



**COMMITTEE ON DIVERSITY
UNDERGRADUATE RESEARCH SYMPOSIUM**

**6:00 – 8:30 PM
WEDNESDAY APRIL 10TH, 2013**

Abstract Reviewers

Carlos Amorim, UFRGS, Brazil
Aaron Armstrong, University of Minnesota
John Crandall, UNLV
Jennifer Danzy Cramer, American Public University
Illy Diaz, University of Victoria
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Diana Messer, Mercyhurst University
Gabrielle Russo, UT Austin
Joshua Sadvari, Ohio State University
Jill Scott, University of Iowa
Brittany Walter, University Central Florida
Taylor Yuzwa, Mercyhurst University

***Organized by Cara Wall-Scheffler, PhD
Program by Marcie Myers, PhD***

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Poster Titles and Authors

1. **Gradient, burden, burden/mass ratio and cadence in women: correlated with cost of transport.** S. VIJGEN, J. EYRE, P. KRAMER.
2. **The effect of forelimb mass distribution on the function of arm swinging during human bipedalism.** M. K. SAYRE, L. SHAPIRO.
3. **§ Costly courtship: the energetic burden of walking together.** J. WAGNILD, C. WALL-SCHEFFLER.
4. **Self-selected walking speed as a function of load in reproductive age women carrying an indigenous pack basket.** M. LOVSTAD, A. KENNEDY, M. MYERS.
5. **Bipedalism, energetics, and hair loss in the evolution of the genus *Homo*.** S. HOLTZMAN, M. MOORE, J. DUNN.
6. **Analysis of pelvis morphology and birthing practices: comparisons of modern and prehistoric humans.** J. ENGEL.
7. **Energetics of infant chimpanzees: Implications of nursing and feeding behavior.** J. BRAY, Z. MACHANDA, M. MULLER, R. WRANGHAM.
8. **Foot strike patterns vary with running speed in the habitually unshod Daasanach of Ileret, Kenya.** M. FERRY, K. HATALA, H. DINGWALL, R. WUNDERLICH, B. RICHMOND.
9. **Plantar pressure during vertical climbing in chimpanzees (*Pan troglodytes*).** S. ISCHINGER, R. WUNDERLICH.
10. **The functional role of the gluteus maximus during running.** B. SUMNER, R. ELLIS, R. KRAM.
11. **Using accelerometry to study leaping performance in free-ranging sifakas (*Propithecus verreauxi*).** J. GARDINER, R. WUNDERLICH, B. WILHELM, A. TONGEN, C. MILLER, D. SCHMITT.
12. **Ecomorphological analysis of prehensile tail use in *Alouatta palliate*.** S. GRIFFIN.

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13. § Preliminary results from analyses of the comparative and functional anatomy of the forelimb musculature of Humboldt's woolly monkey (*Lagothrix lagotricha*). L. HAYS, V. WHEELER, M. MUCHLINSKI, J. ORGAN, S. ABSHIRE, T. BUTTERFIELD, A. DEANE.
14. Lessons from a fossil red panda (Ailuridae: Carnivora) for interpreting the evolution of sexual dimorphism in anthropoids. E. FULWOOD, S. WALLACE.
15. On giants and dwarfs: what can Kadanuumuu and Lucy tell us about sexual dimorphism and variability in *Australopithecus afarensis*? B. KASABOVA, P. KRAMER.
16. § Does footwear change energy expenditure? Application to understanding the energetics of extinct bipeds. S. LAUTZENHEISER, P. KRAMER.
17. Three-dimensional analysis of the proximal tibia. E. KOZMA.
18. Evaluating 2D and 3D methods of measuring fluctuating asymmetry of primate skulls. C. OLIVEIRA, L. MOORE, D. ARRANAGA, A. REDD, A. ELLER, F. WHITE, S. FROST.
19. Male mangabeys increase muscle stretch to facilitate relatively wide jaw gapes without compromising muscle force. A. BALDWIN, A. TAYLOR.
20. Quantification of maxillary dental arcade curvature and implications for estimating biological ancestry in forensic anthropology. M. CLARK, D. GUATELLI-STEINBERG, M. HUBBE, S. STOUT.
21. § Cross-sectional morphology of the australopithecine hard palate. M. VOSS, C. HILL, R. MENEGAZ.
22. A preliminary radiographic analysis of dental development in Virunga mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda. A. KRALICK, H. GLOWACKA, M. CRANFIELD, T. STOINSKI, A. MUDAKIKWA, T. BROMAGE, S. MCFARLIN.
23. Variation in mandibular molar morphology within and between *Gorilla gorilla* and *Gorilla beringei*: an emphasis on geographic distribution and normative food resources. S. CANINGTON.

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24. § Incremental growth lines in melatonin-deficient mice. A. PAPAKYRIKOS, Y. WEN, C. AUSTIN, A. KATO, N. TANG, M. ARORA, X. WANG, T. SMITH.
25. A comparative analysis of the dental health of two Middle Woodland assemblages in the lower Illinois Valley. M. SCHWALENBERG.
26. Detection of viruses in eight wild lemur taxa. I. FRIED, S. ZOHDY, P. WRIGHT, T. GILLESPIE.
27. Parasitic swellings in wild geladas at Guassa, Ethiopia: Impacts on survivorship. D. BOYD, N. NGUYEN, P. FASHING.
28. Gestural flexibility in rehabilitant bornean orangutans *Pongo pygmaeus* at the Orangutan Care Center and Quarantine in the state of Kalimantan Tengah. R. CUDMORE, B. GALDIKAS.
29. Getting too close: a behavioral comparison of *Hapalemur aureus* examining the effects of tourist presence at Ranomafana National Park, Madagascar. C. BARATZ.
30. A biocultural examination of exclusive homosexuality in *Homo sapiens*. J. MAGARO, J. WINKING.
31. Growth and ecology in wild chimpanzees: a photogrammetric analysis. N. BRAZEAU, Z. MACHANDA, A. SMITH, A. SANDEL, E. CASTILLO, H. PONTZER, M. THOMPSON, M. MULLER, R. WRANGHAM.
32. Analysis of Daasanach growth in relation to ecology and subsistence strategy. K. RAMIREZ, B. RICHMOND.
33. Body mass estimation from measurements of human male calcaneus. A. GOLEMBIEWSKI, M. MOORE.
34. An analysis of stature in the Mississippi Basin during the transition to agriculture. J. A. WHITE.
35. Alternate light source imaging for tattoo detection: case studies on a South American mummy. A. WANG.
36. Looking into the foundations of folklore: a bioarchaeological and historical investigation of Snow White's seven dwarfs. A. HARRISON, M. MOORE.

