele ( $N_e \leq 100$ ) and much smaller ( $N_e \leq 35$ ) for the complete loss of diversity, which nearly always involved the fixation of the O allele. Declines in heterozygosity at the ABO locus in Native Americans are also consistent with population sizes as small as  $N_e = 10$ . These results imply that although the ancestral Native American population was large enough to maintain A and B alleles, populations expanding into the continent were likely smaller than is appreciated ( $N_e \leq 10-35$ ).

**Community dynamics through space and time in the Hadar and Turkana Basins, Ethiopia and Kenya.**

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The *Australopithecus afarensis* fossil record spans nearly 700,000 years with little observed morphological change. To understand the context of evolutionary stability, this project explores the community structure and species similarities among *A. afarensis* localities through time in different paleobasins. Mammalian taxa (>1 kg) from *A. afarensis* localities were categorized into guilds based on dietary, locomotor, and size classes (defined in the Evolution of Terrestrial Ecosystems Database). To compare guild structure across space, the proportion of guilds from the upper Sidi Hakoma Member in the Hadar Formation, Ethiopia, (n=31 taxa) were compared to guilds in the Tulu Bor Member of the Koobi Fora Formation (n=19 taxa) in East Turkana, Kenya, both dated to ~3.4 Ma. Guild structure was compared between all geological members of the Hadar Formation (the Basal (n=31), Sidi Hakoma (n=94), Denen Dora (n=105) and Kada Hadar Members (n=83)) to

examine change through time (3.45–2.95 Ma). Using chi squared tests, no significant differences were found between geological members at Hadar, despite a trend toward the environment becoming more arid and seasonal. Significant differences were found across space, however, between the lower Sidi Hakoma Member and lower Tulu Bor Member ( $p < 0.05$ ). Further, there is no significant correlation between the Jaccard Similarity index and temporal separation between sub members of the Hadar Formation ( $r^2=0.0061$ ). These findings show that community structure within the Hadar Formation remained stable through time despite environmental change and species turnover, suggesting overall stasis in mammalian community composition throughout the Hadar Formation.

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**Continuous dental eruption and the age at death of Sts 5.**

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The relatively small *Australopithecus africanus* specimen Sts 5 has been argued to be either an immature, small male or a mature female. Here we report on a CT-based analysis of the anterior dentition that informs this debate.

Sts 5 demonstrates extremely short tooth roots, particularly for the anterior dentition. Interestingly, these tooth roots are oriented vertically (relative to the alveolar plane), unlike those found in other apes, humans, and fossil specimens, in which the tooth roots are roughly parallel with the plane of the nasoalveolar clivus. Kaifu (2000) has proposed a model of continuous eruption and angular change in humans: with progressive wear, anterior teeth continue to erupt throughout life and become more vertically oriented to maintain occlusion. As the anterior teeth continuously erupt, the roots also become more vertically reoriented.

We examined CT data of adult apes, humans, and fossil hominin specimens and documented a relationship between the angle of the anterior tooth roots and their length. The extremely short and vertically oriented anterior roots observed in Sts 5 thus suggest that the specimen represents an aged female specimen with extremely worn dentition. Interestingly, this reorientation of anterior tooth roots helps account for the extreme expression of subnasal prognathism of Sts 5 - in apes where there is considerable anterior tooth wear and the roots are

reoriented as described, bony remodeling forms a bulge along the alveolus in the region of the roots, thus increasing the measured prognathism of the individual.

**Tough and then some: New directions for a growing Food Science in primatology.**

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The study of primate foods has moved from categorizing foods to documenting food material properties (FMPs) through the ecological insights of Warren Kinzey and technological breakthroughs of the Darvell-HKU tester. This shift has benefitted primatology by describing the toughness and to a lesser extent stiffness of many primate foods. As we advance our understanding of primate foods, we should expand beyond toughness to capture the multifaceted interactions between primates and their foods. In fact, recent arguments that FMPs show little relationship to primate skulls partly reflect this focus on toughness as just one of the many components of food texture.

Here, we look to Food Sciences, a discipline studying the composition and processing of human foods, as a model for future research into primate diets. Studies of primate FMPs have focused on linear-elastic fracture mechanics. Because many primate foods are viscoelastic, we can supplement these analyses by assessing how the rate of breakdown affects FMPs and their perception in primates. Moreover, studies of adhesiveness, cohesiveness and particle formation are warranted. Sensory analysis, although likely inferred for non-human primates, provides opportunities to understand how primates perceive food textural stimuli and flavor release. Finally, documenting how these material and sensory properties affect oral processing will be key to understanding the evolutionary interactions between primate feeding and diet. In summarizing these ideas, we advocate a texture hypothesis arguing that food textures and their perceptions change dynamically throughout a chewing sequence. Describing these interactions will be important for understanding the evolution of primate feeding.

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**Comparative analysis of covariance structure in the skull and postcranial skeletons of living apes.**

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Living apes exhibit striking locomotor diversity compared to other primate clades. The marked variation in locomotion underlies significant variation in skeletal morphology. These differences in postcranial form and locomotor behavior have lead anthropologists to argue that living apes evolved primarily as a "postcranial radiation". While skull and postcranial traits have been compared among apes, we have little understanding of how covariance structure differs between postcrania and skulls. Here, we compare covariance structure between skulls and postcrania in modern humans, chimpanzees, bonobos, gorillas, mountain gorillas, orangutans and gibbons (all N>20 individuals per species and skeletal region). In the postcrania, we consider limb lengths, midshaft and joint dimensions. Skull measures focus on functionally-relevant variables related to food processing. We created shape variables by dividing postcranial measurements by limb lengths and skull measures by jaw length. We calculated correlation matrices from shape variables per group after mean-centering by sex and subspecies. Preliminary results offer little evidence for systematic differences in covariance structure between postcrania and skulls. The relative standard deviation of eigenvalues from correlation shape matrices suggests African apes and gibbons retain higher levels of integration in skulls compared to postcrania. Humans and orangutans show the opposite pattern. Contrary to a predicted increase in postcranial variation among species, pairwise comparisons of shape matrices among apes suggest more similarity in postcranial correlation structure compared to skulls. Additional comparisons will examine regional variation within postcrania and skulls and comparisons among locomotor/feeding subgroups. These initial results suggest a complex pattern of skeletal covariance evolution in apes.

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#### Do food material properties predict jaw and tooth morphology in primates?

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Food material properties (FMPs) have long been predicted to influence masticatory morphology of human and non-human primates. The existence of a functional and adaptive relationship between skull morphology and diet in primates is well accepted among physical anthropologists, yet few studies have actually used the available FMP data of primate dietary items to support this relationship. For example, robust jaws and thick enamel are commonly associated with hard object feeding, but "hard" is a relative term and rarely defined. Thus, the question of whether FMPs influence variation in masticatory morphology across primate species remains unanswered. Furthermore, this relationship between form and FMPs has often been used to predict the physical properties of the diets of early hominin species. A large-scale, comparative analysis is warranted to justify this assumption and its utility. Here, we test if a relationship among dental and mandibular morphology, percentage of time feeding, and FMPs exists for twenty-seven primate species, with degree of relatedness controlled through the use of phylogenetic generalized least-squares (PGLS). Preliminary analyses indicate a positive relationship between FMP and relative tooth enamel thickness and a trend with shape of mandibular condyles, with the strongest relationship found when maximum FMPs are used in the models. FMPs also appear to be related to feeding time, when controlling for body size. By integrating data on feeding ecology, FMPs, and morphology, we can deepen our understanding of the complex relationship between form and function in living and extinct primate species.

#### A comparison of Mesolithic and Neolithic population affinities using the cranium and postcranium.

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Recent studies have shown that cranial shape variables reflect neutral evolutionary processes and can, therefore, be employed as a proxy for genetic data when reconstructing past population history. As such, craniometric shape data have shown that the initial transition to agriculture in southwestern and central regions of Europe was associated with demic diffusion from the Levant and Anatolia. However, it is currently unclear whether the same demographic signal is discernible in postcranial data. Here we

test this hypothesis utilizing matched craniometric and postcranial data for 11 Mesolithic and Neolithic populations from Europe, the Near East and North Africa. The collated database comprised ten variables from the lower limb (femur and tibia), eight variables from the upper limb (humerus, radius and ulna) and 15 cranial dimensions. Biological affinity matrices based on these three datasets were compared statistically against distance matrices representing geography, time, archaeological group, and temperature. As expected based on previous studies, cranial shape data distinguished Mesolithic and Neolithic populations, even when correcting for geographic and temporal distance. In contrast, the lower and upper limb datasets were significantly correlated with temperature, and were not reflective of archaeological designation or geographic distance. These results suggest that relative limb dimensions are not tracking the same neutral population history as the cranium and point to the strong influence of climatic factors in determining limb morphology in modern human populations, irrespective of whether they are hunter-gatherers or farmers.

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#### Cross-sectional morphology of the australopithecine hard palate.

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The vertically thickened hard palate of *Paranthropus*, like many other derived craniodental features in this species, has been explained by Rak (1983) as an adaptation related to the consumption of a hard/tough and an associated increase in masticatory forces relative to its sister taxa *Australopithecus*. Experimental studies of diet-related morphological plasticity in the mammalian hard palate have demonstrated that cross-sectional properties of the structure, such as cortical thickness and trabecular density, covary with dietary material properties. Assuming similar osteogenic responses to variation in dietary mechanical properties and loading levels, we hypothesize that if the hard palate in *Paranthropus* was subject to greater masticatory stresses relative to the same structure as *Australopithecus*, the former genus should exhibit a thicker palate, thicker cortical bone across the oral lamina, and greater trabecular density. To test this hypothesis, sequential coronal cross-sections of the hard palate were obtained from computed tomography (CT) scans of fossil specimens of both genera (n=17). Results show that *Paranthropus* has a significantly ( $p<0.05$ ) taller anterior palate with thicker cortical bone along the anterior oral lamina when compared to *Australopithecus*. Although the quantity of fossil evidence is limited by preservation, this study tentatively supports the hypothesis that the morphology of the hard palate in *Paranthropus* was influenced

by high levels of cyclical and/or peak masticatory strains during postcanine biting and chewing. Thus, variation in the hard palate of australopithecines is consistent with the observed craniodental variation, suggesting a divergence in dietary material properties and masticatory behavior between the two genera.

#### **Bayesian divergence dating of Yemeni mitochondrial haplogroups.**

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The southern dispersal route (SDR) out of Africa posits that anatomically modern humans (AMHs) first left Africa by crossing the southern extent of the Red Sea. Yemen would be the first stop outside Africa. If AMHs did follow the SDR and left modern descendants, one would expect to see deep divergences in the Yemeni mitochondrial gene tree. On the other hand, if AMHs followed the SDR but no modern descendants remain or if AMHs did not pass through Yemen on their route, one would expect more recent divergence dates instead.

We used data from 90 Yemeni mitochondrial genomes from haplogroups L3, M, and N that were sequenced using the Illumina Genome Analyzer Ix as well as 68 additional from a wide-array of haplogroups that were previously sequenced using traditional Sanger sequencing. We used multiple methodologies within the BEAST software package to generate divergence dates. One method, which we took from published literature, used a relaxed clock model and a prior on the tree root, but restricted analyses to the coding region. We also used a novel method that attempts to integrate both the coding and control regions by using multiple substitution models. The dates generated were compared to each other and with previously published dates to test for the effects of different methodologies. Our dates were also compared with archaeological dates to look for consistency between different types of data. We also examined our dates to see if they correlate with periods of climatic change and subsequent population expansions.

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#### **The Mummipaedia Project: Crowdsourcing to expand the IMPACT Radiological Mummy Database.**

ANDREW D. WADE and ANDREW J. NELSON. Anthropology, The University of Western Ontario.

At the University of Western Ontario (UWO) a large-scale, international, collaborative database of mummy radiographic datasets (plain film, CT, MRI) has been established. When the IMPACT Radiological Mummy Database went live online in 2012 it included datasets for more than 120 human and animal Egyptian mummies and had received agreements for an additional 250 Egyptian mummies. The database's focus on the Egyptian mummification tradition was a product of our experience with and seed contributions of Egyptian mummy imaging datasets, but was not intended to limit IMPACT to the study of ancient Egypt. Rather, IMPACT is intended to provide online access to medical imaging of mummies from cultures around the world.

In order to identify potential contributors a catalogue of extant Egyptian mummies, already several thousand entries long, was developed based on a simple Microsoft Excel spreadsheet. A spreadsheet populated by a single researcher using news and research articles, however, is an inefficient means of accurately and centrally cataloguing mummies from all other cultures. Crowdsourcing, the distribution of tasks to an undefined community of participants, taps into the power of an overwhelming popular interest in mummies and into the firsthand access that individuals and interested societies have to local museum holdings. The openly accessible Mummipaedia Project is being developed to expand the depth and breadth of our knowledge of all mummy holdings worldwide, to identify further IMPACT contributors where mummies have been imaged, and to identify potential future mummy imaging projects where they have not.

#### **Cholesteatomas: The application of paleopathologic and forensic anthropologic knowledge from a classroom.**

SAMANTHA A. WADE and HEATHER WALSH-HANEY. College of Arts and Sciences: Department of Justice Studies, Florida Gulf Coast University.

This presentation discusses the identification of a skeletal pathology used to construct the biological profiles of two unknown skeletons. While this presentation discusses cholesteatoma etiology and symptomology, we draw attention to the importance of student training via a scholar-practitioner teaching model spanning nearly four decades.

Cholesteatomas arise as a congenital defect, secondary to a traumatic injury or develop due to a chronic bacterial or viral infection of the inner ear. Beginning as a squamous epithelial cyst that may mark the petrous pyramid, auditory ossicles, mastoid process; the condition presents as a lytic lesion.

In 2011, we evaluated the unidentified remains of a presumed Cuban national whose body was discovered in Marathon, Florida. During analysis, the first author noted what appeared to be a cholesteatoma on the right temporal, superior to the external auditory meatus. It showed signs of lytic activity; yet, outward sclerotic margins suggested little

exudation of fluids, a common symptom of a cholesteatoma. This observation immediately brought to mind a 1972 case study concerning Dr. William R. Maples' first forensic anthropology case. The Maples case was integrated into the forensic anthropology curriculum established by Walsh-Haney. Therefore, two generations of scholar-practitioner training blended together classroom learning and the application of knowledge towards actual practice. Maples positively identified the European American male based upon his knowledge of cholesteatoma symptoms which include otorrhea seepage. While the pathology of the cholesteatoma in the Cuban national does not appear to be as virulent as that found in Maples' case the diagnoses were similar.

#### **Costly courtship: The energetic burden of walking together.**

JANELLE M. WAGNILD and CARA M. WALL-SCHIEFFLER. Department of Biology, Seattle Pacific University.

Research has shown that individuals have an optimal walking speed—a speed which minimizes energy expenditure for a given distance. As the optimal walking speed varies with mass and lower limb length, it is therefore susceptible to sexually dimorphic variation, with males in any given population having faster optimal walking speeds; this potentially creates a dilemma for mixed-sex walking groups. Here we examine speed choices made by individuals of varying stature, mass, and sex walking together. Individuals (N=18) walked around a track alone, with a significant other (with and without holding hands), and with friends of the same and opposite sex while their speeds were recorded every 100m. Our findings show that males walk at a significantly slower pace to match the females' paces ( $p=0.021$ ), when the female is their romantic partner. Additionally, hand-holding causes both individuals to walk slower than either of their optimal speeds (for males significantly slower,  $p=0.016$ ). Significant pace adjustment appears to be limited to romantic partners because the paces of friends of either sex walking together did not significantly change ( $p>0.05$ ). These findings have implications for both mobility and reproductive strategies of groups. Because the male carries the energetic burden by adjusting his pace (slowing down 7%), the female is spared the potentially increased caloric cost required to walk together. In energetically demanding environments, we will expect to find mixed partner walking groups at a lower frequency than single sex groups particularly when travelling longer distances.

#### **A cross community comparison of female chimpanzee (*Pan troglodytes schweinfurthii*) social behavior in Kibale National Park Uganda.**

MONICA L. WAKEFIELD<sup>1,2</sup> and KYLEB D. WILD<sup>1</sup>. <sup>1</sup>Department of Anthropology, University of California, San Diego, <sup>2</sup>Department of Anthropology, Yale University.

Female chimpanzee gregariousness and social interactions vary considerably both within and between populations. Direct comparisons across sites are needed to both quantify the differences and test which factors influence the observed variation in behavior. However, this has been difficult due to methodological differences across studies. Here we compare female social behavior in two communities, Kanyawara and Ngogo, in Kibale National Park, Uganda. These two sites, while only 10 km apart, differ markedly in both ecology and demography providing a unique opportunity to study behavioral variation and corresponding influences within one population. Previous research has suggested that Kanyawara females spend the majority of their time alone and rarely interact with other females. In contrast, Ngogo females are reported to be relatively gregarious spending the majority of their time in association with other females. We conducted continuous focal follows of females at both sites using comparable methods. Female grouping patterns and group randomization tests showed that Ngogo females were more gregarious than Kanyawara females. However, some females at both sites formed strong dyadic bonds with other females. Rates of social interactions at both sites were higher than previously reported in East African populations, but aggression rates at Kanyawara were high, while grooming was extremely rare; whereas at Ngogo, aggressive interactions were rare while grooming among females was relatively common. We discuss our results within the context of the ecological and demographic differences between the two sites. This study also highlights the need for focal follows of females to understand female behavior.