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37. Natural history museum visitors' understanding of human evolution. S. SMITH.
38. Chronological age estimation of Native American remains in an archaeological context: re-examining the sternal rib end. A. LAMBERT, G. DABBS.
39. Geographic and seasonal variation in the decomposition of pig carcasses in western New York using accumulated degree-days. J. STABELL.
40. Paleoenvironmental conditions at the Oligocene-Miocene boundary in Sumatra, Indonesia: environmental template for the evolution and dispersal of Hominoidea in Island Southeast Asia. N. O'SHEA, E. A. BETTIS III, Y. ZAIM, R. CIOCHON.
41. Global survey of PGA indicates high CNV variability in human populations. K. DEROSA, R. SCOTT, J. XING.
42. Y-genotyping of haplogroups E and J in the Yemeni population. T. SCOTT, A. MIRO-HERRANS, S. MCNULTY, V. PAPASTAVROS, C. MULLIGAN.
43. Ancient DNA from the Late Woodland component of Schild archaeological site. A. REYNOLDS.
44. Ancient DNA analysis and differential diagnosis of ankylosing spondylitis in two Hopewell individuals. A. CRANE.
45. Evidence of scurvy on the Vrina Plain: a bioarchaeological analysis of infant skeletal remains from ancient Roman Butrint. A. JONES, T. CRIST.

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Male mangabeys increase muscle stretch to facilitate relatively wide jaw gapes without compromising muscle force.

AVIONNA L. BALDWIN¹ and ANDREA B. TAYLOR^{1,2}. ¹Department of Evolutionary Anthropology, Duke University, ²Doctor of Physical Therapy Program, Department of Community and Family Medicine, Duke University School of Medicine.

Sooty mangabeys (*Cercocebus atys*) are sexually dimorphic monkeys that routinely feed on hard-shelled nuts. Feeding observations indicate they generate powerful postcanine muscle and bite forces to fracture the nuts. Males also engage in wide-gape canine threat displays. Generating relatively large muscle and bite forces and wide jaw gapes places competing demands on the masticatory apparatus. How do males generate relatively wide jaw gapes while maintaining adequate muscle/bite forces? In this study, we examined jaw-muscle fiber architecture of the superficial masseter (SM) and temporalis (TM) muscles in adult male (n=4) and female (n=5) *C. atys*. We tested the hypothesis that compared to females, males have relatively: 1) longer, less pinnate fibers; and 2) smaller PCSAs, as an architectural trade-off of their longer, less pinnate fibers. We measured muscle mass, fiber length (proportional to stretch) ,

pinnation angle and physiologic cross-sectional area (PCSA; proportional to maximum muscle force). To examine relative differences, variables were adjusted by jaw length. As predicted, males have relatively longer SM and TM fibers ($p < .05$). Contrary to predictions, males and females have similar SM PCSAs ($p = 0.231$) and males trend toward a relatively larger TM PCSA ($p = 0.071$). Results suggest that males increase muscle stretch to facilitate relatively wide jaw gapes without compromising TM force, but they do so in a metabolically costly way by increasing muscle mass. These findings, in combination with previous work on other monkeys, indicate that primates are circumventing the expected trade-off by altering other aspects of muscle biology, including muscle mass and fiber type distribution.

Funded by NSF (BCS 0962677) and research and travel grants from the Duke University Undergraduate Research Support Office.

Getting too close: a behavioral comparison of *Haplemur aureus* examining the effects of tourist presence at Ranomafana National Park, Madagascar.

CAROLINE BARATZ. School of International Training, Department of

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Anthropology, University of California, San Diego.

Madagascar's tourism earnings have risen 11% since the 1990's, with nature tourism accounting for 55% of this profit. As a result, Madagascar's national parks have seen a vast increase in visitors and tour groups, with limited research on their effects. This study examines how tourism influences the activity budget of two troops of *Hapalemur aureus* in Ranomafana National Park. Data was collected through group scan sampling using 3-minute observation intervals from November 8, 2012 until November 24, 2012 for a total of 41 hours within Ranomafana's primary forest. The two groups were selected based on their locations in the park and the frequency with which they were in the presence of tourists. One troop, frequently in tourist presence, was located on the established trail circuit (Group Near). The other, very rarely in tourist presence, was located deeper in the forest corridor at a significantly higher elevation (Group Far). Results show that Group Near, more frequently in tourist presence, spent significantly less time feeding (10% of time observed) and traveling (22%), as compared to Group Far who spent 22% of time observed feeding and 29% traveling ($F_{1,11}=3.52$, $p=0.001$). Group Near engaged in significantly

grooming behavior (6%) than Group Far (3%, $F_{1,11}=5.85$, $p=0.034$). While differences in activity budgets do appear to be affected by tourist presence, these data must remain preliminary due to the small sample size and limited number of data collection hours. Future and more extensive research, taking ecological differences into consideration, is recommended.

Parasitic swellings in wild geladas at Guassa, Ethiopia: Impacts on survivorship.

DEREK A. BOYD, NGA NGUYEN and PETER J. FASHING. Department of Anthropology, California State University Fullerton.

Parasitic infections typically lead to reduced host fitness because energy that hosts expend on parasites is energy they could have devoted towards their own survival and reproduction. *Taenia*, a diverse genus of tapeworms, infect and adversely affect the health of a diverse array of mammals, including domestic livestock and humans. Less well known is that gelada monkeys also regularly suffer from *Taenia* infections which result in large subcutaneous fluctuant cysts (coenuri). Because these cysts are undoubtedly energetically demanding and clearly impede physical movement, we sought to determine

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whether they also impact mortality in a wild population of geladas at Guassa, Ethiopia. We visually monitored all adult and immature geladas in the Guassa study population over a continuous 6-year period (Jan2007-Dec2012) for macroscopic evidence of coenuri and evaluated the impact of coenuri on survivorship. We found that (A) adults were more likely to exhibit coenuri than immatures (28% of 146 vs. 2% of 164), (B) similar proportions of adult males (29% of 48) and females (28% of 98) possessed coenuri, and (C) mortality was higher for adult males and females with coenuri than for members of their sex without coenuri (♂♂ : 36% vs. 15% mortality; ♀♀ : 59% vs. 21%). Our results suggest that coenuri may be a major source of mortality for adult geladas and that further study of the life cycle of *Taenia* (whose other hosts likely include sympatric wild canids) in this system will have major implications for our understanding of community ecology and conservation at Guassa.

Energetics of infant chimpanzees: Implications of nursing and feeding behavior.

JOEL BRAY¹, ZARIN P. MACHANDA², MARTIN N. MULLER³ and RICHARD W. WRANGHAM².

¹Department of Evolutionary Anthropology, Duke University,

²Department of Human Evolutionary Biology, Harvard University,
³Department of Anthropology, University of New Mexico.

Infancy in primates is marked by dependence on the mother for milk and terminates with weaning. During this period, chimpanzee mothers have been documented to deplete their energy reserves to feed dependent offspring, constraining future reproductive opportunities. While an infant's energy derives exclusively from nursing at birth, and is acquired exclusively from solid food post-weaning, data on this transition in chimpanzees is sparse. To explore the relationship between female energetics and infant nursing and feeding behavior, we observed 15 chimpanzees between the ages of 1 month and 4.5-years-old in the Kanyawara community of Kibale National Park, Uganda. We compiled short-term and long-term data from infants to calculate daily nursing and feeding times and solid feeding rates. Nursing was highest among infants below 12 months ($4.50 \pm 2.16\%$) and above 36 months ($4.95 \pm 1.22\%$), dropping for infants in the middle. Daily solid feeding times increased steadily, starting at zero for infants below 6 months and peaking for infants above 48 months ($49.36 \pm 23.18\%$). Similarly, feeding rates on *Uvariopsis congensis* were zero for

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infants below 12 months and increased each year, peaking for infants above 36 months (3.23 ± 1.09 fruits processed per minute). These results are consistent with data from other field sites and suggest that nursing and feeding behavior is regulated by both infant energetic requirements and maternal energy reserves, although temperamental differences may account for some variation. These findings suggest that further research on infant behavior is essential to a complete understanding of maternal and infant energetics.

Funding provided by Duke University Undergraduate Research Support Office, Harvard University, and National Science Foundation grants 0849380 (RWW & MNM).

Growth and ecology in wild chimpanzees: a photogrammetric analysis.

NICHOLAS F. BRAZEAU¹, ZARIN P. MACHANDA¹, ALEXANDER R. SMITH¹, AARON A. SANDEL², ERIC R. CASTILLO¹, HERMAN PONTZER³, MELISSA EMERY THOMPSON⁴, MARTIN N. MULLER⁴, RICHARD W. WRANGHAM¹.

¹Department of Human Evolutionary Biology, Harvard University,

²Department of Anthropology, University of Michigan, ³Department of

Anthropology, Hunter College, ⁴Department of Anthropology, University of New Mexico.

To date, chimpanzee growth and ontogenic trajectories have only been derived from captive or provisioned populations despite several indications that captive chimpanzees grow faster and larger than wild counterparts. In this study, I examine the effects of ecology on wild chimpanzee growth in Kanyawara, Kibale National Park, Uganda. Body size estimates of the Kanyawara chimpanzees were acquired using a novel photogrammetric technique that builds upon previous designs which increases measurement reliability. This is the first study to collect wild chimpanzees' body size estimates non-invasively and without provisioning. Photographs were acquired for 49/58 individuals from May-August 2012. Under ideal conditions, body size estimates demonstrated an average 3.6% coefficient of variation within individuals. Furthermore, adolescent and adult male body sizes were correlated with modified urinary creatinine concentration slopes, which are used as a proxy for muscle mass ($r^2=0.31$; $p<0.05$). We also found distinct differences and delays in the Kanyawara chimpanzee growth pattern relative to the previous reports from captivity. As a result, there is a

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need for longitudinal non-invasive growth studies in order to discern the wild chimpanzee growth pattern. Preliminary data suggests that wild chimpanzee and human growth patterns may be more similar than previously expected.

Funding provided by Harvard University, Herchel Smith-Harvard Fellowship (NFB), Goelet Fund (NFB), American Society of Primatologist Small Grant (NFB), MCZ/HUH Grant-In-Aid of Undergraduate Research (NFB), and National Science Foundation grants 0849380 (RWW & MNM).

Variation in mandibular molar morphology within and between *Gorilla gorilla* and *Gorilla beringei*: an emphasis on geographic distribution and normative food resources.

STEPHANIE CANINGTON^{1,2}.
¹Department of Anthropology, Auburn University, ²National Museum of Natural History, Smithsonian Institution.

At present there exist two recognized species of *Gorilla*. Formerly classified as *Gorilla gorilla gorilla* and *Gorilla gorilla beringei*, the latter was elevated to species status by Groves (2001). Interspecific osteological variation is well-documented, as are respective geographic distributions. *G. beringei* appears to have the highest dietary diversity due to the variability of its

high altitude habitat, whereas *G. gorilla* lives at lower elevations and consumes a more steadily frugivorous diet year round. This study tests the hypothesis that a greater degree of intra-specific molar variation is present in *G. beringei* as compared to *G. gorilla* due to a greater dietary range. It also confirms sexual dimorphisms exist in the lower molars of both species. Osteometric data was collected from ten male and seven female *G. beringei* specimens and seventeen male and ten female *G. gorilla* specimens at the National Museum of Natural History. Measurements included two dimensions of individual molar measures and a measure of tooth row length, measured as the greatest distance from the M1 to the distal-most M3, on both left and right sides of the mandible. The quantitative results showed that the average male *G. beringei* displayed larger molars and a longer tooth row than either the average female *G. beringei* or the average male or female *G. gorilla*. Additionally, sexual dimorphisms were evident in both species of *Gorilla*.

Quantification of maxillary dental arcade curvature and implications for estimating biological ancestry in forensic anthropology.

MELISSA CLARK, DEBBIE
GUATELLI-STEINBERG, MARK

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HUBBE and SAM STOUT. Department of Anthropology, The Ohio State University.

Previous studies show that palate shape can be used as an indicator of biological ancestry in the identification of modern human remains. Qualitative analyses suggest that individuals of African, European, and Indigenous American ancestry tend to have hyperbolic, parabolic, and elliptical-shaped palates, respectively. The purpose of this study was to evaluate interobserver error in ancestry estimation using the shapes outlined in previous studies. This study also explores shape variation in the Gullah African-American and Seminole Indigenous American populations using the geometric morphometric analysis of maxillary dental casts. The first phase of this study was composed of a survey in which ten graduate students with training in osteology were asked to ascribe biological ancestry to twenty-nine maxillary dental casts from the Gullah and Seminole samples from the Renee M. Menegaz-Bock Dental Anthropology Collection. The results show that palate shape is not an effective indicator of ancestry in these populations: The mean classification accuracy for the survey was only 27.9% (p-value = 0.58), indicating that the likelihood of assigning the correct ancestry to a

given cast using palate shape was not much higher than random assignment. This study is important for the field of forensic anthropology because it provides a quantitative evaluation of a traditional qualitative method used in the identification of human remains, which ensures that anthropological methods continue to meet legal standards for evidence.

Ancient DNA analysis and differential diagnosis of ankylosing spondylitis in two Hopewell individuals.

ADAM CRANE. Anthropology Department, Indiana University Bloomington.