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#### **Marry me, marry my family: Congenital anomalies at Khirbet Qazone.**

JESSICA L. WALKER<sup>1</sup> and MEGAN A. PERRY<sup>2</sup>. <sup>1</sup>Department of Anthropology, University of Pittsburgh, <sup>2</sup>Department of Anthropology, East Carolina University.

The 1<sup>st</sup> – 3<sup>rd</sup> century A.D. cemetery of Khirbet Qazone (n=30), located on the southern Dead Sea littoral, served the mourners and deceased residing within this historically fertile area. First as part of the Nabataean Kingdom, and then under Roman rule, the region contained a dynamic mix of Jewish, Nabataean Arab, and/or Hellenized groups, based on epigraphic and other written evidence. Analysis of the human skeletons, excavated by the Hellenic Society for Near East Studies in 1996, 1997, and 2004, revealed a number of congenital conditions among the sample, including transitional vertebrae and abnormalities of the suprascapular region.

The relatively high frequency and unique nature of these and other anomalies (compared with other samples) suggests that the cemetery

contains a genetically-closed community, unexpected for a region with notable gene flow from different subpopulations. In addition, some of the anomalies have not been reported outside the medical literature. The skeletal data suggests that gene flow within the region was restricted, and inbreeding between the different linguistic and cultural subgroups was low, contrary to the evidence provided in historical accounts.

#### **Covariation of haversian structure density and bone resorption in human bone.**

ROBERT A. WALKER and HEATHER E. CUTLER. Basic Sciences (Anatomy), New York Chiropractic College.

Haversian structure densities increase and bone mass decreases with age among humans. Both may be affected, by sex of the individual, by disease and nutritional status and thus reflect the life history of individuals. Densities of haversian structures (complete and fragmentary osteons) and bone resorption are examined in the midshafts of the human humerus, radius, ulna, clavicle, femur, tibia and fibula in a sample of 16 males (mean age 68) and 23 females (mean age 80). They range in age from 14 to 107 years. Resorption is assessed as percent of the microscopic field composed of solid bone. Osteon and fragment densities are quantified as structures per sq. mm. Rates of resorption vary with age by bone. Among males, there is little change with age among all bones examined. Females have significantly more bone resorption, and as bone mass decreases, haversian structures per sq. mm. increase, even as bone mass per sq. mm. decreases. Resorption does not differ among bones in males. Among females, it is significantly greater in some bones, particularly the femur and humerus. Osteon density differs significantly among bones in males, being higher particularly in the tibia and humerus, but not so among females. Increased cortical thinning coupled with increasing density of haversian structures among females suggests an adaptation to applied loads on a decreased total cross sectional area of bone. Each bone responds independently to aging, rather than demonstrating a systemic response, each bone acting as an independent organ.

#### **Comparison of the metabolic costs of feeding in a range of food types in small-bodied primates.**

CHRISTINE E. WALL<sup>1</sup>, JANDY HANNA<sup>2</sup> and MATTHEW C. O'NEILL<sup>3</sup>. <sup>1</sup>Department of Evolutionary Anthropology, Duke University, <sup>2</sup>Structural Biology, West Virginia College of Osteopathic Medicine, <sup>3</sup>Department of Anatomical Sciences, Stony Brook University School of Medicine.

What is the metabolic cost of feeding in primates? These costs reflect the mechanical environment during feeding and may be an important selection pressure on craniofacial structure and daily energy use. At present, however, almost no metabolic measurements exist for primate feeding. We present new data

on the metabolic cost of feeding in several small-bodied primates. These data are used to test the hypothesis that the metabolic cost of feeding is positively correlated with food properties and food preparation prior to mastication.

Data were collected for *Loris tardigradus* (n=1), *Microcebus murinus* (n=2), *Haplemur griseus* (n=4) and *Saimiri sciureus* (n=3). Rates of O<sub>2</sub> consumption and CO<sub>2</sub> production were measured while each individual sat in a respirometry chamber and ate. Comparisons were made for foods varying in size and material properties (mealworms, fig, carrot, bamboo, and almond). The cost of each feeding bout was subtracted from resting metabolism to determine mass-specific, net feeding cost (W/kg).

The lowest feeding costs were for mealworm in *Loris* and *Microcebus* (0.4-1.8 W/kg). Large, soft figs had similar feeding costs compared to smaller but relatively tough foods in *Saimiri* (fig mean=3.4 W/kg, carrot mean=3.3 W/kg, almond mean=3.5 W/kg). The feeding cost for whole objects was substantially higher (>20%) than the cost of chewing alone (e.g., almond whole vs. thin slices) indicating that food preparation is an important contributor to feeding costs. These results suggest that food preparation, size, and material properties correlate positively with the metabolic costs of feeding.

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#### **Does pregnancy really inhibit women's mobility? Insights from a longitudinal energetics study.**

CARA M. WALL-SCHEFFLER. Biology, Seattle Pacific University, Anthropology, University of Washington.

An increased understanding of changes in women's locomotor energetics during pregnancy would elucidate possible places where and when selection might act on mobility strategies. In this study, five women (mean age=31.8 years) were recruited prior to pregnancy and were followed through their pregnancies as well as during post-pregnancy infant carrying. The collections consisted of the women walking at 4 walking speeds (1 slow, 2 medium, 1 fast) in a randomized order while their metabolic rates were collected. Each woman's metabolic rate was collected prior to her pregnancy, and then every 4 weeks during her pregnancy; the metabolic rate for each speed from each trimester was averaged. Post-partum, each woman walked at the same four speeds unloaded, with her infant in a sling and also in her arms. For each participant's pre-pregnancy, first through third trimesters, and post-partum (loaded and unloaded) conditions, a curvilinear Cost of Transport (CoT) equation was calculated. From these equations, the following measures were determined: the acuteness of the CoT curve, the minimum cost of transport (MinCoT), and the speed at which the MinCoT occurred (optimal speed). From pre-pregnancy to the third trimester, the CoT curvature became significantly more acute (p=0.01) and the MinCoT became significantly more energetically expensive (p<0.001); however, while the optimal

speed reduced, this was not significant ( $p=0.396$ ). These changes do not immediately disappear following pregnancy. When compared with reports of pregnant women's mobility choices, these results suggest that despite low daily gestational costs, mobility costs for pregnant women are high.

**Cross-sectional geometry of chimpanzee finger bones.**

IAN J. WALLACE<sup>1</sup> and BIREN A. PATEL<sup>2</sup>.  
<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, <sup>2</sup>Cell and Neurobiology, University of Southern California.

During knuckle-walking, chimpanzee finger bones contact the substrate and sustain large mechanical loads. Digital flexor muscles are not recruited to moderate these loads during weight support. Manual pressure data suggest that the loads sustained by chimpanzee fingers during knuckle-walking are not evenly distributed across the digits. Higher pressures are experienced by digits 2 and 3 than by digit 5. Given that bone tissue has the capacity to adjust to its functional environment such that its morphology is "optimized" according to mechanical demand, the load variation implied by pressure data should have a predictable effect on the relative robusticity of chimpanzee finger bones, namely, the bones of digits 2 and 3 should exhibit greater robusticity than those of digit 5. Furthermore, knuckle-walking engenders larger bending moments in obliquely oriented proximal phalanges than in horizontally oriented middle phalanges, which should lead to relatively greater robusticity in proximal versus middle elements. To assess these predictions, we measured the mid-diaphyseal cross-sectional geometry of the proximal and middle phalanges of digits 2-5 in 20 wild-shot, adult chimpanzees using micro-CT. As predicted, we found that cortical bone area (scaled to body mass) and polar moment of area (scaled to the product of body mass and bone length) are consistently larger in (1) phalanges from digits 2 and 3 than from digit 5, and (2) proximal versus middle phalanges from the same digit. The results of this study provide support for the idea that diaphyseal bone morphology reflects, at least to some extent, habitual locomotor behavior.

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**Paleodemography and paleoepidemiology in the Middle and Late Mississippian.**

KYLE D. WALLER, REBECCA E. SHATTUCK and KELSIE WILSON.  
 Anthropology, University of Missouri.

The cause of the abandonment of fortified Mississippian population centers is unclear, and has generated considerable debate among archaeologists. In this study, we seek to contribute to these debates by examining the demographic impact of abandonment at two Middle Mississippian and two Late Mississippian sites in Missouri. We use theoretical and methodological advances in

paleodemography and adult age estimation to compare the force of mortality and survivorship between sites and between sexes within sites, examine the effects of linear enamel hypoplasia on risk of death, and compare our results to previous life-table demographic analyses. Kaplan-Meier curves were fit to age estimates from transition analysis to generate empirical age-at-death distributions. Gompertz and Gompertz-Makeham hazard parameters were then plotted against the Kaplan-Meier curves to examine their fit, and then used to calculate force of mortality and survival functions. The hazard parameters suggest that the force of mortality was greatest for young females of reproductive age at all sites, increasing with greater site sizes. Using the Usher model and Cox semi-parametric hazard models, it was additionally demonstrated that individuals with linear enamel hypoplasias have a significantly greater age-specific risk of death than individuals without, suggesting that childhood frailty reflects, in part, reduced survivorship in these populations. Transition analysis and hazard models indicate a longer lifespan and more robust response to systematic insults than was implied by traditional demographic methods.

**Electromyography of chimpanzee mastication: Muscle recruitment order.**

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 Department of Organismal Biology and Anatomy, The University of Chicago.

This study investigated patterns of muscle recruitment of both the balancing- and working-side muscles during mastication in Pan troglodytes. Video data of left- and right-side chewing of a variety of foods was taken from four individuals, and the corresponding electromyographic data of the firing of the superficial and deep masseter and the anterior and posterior temporalis muscles were collected. Results were compared to jaw-muscle recruitment order in Old World monkeys. EMG data were processed using a root-mean-square analysis with a time constant of 84 milliseconds. For each power stroke, for each muscle, we calculated the relative timing of peak activity and of 25%, 50%, 75% activity before and after the peak. This analysis revealed that, for both the superficial and the deep masseter muscles, peak firing of the balancing-side muscle precedes that of the working side. For the anterior temporalis, peak firing of the balancing side precedes that of the working side. The working- and balancing-side posterior temporalis muscles show no consistent firing pattern. These patterns are consistent with those of Old World monkeys for the superficial masseter, but differ for the deep masseter and posterior temporalis.

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**Status and stature: Analysis of the association between socioeconomic status and adult stature in medieval London c. 1350-1538.**

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Adult stature reflects, among other things, exposure to physiological stressors such as disease and malnutrition during development. Studies in living and past populations have found significant positive associations between stature and health, and negative associations between stature and risks of mortality. Examination of the relationship between social status and stature has yielded conflicting results, with only some studies finding significant associations between the two. This study examines stature variation within and between higher and lower status adults in the St. Mary Grace cemetery in London dated to 1350-1538 ( $n = 52$ ). Using femur and tibia maximum lengths as a proxy for stature, this analysis tests the hypothesis that high status individuals are better buffered from physiological stressors during development and have higher mean adult stature, and less variation thereof, compared to low status individuals. The results indicate that among males, high status individuals are significantly taller and that variation in stature is significantly lower. Among females, there are no significant differences in mean stature or variation in stature between high and low status individuals. A higher proportion of low status individuals are below the mean stature for sex, though this difference is not statistically significant. These results may indicate a more varied diet or heightened exposure to physiological stressors for lower status people. The lack of an association between status and stature among females may indicate that females were better buffered against physiological stress than males, which could have acted to reduce the differences between socioeconomic status for females.

*Data for this study come from a project funded by the Wenner-Gren Foundation (#8247)*

**The functional significance of female copulation calls in olive baboons (*Papio anubis*).**

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Females in a variety of catarrhine species produce elaborate vocalizations, or copulation calls, in conjunction with maximal swelling tumescence and male ejaculation. One reasonable hypothesis is that copulation calls function to incite male competition. However, new data indicate that in some species these calls may instead function to encourage mate-guarding from consort partners and therefore evolved as a mechanism of female mate choice. As a preliminary test of this hypothesis, we recorded female copulation calls during 90 copulations involving 8 females and 10 males in 2 troops of wild olive baboons (*Papio anubis*) at Gombe Stream National Park, Tanzania. The olive baboon offers an interesting opportunity to

test the female choice hypothesis because male olive baboons of all ranks follow consorting pairs and compete for access to viable females. In the current study, males were observed contesting consorts during nearly half ( $n=34$ ) of all observed consorts ( $n=73$ ). If calls function as a signal to male partners to continue consorting, it is likely that female calls are related to whether a consort is contested. Females called more often during uncontested than contested copulations ( $\chi^2=4.452$ ,  $df=1$ ,  $p<0.05$ ), and when their male partner was high-ranking versus low-ranking ( $\chi^2=4.735$ ,  $df=1$ ,  $p<0.05$ ). Variability in individual female's acoustic patterns based on partner rank and time in female's cycle is addressed. Our results lend support for the female choice hypothesis for the evolution of copulation calls, and demonstrate that female mate preferences can be reflected in behaviors outside of those typically incorporated in female choice studies.

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**The placement of the maxillo-zygomatic suture in primate midfacial skeleton: An investigation on Old World Monkeys and New World Monkeys.**

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<sup>1</sup>Division of Basic Medical Sciences, Mercer University School of Medicine, <sup>2</sup>Department of Anthropology, University at Albany, <sup>3</sup>Department of Biology, Mercer University.

Craniofacial sutures are weak points compared to rigid bone on the skull thence they must be shielded from unduly high stresses so as not to disrupt vital growth processes and skeletal functions. Thus, it is hypothesized that the placement of sutures should maximize their growth potentials yet minimize their negative biomechanical impacts, especially in areas under high stress during dietary activities, such as the midface. Specifically, for any given suture, it is hypothesized that suture position would be different in skulls of different form adapted to different dietary ecology. In this study, we investigated the position of the Maxillo-Zygomatic suture (MZS) in five species of Old World Monkeys (OWM) and six species of New World Monkeys (NWM) by calculating the relative Zygoma breadth compared to the facial breadth at the level of the inferior rim of the orbit. Results demonstrated that the MZS in NWM has a more lateral position compared to that in OWM. Consequently, the ratio of facial surface vs. temporal surface of the Zygoma in NWM is relatively smaller than that in OWM, which is coupled with different configuration patterns in the orbital and pterion areas. Variation is also present within closely related taxa. For example, the MZS is more laterally placed in *Cebus apella* than in *C. albifrons*.

These findings suggest different bone interaction patterns related to differences in dietary ecology. The significance of the placement of sutures thus warrants careful ontogenetic, phylogenetic, and biomechanical studies.

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**Size and shape maturation of the human cochlea.**

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Previous studies suggest that the human cochlea attains a size within the adult range as early as 23 weeks in utero, but 3D shape changes have as yet not been assessed. Here we document the shape component of form change of the human fetal cochlea and test whether the shape is distinct from that seen among adults. We collected microCT data for 12 fetuses ranging from 16 to 39 weeks in utero and data for 5 adults. Each cochlea was reconstructed in 3D and a spline function was fitted along the centre of the duct. A total of 25 landmarks were placed at equidistant points along the line and were subjected to form analysis. Measurements of cochlear length, width, height and volume were also collected. Findings indicate that there is little difference of cochlea shape between fetuses and adults but, in contrast to previous studies, a small difference of size was observed.

Analyses revealed a significant correlation ( $p<0.05$ ) of PC1 scores with centroid size. This was associated with shape changes primarily in the apical region. Discriminant function analysis found no significant differences of cochlear shape in pairwise comparisons between the smallest fetuses, largest fetuses and adults. Mann-Whitney Tests suggest that the adult cochlea is on average significantly bigger than the largest fetuses in terms of length (+10%), width (+10%) and volume (+30%). These results suggest that whilst the general coiled shape is reached at an early stage of development, there may be size related morphological changes after birth.

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**Earliest evidence of distinctive modern human-like hand morphology from West Turkana, Kenya.**

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Despite recent discoveries of relatively complete hands from two early hominin species (*Ardipithecus ramidus* and *Australopithecus sediba*), fundamental questions remain about the evolution of human-like hand anatomy and function. These questions are driven by the paucity of hominin hand fossils between 1.8 and 0.8 million years old. In 2010, a team from the West Turkana Paleontology Project of the National Museums of Kenya recovered a hominin third metacarpal (KNM-WT 51260) from the newly discovered site of Kaitio. Kaitio is located in northern Kenya west of Lake Turkana and dates to about 1.4 Ma. In all ways, this bone resembles that of a modern human in overall proportions and morphology. The metacarpal is long, falling within the upper range of modern European and African American males, and is one of the longest hominin third metacarpals known among Neandertals and early modern humans. Notably, KNM-WT 51260 displays a well-developed styloid process, the most distinctive features of the human and Neandertal hand, not present in earlier hominins. The morphological similarity of KNM-WT 51260 to human third metacarpals, and its spatio-temporal context, suggests that this fossil is attributable to *Homo erectus sensu lato*. KNM-WT 51260 shows that modern human-like hand morphology and function was present within a behavioral context characterized by Acheulean technology. It provides the earliest evidence of a key shared derived characteristic of modern human and Neandertal hands, and suggests that the distinctive complex of radial carpometacarpal joint features in the human hand arose early in the evolution of the genus *Homo*.