The association of the histocompatibility allele, HLA-B27, with ankylosing spondylitis (AS) in modern populations has been well documented in previous studies. Additionally, detection of HLA-B27 via aDNA analysis in medieval European individuals with symptoms of AS suggests this association was true of historical populations. The HLA-B27 allele occurs in particularly high frequencies in modern Native American populations relative to other groups; therefore, aDNA analysis of ancient Native American individuals with symptoms of AS presents an excellent opportunity for testing the association of HLA-B27 with the

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disease in older contexts. Rib samples for aDNA analysis were obtained from 11C43-7 and 11C36-4, two Hopewell individuals with pathologies consistent with AS. They exhibit various stages of bony ankylosis affecting the entire vertebral column, including the sacroiliac, costovertebral, and costotransverse joints. The pathologies were evaluated against the New York and Rome criteria for the diagnosis of AS in living individuals, as well as against previous osteological descriptions of the disease. This evaluation confirmed the previously published AS diagnosis of 11C36-4, such that ongoing aDNA analysis can assess the association of HLA-B27 with an accepted case of the disease in prehistoric contexts. This study is important to the assessment of disability in ancient North America, as the positive association of HLA-B27 with AS can provide an alternative assessment to clinical diagnosis for the disease in ancient populations. Thus, confirming the association of HLA-B27 with AS in ancient Native American populations could identify an otherwise unobservable pattern of debilitating arthritic disease.

Supported by NSF grant BCS-09 25111 to Kaestle and Cook.

Gestural flexibility in rehabilitant bornean orangutans *Pongo pygmaeus*

at the Orangutan Care Center and Quarantine in the state of Kalimantan Tengah.

REBECCA J. CUDMORE¹ and BIRUTÉ M. F. GALDIKAS². ¹Department of Anthropology, University of Oregon, ²Orangutan Foundation International.

Great ape communication research attempts to reveal the cognitive abilities of our closest living relatives and to inform our understanding of the evolution of human language. Although great ape gestural communication has been well documented, relatively few studies are specific to the orangutan. The aim of this study was to determine if rehabilitant orangutans (*Pongo pygmaeus*) at the Orangutan Care Center and Quarantine (Pasir Panjang, Indonesian Borneo) use distinct gestures toward other orangutans versus toward humans. Because orangutans are an arboreal species whose arms are typically not free to gesture, we predicted that orangutan gestures are adapted to employ the *whole body*. Using 59 sub-adults in 18 different home enclosures, we examined gestural types and frequencies in comparisons of orangutan-orangutan and orangutan-human communication. Orangutan-human trials were run with both the experimenter *facing* and *non-facing* to further measure gestural flexibility.

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Preliminary results show that 92% of orangutan-human gestures were made with the limbs, while the majority (46%) of orangutan-orangutan gestures were facial. When the human experimenter was *facing*, 76% of gestures were visual, while when *non-facing*, only 7% were visual. Our results suggest that limb gesturing toward the experimenter may be partly attributable to rehabilitant orangutans learning that caretakers respond more readily to anthropocentric gestures, like *arm/hand pointing*. Further, these orangutans alter gestural mode when the experimenter's face is not visible. Our preliminary findings demonstrate that these orangutans use gestures *flexibly*. Behavioral flexibility, resulting in the alteration of an animal's normal behaviors, has been defined as a good measure of intelligence.

This study was funded by Conservation International's Primate Action Fund, the Global Oregon Undergraduate Research award, and the University of Oregon Anthropology department.

Global survey of PGA indicates high CNV variability in human populations.

KATE DEROSA^{1,2}, ROBERT SCOTT^{1,3} and JINCHUAN XING⁴. ¹Department of Anthropology, Rutgers University, ²Department of Biological Sciences, Rutgers University, ³Center for Human

Evolutionary Studies, Rutgers University, ⁴Department of Genetics, Rutgers University.

Human pepsinogen A (PGA) is an inactive precursor for pepsin, the major protease in the stomach, and accounts for over 50% of all protein products in gastric cells. There are three different PGA genes in humans, PGA3, PGA4, and PGA5, located in the 11q13 region of the genome. Throughout the genome, genes and non-coding regions can have copy number variations (CNV) where there can be either a duplication of a gene(s) or a deletion of one or more gene copies. Some CNV are known to play a role in disease, although many of their exact functions remain unknown at this time. Only 7.6% of the most recent build of the human reference genome contained some type of CNV. For the purposes of this study, HapMap and Human Genome Diversity Project individuals were examined to determine how frequently CNV are found within the PGA region. These individuals were from European (CEU), Chinese (CHB), Japanese (JPT), Yoruba (YRI), and Pygmy ancestry. Out of 299 individuals studied, 78.93% were found to contain a CNV within the PGA region. This variation is consistent across all studied populations with 63.4% of Mbuti Pygmies, 38.9% of Biaka Pygmies, 86.7% of CHB, 98.9% of YRI, 91.1% JPT,

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and 58.9% of CEU having a CNV in this region. Given that only 7.6% of the entire genome experiences CNV, it has been determined that the PGA gene is highly variable through the human population.

Analysis of pelvis morphology and birthing practices: comparisons of modern and prehistoric humans.

JESSICA ENGEL. Department of Anthropology, Florida State University.

Obstetrics has changed drastically with improvements in the scientific community, yet there are still many inaccessible places of the world that modern medicine has not touched. This study compares cultural practices utilized in child birth and pelvic morphology between industrialized modern humans and prehistoric humans. Morphological changes in the female pelvis of Florida's Windover population, circa 6,509 to 5,408 BCE, were investigated as the prehistoric sample, while data from a study by Tague and Lovejoy and the Midwife Information and Resource Service were used as the industrialized modern sample. Ethnographic accounts of non-industrialized cultures illustrate variations in birthing practices and were compared to modern techniques in order to examine rates of successful birthing. Comparisons of the transverse dimensions of the samples show

decreases in the dimensions of modern samples, resulting in a more narrow shape. Modern industrialized females, therefore, may face more difficulty in labor, and rely more heavily on modern medical intervention. Moreover, wide variation in birthing practices among modern cultures does not suggest a single successful method, but highlights common procedures spanning groups that can offer new information concerning more efficient childbirth methods.

Foot strike patterns vary with running speed in the habitually unshod Daasanach of Ileret, Kenya.

MATTHEW FERRY¹, KEVIN G. HATALA^{1,2}, HEATHER L. DINGWALL³, ROSHNA E. WUNDERLICH⁴ and BRIAN G. RICHMOND^{1,5}. ¹Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ²Hominid Paleobiology Doctoral Program, Department of Anthropology, The George Washington University, ³Department of Human Evolutionary Biology, Harvard University, ⁴Department of Biology, James Madison University, ⁵Human Origins Program, National Museum of Natural History, Smithsonian Institution.

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Humans and our ancestors likely have a long evolutionary history with running, but it was not until recently that we did so wearing shoes. It has been argued that habitual barefoot running (today and in our evolutionary past) may necessitate a biomechanical strategy in which runners utilize a forefoot strike (FFS) to mitigate the high impact forces and potential risk of repetitive stress injury associated with a rearfoot strike (RFS). However, recent research has shown that FFS running is not typical in a habitually unshod Daasanach population (Ileret, Kenya), and running speed, among other factors, influences variation in strike patterns. Because substrate compliance has been shown to influence strike patterns in shod runners, and our previous study was conducted only on a firm pressure pad, in this study we analyzed foot strike angles in a sample of six consenting, habitually unshod Daasanach adults when running on a natural surface trackway. Subjects were asked to run at their preferred endurance running and sprinting speeds while their foot strikes were filmed with a high-speed (240 Hz) camera. In accordance with previous results, the majority of Daasanach subjects used a RFS, and never used a FFS, at endurance speeds. Our results show that foot strike angle is significantly correlated with running speed ($r=-0.63$, $p<0.0001$) in the

Daasanach, with more midfoot strikes and FFS at increased speeds. This study further supports the hypothesis that running foot posture varies across habitually unshod populations and can be influenced by running speed.

Funding for this research was provided by The George Washington University Luther Rice Undergraduate Research Fellowship, The Leakey Foundation, the National Science Foundation grants DGE-080163 and BCS-1128170, and The George Washington University Office of the Vice President of Research Undergraduate Research Award.

Detection of viruses in eight wild lemur taxa.

IAN FRIED¹, SARAH ZOHDY^{1,2}, PATRICIA WRIGHT³ and THOMAS R. GILLESPIE^{1,2}. ¹Department of Environmental Studies, Emory University, Atlanta, GA, ²Department of Environmental Health, Emory University, ³Department of Anthropology, Stony Brook University, Stony Brook, New York.

Diarrheal viruses are one of the most common causes of death in humans in developing countries; however, they have seldom been studied in wild non-human primates (NHPs). Due to a similar evolutionary history between human and NHPs, as well as the increasing proximity of human

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populations to shrinking NHP territories, an understanding of NHP disease has the potential to inform decision making for primate conservation and human health. In the first study to examine diarrheal viruses in wild lemur taxa, we screened samples for *Adenovirus*, *Enterovirus*, *Rotavirus*, and *Norovirus* (genogroups GI and GII), which are found in human populations in Madagascar. 87 fecal samples were non-invasively collected from lemurs that vary in feeding patterns in Ranomafana National Park (RNP) during the 2011 and 2012 dry seasons (May-August). Out of the eight taxa tested, five were infected by one or more of the diarrheal viruses. *Adenovirus*, the most commonly exhibited virus, was found in 27.4% of the samples, while *Enterovirus* was found in 20%. Because these viruses are transmitted via the fecal-oral route, we compared lemur dietary habits to infection rates and found that individuals with more terrestrial feeding patterns had higher viral loads than more arboreal feeding species. Given the nature of transmission of these viruses, changes in prevalence patterns will likely differ in the rainy season. Transmission of these viruses from humans to lemurs poses a serious risk for these already endangered species, while transmission from lemurs to humans could become a

serious health risk for tourists and locals.

Lessons from a fossil red panda (*Ailuridae: Carnivora*) for interpreting the evolution of sexual dimorphism in anthropoids.

ETHAN FULWOOD^{1,2} and STEVEN WALLACE³. ¹Department of Anthropology, University of Tennessee, ²Department of Ecology & Evolutionary Biology, University of Tennessee, ³Department of Geosciences, East Tennessee State University.

Comparative research has identified multiple behavioral correlates with sexual dimorphism in primates. However, the extent to which these patterns reflect novelties of primate social organization remains unresolved. Here, new data from the Late Miocene ailurid *Pristinaailurus bristoli* and the modern red panda *Ailurus fulgens* are interpreted to test for changes in sexual dimorphism in a non-primate lineage. *A. fulgens* is fully arboreal, which is hypothesized to constrain size dimorphism, while *P. bristoli* is believed to have been terrestrial/scansorial. Modern red pandas also show a promiscuous, non-competitive mating system, which is linked in primates with low sexual dimorphism.

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No significant dimorphism was found in *A. fulgens* except in dimensions of the canine ($p < .05$). The percentage of differences between each male/female pair of *A. fulgens* that were at least as great as those between the pair of *P. bristoli* was calculated for a series of cranial and postcranial measurements. The percentage of *A. fulgens* pairs as different as the *P. bristoli* pair in postcranial measurements was less than 5% for all dimensions but humerus breadth ($p = .057$). This was interpreted as evidence for greater body size dimorphism in *P. bristoli*. A maximum likelihood analysis incorporating these data and 43 other musteloid taxa indicated that low dimorphism in *A. fulgens* is derived (74% likelihood). This suggests that correlates of sexual size dimorphism in primates may have impacted ailurids, despite their lack of primate social complexity. Canine dimorphism persists in *Ailurus*, however, in contrast to many primates with non-competitive mating systems.

Funding: NSF REU grant to Steven Wallace.

Using accelerometry to study leaping performance in free-ranging sifakas (*Propithecus verreauxi*).

JOANNA GARDINER¹, ROSHNA WUNDERLICH¹, BRITTANY WILHELM², ANTHONY TONGEN²,

CHARLOTTE MILLER³ and DANIEL SCHMITT³. ¹Department of Biology, James Madison University, ²Department of Mathematics, James Madison University, ³Department of Evolutionary Anthropology, Duke University.

Measurements of performance are critical to analyses of fitness in wild populations and necessary in order to study locomotion as part of life history strategies. Sifakas (*Propithecus verreauxi*) are arboreal primates who travel using vertical clinging and leaping. Animals of all ages and all levels of physical ability travel along the same arboreal pathways and have to cross the same gaps. This presents potential challenges to smaller, younger animals, and less agile, older individuals. We used a novel 3-dimensional accelerometry system to identify locomotor behaviors and quantify leaping performance in one adult and one juvenile sifaka in both an enclosed experimental room with multiple substrates and a free-ranging outdoor enclosure at the Duke Lemur Center. Accelerations and simultaneous locomotor behavior data were collected in the experimental setting and then for a four-hour period in the free-ranging setting to clearly establish the relationship between movement and accelerometer output. Data were filtered and waveforms and

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peaks were identified. Up to 94% of single and cyclic vertical leaps were distinguished from all other locomotor patterns using the vertical component of the acceleration signal. Cyclic leaping and bipedal galloping exhibit similar center of mass vertical acceleration patterns but are distinguishable from one another using the relative magnitude of the peaks and the horizontal component of acceleration. Resultant magnitudes of acceleration positively correlate with estimated leap distances. These data serve both to establish these methods for measuring leaping performance in the field and to reveal profound biomechanical similarities between leaping and bipedalism in sifakas.