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**Ancient DNA and the metagenomics of disease.**

CHRISTINA WARINNER. Anthropology, University of Oklahoma, Centre for Evolutionary Medicine, University of Zürich.

High-throughput genomic and proteomic sequencing has opened up dramatic new opportunities to study health and disease, and the demonstrated success of applying these techniques to archaeological material is revolutionizing the field of paleopathology. The recent discovery that human dental calculus preserves abundant, high quality microscopic and biomolecular remains opens up further possibilities and extends the application of these techniques to non-mummified remains previously thought to be out of reach for most biomolecular studies of ancient disease. This paper presents new results from combined metagenomic and metaproteomic analyses of human dental calculus specimens collected from four Medieval individuals with osteological evidence of periodontitis (Dalheim, Germany, c. 1100 CE). We document the presence of more than 500 bacterial taxa known to inhabit the human oral cavity, including 16 bacterial pathogens associated with periodontal disease and caries infection. We further identify

proteomic evidence for more than 20 human proteins involved in acute immunological response to bacterial infection. By employing multiple lines of biomolecular evidence, we demonstrate that high-resolution characterization of complex ancient bacterial infections in humans is now within reach. The emerging fields of paleometagenomics and paleometaproteomics are changing the way we think about ancient disease and how archaeological studies can contribute to a medical understanding of health today.

**A new method for assessing dietary differences using interproximal tooth wear analysis.**

AMY L. WARREN. Department of Anthropology, University of Missouri.

Interproximal tooth wear analysis can yield important information about dietary differences that is obscured in occlusal wear analysis, but earlier studies using interproximal wear to compare diets failed to take into account the overall size and shape of the wear facet, considering only facet length. In this study, dietary differences between two temporally and geographically similar skeletal populations were analyzed using a new method that better describes the size and shape of the wear facets. Length, height, area, and perimeter measurements of the facets (P1 distal, M1 mesial and distal, M2 mesial) were obtained from individuals using digital microscopy, and compared to each other and between the two populations.

Statistical analyses of this method suggest it is only necessary to obtain facet area and perimeter measurements, which are obtained simultaneously, thus reducing data collection time while most accurately describing overall facet size. As expected, all measurements are highly correlated ( $r = 0.65-0.989$ .) Principle components analysis shows that a single component explains greater than 87% of the variance in all measurements for all teeth and that area and perimeter loadings are strongest (0.973-0.990.) Discriminant function analysis confirms that area and perimeter measurements are most useful for classifying individuals into appropriate groups. Intra-observer error analyses produce high reliability scores and low technical error of measurement values indicating that the method is repeatable and reliable. Application of the method reveals significant differences in interproximal wear facet size between the two populations providing additional evidence for dietary differences.

**Dental variation in Iron Age populations of southern Africa.**

KERRY A. WARREN, SIMON HALL and REBECCA R. ACKERMANN. Department of Archaeology, University of Cape Town.

Evidence for Iron smelting, agriculture, elaborate pottery styles and increased sedentism appear abruptly in areas previously inhabited by hunter-gatherers and herders during the Early

Iron Age (EIA) of southern Africa from around 250AD. Ceramic evidence connects these (cultural) populations to the second millennium Iron Age sites in eastern Botswana. This material culture differs from second millennium Late Iron Age (LIA) sites in South Africa which are attributed to migrations from east Africa and are connected, via the material culture, to modern Sotho-Tswana and Nguni speakers. Although the material culture of this period is well-studied, there is a gap in correlating Iron Age biological identity with the established cultural identity. Here we present an analysis of metric and non-metric dental variation to better understand biological relationships among these populations. Specimens from the LIA, EIA and Eastern Botswana are compared with each other, and to specimens from Iron Age Zambian sites, modern Bantu-speakers and a historic Ndebele site from the mid-nineteenth century. This research indicates few differences between the EIA and LIA groups, although surprisingly populations from eastern Botswana are more similar to the LIA group than the EIA group. The Iron Age samples are significantly different from the modern sample, while the historic sample lies intermediate to the Iron Age and modern samples, indicating that Iron Age peoples had a pattern of dental variation that differs from what is seen in modern (admixed?) descendants. This has important implications for our understanding of the sub-Saharan African dental complex.

**Dr. Karen Burns: Pioneer in Forensic Anthropology at the University of Florida.**

MICHAEL W. WARREN. Department of Anthropology, University of Florida.

Graduate students are instrumental in shaping both the present and future direction of anthropological inquiry in their departments. Highly successful doctoral students are able to capitalize on their mentor's guidance and bring together the resources needed to become among the world's experts within their chosen area of expertise. The University of Florida has, for the past 40 years, played an active role in establishing the subfield of forensic anthropology. The principle actor was Dr. William Maples, a member of the first cohort of anthropologists responsible for the development of forensic anthropology as a subfield within biological anthropology. His first graduate student with a focus on human identification was the late Karen Ramey Burns. Dr. Burns was a pioneer in finding courses across campus – from the College of Medicine to the Law School – to construct a curriculum that did not previously exist. Of course, “Kar” Burns went on to become an internationally-recognized anthropologist and educator within the emerging field of forensic human rights investigations. But at our university, she is remembered as being Dr. William Maples' first forensic anthropology graduate student and a trailblazer for those of us who followed in her footsteps. The strong presence of forensic anthropology at our university is a direct result of the influence of Dr. William Maples and his first student, Dr. Karen

Ramey Burns, who despite her passing, continues to provide us a path towards success.

**Lower limb joint mechanics in men and women.**

ANNA G. WARRENER. Human Evolutionary Biology, Harvard University.

Women tend to walk and run with greater hip adduction, internal rotation of the thigh and increased valgus angle during locomotion. These kinematic differences are generally assumed to be the result of sexually dimorphic aspects of body shape, but how these differences affect lower limb joint mechanics is unclear. Few inverse dynamics studies include women and sample sizes for both sexes are often small. This study compares moments, muscle force and effective mechanical advantage (EMA) of the lower limb joints during walking and running to determine if any systematic differences between men and women are present. Twenty-seven individuals (male =14, female = 13) provided informed consent to participate in this study (IRB approval from Washington University in St. Louis). Subjects walked and ran over a force-plate (AMTI model OR, 1000Hz) embedded half-way down a 7.8m long trackway while kinematics were simultaneously recorded (Vicon, 200Hz). Subject specific muscle moment arms and skeletal measurements were determined from full lower body MRIs (Avanto 1.5T scanner, isotropic 1.7mm resolution). An inverse dynamics solution was used to solve for joint moments and muscle forces. Results indicate that while the subjects were dimorphic in multiple aspects of body shape there were few significant differences in joint mechanics, muscle force or EMA. Women tended to have higher hip abductor moments and lower abductor EMA across gaits, while men had significantly higher ankle plantarflexor moments during walking. The results are discussed in relation to skeletal dimorphism and provide important baseline data on joint function in men and women.

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**Strontium isotope identification of migrants in the collective burials at the Late Neolithic Rego da Murta Dolmens (Alvaiázere, Portugal).**

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This study uses strontium isotope ratios (<sup>87</sup>Sr/<sup>86</sup>Sr) from dental enamel to identify possible migrant individuals among Late Neolithic to Early Bronze Age (c. 3500-1800 BC) populations interred at the Rego da Murta I

and II dolmens (Alvaiázere, Portugal). Strontium isotopes are absorbed into local plants and incorporated into the hard tissues of animals and humans through water and food intake. The isotopic composition of the bioavailable strontium depends on the local geology and the types of rocks and sediments in the subsurface. As dental enamel is formed during childhood and not subsequently remodeled, its  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio records the geologic signature of an individual's childhood homeland. By comparing the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio in the dental enamel of individuals in these late prehistoric collective burials with the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio of local fauna and microfauna, it is possible to identify individuals who migrated to this region of Portugal after spending at least part of their childhoods in another location. For this project dental enamel was sampled from 25 humans and 8 animals from the Rego da Murta I and II dolmens. Based on the results, 20% of individuals from Rego da Murta I and 27% of individuals from Rego da Murta II can be classified as migrants. Although this data is preliminary, it suggests a good deal of geographical mobility in these populations. Additional strontium isotope mapping of the surrounding regions is necessary to identify possible places of origin.

#### **Normative ideologies of sample construction in bioarchaeological studies.**

RACHEL J. WATKINS. Anthropology, American University.

'Careful' and 'contextualized' are terms that indeed apply to much of the current research conducted toward understanding the social experience of disease and disability. However, this does not mean that the descriptive labels and categories used to organize our data lack the implication of static or typological definitions. As such, this paper argues that these categories require further theoretical examination. The discussion focuses on interrogating the normative temporal, spatial and ethnoracial frameworks that bear upon interpretations of health and disease in bioarchaeological studies. A brief review of several identified skeletal collections is used to demonstrate how these population samples are subject to standardized associations with ethnic groups, as well as specific points in space and time. The discussion moves on to address how these normative categorizations limit the explanatory power of biocultural analyses of health and disease, and considers a more critical approach to data organization and analysis.

In conclusion, this paper argues that theoretical exercises such as this provide opportunities for bioanthropologists to turn a much needed, critical eye toward the research methodologies we use to explore the social and political dimensions of health. In doing so, we open up spaces of dialogue with each other and colleagues in other subdisciplines regarding the unique position biological anthropologists occupy at the nexus of science and social science. These communications in turn facilitate shared, *intradisciplinary* research that unravels

the social and biological complexities of illness, disease and disability.

#### **"Stand fast and suffer long": The ethics of repatriation.**

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Ralph Waldo Emerson (1904) envisioned "A Nation's Strength" in "Men who for truth and honor's sake, Stand fast and suffer long." The repatriation of human remains to descendant communities is similarly based in ethical truths and upheld by the endurance of those who began this work and continue to facilitate the process today. Now over two decades old, federal and state legislation reinforce the moral imperative of respect for diverse cultural perspectives and work to facilitate the interests of multiple communities. However, upholding ethical responsibilities and executing the law is often contentious...but where should the necessary flexibility rest? In this presentation we discuss the 1) ethics and responsibilities that underlie repatriation, 2) legal mandates and applications, and 3) describe a protocol that facilitates respect for human remains and the interests of descendant communities, endeavors to preserve information, and is continually evolving to adapt to the individual and unique challenges of case-specific repatriation projects. In the end, the strength behind repatriation is its moral imperative and the maintenance of integrity in the process involved.

#### **The Bronze Age cemetery from Hăpria, Romania.**

JENNA M. WATSON<sup>1</sup> and MIHAI CONSTANTINESCU<sup>2</sup>. <sup>1</sup>Anthropology, Wellesley College, <sup>2</sup>Anthropology, "Francisc I. Rainer" Institute of Anthropology, Romanian Academy, Bucharest..

This poster examines 27 Bronze Age human skeletons of the cultural group Livezile from the sight of Hăpria, Romania dating between 2900-2400 BC. The Livezile were located in the western branch of the Carpathian Mountains (Apuseni Mountains) in Transylvania, Romania. This group produced 21 funeral discoveries (66% cemeteries, 25% groups of graves and 9% isolated graves). Hăpria is the only site with flat graves. Skeletal analysis indicates an age range from infants to adults in their 40's. Among the sample were seven children ranging from six months to 10 years, and one teenager approximately 13-16 years old. Of the 27 skeletons analyzed, 10 were male, five were female and 12 were undetermined due to poor preservation of sexual characteristics.

The most common disease present was Degenerative Joint Disease (DJD) with 10 of the 27 (37%) individuals affected. Of the 10 skeletons exhibiting DJD seven (70%) were at least 30, but no older than 50. Foot bones (50%), proximal and distal femurs (30%), thoracic vertebrae (40%), and proximal ulnae (30%) had

the highest incidence of DJD. One case of trauma was present. A male skeleton displayed an oblique cut mark going anterosuperior to posteroinferior on the left medial calcaneus. No evidence of healing suggests he may have died from his wound.

Analysis of the tumulus graves can provide clues to the social organization of the Livezile, and skeletal analysis can help us to better understand the cultural and physical changes communities from the Apuseni Mountains experienced over their existence.

#### **Fluctuating and directional asymmetry: Skeletal evidence for life history theory and human evolutionary ecological variation in an archaeological South Dakota Arikara population.**

ERIN B. WAXENBAUM and BLAKE ERICKSON. Anthropology, Northwestern University.

The majority of human infant long bones are physically symmetrical at birth with factors such as use preference, malnutrition, and disease contributing to asymmetrical growth during development. The present research uses life history theory and evolutionary ecology to explore fluctuating and directional asymmetry in South Dakota Arikara skeletal remains (700-1862CE).

Right and left maximum lengths of the humerus, radius, femur, and tibia were recorded for 308 individuals. Data were separated by age range and sex in order to analyze whether skeletal asymmetry changes over development and whether adult males and females are equally asymmetrical. Comparison with an archaeological New Mexico Ancestral Puebloan sample (n=198) was also performed in order to assess differing cultural impact on asymmetry.

Our results contribute to and reaffirm previous research showing that infants are predominantly symmetrical. In turn, children exhibit fluctuating asymmetry while adolescents and adults exhibit directional asymmetry. Among the adults sampled, females are more asymmetric than males in humeri and radii (p=0.209; p=0.189) while males are significantly more asymmetric than females in femora and tibiae (p=0.023; p=0.048). Adult male and female Arikara exhibit significantly more asymmetric humeri than their same-sex Ancestral Puebloan counterparts (p=0.000; p=0.002). As a whole, this research presents asymmetry as a single biological manifestation resulting from cultural activities and environmental stressors on an archaeological population.

#### **Ancient footprints in Ciur-Izbuc Cave, Romania: Preservation and re-analysis.**

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In 1965, Ciur-Izbuc Cave in the western Carpathian Mountains of Romania was

discovered to contain nearly 200 ancient human footprints. At that time, primary researchers interpreted the footprints to be those of a man, a woman and a child who entered the cave by an opening which is now blocked but which was usable in antiquity. The age of the prints was based partly on their association with cave bear footprints and bones, and the belief that cave bears became extinct near the end of the last ice age.

Since their discovery, the human and bear evidence and the cave itself have attracted spelunkers and other tourists, so that the ancient footprints are in danger of destruction by modern humans. In an effort to conserve the footprints and information about them and to reanalyze them with modern techniques, Ciur-Izbu Cave was restudied in 2012.

Modern results are based on fewer than 25% of the originally described human footprints, the rest having been destroyed. It is impossible to confirm some of the original conclusions. The footprints do not cluster about three different sizes, and the number of individuals cannot be known. Two cases of bears apparently overprinting humans help establish antiquity. However, insufficient footprints remain to determine stride lengths, lines of progression, or foot angles. Detailed 3-D mapping of the footprints does allow a more precise description of human movements within the cave.

For discoveries of such natural treasures, we recommend the most thorough scientific analysis possible at the outset, especially where land usage rights do not permit restricted access to them.

#### **An analysis of the *Ardipithecus ramidus* pelvis reconstruction using 3D geometric morphometric techniques.**

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As a putative hominin, *Ardipithecus ramidus*' mosaic postcranium is argued to demarcate the morphological transition from arboreality to bipedal locomotion that occurred following the human-chimp divergence. Its interpretation as a terrestrial biped is largely confined to pelvic features, while its arboreal adaptations are argued to relate to features on the upper limb and the foot. In particular, the forelimb complex has been used to postulate *Ar. ramidus* as an above branch quadruped that utilized palmigrady while bridging and climbing, with possible functional affinities to early Miocene stem hominoids such as *Proconsul*.

Here we test these interpretations with a 3D morphometric analysis of the reconstructed *Ar. ramidus* innominate. 23 homologous pelvic landmarks were collected on a range of extant

anthropoid taxa (platyrrhines, hominoids, cercopithecoids) and several fossil hominoid taxa (*Proconsul nyanzae*, *Ar. ramidus*, *Au. africanus* and *Au. afarensis*). These data were GPA adjusted and subjected to standard multivariate analyses, including PCA.

Our results show that in a number of respects, the ARA-VP-6/500 reconstruction is morphologically distinct from the innominate of *H. sapiens* and australopiths, and, unlike those taxa, conforms to broad allometric relationships observed in extant monkeys and apes. Overall, the reconstruction most closely resembles the innominates of extant catarrhines and *P. nyanzae*. However, the posteriorly projecting ischium and unusual mediolateral positioning of the ilium distinguish *Ar. ramidus* from most other anthropoids, while the relative orientation of the ischium and pubis to the ilium is similar to both cercopithecoids and australopiths. The functional implications of these results are discussed.

#### **Behavioral effects of human activity on wild white-faced capuchins (*Cebus capucinus*) at Curú Wildlife Refuge and Hacienda in Puntarenas, Costa Rica.**

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White-faced capuchins (*Cebus capucinus*) in Curú Wildlife Refuge (CWR), located in Puntarenas, Costa Rica, were observed using instantaneous focal animal and group scan sampling for 8 weeks in March and April 2012. The monkeys were observed in order to assess the impact of human development and presence on monkey behavior, with a focus on aggressive, affiliative, and foraging behavior; the primary goal was to ascertain whether the capuchin populations at CWR are overhabituated. Though there exist no clear behavioral parameters that measure overhabituation, it can be defined as an extreme state of habituation in which non-human primates not only lose fear of humans, but also actively include humans in social interactions or treat them as a resource for food. Two groups (approximately 20-30 individuals each) of capuchins were observed. The first, located near the tourist development at the southwestern area of CWR, represented a habituated population that regularly foraged, rested, and groomed in the presence of humans. The second, located in the northeastern area of CWR did not visit the center of human activity and exhibited fear of humans. The habituated group exhibited significantly fewer instances of threatened behavior in response to human presence ( $F=39.04$ ,  $df=1,58$ ,  $P<0.0001$ ) and spent significantly more time eating and foraging ( $F=40.4$ ,  $df=1,149$ ,  $P<0.0001$ ). While the habituated monkeys at CWR may not be overhabituated, they could become that way as development, especially ecotourism, increases. Overhabituation is a problem that affects capuchins in Costa Rica. It is critical that the consequences of habituation be studied more carefully.

#### **Heel-strike and impact transient during bipedal walking: Implications for the acquisition of a habitual bipedal gait.**

JAMES T. WEBBER and DAVID A. RAICHLIN. School of Anthropology, University of Arizona.

Human bipedal walking is characterized by a habitual "heel-strike plantigrade" gait. However, the significance of foot posture during walking is not as well understood. Studies suggest employing a heel-strike when running may lead to injury due to the magnitude of impact transient forces upon initial contact and running with a mid-foot strike reduces these forces without significantly increasing the cost of transport. This work leaves open the questions of 1) do mid-foot strikes produce similar kinetic advantages during walking, and if so, 2) why should humans' heel-strike at any speed? In this study, we use kinematic and kinetic data to examine the energetic advantages a plantigrade gait confers during bipedal walking. Subjects ( $n=11$ ) walked at self-selected speeds using both a heel-strike and mid-foot gait, and we compared walking speed, walk-to-run transition speed, the estimated costs of locomotion (lower limb muscle volume activated during walking), and impact transient forces. Compared to normal heel-strike gaits, mid-foot gaits decreased impact transient ( $p<0.001$ ), but increased active muscle volume ( $p=0.0099$ ), decreased walking speed ( $p=0.0478$ ), and reduced walk-to-run transition speed ( $p=0.016$ ). Thus, in walking, as opposed to running, mid-foot strikes offer the advantage of a reduced impact transient but compromise with an increased energy cost and a slower walk-to-run transition speed. These trade-offs may be a key to understanding the functional benefits of heel-strike during walking. Given debates over the locomotor mechanics of early hominins, this study contributes new data to our understanding of the adaptive advantages of a striding bipedal gait during human evolution.

#### **Hands up! Estimating paleodemographic rates from archeological data.**

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This paper is about modelling the rate at which events occurred from an archeological context. We employ the method for seven Mediaeval Scandinavian cemeteries to estimate yearly burial rates: the yearly number of burials in a community. The estimated rate is a proxy for the changes in population size of the community analysed.

The archaeological indicator used is the way the lower arms were placed at the burial (arm position). The dating of the different positions is known. Observed frequencies of the various positions are used to estimate a temporal probability density function by Maximum Likelihood Estimation. The expected number of burials per year was calculated twice: once with

the parameter values from the fitted model and once with an assumed constant burial speed.

The populations analysed comprise different types of communities. The rural graveyards belonged to two small farming villages, and a monastery with two socially different groups of burials. The four urban cemeteries were used by a parish in a large town, an economically stressed suburban population, and two possible leprosaria. All communities experienced fluctuations in the burial rate, and show peaks at different points in time.

The estimated beta distribution fits the observed values better than a flat distribution. Arm position is a good indicator, but cannot define an exact time point at which a burial happened. Short-term events, like a single epidemic, will not be captured by changes in the burial rate; still the measure is sufficient to display long term trends in population fluctuation.

#### **A comparison of fluctuating asymmetry in the craniofacial skeleton of residents of Mexico and immigrants from Mexico to the United States.**

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This study examines levels of fluctuating asymmetry (FA) in residents of Mexico and immigrants from Mexico to the United States. FA provides a measure of developmental stress in individuals. It is hypothesized that the migrant sample would represent individuals of a lower socioeconomic status who experienced higher stress levels during development and these individuals would consequently have higher levels of FA. The immigrant sample comes from the Pima County Medical Examiner's office in New Mexico. The individuals in this sample died while crossing the border into the United States. These individuals come mainly from Central and Southern Mexico and are thought to be mainly low socioeconomic status individuals. The resident samples come from two identified cemetery collections from Central and Southern Mexico with birth dates from the early to mid-twentieth century. Three-dimensional cranial landmarks were collected from 364 individuals. Geometric morphometric methods were used to calculate a FA score for each individual. Results indicate that the FA levels between the residents and migrants do not differ significantly. This presentation will discuss effects of sex on FA along with FA comparisons among Mexican migrants, residents, and a contemporary sample from the United States representing a higher socioeconomic group. These results will be contextualized in terms of current trends in the demographics of border crossers. The ability to accurately reconstruct developmental stress and socioeconomic status in human populations is of broad interests to researchers working on prehistoric, historic, and modern samples.

#### **Knee osteoarthritis and pain: data from the Osteoarthritis Initiative and their implications for reconstructing past quality of life.**

ELIZABETH WEISS. Anthropology, San Jose State University.

Osteoarthritis is the most common bone pathology found in the bioarchaeological record. How pathologies affected individuals in the past is of interest to anthropologists trying to reconstruct past lives. This study examines pain intensity in relation to anthropometric measurements, such as body mass index, and osteoarthritis severity. If pain increases with body mass index, then past populations may not have experienced pain as severely as modern populations since body mass has increased over time. Data for the analyses are from the OAI public use data set. The current study uses nearly 5000 individuals from OAI to aid in understanding pain. Pain was recorded on a patient-reported ten point scale. All individuals were diagnosed as having knee osteoarthritis; knee osteoarthritis severity was based on a three point scale of osteophyte formation. Body mass index was based on a height to weight ratio and values were placed in four categories (1 < 18.50, underweight; 2 = 18.50–25.00, normal weight; 3 = 25.01–30.00, overweight; 4 > 30.00, obese). Pain severity increased in individuals with higher body mass indices (chi-square = 135.58, P < 0.001). This relationship was also found within each osteophyte category (Mantel-Haenszel chi-squares ranging from 8.05 to 86.16, Ps < 0.01). These results suggest that an increase in body mass index causes an increase in knee osteoarthritis pain even when controlling for the severity of the osteoarthritis and, thereby, the results imply that individuals afflicted with osteoarthritis in the past may have experienced less pain than modern individuals.

#### **Laying the Yanomami to rest: the endless saga of the blood samples.**

KENNETH M. WEISS. Anthropology, Penn State University.

After years of struggle we are nearing the time when the Yanomami blood samples collected from Brazil nearly 50 years ago can be returned and laid to rest by their funeral rites. This has been a complex story of legitimate rights and grievances, demagoguery and posturing, misunderstanding, legitimate science and opportunism. Accusations made about the nature of research in this population have been sensationalized, but the merits (or otherwise) of these accusations are unclear. In any case, to the extent any population can withdraw from a study long after becoming part of it, for whatever (or no) reason, this will happen for the Brazilian Yanomami. It has not been easy, and perhaps more profoundly, the return will be symbolic and will not settle any of the legitimate grievances they may have, because whatever may have been done to, or for, the Yanomami, *no* evils have to my knowledge resulted from the blood samples themselves.

#### **Set apart: Why were these men dumped in that grave?**

KATHERINE J. WELCH<sup>1</sup>, THOMAS CRIST<sup>2</sup>, LINDA L. TAYLOR<sup>1</sup>, MONICA FARALDO<sup>1</sup> and MIHAI CONSTANTINESCU<sup>3</sup>. <sup>1</sup>Anthropology, University of Miami, <sup>2</sup>Programs in Physical Therapy and Sociology/Anthropology, Utica College, <sup>3</sup>Institutul de Antropologie, "Francisc I. Rainer" al Academiei Romane, Bucharest.

Present-day Bucharest (Romania) has been the site of repeated waves of conflict for centuries. We report on the physical evidence of this pattern exhibited in three sets of skeletal remains, recovered as part of a larger archaeological study of University Square and the cemetery associated with St. Sava church. The skeletons were recovered from a common grave 100m distant from the cemetery and dated to 1550-1650 AD. We collected qualitative and quantitative data on variables related to sex, age, ancestry and trauma. Our data show that all were male, aged 25-50 at time of death. Ancestral affinity was calculated with FORDISC software. The results suggest one male had European ancestry, another Asian and the third African. Each displayed signs of multiple healed and perimortem traumas, including sharp, projectile, and blunt force trauma. Lead shot was recovered from the neck area of two individuals. The third had an arrowhead in the same area, in addition to his having been beheaded. The orientation of the remains suggests that the bodies were buried unceremoniously. In sum, our ancestry findings are consistent with the biological diversity of entities contesting for control of the area. Their sex and age are consistent with the composition of armies of that era. Their bones disclose that their lives were marked by injuries and that each died violently, likely in armed conflict and/or execution. The ancestry and actions of these three individuals probably led to their deaths and their segregation from the local community cemetery.

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#### **Copulation calls of *Cercopithecus mona* in the wild.**

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*Cercopithecus mona* is one of the few guenon species that emits calls during copulation. Here, we describe the structure of copulation calls made by wild mona monkeys on Grenada and in Cameroon. Analog recordings were digitized and then analyzed using Raven Pro v.1.4. The copulation calls have two components: grunts, given by males, and warbles, given by females. Each component is emitted multiple times during heterosexual copulatory bouts. The total number of times each

component is given per bout is highly variable, as is the relationship between the two components. The grunt is a tonal, short-duration ( $\bar{x} = 0.097$  sec), low-frequency call (below ca. 3 kHz) that is similar to calls given in other contexts. In comparison, the warble is a frequency-modulated, longer-duration call ( $\bar{x} = 0.652$  sec) that is easily recognizable. Warbles show greater variation than grunts; they typically include three harmonics below 4 kHz, but can include higher frequencies. The distinctiveness of warbles compared to grunts suggests that a primary function of the mona copulation call may be to increase female reproductive success. Studies of other monkeys support this hypothesis; however, common explanations such as increased mating partners (sperm competition), increased parental investment, decreased infanticide, and the encouragement of synchronous breeding do not make sense for mona monkeys that have small testicles, little male parental investment or infanticide, and year-round breeding (on Grenada). Given that copulation calls are so rare among the genus, additional field studies are warranted to determine the function of these calls in *C. mona*.

#### Temporal changes in Arikara femoral torsion.

DANIEL J. WESCOTT<sup>1,2</sup> and DEBORAH L. CUNNINGHAM<sup>1</sup>. <sup>1</sup>Department of Anthropology, Texas State University, <sup>2</sup>Forensic Anthropology Center at Texas State.

Femoral torsion is a biomechanically relevant parameter that can aid in reconstructing activity in past populations. This study investigates temporal trends from the mid-sixteenth century to early nineteenth century in femoral torsion among the Arikara, a Great Plains Native American tribe that had a mixed subsistence economy based on horticulture, gathering, hunting, and fishing. Torsional angle was assessed by direct measurement and by using the orientation of the maximum bending rigidity ( $\theta$ ) at subtrochanteric in 119 females and 165 males from three variants of the Arikara Coalescent tradition. Previous research supports significant temporal changes in Arikara long bone diaphyseal shape and strength among females associated with increases in workload necessary to produce surplus crops during the historic period. While there were no major changes in the types of activities conducted by the Arikara during the Coalescent tradition, there was an intensification of crop and hide production by females to increase output for trade. The results of this study show that asymmetry in femoral torsion increases dramatically from the protohistoric (mean asymmetry = 7°) to the early historic period (mean asymmetry = 30°) among females. We hypothesize that the change in torsion angle may be associated with sitting posture. Specifically, the asymmetry in torsion may be related to females spending a substantial amount of time in a modified W-sitting posture that widens the base of support for the body and results in greater stability and comfort when sitting for long durations.

#### Habituation to tourists: Protective or harmful?

JESSICA L. WESTIN. Math/Science, Kirkwood Community College.

Human-modified habitats can have devastating consequences for primate populations. Mining, extractive foraging, agriculture, logging, etc., all dramatically change the landscape in which primates reside, often with dire consequences for the animals. Tourism projects, on the other hand, attempt to protect forest habitats and preserve primate populations for tourist enjoyment. Forests may be only minimally disturbed, and primates often habituate to tourist presence. This scenario begs the question: does habituation to tourists result in unintended negative consequences? I conducted a systematic study of tourism impact on red howler monkey health and behavior at Brownberg Natuurpark in Suriname, South America. My results demonstrate that monkeys living in close proximity to tourists are habituated to tourist presence (they responded less often to human disturbance than monkeys with infrequent human interactions). I also found, however, that tourist area monkeys changed their behavior patterns over the long term in response to tourist presence in ways that could affect their energy balance or nutritional status. Health comparisons between more- and less-habituated monkey groups also revealed poorer health in the habituated monkeys indicating that habituation may have made the monkeys more vulnerable to these negative effects. These results are especially important in the context of primate population management and ethnoprimateology, as tourism projects are promoted as conservation tools in many parts of the world.

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#### Dominance rank and exposure to predators in Wild Blue Monkeys (*Cercopithecus mitis stuhlmanni*).

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Many studies of cercopithecine monkeys implicate dominance rank as an important variable influencing fitness, but there is growing awareness of the paucity of data for many species, and variation in rank's effects. We studied how dominance rank affected the exposure of wild adult female *Cercopithecus mitis* to predators. Dominance hierarchies in blue monkeys have been characterized as stable but shallow. Focusing on adult females in two study

groups inhabiting the Kakamega Forest, Kenya, we monitored their location in the canopy and in individual tree crowns over a two month period. Although blue monkeys are generally arboreal, we found that high-ranking females were somewhat more likely than low-rankers to use the ground, which is likely risky. Otherwise, rank did not predict the location of individuals in the trees, and concomitant exposure to aerial predators. Our results confirm a previous report from a third group in our study population. They are also consistent with other findings suggesting that dominance rank has limited effects on behavior in this species, despite being readily detectable. Effects of dominance rank are clearly variable in cercopithecines.

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#### Adult kinda baboon (*Papio kindae*) behavior: Preliminary results from a two year study.

ANNA H. WEYHER and KENNETH L. CHIOU. Anthropology, Washington University in St. Louis.

For this study, we used a subset of data from 24 months of behavioral research on adult kinda baboons (*Papio kindae*) in Kasanka National Park, Zambia to investigate 1) the proportion of time males and females spend in proximity to one another, 2) the amount of time kinda females spend in proximity to other females compared to males, and 3) the frequency and directionality of opposite-sex grooming interactions. We examined 797 ten-minute focal samples totaling approximately 130 hours of data collection.

Grooming interactions were highly asymmetrical between the sexes, with male-to-female interactions accounting for 65% of observed opposite-sex groomings.

We calculated composite proximity scores (C-scores) in order to examine patterns of association among adults of both sexes as the number of observed associations over the sampling effort of dyad members, across distances of 0- 6 meters. C-scores show that all adult males and all adult females formed close associations, or "friendships," with one or more opposite-sex partners. Females on average had 2 male partners while males had 3.5. 52.3% of all proximity interactions were between males and females, 41.6% were among females, and the remaining 6.1% were among males.

These results stand in sharp contrast to findings in studies of other 'savannah baboon' species which are female-bonded, and to studies of baboon species in which females are the primary groomer in male-female relationships and rates of affiliative female-female interactions are higher than male-female interactions.

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**The reality of virtual anthropology: testing the utility of computer generated models for the quantitative assessment of the cranium.**

AMBER D. WHEAT and BRIDGET FB. ALGEE-HEWITT. Anthropology, University of Tennessee.

Recent advances in data acquisition methods for geometric morphometry offers opportunities for improving upon traditional procedures for craniofacial analysis by changing the way in which we access skeletal materials and evaluate population-informative traits. We argue that a virtual skeletal collection containing three dimensional models of the cranium would (1) improve ease of access to reference materials, (2) encourage experiential equality among osteologists in terms of the quantity and variation of materials analyzed, and (3) provide a wealth of study materials in a "virtual" bone lab. Multiple laser scans of individual cranium from six Danish cemetery populations in the Anthropological Data Base Odense University (ADBOU) skeletal collection were taken using the Next Engine Desktop Scanner. This high-definition color copy of each cranium allows for the study of the skeletal features in a fully-resolved three-dimensional space. Prior research shows promise for replacing the actual skeletal materials with virtual models. We confirm the quality of these models by comparing craniometric data obtained from the laser scans against coordinate data collected in the laboratory setting using a Microscribe digitizer and a subset of the actual crania. We demonstrate the unique advantages of virtual models in quantifying non-metric cranial traits by means of sliding semi-landmarks and coordinate meshes, using the open-access software, Meshlab and tpsDig/tpsUtil. We offer recommendations for three-dimensional model building using laser scans, coordinate extraction from these virtual crania, and the effective use of this high dimensional data for studies of human variation and for individual identifications in forensic contexts.