Body mass estimation from measurements of human male calcaneus.

AMBER GOLEMBIEWSKI and MEGAN K. MOORE. Department of Behavioral Sciences, University of Michigan-Dearborn.

Estimating or determining obesity from the human skeleton could greatly assist forensic anthropologists in identifying unknown remains. The body weight of a person can have an effect on the growth, size, shape, and density of the skeleton. The human calcaneus supports the entire body weight and therefore presumably undergoes

morphological changes as an individual gains excess weight. We hypothesize that excess load-bearing due to obesity will have an impact on the shape, density and size of the calcaneus. Using the biomedical software Amira 5.4, three-dimensional models were constructed of forty left adult human male calcanei from the William M. Bass Donated Human Skeletal Collection from the University of Tennessee, Knoxville to test this hypothesis. The height, length, and breadth of the calcanei were recorded using original measurement standards established by Martin (1928). Surface area and volume measurements as well as the circumference of the posterior calcaneus body were also taken. Measurements were analyzed via ANOVA using SPSS, version 19. A significant difference ($p < .05$) in calcaneus surface area is seen between the samples of obese ($BMI > 30$) and non-obese ($BMI < 29.5$) individuals used in the study. No significant differences associated with obesity for length, height, or breadth measurements of the calcaneus were observed. These results suggest that increased body mass, associated with obesity, does preserve a recognizable signature on the calcaneus. Developing a methodology to estimate body weight from such signatures holds great promise for both forensic anthropologists but also

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bioarchaeologists investigating the health of past peoples.

Ecomorphological analysis of prehensile tail use in *Alouatta palliata*.

STEPHEN GRIFFIN. Department of Anthropology, Middle Tennessee State University.

Adaptations allow members of the genus *Alouatta* to have increased sensitivity and better grip in the distal end of their tails. Although *Alouatta* do not use their prehensile tails as frequently as other genera of Atelinae, the tails still play an integral role in their lives. The goal of the study was to take an ecomorphological approach to prehensile tail use in *Alouatta palliata* to see if the morphology of the tail properly predicts the behavior of mantled howlers. The hypothesis was that mantled howler monkeys would use the distal end of their prehensile tail most frequently regardless of substrate or activity. More specifically, it was predicted that the howler monkeys would use their prehensile tail most often during suspensory feeding on smaller substrates.

Research took place at La Suerte Biological Station in northeastern Costa Rica from June 28 to July 11, 2012. Data was collected on 4-5 groups of mantled howlers who live in both primary and

advanced secondary rainforest. To collect the data, an instantaneous 30 minute focal animal sampling technique with two minute intervals was used. The results supported the hypotheses in that howlers used their distal end 85% of the time they used their tails. Therefore, the morphology of the howler monkeys' prehensile tail does offer an accurate prediction for their behavior. Additionally, the howler monkeys used their prehensile tails to aid them while feeding 78% of the time, suggesting that the specialized traits in the distal end function as a feeding adaptation.

Looking into the foundations of folklore: a bioarchaeological and historical investigation of Snow White's seven dwarfs.

ALLYSON HARRISON and MEGAN K. MOORE. Department of Behavioral Sciences, University of Michigan-Dearborn.

The story of Snow White and the seven dwarfs, made popular by the Brothers Grimm in 1812, is well-known in European folklore. This study seeks to understand if historical records and bioarchaeology can be used to investigate the origin of specific components of folklore. It has been hypothesized that the dwarfs in the Brothers Grimm story were based on mine workers (sometimes children)

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whose poor nutrition and unsanitary living conditions led to inhibited growth and development resulting in shorter stature. These individuals were thus identified as ‘dwarfs’. The intent of this study is to explore this connection between specific aspects of folklore and the bioarchaeological and historic record. In order to investigate this question, we examined the Germanic historical accounts of the Brothers Grimm journey to collect folklore. Additionally bioarchaeological studies of mining, such as documented skeletal deformations associated with the job, were analyzed from nineteenth century Europe. Examination of historic records confirms that miners were commonly malnourished. Further, bioarchaeological studies suggest that mine workers were shorter than their laboring counterparts during this time period. Our research showed that at the time of the Brothers Grimm journey there was a specific group of individuals who were distinctly shorter than everyone else in their communities. Based on our research, the small stature of the mineworkers is consistent with the description of the mine working dwarfs in the Brothers Grimm Snow White story, demonstrating that historical investigation and bioarchaeology can be used to provide evidence for the foundations of folklore.

Preliminary results from analyses of the comparative and functional anatomy of the forelimb musculature of Humboldt’s woolly monkey (*Lagothrix lagotricha*).

LINDSEY HAYS¹, VALERIE WHEELER², MAGDALENA MUCHLINSKI³, JASON ORGAN⁴, SARAH ABSHIRE⁵, TIMOTHY BUTTERFIELD⁵ and ANDREW DEANE³. ¹Department of Anthropology, Eastern Kentucky University, ²College of Health Sciences, University of Kentucky, ³Department of Anatomy and Neurobiology, University of Kentucky College of Medicine, ⁴Department of Anatomy and Cell Biology, Indiana University School of Medicine, ⁵Department of Rehabilitation Sciences, University of Kentucky College of Medicine.

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’

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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 available 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.

Bipedalism, energetics, and hair loss in the evolution of the genus *Homo*.

SHELBY HOLTZMAN, MEGAN MOORE and JANET DUNN.
Department of Behavioral Sciences,
University of Michigan-Dearborn.

The origins of the body form of genus *Homo* has been the subject of much investigation. We focus on the period from 3 to 1.6 mya, a time when the hominin physical form and behavioral adaptations were undergoing major changes and is likely the period during which the loss of body hair occurred. Hairless, helpless, large-brained infants no longer possessing a grasping toe would have required a more active carrying method than the more robust and capable infants of their ancestors. Through a survey of existing literature we present a timeline for these changes and discuss the behavioral and material consequences of this transition. The effects not considered previously are the role of hair loss and changes to the infant foot in relation to active and passive carrying, and the emergence of an infant-related material culture in the intermediate time between piliferous australopithecines and the bare *Homo erectus*. We offer a new interpretation of the fossil evidence and argue that by at least 1.6 mya, hominins were starting to be

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recognizably human, with efficient bipedal locomotion, hairless bodies, and strategies of child rearing and social interaction influenced by the active carrying of infants.

Plantar pressure during vertical climbing in chimpanzees (*Pan troglodytes*).