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**Relationship between foot proportions and gait performance in modern bipeds.**

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Although modern bipeds walk and run with ease, the biomechanics of bipedalism are anatomically and functionally complex. We examined timing and magnitude in forward advance of the lead swing foot with respect to heel elevation (plantarflexion) of the lagging support foot to further understand how human bipeds achieve economical stride lengths. We investigated foot anatomy with high-resolution MRI and walking kinematics with 3D motion capture in 40 healthy adults. Given the support

foot rises via plantarflexion as the swing foot dorsiflexes into touchdown, we expected 1) adults with a relatively short rearfoot to contact the ground with a swing foot positioned farther from the lag foot than adults with a relatively long rearfoot and 2) adults with greater mid-rearfoot length to increase stride length for a given foot angle.

This late terminal phase of walking gait represented  $7.4 \pm 0.5\%$  of the stride cycle, yet accounted for  $18.8 \pm 2.0\%$  of stride length. Small angular excursions characterized the lead limb contributing little to stride length:  $0.2^\circ$  dorsiflexion,  $2.0^\circ$  knee extension,  $1.0^\circ$  hip flexion. However, excursions of the lag limb were significantly larger and correlated more strongly with lead foot translation:  $13.5^\circ$  plantarflexion ( $r, 0.52$ ),  $2.0^\circ$  knee extension,  $7.4^\circ$  hip flexion ( $r, 0.78$ ). When sex differences were taken into account, mid-rearfoot length had a significant effect on lead foot translation ( $p = 0.04$ ). Thus, foot proportions and lag limb rotations that occur late in the gait cycle contribute markedly to stride length with implications for human evolution and locomotor energetics.

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**Stable isotopes and the three evolutionary forces in Biomedical Anthropology.**

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Disease, diet and climate are the three main evolutionary forces acting upon any living population. To understand the evolutionary dynamics and histories of diseases, and to reconstruct pathogenesis and epidemiology are the primary goals of paleopathologists, their overarching goal being the use of such information to inform modern medical knowledge, theory and practice. Because we are isotopic reflections of our physical environments and to some extent, our physiology, isotopic information can aid the understanding of disease, diet and environmental interactions. Here we use data from Africa and the Americas to demonstrate ways in which stable isotopes have been used to identify diet, environment (physical and social), and human behavior e.g., geographic mobility, infant feeding as risk factors of disease, and suggest ways that the potential contribution of stable isotopes to biomedical anthropology might be better realized. These include: 1) integration of isotopic data on mobility, physical and cultural environmental change with paleopathological data, 2) expanded use of tissue clocks with microsampling techniques, 3) development of other isotopes (e.g. sulphur, hydrogen, iron) and their integration with carbon, nitrogen, oxygen, strontium, and 4) use of compound specific analyses to refine diet reconstruction and better understand physiological and disease dynamics affecting proteins.

**Food for thought: The contributions of George Armelagos to food and culture studies.**

RANDOLPH J. WIDMER. Comparative Cultural Studies, University of Houston.

George Armelagos is well known for his academic contributions to the study of human health and disease in anthropological populations and is one of the founders of biocultural anthropology. However, George also contributed an enormous amount of research to the general topic of food and culture and has been instrumental in bringing biocultural studies to the general population in popular books and videos. These works include *Consuming Passions* a book about the anthropology of eating that attempts to understand society and culture through eating. He authored an article with Peter Farb entitled *The Food Connection in Natural History*. He also was instrumental in the video production "How Beer Saved the World", which discusses the importance of beer in the subsistence base of cultures and its role in the development of civilization. George participated in Wenner Gren Foundation International Symposium on Food Preferences and Aversions organized M. Harris and E. Ross in Cedar Key, Florida, October 23-30, 1984. Organized the Medical Anthropology Roundtables Luncheon and Wine and Cheese. 87th Annual meeting of the American Anthropological Association. November 17, 1988. Phoenix and was Invited Participant, National Academy of Science National Research Council, Food and Nutrition Board's Committee on International Nutrition in Washington, D.C.. I will highlight these contributions both to academia and to the general public.

**Competition for woodland and forest resources between humans and nonhuman primates in Tana River, Kenya.**

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The Pokomo people of the lower Tana River, Kenya, rely on woodland and forest products for construction material. The lower Tana River forests are also home to two endemic and endangered monkeys, the Tana River mangabey *Cercocebus galeritus* and the Tana River red colobus *Procolobus rufomitatus*. To investigate the pressure the Pokomo may exert on the primates' forest habitat, we held participatory workshops in 13 Pokomo villages in June and August 2011. We asked participants to list species used to build their houses and make other household items (canoes, beehives, mats, baskets). Species lists of the primate diets were compiled from previous long-term studies. Cultural importance indices (CI), measuring how many informants mentioned each species in each use category (housing poles, roof thatch, ropes, canoes, beehives, mats, baskets) (Tardio & Prado-de-Santayana, 2008), were calculated for each species listed by the Pokomo. We

calculated CIs for all use categories and seven housing pole categories. Four of the top five species in all use categories are in the top five diet species of the mangabey; only one is in the top five for the red colobus. When only housing poles are analyzed, only one of the top five used by humans is in the top five for the mangabey; there is zero overlap with the diet of the red colobus. Although CI and similar indices are common approaches when investigating plant use, we conclude that they fail to capture the amount used by the Pokomo and the use's impact on forest structure.

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**From the mouths of monkeys: Tuberculosis among synanthropic primates.**

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Tuberculosis has been considered a serious threat to laboratory nonhuman primates (NHP) for at least a century. Little is known about TB's prevalence in natural populations. The disease is caused by *Mycobacterium tuberculosis* complex (MTBC) bacteria and is rampant in areas of Asia, Africa, and South America, with >7 million new cases in 2010. These high-endemicity areas are also home to the majority of the world's NHP species. South and Southeast Asian human populations are unique in the world for their close, often intimate, relationships with NHP. NHP are kept as pets or performance animals, and are also found in temples, zoos, wildlife reserves, and urban settings.

We have shown previously that synanthropic (those that thrive in human-altered environments) NHP are at increased risk for human-associated diseases. Here, we tested 763 monkeys and 338 humans from South and SE Asia, which had varying degrees of interspecific contact, for the presence of MTBC nucleic acids in their mouths. Our data show that, in areas/contexts with the highest human prevalence of MTBC DNA in buccal swabs, NHP in the same context are also likely to have DNA from MTBC in their mouths at a similar frequency. Pet and temple NHP are significantly more likely than NHP in any other context to be positive for MTBC presence, and these results are consistent across time and by country.

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**Untold tales: Skeletons from the Little Bighorn contrasted with Seventh Cavalry medical documents.**

P WILLEY. Anthropology Department, Chico State.

Skeletal information constitutes the last stand for bioarchaeologists interpreting lives of past populations. But small sample sizes and vagaries of the skeletal system hinder the reliability of conclusions based on skeletal remains, limiting quality, detail and precision of interpretations. Although often acknowledged as inherent challenges, skeletal biologists rarely assess the limits of their analyses.

This study provides such a comparison, contrasting a skeletal series with medical documents. The two sources employed consist of Battle of the Little Bighorn (June 1876) skeletons (MNI=44) and Seventh Cavalry medical records (1866-1884, 20,155 documents). The research hypothesis predicts that skeletons from the Little Bighorn fail to manifest many of the illnesses documented in the Seventh Cavalry's written records.

The Little Bighorn skeletons demonstrate few ailments shown in the Seventh Cavalry's medical records. The most frequent skeletal defects consist of congenital, infectious, non-diagnostic and traumatic defects. On the other hand, using the 19<sup>th</sup> century medical nosology as a framework, nearly two thirds (64.1%) of the records' ailments could not be diagnosed skeletally. Approximately one third of the records might possibly be demonstrated by the skeletons. And only 0.2 percentage of the medical records directly and certainly involved the skeletal system.

As gripping as the tales that skeletons tell about their illnesses, many stories lie secreted within them or omitted altogether. These deficits, in brief, are the tales the skeletons do not tell.

**The differential burn patterns in a hanging specimen compared to a specimen positioned on the surface.**

AMANDA N. WILLIAMS. Department of Anthropology, University of Montana.

Forensic anthropologists can analyze burn patterns on a victim's body to infer about the position of the body during a fire. The analysis of burn patterns in relation to position around time of death can potentially provide information to investigators about the events surround an individual's death. This study seeks to examine the similarities and differences in the direction of burn patterns on a body that is hanging up compared to a body lying flat on the floor. This study found that there were differences in burn patterns between the two specimens. The specimen hanging up exhibited a black charring pattern that covered over 90 percent of the body. The floor specimen exhibited a different discoloration pattern, from tan, to dark brown, to a light grey color on the exposed surface. The surface lying against the floor exhibited little to no discoloration and exhibited an outline on the body that was reflective of its position lying against the floor.

These findings are important because the floor specimen is consistent with what previous scholars have found in relation to the severity of burn patterns in individuals that have been positioned on the surface. The specimen hanging up exhibited a significantly different pattern that makes it possible to distinguish it from the floor specimen. These findings can be useful for investigators because they could potentially use this information to determine if a body was originally placed in the position it was recovered in.

**Evidence of possible interpersonal violence in a female bronze age skeleton from Romania.**

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An archaeological excavation in 1973 uncovered the skeletal remains of a woman from the Bronze Age Monteoru culture. The remains were found near Săucești village in Bačau County, eastern Romania. Burial 1973 presents fracture patterns consistent with modern, documented cases of interpersonal violence. Bioarchaeologists caution to be wary of inferring interpersonal violence from skeletal remains alone; however, it is important to recognize contextual markers and fracture patterns that suggest the possibility of non-accidental injuries sustained by specific sex and age groups in a population. Analysis of the pelvic girdle and the cranium indicate that Burial 1973 was a woman who was 40-45 years old when she died. Her skeleton exhibits two healed, depressed lesions on the frontal and left parietal bones and healed fractures of the distal thirds of her right radius and ulna. Observation and measurements of the cranial lesions suggest blunt force trauma. The right forearm fracture appears to be a parry fracture, but also could represent a Colles fracture resulting from a fall. Another excavation in the same region in 2003 revealed the remains of second Monteoru woman (Burial M. 11/2003) who also presented healed depressed fractures of her right parietal and occipital. Interpersonal violence and, by extension, domestic violence, could be an explanation for these fractures given the sex of the individuals and their patterns of injury. The possibility of accidental injury, however, cannot be excluded in the absence of a larger sample and more specific contextual evidence.

**Reconstructing the craniofacial maturation of Neandertals.**

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Neandertal immature craniofacial remains are well preserved, providing a unique diachronic perspective on their growth and development. To infer the craniofacial

maturation of Neandertals, a large sample ( $n = 42$ ) of fossil infants, juveniles, subadults and adults is compared to an ontogenetic sequence for modern humans ( $n = 294$ ) using an interpolation of growth trajectories generated from piecewise regression. Modeled growth trajectories and shape changes in the calvarium, face and mandible are subsequently explored in a multivariate framework. The two species of *Pan* (*P. troglodytes*,  $n = 156$  and *P. paniscus*,  $n = 151$ ) provide a benchmark upon which to evaluate the differences between Neandertals and modern humans. Craniofacial changes during the postnatal maturation of Neandertals and modern humans are complex and no single description can adequately characterize differences in growth rates and the duration of the growth of traits. Although Neandertals are larger at birth for many craniofacial features, modeled growth curves indicate Neandertal life cycle maturation was accelerated only for some mandibular and palatal dimensions. For dimensions of the calotte, such as upper cranial height and cranial length, it is modern humans who exhibit a more rapid growth rate but with a shorter duration of growth compared to Neandertals. To the extent that life cycle age can be reconstructed from dental eruption, modeled growth curves for Neandertals imply that they achieved craniofacial maturation at ages comparable to those characterizing modern humans suggesting fundamental patterns of human life history arose in an ancestor of archaic and modern *Homo*.

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#### Isotopic measures of intra-individual variation in fetal bone collagen and apatite.

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Stable isotope analysis has been used to reconstruct infant feeding practices, and to evaluate developmental metabolic conditions. Several studies have documented isotopic changes during growth of tissues with relatively fast accretion rates, however intra-individual isotopic variation within these tissues has not been fully addressed. To evaluate intra-individual variation, 40 bone samples were collected from a well-preserved fetal individual (37 weeks gestation) from the Kellis 2 Cemetery (c. 100-360 AD), Dakhleh Oasis, Egypt. Samples were selected based on known time-sensitive fetal development of primary and secondary ossification centers. Results from analyses of bone collagen ( $n = 22$ ) indicate intra-individual variation greater than 1.2‰ for  $\delta^{13}\text{C}$  and 2.7‰ for  $\delta^{15}\text{N}$ . Results for bone carbonate ( $n = 18$ ) indicate variation greater than 1.4‰ for  $\delta^{13}\text{C}$ . There is significant variation in  $\delta^{15}\text{N}$  ratios between areas of bone that have undergone

recent rapid growth, versus bones with more established ossification. These variations may represent intramembranous versus endochondral ossification within the individual, emphasizing that timing of fetal bone growth should be taken into account when selecting samples. This also suggests that increased demands for energy and protein placed on the mother during pregnancy may be evaluated using high-resolution techniques on fetal remains.

#### The effects of resource stress on rates of traumatic injury in medieval and post-medieval southern German and alpine Austrian populations.

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The relationship between conflict and resource availability has been frequently documented in archaeological and ethnographic research. We test the hypothesis that high resource stress is correlated with traumatic injury by examining trauma in five German and Austrian skeletal series dating from the 10<sup>th</sup>-19<sup>th</sup> centuries AD. The Little Ice Age (LIA), ca. AD 1300-1850, was a time of unpredictable and cold weather that historical climatologists associate with increased resource stress. The prior period was warmer and temperatures less variable. This comparison of pre-LIA and LIA periods provides the context for addressing impacts of resource stress on rates of traumatic injury.

The presence of traumatic injuries was quantified on an individual level and by three body regions: the cranium, ribs, and long bones. 12.8% of LIA individuals (24/188) and 12.3% of pre-LIA individuals (7/57) showed evidence of traumatic injury. The frequency of cranial and long bone trauma was greater in the LIA, while the prevalence of rib trauma was greater in the pre-LIA. None of these temporal differences reached statistical significance (chi-square;  $p > 0.05$ ). These findings suggest that more complex versions of the resource stress-violence model should be applied in this context, that LIA-associated resource stresses were variable enough for conflict to be mitigated in these communities, or that traumatic injury in the LIA is not visible in the skeleton.

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#### The number of vertebrae in early hominins: insights from *Australopithecus sediba*.

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The vertebral column plays a central role in posture and locomotion, including bipedalism in the human lineage. Despite this, the evolution of its numerical composition (regional number of vertebrae expressed as a vertebral formula) is contentious and not well understood. Compared to our closest living relatives, chimpanzees and gorillas, modern humans have shortened thoracic and longer lumbar regions (12- versus 13-thoracic and 5- versus 4-lumbar vertebrae). Previously known early hominin partial vertebral columns (*Australopithecus africanus* and *Homo erectus*) are either transitional in appearance (Sts-14) or have fragmented, incomplete thoracolumbar transitions. New material attributed to the Nariokotome *H. erectus* skeleton demonstrate that this individual had the same pattern as modern humans (12T:5L), along with a cranially-placed transitional vertebra (the one in which zygapophyseal orientation changes) compared to modern humans. Here, we provide new data evidenced from two partial skeletons belonging to *Australopithecus sediba* (MH1 and MH2). Together, they preserve 25 vertebral elements, including the transitional and last thoracic vertebrae, which are complete and preserved in articulation. Based on multiple lines of evidence, we reconstruct the vertebral column of *Au. sediba* with 7-cervical, 12-thoracic, 5-lumbar, and 5-sacral vertebrae, along with a cranially-placed transitional vertebra. We argue that this pattern also characterized *Au. africanus* and African *H. erectus*. This contrasts with recent models of vertebral formula evolution (e.g., that implied in the interpretation of *Ardipithecus ramidus*). Finally, we speculate on the evolutionary history of the hominin vertebral column, including the LCA and earliest hominins, as well as functional implications of proposed vertebral patterns.

#### Paradox and promise: The role of recent advances in paleodemography and paleoepidemiology to the study of ancient "health" patterns.

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In the twenty years since Wood and colleagues published the "Osteological Paradox," bioarchaeology has made tremendous analytical and methodological strides reflecting its commitment to a truly inter- and multidisciplinary framework. While scholars continue to reference the publication and ponder the theoretical implications with respect to their data, the methodological challenges presented in the publication and associated with analyzing death assemblages have been largely ignored with several notable exceptions. An unfortunate result has been the fragmented conceptual and operational definitions tied to such terms as stress, health, adaptive success, and morbidity, among others. In far simpler terms, it is unclear

what bioarchaeologists are measuring when counting lesions on bones and teeth.

In response, this paper highlights recent methodological advances in paleodemography and paleoepidemiology through case studies from the Late Pre-Columbian periods in Illinois and Ohio River valleys and elsewhere. Fundamental issues addressed include 1) effective age estimation techniques, 2) coding for paleopathological data, and 3) statistical models for right-censored data. The results from recent analyses of well-known skeletal assemblages, such as Dickson Mounds and Norris Farms, are compared and contrasted with previous investigations. Emphasis is placed on analyzing age- and sex-specific mortality patterns prior to, and in conjunction with, the statistical analysis of lesions and other routinely collected data in bioarchaeology. The methods and results presented provide one means to tackle the issues of selective mortality and heterogeneity of frailty.

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#### **Trade-offs between intra-group reproductive competition and inter-group territorial competition in male chimpanzees.**

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For male chimpanzees, each additional male group member poses a trade-off in terms of reproductive benefits and costs. Groups with more males are more likely to win intergroup contests, and thus defend larger territories, providing more food for self, mates and offspring. At the same time, each additional male represents increased competition for mating opportunities. Here we use observational and genetic data to examine these tradeoffs in the neighboring Mitumba and Kasekela communities in Gombe National Park. Coalition size had important consequences: as the Kasekela males increased their numerical advantage, they spent a greater proportion their time ranging within historic Mitumba range (N=14 years; linear regression:  $R^2=0.53$ ;  $P=0.003$ ). Despite this, two of the Mitumba males (Rudi and Edgar) reduced their coalition strength by killing their group's other adult male, Vincent. During Vincent's tenure as alpha male (1996-2004), he sired 4 of 6 known paternities, while Edgar and Rudi each obtained only one. After killing Vincent, only Rudi and Edgar sired offspring, obtaining 4 and

2 paternities, respectively. Both of the attacking males thus increased their proportion of paternities after killing Vincent – but suffered costs, including not only increased competition for territory, but also the death of an infant killed during an intergroup encounter. These findings underline the intensity of reproductive competition among male chimpanzees, and suggest that under certain conditions, chimpanzees may be more sensitive to the short-term gains obtained from eliminating within-group rivals than to the resulting long-term costs of reducing their coalition size for intercommunity competition.

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#### **Defining, operationalizing, and assessing the relationship between stress and health in contemporary Tanzanian mothers and children.**

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In 1926, Canon proposed that health occurs when organisms are at physiological homeostasis and added that any external factor with the potential to disrupt physiological homeostasis be labeled stress. The second law of thermodynamics indicates that organisms are constantly stressed as they strive to maintain physiological homeostasis in the face of entropy. The ubiquity of stress makes it difficult to determine which predictor and outcome variables to consider when seeking to understand the etiology of health. For those who conduct research in cultures other than their own, this difficulty may be compounded by ethnocentrism. Adopting Canon's definitions, we assess health among 141 Tanzanian mother-child dyads. We seek to overcome the difficulties described above by spreading our bets; we incorporate multiple health outcome measures (growth, biomarkers of immune function and iron status) and potential predictors (maternal mental health, subjective social status, food insecurity and socio-demographics). Variables were selected on the basis of validated research among populations occupying similar environments and our understanding of the physiology of stress. Preliminary analyses indicate that child and maternal nutritional status are not associated with wealth, food insecurity, maternal mental health, or subjective social status. Among children <1 year of age, high food insecurity and low subjective social status are associated with higher inflammation, an association which is partially mediated by maternal mental health. Implications for bioarchaeology include the need to consider as many health outcomes and

predictors as possible and to recognize that stress may be mediated by variables such as mental health.

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#### **A comparison of aging methods and hazard analyses using a skeletal sample from the Larsen Village Cemetery (39WW2) in South Dakota.**

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Age estimation methods utilized in Paleodemography have long been criticized for their inability to accurately reflect the population being studied. Milner and Boldsen (2012) argue that there are few methods to systematically and quantitatively combine information from independent features within a single skeleton, and that age estimations without terminal ages or that do not reflect the older individuals in a population produce bias age structures. The age-at-death estimation method chosen has the potential to change the hazard analyses reliant on accurate estimations.

This study examines the adult mortality profile for the protohistoric, Postcontact Coalescent, Larsen Village Cemetery (39WW2) from South Dakota (N=197). The purpose of this study is to demonstrate how different aging techniques affect the mortality profiles using traditional aging methods (e.g. Lovejoy et al. 1985), transition analysis, and the subjective/experience-based approach suggested by Milner and Boldsen (2012).

Results from the Gompertz and Gompertz-Makeham hazard models suggest a similar demographic profile for the Larsen Village Cemetery as suggested by Owsley et al. 1979. The risk of death for young adult females and individuals over 50 years of age is high. An increase in older individuals (70-80 years old) is suggested when transition analysis is used. Ironically, there were significant correlations between the different age-at-death methods utilized, which supports Wilson and Steadman's (2007) findings using the Orendorff skeletal sample. Also, these findings support Milner and Boldsen's (2012) suggestion that experience based methods may fair no better or worse than maximum likelihood estimations derived from transition analysis.

#### **Social differentiation among Hualcayán burials: A bioarchaeological analysis comparing external long bone measurements in the North-Central Highlands, Peru.**

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This bioarchaeological study serves to determine whether the socio-political status of a

population is reflected in the composition of the looted *machay* tombs at Hualcayán (1 AD - 1400 AD) in the north-central highlands, Peru. Archaeological studies of Andean mortuary practices reveal much about the social organization of kin-based corporate groups, or *ayllus*. *Ayllus* emphasize unity as well as hierarchy and group affiliation determines access to labor, land, water, and other collective assets. Elite *ayllus* had the responsibility to fulfill certain obligations—including participation in political decision-making and religious rituals. A privileged *ayllu* interred their deceased in large funerary structures to convey the status of the individuals buried.

The cemetery consists of approximately 90 *machay* tombs that vary from small semi-circular rooms beneath natural rock crevices to chambers built underneath large boulder outcrops. This study compares the external long bone dimensions between one large and one small *machay* to test whether the differing tomb sizes reflect disparities in socio-political standing between *ayllus*. Non-elites with heavy workloads put physiological stress upon their bodies and generally display more robust long bones compared to those partaking in administrative or ritual activities. Measurements documenting a lower midshaft circumference of the tibiae and femurs from the large tomb may suggest that privileged *ayllus* buried group members in the larger *machays* to express the powerful social position of the deceased. The results of this study demonstrate how skeletal analysis may reflect social differentiation among prehispanic Andean groups.

**The Royal Hypogeum and Tomb VII of the Middle/Late Bronze-Age palace from Qatna (Tell Mishrife, Syria): Burial places of the elite?**

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Excavations at the ancient city of Qatna brought to light one of the largest palaces from the Middle Bronze Age in the Near East. In the years 2002 and 2009, two rock-cut chamber tombs - the four-chambered Royal Hypogeum (RH) and the double-chambered Tomb VII - were discovered underneath the palace. The tombs had been in use until the Late Bronze-Age and remained undisturbed after the destruction of the Palace c. 1340 BCE. Precious grave goods and the integration of the tombs into the palace architecture suggest that members of the royal family (RH) and members of the social elite have been interred in them.

Except for a few articulated elements/skeletons, most of the bones in both tombs were found commingled and more or less highly fragmented. For the RH the minimum number of

individuals (MNI) was estimated at 20 whereas it was much higher in Tomb VII (preliminary data suggest 78). Individuals from both sexes and of all age groups were represented. Osteoarchaeological indicators point to overall favourable living conditions for the interred adults in both tombs (very low prevalence of traumatic lesions and degenerative joint disease, low prevalence of caries along with generally minor tooth wear). Several bones exhibit changes indicative of DISH and HFI; conditions which have been linked to metabolic disorders. The study of the skeletal remains thus provides interesting insights into the life style of the "social elite" of the ancient city of Qatna.

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**Social learning of food preferences in juvenile chimpanzees.**

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Foraging is an essential component of survival for any animal, and yet remarkably little is known about how juvenile primates develop capacities to forage successfully. For example, how do young primates learn which foods are appropriate to eat? One possibility is that they observe which foods other individuals have eaten, relying on cognitive capacities for social learning. Here, we utilized an experimental approach to investigate the capacities of young chimpanzees (*Pan troglodytes*), ages 3 to 11 years, to learn socially about novel foods. We conducted a series of four experiments assessing whether young chimpanzees would observe the behavior of a demonstrator in choosing between two novel, yet palatable, food items (dried fruits). The four experiments tracked subjects' capacities to learn from: 1) a conspecific (peer) demonstrator, 2) a human demonstrator, 3) multiple human demonstrators, or 4) a human competitor. Our results demonstrated that young chimpanzees were significantly more successful in learning about novel foods in a competitive context than in "neutral" or cooperative learning contexts, with these results apparent in both their overall performance and their initial choice between the two food items (or first trial performance). These results build on prior work indicating that chimpanzees are more proficient in utilizing social cues to locate hidden food in competitive contexts. They suggest that competitive feeding interactions may be critical in how chimpanzees learn about novel foods in their environments. Our findings also prompt continued study of the role of social learning in the acquisition of foraging capacities among juvenile primates.

**The co-association of hypoplastic enamel defects, carious lesions, and non-specific stress in subadults from pre-Columbian Tennessee.**

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The health contexts of the subadults from the Late Archaic and Late Mississippian periods provide the interpretive context for the occurrence of deciduous hypoplastic enamel defects (HED). The subadults which possessed deciduous dentition (skeletally <7 years of age) from 7 sites (N=386) from the agriculture-intensive late Mississippian (AD 1300-1550) period of East Tennessee were compared to the same skeletal age cohort from 5 sites (N=111) which reflected a hunter-gatherer subsistence economy and dated to the Late Archaic (2500-100 BC) period of west-central Tennessee. Analysis of the data focused on comparing and contrasting health status indicators (growth stunting, cribra orbitalia, porotic hyperostosis, LEH, and periostitis) with HED between samples of subadults which differ in subsistence and settlement pattern. The prevalence of HED and other pathologies between temporal groups by age cohort (infant [0-2 years], child [2-5 years] juvenile [5-7 years]) were unexpectedly not statistically significant. Indeed, it appears that the Late Mississippian pattern of HED is a more exaggerated version of the pattern observed in the Late Archaic. Additionally, the results of the statistical analyses indicate some significant trends between the Late Archaic and Late Mississippian subadult samples. For example, for the subset of cases which had dental, cranial and long bone data, very statistically significant co-associations were found for carious lesions and non-specific infection (p=0.0100) and with HED.

**The rhesus macaques (*Macaca mulatta*) of India: A liminal animal.**

LINDA D. WOLFE. Anthropology, East Carolina University, Anthropology, East Carolina University.

Donaldson and Kymlicka in Zoopolis (2011) divide animals into three groups: domesticated, wild, and liminal animals. Liminal animals are different than domesticated and wild animals in that their habitats overlap with humans but individual humans do not own them. Examples include raccoons, squirrels, and feral domestic cats. Liminal animals may have domesticated or wild counterparts but have adapted to their anthropogenic habitats and are not easily domesticated or reintroduced into the wild. Rhesus monkeys are an example of a liminal animal that live in empty houses, parks and public gardens in the cities of India. They accept handouts of food, steal food from homes and markets, and forage for insects and vegetation wherever they are available. The overwhelming dangers to city monkeys are people who do not appreciate their presence and feral domestic dogs. While Westerners may be aware of the liminal animals living around them, they do not encounter monkeys in their daily activities. Moreover, Western religious literature lacks a role of animals such as that found in the role of Hanuman, the monkey semi-God, in the Hindu literature of the Ramayana. Because of popularity of the Ramayana and the role of Hanuman, monkeys are afforded protection and respect by the Hindus of India. As a result of the

misunderstanding of the position of monkeys in Indian culture, news stories that appear in Western newspapers are often misleading. This poster explores the ethnoprimateology of the rhesus monkey of India and the misunderstandings of Western news reporters.

**Skeletal stress markers in Korea's Joseon Dynasty population and their relationship to burial types.**

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The aim of this research is to examine whether there is an association between skeletal markers of physical activity (i.e., degenerative joint disease, enthesopathies, Schmorl's nodes) and burial types (i.e., earth-pit and lime-mortar type) in the Joseon dynasty population, of Korea. We hypothesized that the skeletal markers related to physical activity would be differently represented along burial types of the dead.

To test the hypothesis, 170 individuals from Seoul, Korea (mid 15<sup>th</sup> – early 20<sup>th</sup> century) were examined. The frequencies of DJD, enthesopathies in the 6 peripheral joints (i.e., shoulder, elbow, wrist, hip, knee, and ankle), two types of vertebral DJD (i.e., intervertebral and apophyseal joints), and SN in the spine were analyzed. The association between the frequencies of pathologies and burial type was analyzed by the Cochran-Mantel-Haenszel test in which age and sex were controlled.

The results revealed that there is no significant association between DJD in the peripheral joints and SN, and their relationship to burial type. However, when it came to enthesopathies, the ulnar tuberosity in males and linea aspera in females showed a significant association with burial type. In the intervertebral joints, cervical and thoracic region of males and thoracic and lumbar region of females revealed a significant association with burial type. The apophyseal joints showed a significant association with burial type in only cervical region of males. These results enable us to understand the nature of skeletal markers of physical activity and make inferences about the lifestyle of the Joseon dynasty population of Korea.

*This study was conducted by Brain Fusion Program Research Grant (2010) from Seoul National University.*

**Strategies in below branch locomotion in non-specialized quadrupeds.**

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The shift to specialized suspensory locomotion is interpreted as a major transition during the primate evolution. The ability to locomote both above and below branches has many potential benefits including balance and foraging, but presents challenges associated with safety and energy expenditure. There is limited data about which, if any, mechanical solutions

animals use to meet these challenges. Here we explore the limb mechanics of above and below-branch locomotion in a relatively large-bodied primate (*Varecia variegata*). We test the hypotheses that during inverted quadrupedalism (1) the hands and feet remain above the substrate to provide security; (2) that the effective limb length (ELL) is greater than in above-branch locomotion, thus requiring less muscular effort to support the body against gravity and providing longer limbs for swinging locomotion.

Video recordings of *V. variegata* (n=3) walking on a horizontal pole were digitized for hand, foot, shoulder and hip position throughout the stride. Contrary to our hypotheses, during inverted walking animals adopted more crouched (pulled-up) postures with shorter ELLs. This crouched movement may engender higher metabolic costs compared to above-branch walking. The pattern of hand and foot position throughout the stride is similar during both above- and below-branch locomotion: The foot remains on the same side of the substrate as the animal's body, the hand on the opposite. This hand position maintains the ability to pull the hands and body towards the branch at any time. Conservation of gait between locomotor orientations may have been advantageous during the evolution of specialized suspensory locomotion.

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**A biocultural approach to warfare and violence during the late prehistoric period in the Middle Cumberland region of Tennessee.**

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A biocultural approach was utilized to address warfare and violence among late prehistoric communities in the Middle Cumberland Region (MCR) of Tennessee. Bioarchaeological evidence of trauma was placed within the local environmental and social context of the region using mortuary analysis as well as other archaeological and physiographic evidence.

A total of 870 individuals from 13 Mississippian sites in the Nashville basin were analyzed for evidence of warfare-related violence, including cutmarks associated with scalping, projectile point injuries, evidence of decapitation or dismemberment and cranial blunt force trauma. Information on mortuary practices such as burial location, body position, and grave goods was also collected. Evidence of violent trauma was identified in approximately 5.4% of individuals from the MCR sample. There were significantly more male victims than female, with 3.5% of females and 11.2% of males showing evidence of interpersonal violence. The most common injury noted in the MCR sample was cranial blunt force trauma with 53% of victims having at least one healed cranial depression fracture. The location of these wounds on the skull differed significantly between males and females. Analysis of mortuary context did not reveal any significant

differences between victims and nonvictims. The lower rate of warfare-related trauma in the MCR as a whole compared to other regions, as well as the relatively high proportion of healed cranial blunt force trauma, may be due to local adaptations to the unique local social and natural landscape in the MCR.

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**Understanding the origins of primate retroviruses: Molecular epidemiology in deep time (and deep oceans).**

MICHAEL WOROBEY and GUAN-ZHU HAN. Ecology and Evolutionary Biology, University of Arizona.

Simian immunodeficiency viruses (SIV) and simian foamy viruses (SFV) are the two most important retroviral lineages that cause infections in primates. SIV is well known as the progenitor of HIV, while SFV shows a fascinating pattern of co-divergence with its primate hosts. Despite their importance, major questions persist about the timeline of the origin and evolution of these viruses.

Endogenous retroviruses, formerly free-living viruses that are now part of the host genome, provide molecular fossils for studying the ancient evolutionary history of retroviruses. We have recently discovered (1) endogenous lentiviral insertions, related to SIV, within the genomes of several species of the weasel family (*Mustelidae*); (2) an endogenous foamy virus in the genome of the aye-aye (*Daubentonia madagascariensis*), a basal lemur from Madagascar; and (3) endogenous foamy virus-like elements in the genome of the coelacanth (*Latimeria chalumnae*). The insights provided by these discoveries for understanding the long term origins and emergence of these retroviral lineages will be discussed.