SARA B. ISCHINGER and ROSHNA E. WUNDERLICH. Department of Biology, James Madison University.

Metatarsal torsion and robusticity have frequently been used to infer locomotor function in extinct primates, including fossil hominins. Apes possess a robust, everted metatarsal 1 (lateral torsion), and inverted metatarsals 2-5 (medial torsion). It has been suggested that this distinct forefoot design allows the metatarsal heads of an inverted foot to lie flat on the substrate, and that the decreasing length and robusticity across the metatarsal row reflects load bearing during vertical climbing. We test this hypothesis by collecting the first quantitative data on plantar load distribution during vertical climbing. We trained two *Pan troglodytes* to climb a vertical pole instrumented with a flexible Pliance pressure mat (Novel GmbH). We quantified plantar pressure in 11 anatomical regions (phalanges; metatarsals 1, 2/3, 4/5; medial and lateral midfoot, heel) and described load distribution across the

foot during stance phase of vertical climbing. When vertical climbing, *Pan troglodytes* transfer their weight from the midfoot to the lateral metatarsals and then to the medial metatarsals. Peak pressure was significantly greater under metatarsals 2/3 than under metatarsal 1 and 4/5 ($p=0.0475$, $p=0.0001$). Peak pressure under metatarsal 1 was significantly greater than under metatarsals 4/5 ($p=0.0345$). *Pan troglodytes* use an inverted foot with an abducted hallux during vertical climbing. Torsional characteristics allow *Pan troglodytes* metatarsals to align plantar surfaces with the substrate facilitating lateral to medial weight transfer across the metatarsal row, while the robusticity of the *Pan troglodytes* medial forefoot is an adaptation for high push-off forces during climbing.

Evidence of scurvy on the Vrina Plain: a bioarchaeological analysis of infant skeletal remains from ancient Roman Butrint.

AMANDA JONES¹ and THOMAS CRIST². ¹Department of Archaeology and Anthropology, University of Wisconsin La Crosse, ²Department of Anatomy and Anthropology, Utica University.

Butrint is an archaeological site located on the southern tip of present-day Albania. During the 1st century AD,

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Butrint grew in both size and population, expanding to the Vrina Plain and developing into a Roman suburb that remained influential in the area until the 3rd century AD. The present analysis centers on the skeletal remains of three infants who were buried in individual amphorae located under the floors and walls of a Roman villa. After estimating each infant's age, we examined the remains for skeletal lesions of nutritional stress such as porosity on the cranial vault, orbital roof, greater wing of the sphenoid, squamous portion of the temporal, bilateral posterior surface of the maxilla, bilateral internal surface of the zygomatic, and the metaphyseal and diaphyseal surfaces of long bones. When interpreted in the context of the clinical symptoms of scurvy in infants and the metabolism, absorption, and bioavailability of vitamin C, these bioarchaeological data indicate a diagnosis of scurvy, to the exclusion of other possible conditions. This research makes a significant contribution to bioarchaeological analyses at Butrint by providing evidence of systemic nutritional stress, specifically scurvy, in this population. A close examination of the remains of these infants has revealed a disease process that may have directly contributed to their early deaths. By weaving together skeletal evidence of metabolic disease and archaeological context, this study has

uncovered a potentially significant stressor affecting the ancient inhabitants of a once-thriving settlement on the Vrina Plain.

On giants and dwarfs: what can Kadanuumuu and Lucy tell us about sexual dimorphism and variability in *Australopithecus afarensis*?

BORYANA E. KASABOVA and PATRICIA A. KRAMER. University of Washington, Seattle.

Recent analysis indicates that the estimated lower limb length (eLLL) for KSD-VP-1/1 (0.763 – 0.791m) is substantially longer than that of AL-288-1 (0.525m). The ratio of shorter to longer eLLL for these specimens ranges from 1.44 to 1.51, which raises the question of whether or not these two are likely to belong to the same paleospecies (*Australopithecus afarensis*).

In order to determine the probability of randomly selecting two members of the same group with an eLLL ratio ≥ 1.44 , 66 primate groups were examined: 19 non-human primates, 46 modern human populations, and a combined sample that represents species-level human variation. Virtual populations of 10,000 individuals were created using the descriptive statistics of the groups because only 11 out of the 66 groups included two individuals who could generate a ratio ≥ 1.44 . The

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virtual populations allowed for the existence of individuals that can produce the sought ratio for all groups. 1,000 sets of two individuals were drawn from each virtual population.

The probability of two randomly selected individuals generating an eLLL ratio ≥ 1.44 ranges from 0 (*Hylobates*, *Presbytis*, *Trachypithecus*, Andaman Islanders) to 0.0076 (*Macaca mulatta*). If the distribution and variability of early hominin lower limb lengths is adequately represented by extant primates, these results indicate that it is unlikely that two individuals as different in their eLLL's as KSD-VP-1/1 and AL-288-1 could have come from the same paleospecies. However, more work is needed to understand the morphological variability of paleospecies, particularly that introduced by time.

Three-dimensional analysis of the proximal tibia.

ELAINE KOZMA. Department of Anthropology, New York University.

Proximal tibial shape has been shown to reflect important functional differences in the knee joint of extant hominoids, especially that of humans. In order to accurately demonstrate the relationship between morphology and function, it is necessary to describe shape variation. Although specific

features of tibial morphology have been quantitatively analyzed, overall proximal tibial shape has not. This study tests whether three-dimensional geometric morphometric analyses can be used to distinguish shape differences independent of size in the proximal tibia of extant hominoids. Three-dimensional surfaces of the proximal tibia of humans, chimpanzees, gorillas, orangutans, and gibbons were captured using a Next Engine scanner. Data were collected on condyle shape and curvature, as well as on tibial tuberosity size and position using Landmark software. Analyses indicate that three-dimensional geometric morphometrics of proximal tibial shape can be used to distinguish taxa. After Procrustes analysis, a principal components analysis showed that modern humans are distinct from extant apes. Principal component scores show that humans and extant apes are statistically different ($P < 0.05$). The results of this study allow further comparisons between the proximal tibiae of extant hominoids and Plio-Pleistocene fossil hominins and provide important information on the morphometric and functional relationships that differentiate early members of the human lineage. These findings clarify the relationships between shape variation and function in extant hominoids and provide new data that can be used to make

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inferences about the functional-behavioral transformations that took place during the earliest evolutionary stages of the acquisition of human bipedalism.

A preliminary radiographic analysis of dental development in Virunga mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda.

ALEXANDRA E. KRALICK¹, HALSZKA GLOWACKA², MICHAEL R. CRANFIELD³, TARA S. STOINSKI⁴, ANTOINE MUDAKIKWA⁵, TIMOTHY G. BROMAGE⁶ and SHANNON C. MCFARLIN^{1,7}.