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**Honey exploitation by chimpanzees and hunter-gatherers indicates an ancient use of fire by humans.**

RICHARD W. WRANGHAM and ZARIN MACHANDA. Human Evolutionary Biology, Harvard University.

Honey is a ubiquitous and preferred food for all African apes and human foragers, often occurring at high density and providing much more food for foragers than for apes. Here we investigate the factors constraining the frequency of honey-eating by chimpanzees *Pan troglodytes* foraging on honey of stinging bees *Apis mellifera*. We studied *Apis* honey-eating over 19 years by chimpanzees of the Kanyawara community, Kibale National Park, Uganda. Honey-eating occurred in a strongly seasonal pattern and occupied less than 1% of feeding time. In 48% of their investigations of hives, chimpanzees obtained no honey. Some visits were to old hives with few bees and little honey, but active hives were strongly defended by bees, responsible for chimpanzees fleeing the hive in at least 59% of visits. We conclude that defense

by bees prevented chimpanzees from eating honey at higher rates. By contrast African foragers are never deterred from honey-eating by the activity of *Apis* defenders, thanks to their use of smoke to control bee aggression. A review of the mutualistic interaction of foragers with greater honeyguides *Indicator indicator* indicates that honeyguides have an innate propensity to lead humans to honey, that hominids are the most likely species responsible for the evolution of this habit, and that the habit depended on ancient human control of fire.

**Applying Extreme Value Analysis in assessing the material properties of the most challenging foods consumed by primates.**

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The average dietary toughness of closely-related species that exhibit distinct craniodental features for obdurate and non-obdurate feeding (e.g. *Sapajus apella* versus *Cebus olivaceus*) can be statistically similar. What often distinguishes food material property (FMP) distributions between these species is a right-tailed skew marking the inclusion of a few exceedingly tough and/or stiff foods in the obdurate feeder's diet. This observation suggests that maximum FMP values may better differentiate obdurate from non-obdurate feeders and may indicate a propensity for fallback feeding in species with higher maximum FMPs. Here, we consider methods for comparing maximum values within the framework of Extreme Value Analysis – a branch of statistics focused on extreme deviations. We consider randomization approaches, point over threshold (POT) analyses and fitting FMPs to generalized extreme value distributions in pairwise comparisons of obdurate versus non-obdurate feeding capuchin, orangutan and lemur species. As an initial case study, randomization approaches suggest observed difference in maximum dietary toughness between *S.apella* and *C.olivaceus* exceeds that expected by chance with significantly greater maxima in the *S.apella* diet. Preliminary POT analysis similarly suggests *S.apella* consumes a greater number of tougher foods over 2,000 J/m<sup>2</sup>. The negative shape parameter in the resulting fit to a Generalized Pareto distribution suggests an upper limit to maximum toughness in *S.apella*. This upper bound may reflect masticatory apparatus limitations and underlie a switch to manual food processing. We hope these approaches add to our toolkit for studying primate diets and advance the theoretical importance of considering variance in FMPs in obdurate feeders.

**Major histocompatibility complex (MHC) variation in a population of wild chimpanzees.**

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The highly polymorphic genes of the Major Histocompatibility Complex (MHC) are of interest for their immunological role in antigen presentation to T-cells and natural killer (NK) cells, and also for their effect in mate-choice and reproductive success. Understanding how this gene complex evolves is essential to understanding its function and evolutionary trajectory. Consequently research has investigated these genes in non-human primates, particularly chimpanzees, but relied on samples from captive animals. Although we now have good understanding of how MHC genes work at the level of the individual, we do not understand their distribution at the population level because captive chimpanzees unlikely represent the natural variation in the wild. Thus, basic but crucial questions remain unanswered concerning the quantity and quality of the MHC diversity maintained by wild chimpanzee populations. Therefore, we conducted this study of the wild Eastern chimpanzee population (*Pan troglodytes schweinfurthii*) of Gombe National Park, Tanzania, a subspecies underrepresented in captive populations. Using DNA isolated from feces, we sequenced 119 individuals for the *MHC-B* gene (*Patr-B*) and detected 11 alleles. Seven of the alleles were novel and differed from other alleles by amino-acid altering mutations at immunologically important sites. Furthermore, one or two alleles are maintained at high frequency ( $\geq 30\%$ ), whereas the others are maintained at much lower frequencies ( $\leq 15\%$ ). This pattern of allele number and frequency is comparable to that found in tribal human populations, suggesting it represents the base level of *MHC-B* diversity necessary to maintain a healthy and naturally reproducing chimpanzee or human population.

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**Identifying the source of bone marks via optical profilometry 3D images.**

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Conservation Programme, University of California in Los Angeles, <sup>4</sup>Geological Sciences and Geoanthropology, Indiana University.

Differentiating cut marks, tooth marks, trampling marks, tool marks, et cetera in bones is a long-standing problem in forensic and biological anthropology. In this controlled experiment, we first subjected animal bones to a) cutting with a steel knife; b) cutting with a stone tool, and c) chewing by crocodiles. We then documented the resulting markings in a stage light microscope equipped with a Wyko NT3300 Optical Profilometer, which records in 3D the topography of a small surface area. The 3D profiles of the various marks were found to display significant differences that are not captured with traditional microscopy, or even with high-resolution imaging techniques such as electron microscopy. We conclude that 3D images of bone marks, obtained via optical profilometry, appear to be highly useful for identifying the source of the marks.

**Mechanical food properties and tooth wear differentiate three populations of *Lemur catta* in southwest Madagascar.**

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Since 2008, we have been investigating the degree to which food mechanical properties may contribute to tooth wear in wild populations of *Lemur catta* in southwestern Madagascar. Our work has established that dependence on fruit of *Tamarindus indica* (kily) is related to the degree of wear. Here we compare diets of populations from our three sites and examine how different components of diet may contribute to wear.

We observed lemur populations in the gallery forest of Bezà Mahafaly Special Reserve (BMSR; Parcel 1), the dry/spiny forest of BMSR (Parcel 2), and the dry forest and scrubland of Tsimanampetsotse National Park (TNP) in wet and dry seasons from 2008-2012. Following plant collection, we tested foods for toughness, elastic modulus, and hardness with the Darvell mechanical tester.

Food toughness, but not hardness or modulus, is highest in Parcel 2; the TNP and Parcel 1 values are not significantly different from one another. Tooth wear follows a different pattern with wear highest in Parcel 2 and lowest in TNP. The pattern of wear does not match dietary toughness values except for Parcel 2; however, the pattern follows frequency reliance on kily fruit. Both Parcel 1 and Parcel 2 lemurs consume kily at high frequencies in the dry season (up to 65% of total feeding time), with the majority of the fruits in Parcel 2 eaten off the ground. The combination of high seasonal kily consumption and its high mechanical values may

help explain the wear patterns in this particular primate population.

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#### **Digestive strategies: Scaling of feeding time and gut retention.**

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Feeding mechanisms and behaviors must evolve in consort with digestive physiology for efficient energy harvesting. A dichotomy in digestive strategies has been suggested: the “efficiency” strategy characterized by low relative dry matter intake (rDMI) with long mean retention time (MRT) and the “high intake” strategy of high rDMI with short MRT. Here, we evaluated this model by analyzing relationships among feeding time, body mass and mean retention time in primates. Values for feeding time, MRT and body mass for 20 primate species were taken from the literature. We ran comparative analyses using both raw data and phylogenetic generalized least squares (PGLS). Using PGLS, feeding time is significantly correlated with body mass, but MRT is not. There is a statistically significant negative relationship between feeding time and MRT when body mass is controlled for ( $p=0.049$ ). When the relationships between feeding time and both MRT and body mass are examined, including an interaction between MRT and body mass, the overall model is significant ( $p=0.032$ ). This interaction effect indicates that the relationship between feeding time and MRT is negative in small-bodied primates but positive in large-bodied primates. At a body mass of ca. 2.6 kg., there is no change in feeding time with MRT. These results suggest that the efficiency strategy works well for primates of small body mass, but primates with large body masses must change their digestive strategy to one characterized by long feeding times and long MRTs.

#### **Scaling patterns of talar articular surfaces within Euarchonta.**

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The articular facets of synovial joints must transmit forces while maintaining relatively low stresses. Joints that transmit higher forces should therefore have larger facet areas to prevent overloading. The relative contributions of body mass and muscle-induced forces to joint stress are unclear, but generate opposing hypotheses. If mass-induced forces dominate, facet area should scale with positive allometry to mass. Alternatively, muscle-induced forces

should cause facets to scale isometrically with mass. Both scaling patterns have been reported for articular surfaces of the femoral and humeral heads, but more distal elements are less well studied. Additionally, examination of complex articular surfaces has largely been limited to linear measurements, so that “true area” remains poorly assessed. To re-assess these scaling relationships, we examine the relationship between body size and articular surface areas of the talus. Area measurements were taken from microCT scan-generated surfaces of all talar facets from a comprehensive sample of euarchontan taxa. Log-transformed data were regressed on literature-derived log-body mass with both ordinary and phylogenetic least squares regression. Groups representing “all euarchontans”, “all primates” and “anthropoids only” exhibit mainly positive allometry; only the medial tibial facet scales isometrically. Among strepsirrhines, slope estimates tend to be allometric, but confidence intervals include isometry. Scaling coefficients are not correlated with sample size, clade inclusivity, or behavioral diversity of the sample. These results suggest talar facet areas scale proportional to stresses induced by larger body mass, rather than greater muscle forces. Whether this is a difference between proximal and distal joints remains to be addressed.

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#### **Re-evaluating the functional and adaptive significance of Neandertal nasofacial anatomy.**

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The retention of a wide nose in Neandertals living in glacial time periods deviates from the expected cold-adapted morphological pattern based on recent human populations living in cold-climate conditions. Given this disparity, many scholars have rejected adaptation to cold climate as a major factor in the evolution of Neandertal nasofacial anatomy. Heat and moisture exchange in the nasal passages, however, are facilitated by a large mucosal surface and a narrow channel for respired air. As such, there are multiple morphological solutions for improving air conditioning capacity in cold-climate conditions. If the overall gestalt of Neandertal nasofacial architecture is analyzed in the context of the parameters that govern heat and moisture exchange, it becomes evident that a wide nose does not negate the importance of climate in explaining Neandertal facial evolution. Here we assess nasofacial dimensions of Neandertals and other archaic humans and examine how these dimensions would influence the air conditioning capacity of their noses. Among Middle and Late Pleistocene *Homo*, there is evidence that nasal morphology varies with climate, albeit within an archaic architectural nasofacial framework. Neandertal internal nasal dimensions are greater

in both height and length than archaic humans from sub-Saharan Africa. Furthermore, while other aspects of the nose are relatively broad, superior internal breadth dimensions in Neandertals are narrowed relative to sub-Saharan archaics. These differences parallel those seen in modern humans, indicating that Neandertals had an increased capacity for nasal heat and moisture exchange over their African counterparts and thus exhibit clear evidence for cold-climate adaptation.

#### **Modularity and integration in the human cranial vault.**

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Previous research on morphological integration and modularity of the cranium has focused on larger functional units of the vault, base, and face. However, comparatively few studies have explored patterns of modularity and integration within these divisions, in particular the vault. The present study analyzes variation along the midsagittal outline of the human cranial vault for interactions among the frontal, parietal, and occipital bones. Arc lengths and measurements including chords, subtenses, and fractions in the midsagittal plane were collected from 130 crania of known sex and ancestry from the Hamann-Todd Collection at the Cleveland Museum of Natural History, and were compared using correlation matrices and principal components analysis (PCA).

In contrast to most PCA results using craniometric data, our results show a much lower proportion of total variation in PC1 (38%), indicating that integration is relatively lower in the vault module in terms of allometric size. PC2 and PC3 represent a combined 41% of the total variation and display modularity of bones through high magnitude loadings with distinct variation vectors corresponding to each bone’s measurements, specifically in the parietal (PC2) and the frontal (PC3) bones. The PCA results indicate that the three bones vary largely independently from each other in terms of shape. Therefore, modularity appears to influence patterns of phenotypic variation within the vault at least as much as integration.

This study suggests that bones in the midsagittal plane behave as modular units, and that studying the cranial vault as a single module masks important variation patterns within each subunit.

#### **Cranial suture complexity alters sutural mechanical behavior: An FEA investigation.**

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Sutural complexity is hypothesized to reflect the loading environment of the cranial vault. While direct mechanical tests of how complexity affects suture mechanics have been

limited, most investigations associate the presence of increased complexity as a compensatory mechanism for increased masticatory or paramasticatory activity. Owing to methodological difficulties and sampling limitations of in vivo study, stress and strain within and around sutures are usually characterized through theoretical approaches.

We use finite element analysis (FEA) to investigate how sutural complexity alters sutural mechanics as well as stress and strain in adjacent cranial bone. Using published material property data and assuming isotropy and homogeneity, four separate 2D FEA models representing the human sagittal suture and parietal bones were constructed and loaded in COMSOL 3.5®. Two of the models function as idealized baseline benchmarks (linear and sine wave sutures), while the other two are based on actual ectocranial suture morphology.

Our models indicate that suture complexity is positively associated with sutural and vault stiffness. Simple suture morphology demonstrates more strain within the sutural gap and less stress in surrounding bone. Conversely, complex sutures display less strain within the sutural matrix while producing stress concentrations in bone local to sutural margins. These results suggest that -- under conditions of isotropy and homogeneity -- complexity stiffens the joint but at a cost of localized increased stress in adjacent bone. We speculate that reduction of elastic modulus of bone local to sutural margins may serve to mitigate these stress concentrations in vivo.

**Endostructural morphology of the late Early Pleistocene human dental remains from Uadi Aalad and Mulhuli-Amo, Danakil (Afar) Depression of Eritrea.**

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Field work performed during the last decade in various Early Pleistocene east African sites has significantly enlarged the quality and variety of the *H. erectus/ergaster* record. Additional evidence comes from the northern

part of the Danakil depression of Eritrea, where research carried out since mid-nineties resulted in the discovery of over 200 late Early Pleistocene sites within a ~1,000 m-thick fluvio-lacustrine sedimentary succession outcropping in the Dandiero rift basin, near Buia.

Together with an adult cranium (UA 31) displaying a blend of *erectus*-like and progressive morpho-architectural features, the latter more commonly found in Middle Pleistocene specimens, the 1 Ma old *Homo*-bearing outcrop of Uadi Aalad has also delivered two isolated permanent incisors (UA 222 and UA 369).

Since 2010, our research action extended to the 4.7 km apart coeval site of Mulhuli-Amo (MA), a fossiliferous area preliminarily surveyed because of its concentration of Acheulean stone tools. So far, the site has provided nine human remains, including the unworn crown of a lower permanent molar (MA 93).

The three tooth specimens have been imaged by microtomography at the Tomolab of the Elettra Synchrotron Light Laboratory of Trieste (isotropic voxel size ranging from 8.3 to 10.0 µm).

Both incisors have a relatively thin enamel compared to the modern human condition; as seen in *H. antecessor*, they show a smooth EDJ and a distinct root pulp canal shape. The best endostructural fit available in our comparative record for the low and squat LM1/M2 crown from MA is represented by North African *H. heidelbergensis*.

*The Buia Research Project is supported by the Italian Ministry for University and Research, the Univ. "La Sapienza" of Rome ("Grandi Scavi"), the Italian Ministry for Foreign Affairs, the L.S.B. Leakey Foundation.*

**Ontogeny of bipedalism: Changes in the location and direction of the ground reaction force in toddlers.**

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Paleoanthropologists rely on form-function relationships to reconstruct locomotion in fossils. But testing such relationships is challenging. Since juvenile trabeculae are highly responsive to functional loading, an ontogenetic study is an excellent natural experiment with which to test form-function relationships and detect functional loading signals within bones. A pattern of pedal loading from heel-strike to hallucal propulsion is a distinct feature of mature human bipedalism that develops gradually. This study tested the hypothesis that previously reported changes in trabecular architecture reflect changes in the location and direction of the ground reaction force resultant (GRFr) throughout early locomotor development. 3D kinematic and force data were collected on a mixed-longitudinal sample of 20 toddlers, representing the first three years of locomotor independence, and used to calculate the position and direction of the GRFr relative to bony landmarks of the foot.

At the onset of independent walking, the GRFr projects vertically through the distal

calcaneus at touchdown. By the end of the first year of walking, the GRFr has shifted and projects posteriorly through the proximal calcaneus at heel-strike. In new walkers, the GRFr is located proximal to the second and third metatarsal heads at lift-off, projecting slightly anteriorly. Hallucal propulsion is present by the end of the first year of walking. Results are consistent with pedal trabecular architecture indicating that prior to two years, toddlers lack internal morphology associated with a powerful toe-off. These data elucidate relationships that can be used to interpret foot function and the development of bipedalism in early hominins.

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**A geometric morphometric analysis of lower deciduous first molars and their succedaneous dentition.**

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Lower deciduous first molars (ldm1) are rarely studied despite their unique shape and occlusal arrangement relative to all other teeth in the permanent and deciduous dentition. Research available on deciduous first molars includes metric and discrete trait analysis. There are no published studies using geometric morphometric methods on human deciduous molars in relation to their succedaneous dentition. Shape analysis may offer additional insight into earlier evolutionary dental shapes or the processes behind dental development. Geometric morphometric analysis was conducted on ldm1s, lower first premolars (LPM1) and lower first permanent molars (LM1) to examine which of these two permanent teeth the deciduous first molar most closely resembles. Landmark and outline shape analysis was done using Wolfram Mathematica. Procrustes, principal components and ANOVA tests were run on the sample. Results show that each of the three tooth categories cluster distinctly from each other despite molars being the same tooth type. Furthermore, the ldm1 has the most variation within its category. The ldm1 is statistically different from LPM1 but not LM1 suggesting that it is morphologically closer to a molar than its succedaneous premolar. Further investigation of the ldm1 may find that its unusual shape is related to an earlier evolutionary molar shape or is simply a product of complicated dental development.

**Preliminary research on hereditary features of Yinxu Population.**

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Yinxu was the capital during the last phase of the Shang dynasty (ca. 1250-1050 B.C.), located northwest of Anyang city in Henan province, China. It is one of the oldest

and largest archeological sites in China, famous for the discovery of China oldest writing evidence, the oracular bones. Until today, no DNA research had been made on the human remains of Yinxu.

The 37 individuals sampled in this study have been discovered in middle to small size burials, and therefore constitute a representative sample to study Yinxu commoners' society. Mitochondrial DNA analysis showed that the Yinxu population included the haplogroups D, G, A, C, Z, M10, M\*, B, F and N9a. According to the analysis of molecular variance, the distribution frequency and the rare published data, the Yinxu population shows a closest genetic affinity with the populations of Dadianzi and Zhukaigou early Bronze Age sites (Inner Mongolia), but a more distant relation to the historical period populations. The Yinxu population is also very similar to the modern northern Han Chinese.

The archaeological and anthropological evidence show that the society of Yinxu was composed of individuals coming from various regions. The comparison of the genetic traits of Yinxu population to the modern northern Han Chinese population shows that Yinxu population significantly contributed to the formation of the matrilineal genetic heritage of the modern northern Han Chinese population. The Y-chromosome DNA research is still ongoing, and will provide more genetic information of Yinxu residents soon.

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#### **Influence of food material properties and cooking on meat-eating performance in humans.**

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Butchery evidence attests to the ability and propensity of hominins to alter food with pre-ingestive behavior. Thus, the food material properties (FMPs) of meat and scale of bites eaten will be intrinsic to the tissue eaten and altered by preparation like cutting and cooking. Here, we report fracture toughness for cooked and raw beef (eye of round) and the effects of cooking on feeding rate. Fracture toughness was measured using a scissor test on an FLS-1 Tester on cooked and raw meat slices ranging in thickness from 1.4 to 3.1 mm. Because the scissor test requires modification of meat scale, it is not a complete or ideal tool to describe meat FMPs but allows some assessment of the effects of cooking and tissue anisotropy on meat toughness. Fracture toughness was greater for cuts across the meat grain. For cuts along the meat grain, fracture toughness varied widely and

there was no significant difference between cooked and raw meat. Preliminary results showed significantly greater fracture toughness for cooked meat as opposed to raw meat when cuts were across the meat grain ( $p < 0.05$ ) consistent with drying increasing toughness. Cooked meat was noticeably friable along the grain. Thus, cooking may have opposite effects on the ease of meat comminution depending on directionality and bite scale. A large and significant increase in feeding rate when meat was cooked was found for subjects fed cooked versus raw meat ( $p < 0.01$ ). This difference could be attributable to either meat FMPs or palatability.

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#### **An investigation into the effects of X-ray on the recovery of DNA from skeletal remains.**

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The use of radiological methods to examine mummified and skeletal remains from archaeological contexts is assumed to be non-invasive and non-destructive. Although, there has been speculation concerning possible radiation-induced damage to DNA recovered from archaeological specimens following exposure to radiation, little research has been published. It is known that ionizing radiation may cause different effects on DNA whether X-ray photons interact directly with the DNA or more often indirectly through dissociated water molecules (radiolysis). Nearly everything known about the affection of DNA damages caused by ionizing radiation is based on investigation in living, hydrated organisms.

Here we present a study directly examining the effect of ionizing radiation on ancient DNA as well as the influence on the accessibility and analyses success. Long bone samples from nine individuals from three different burial sites were exposed to an X-ray dosage commonly used for paleoimaging and additionally to a 10-fold higher dosage. Comparison of unexposed, exposed and 10-fold exposed samples has been carried out qualitatively and quantitatively by amplification of autosomal STRs employing a multiplex PCR and real-time quantitative PCR.

The results show no statistical significant affection caused by radiation-induced DNA damage. There are no significant effects either on samples that were simply or multiply exposed to X-rays compared to non-exposed samples, nor between the individuals from different burial sites. Concluding, ionizing radiation has no effect on the DNA preservation in archaeological specimens.

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#### **Locomotor anatomy of patas monkeys (*Erythrocebus patas*).**

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Patas monkeys (*Erythrocebus patas*), largest of the guenon group, are distributed across equatorial woodland savanna habitats of Africa. They have a large home range and long daily range, parallel to savanna baboons, and a locomotor system structured for long distance walking and high speed running. Previous studies note their digitigrade hand and foot postures, and distinctive vertebral column and thermoregulation.

This study presents new data on the relative mass and proportions of the musculo-skeleton based on whole body dissections of patas monkeys ( $n=2$ ). Comparative data from vervet monkeys (*Cercopithecus aethiops*), macaques (*Macaca*) and baboons (*Papio cynocephalus*) reveal similarities in forelimbs (12.5%) and hind limbs (22.5%) relative to total body mass. Among these three genera, the relative mass of thigh and foot segments to total hind limb mass is similar: thigh 65-67%; foot 9.6-10.7%. However, relative mass of forelimb segments differ: the patas arm segment is 59%, and hand, 7%; in macaques the arm segment is 50-52% and hand, 10-11%. In proportions of bone and muscle groups, for example, the patas foot is 46% bone, compared to the baboon at 33%; the patas quadriceps femoris and calf muscles are relatively heavier, whereas thigh adductors, dorsiflexors and plantar-flexors are relatively lighter.

Limb, muscle, and bone proportions are part of the functional complex that support patas hand and foot postures and long limbs and stride length. Combined with previous research on Old World monkey anatomy and behavior, these data expand and deepen understanding of the patas locomotor adaptation.

#### **Using citrate concentration to determine postmortem interval of forensically-significant skeletal material.**

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Many anthropological investigations have focused on developing methodology for the determination of postmortem interval (PMI) from forensically-significant skeletal material. Currently, no accurate method exists for this purpose. Using adult pig models, Schwarcz et al. (2010) presented results of a study designed to measure the postmortem loss of citrate content in bone. According to Schwarcz and colleagues, citrate content within living bone is fixed at a concentration of  $2.0 \pm 0.1$  wt %, and then decreases at a constant rate after four weeks PMI. Based upon their findings, a PMI of up to

approximately 100 years can be projected by measuring remaining citrate content within the bone. In an effort to replicate their findings, experiments using infant pigs were performed at the forensic decomposition site on Ithaca College's Natural Lands in Ithaca, New York. Bone samples were taken from buried pigs at varying states of decomposition. The samples were chemically analyzed according to the methodology employed by Schwarcz and colleagues. Our results indicate an inability to establish a baseline citrate concentration in the bones across pig models as the initial wt % varied and did not decrease at a constant rate over time. Such differences in initial citrate concentration could greatly skew projected PMI results. Our analysis did not support citrate concentration in bone as an accurate measure of PMI. The differing composition of infant versus adult pig bones may partially account for these results and is discussed in detail.

#### **Masticatory changes associated with mechanical and thermal processing of meat.**

KATHERINE D. ZINK and DANIEL E. LIEBERMAN. Department of Human Evolutionary Biology, Harvard University.

Although meat has played an especially important role in hominin evolution, human molars are bunodont and thus thought to be poorly adapted to chewing raw meat. Here we explore the performance ability of humans chewing raw meat, and analyze the effects of mechanical and thermal food processing techniques on masticatory parameters. 10 male subjects chewed size-standardized samples of raw, sliced, tenderized, or roasted goat meat. Masticatory muscle EMGs were measured during the trials and then transformed into chewing forces using a force-EMG calibration trial. Subjects chewed until they would typically swallow, at which time the resulting bolus was collected. For each subject, we compared the number of chews, force used per chew, total masticatory force, and the degree of intraoral food breakdown per trial among the raw and processed samples (Wilcoxon signed-rank test,  $p \leq 0.05$ ). The results indicate that raw meat does not fracture readily in the oral cavity. Slicing significantly decreased masticatory force (chew number 22% lower; force per chew 19% lower) and size of the largest particle in the chewed bolus was 48% smaller. Roasting to medium-well also improved comminution, reducing size of the largest comminuted particle by 25%. In contrast to the other processing methods, tenderizing did not affect food breakdown, and average force per chew actually increased 18%. These data illustrate the masticatory benefits of slicing and roasting meat prior to consumption, and suggest that food processing may have been necessary for hominins to efficiently masticate and consume large quantities of meat.

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#### **The broader picture: Extension of baboon socio-ecology by adding new findings from Guinea and Kinda baboons.**

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For over four decades baboon socio-ecology was dominated by a dichotomous view which contrasted hamadryas baboons (*Papio hamadryas*) with their multi-level social organization based on one-male units with savannah baboons (*P. anubis*, *P. cynocephalus* and *P. ursinus*) living in female-bonded multi-male multi-female groups. According to socio-ecological theory, variation in food-distribution, competitive regime and predation pressure were thought to provide ultimate causes for the proposed dichotomy. However, doubts accumulated that contemporary ecology is sufficient to explain variation in baboon social systems, e.g. it became obvious that the intra-specific ecological diversity was almost as broad as the inter-specific variation. New data from the two species of baboons that had been only little studied, Guinea (*P. papio*) and Kinda baboons (*P. kindae*), point to an even greater variability in social organization than previously recognized. Guinea baboons live in a system superficially similar to hamadryas baboons, but they differ in a prominent unique feature, the high frequency of male-male interaction and male-male tolerance. First genetic analyses further suggest that in Guinea baboons males are predominantly philopatric. In Kinda baboons, the most obvious feature is their small sexual dimorphisms and high frequency of male-female interaction, suggesting strong male-female bonds. Here we will argue that knowledge of Guinea and Kinda baboons not only expands our view of baboon societies but that this also supports the view that inter-specific differences among societies are more closely associated with variation in life-history, reproductive strategies and the phylogenetic history than with differences in their ecology.

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#### **Do capuchins change the forest through the trees?**

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In this research, we examine the potential impact of capuchin (*Cebus capucinus*) foraging on plant growth. Monkeys remove epiphytes, living and dead plant parts and unstable branches as they forage for fruits, invertebrates, and small vertebrates. We collected 200 hours of behavioral data at Estación Biológica La Suerte in Costa Rica; recording feeding/foraging, substrate type, and collecting all discarded plant parts for measurement. We also assessed

bromeliad density with regard to host species and available light in 76 randomly-selected circular forest structure plots (radius = 5 meters, area = 78.5m<sup>2</sup>). Capuchins removed woody substrates in 10.7% of insect foraging activity records. During fruit foraging, capuchins removed terminal fruits, meristems, and other foliage in 72.8% of the observations. A total of 766 plant parts from 95 species were removed from plants and collected during 100 hours of behavioral data. We found 97 whole bromeliads and 38 partial bromeliads on the forest floor in 76 plots. Although several factors contribute to bromeliad distribution, abundance, and location in the canopy, data presented here suggest that capuchin foraging changes epiphyte density and distribution, potentially influencing branch failure. Our preliminary results also suggest that capuchin removal of decaying branches, terminal buds, and fruit may influence tree growth, productivity, and branch architecture. Significant indirect impacts of monkey foraging on forest community ecology adds a new dimension to understanding the role of primates in ecosystems and highlights the importance of preserving forests large enough to support healthy monkey populations.

#### **Lousy personalities: Aggression, testosterone, and ectoparasite dynamics in a population of wild brown mouse lemurs.**

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Animal personality traits have the potential to influence exposure and susceptibility to parasites. Bold individuals may experience increased contact rates with conspecifics and aggressive behaviors which make them more vulnerable to parasites with direct transmission routes. To better understand whether bold individuals are at a higher risk of ectoparasite infestation than their shy conspecifics, we performed behavioral assays to qualitatively determine degrees of boldness and shyness, measured fecal testosterone levels, quantified louse infestations, and documented the exchange of lice between known individuals in a population of wild brown mouse lemurs (*Microcebus rufus*) in the eastern rainforests of Madagascar. We hypothesize that 1) bold individuals will have higher testosterone levels than shy individuals, 2) bold individuals will harbor more lice than shy individuals, and 3) bold individuals will play a larger role in spreading lice in the population than shy individuals. While we did find that bold individuals had the highest testosterone levels, we found no evidence to support the idea that bold individuals had more lice than shy individuals. However, when examining the patterns of louse exchange between individual

lemurs, our results show that bold individuals act as superspreaders and are responsible for the widespread movement of lice in the population, while shy individuals act as supercollectors harboring higher louse infestations. Taken together, these results suggest that personality traits may underlie differences in host-parasite dynamics. Meanwhile, parasites also impact host condition, and thus may also play a role in the evolution of host personality traits such as boldness and shyness.

**Bridging the gap between individual fossil evidence, paleopopulation dynamics and hominin evolutionary scenarios.**

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Morphological and genetic data gathered from hominin fossils always come from single individuals that live(d) during a short time span in a restricted spatial area. Such data, however, are implicitly taken as evidence for entire populations and/or species, and used to infer hominin paleopopulation dynamics and evolutionary scenarios. Here we ask how long-term large-scale patterns of change at the population/species level can be inferred from observed short-term/small-scale patterns of variation at the individual level. To tackle these questions, we capitalize on existing multibody modeling paradigms from physics and devise an agent-based modeling (ABM) framework running on a high-performance computing (HPC) platform. The ABM/HPC framework permits individual-based simulation of hominin population dynamics over extended spatial and temporal scales. We compare the outcome of ABM/HPC-based simulations with expectations and results of classical population dynamics theory, and with empirical genomic and phenomic data. These comparisons show that while population-level models are useful tools to identify general trends and standardized behaviors, they lack the spatiotemporal resolution to explore and identify non-standard, but probable, scenarios of hominin dispersals and evolution. We illustrate our observations and findings with several examples from late hominin evolution.

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**Comparison between *Australopithecus afarensis* and *Pan troglodytes* honing facet microwear.**

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*Australopithecus anamensis* and *Australopithecus afarensis* evince significant change in P<sub>3</sub> crown morphology (e.g., anterior crown reduction together with distal crown and metaconid expansion) between 4.2 and 3.0 Ma. Canine crown size also reduces in this lineage, but potential functional changes involving occlusion of the maxillary canine and mesial portion of the P<sub>3</sub> have not been addressed. We examined microwear texture along the mesial protoconid crest of P<sub>3</sub> in *Pan troglodytes* (n = 10 males and females each) and *A. afarensis* (n = 18) using white-light confocal profilometry and scale-sensitive fractal analysis. No significant variation was found between male and female chimpanzees. However, *A. afarensis* and *P. troglodytes* differ significantly in two variables (texture fill volume and scale of maximum complexity) that likely correspond to fewer small, shallow microwear features on *A. afarensis* P<sub>3</sub>s. No differences between species were found in surface complexity or feature anisotropy. In chimpanzees, the maxillary canine is honed along the mesial crest of the P<sub>3</sub>, while in *A. afarensis*, which has a reduced and morphologically derived maxillary canine, no honing occurs along this crest. Microwear texture variation may reflect this functional difference and highlights the potential for such analyses to reveal evolutionary changes in the C-P<sub>3</sub> complex in early hominins.

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**The people behind the pox: Paleoepidemiological approaches to treponemal disease.**

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Debate over the origin and antiquity of syphilis has long acted as a stimulus for research in biological anthropology and paleopathology. However, paleopathology has only been able to meaningfully address major questions about the evolution of health and disease by moving away from case studies towards population-based analyses. In keeping with this, we propose here a repositioning of this debate away from its historical focus on the diagnosis of individual cases and towards paleoepidemiological analysis of whole populations over multiple regions. Syphilis and the other treponematoses are infectious diseases, and clinical studies show that when present, they should infect a substantial portion of the population. Here, we present a discussion of the advantages and disadvantages of this approach. This features a series of short case studies focused on treponemal disease from the UK and other regions which feature original and re-analyzed data, and demonstrate how amassing large numbers of affected skeletons enables researchers to draw novel conclusions regarding host characteristics and disease manifestations. Additionally, we present novel paleoepidemiological calculations that demonstrate the sample sizes necessary to carry out such studies of treponemal disease, as preliminary results suggest that as few as 1% of skeletons derived from communities where these conditions were endemic may manifest skeletal involvement. This further serves to emphasize the need for collaborations among research teams to generate such samples. Finally, we discuss how a paleoepidemiological approach to the treponematoses can generate unique insights into their manifestations and evolution, with particular relevance to the health of modern populations.