¹Department of Anthropology, The George Washington University, Washington, DC, USA, ²Institute of Human Origins, Arizona State University, Tempe, AZ, USA, ³Mountain Gorilla Veterinary Project, University of California Davis, USA, ⁴Dian Fossey Gorilla Fund International and Zoo Atlanta, Atlanta, GA, USA, ⁵Rwanda Development Board - Tourism and Conservation, Kigali, Rwanda, ⁶Departments of Biomaterials & Biomimetics and Basic Science & Craniofacial Biology, New York University College of Dentistry, NY, USA, ⁷Center for the Advanced Study of Hominid Paleobiology, The George Washington University, Washington, DC, USA.

Investigations of dental development have figured prominently in attempts to reconstruct fossil hominid life histories. However, comparative data from extant wild great apes of known age remain scarce, particularly from species other than chimpanzees. We report initial results from the first radiographic examination of dental development in wild Virunga mountain gorillas (*Gorilla beringei beringei*), using a well-documented sample of skeletons recovered in Rwanda. Virunga mountain gorillas are the least frugivorous among great apes and, despite their large size, show earlier ages at weaning and first birth. Thus, they provide a unique opportunity to test relationships between dental development, socioecology, and life history among hominoids. We test the hypothesis that mountain gorillas are accelerated in dental development, as they are in other life history traits, compared to chimpanzees. We collected radiographs of mandibular dentitions using a Nomad Pro portable dental x ray, from 16 individuals of known sex and age (0.0-14.9 years). Molar crown and root calcification status was scored following an eight-stage system (Kuykendall, 1996; Demirjian et al. 1973). In only one case did crown calcification stage fall outside of the age range reported for captive chimpanzees (Kuykendall, 1996). Differences were

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more commonly observed in root formation, where calcification stages were reached at later ages in three mountain gorillas. While these results do not support our hypothesis, future studies will incorporate an expanded sample and more refined staging system. Associated individual records also provide opportunities to test links between dental development, life history and health status in this population.

Funding was provided by the GW George Gamow Undergraduate Research Fellowship to A.K., and by the Leakey Foundation, National Geographic Society, and NSF BCS 0852866 and 0964944 to the Mountain Gorilla Skeletal Project.

Chronological age estimation of Native American remains in an archaeological context: re-examining the sternal rib end.

ANDREW W. LAMBERT and GRETCHEN R. DABBS. Department of Anthropology, Southern Illinois University Carbondale.

The rib phase analysis aging technique developed by İscan et al. is a common tool for estimating age from adult skeletal remains in forensic anthropology. However, its effectiveness for estimating the age of ancient adult populations of the New World still needs quantification, a

necessity previously called for by senior scholars. This investigation sought to demonstrate the effectiveness of this aging technique in the archaeological context, hypothesizing that it would be effective. This study sampled 39 males and 17 females from the Archaic and early Woodland periods at the Black Earth Site in Southern Illinois, housed at Southern Illinois University. Age estimates from the İscan et al. rib morphology phase method and pelvic age estimation methods (i.e. analysis of the pubic symphysis and the auricular surface) were recorded and tested for concordance. Because each method provides phase-specific mean age estimates, it was necessary to assign these estimates into the following three age groups: early adulthood, middle adulthood, and late adulthood (i.e. 17-34, 35-54, and 55+ years, respectively). Data analysis with Fisher's exact test shows a significant difference between the rib phase and auricular surface techniques in males ($p = .0095$) and females ($p = .0445$), but no significant differences between rib phase analysis and pubic symphysis techniques: males ($p = .5836$) and females ($p = .9999$). The analysis demonstrated mixed results. The rib end-based age estimates are not concordant with the auricular surface method of estimation, but are concordant with the sex-specific pubic method, which is potentially explained

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by the biological timing of the feature changes.

Does footwear change energy expenditure? Application to understanding the energetics of extinct bipeds.

STEVEN G. LAUTZENHEISER¹ and PATRICIA A. KRAMER^{1,2}.

¹Department of Anthropology, University of Washington.

²Department of Orthopaedics and Sports Medicine, University of Washington.

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.

Self-selected walking speed as a function of load in reproductive age women carrying an indigenous pack basket.

MOLLY LOVSTAD, ALEXANDRA KENNEDY and MARCIE MYERS.

Department of Biology, St Catherine University.

Almost universally, females from indigenous populations walk long distances carrying heavy loads; these loads include infants and toddlers, food, water, firewood, and household belongings. The purpose of our research was to determine how different levels of load carried in an indigenous pack basket affect the

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speeds selected by free-walking reproductive age women given qualitative speed directives. The study involved 14 women between 18 and 30 y who were in the luteal phase of their menstrual cycle or taking oral contraceptives. Subjects carried three different load amounts in an indigenous style pack basket -- 0 kg (an empty pack), 10 kg, and 20 kg -- while walking around a gym perimeter at four different walking speed directives ("slow walk", "walk all day", "brisk walk", "fast walk"). During each of two testing days, 12 trials (all combinations of 3 loads, 4 speed directives) were performed in a random order. Each trial consisted of six minutes walking followed by four minutes resting. Average selected walking speed for each trial was determined from video tape recordings on each side of the gym. Actual walking speed increased curvilinearly with speed directive. For a given speed directive, selected speeds dropped significantly from 0 to 20 kg loads at all but the "slow walk" directive, with the amount of the speed drop increasing at faster speed directives. Such load-related modulation of walking speed could limit daily foraging range, as well as increase the frequency of camp moves, potentially influencing the mobility of the entire population.

This study was funded by 3M Faculty/Student Collaborative Grant #212607 through St. Catherine University.

A biocultural examination of exclusive homosexuality in *Homo sapiens*.

JUDE MAGARO¹ and JEFFREY WINKING¹. ¹Department of Anthropology, Texas A&M University.

Within the order Primates, exclusive homosexuality (the state of having had sexual contact with only same-sex individuals when partners of both sexes are available) is found only in human populations. This study tests the hypothesis that alternative gender roles co-occur with exclusive homosexuality cross-culturally, which would suggest a link between these phenomena. The data presented here are derived from the 258 cultures in the electronic Human Relations Area Files (HRAF) database. Alternative gender was found to be highly associated with the mention of homosexuality and exclusive homosexuality across multiple inclusion/exclusion criteria. When the entries in the HRAF database that do not mention alternative gender or homosexuality are considered to be indicative of the absence of these characteristics, alternative gender is a very strong predictor of the presence of homosexuality ($p < .001$) as well as exclusive homosexuality ($p < .001$).

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When those same entries are excluded as having no data, both correlations still hold ($p < .001$). These results suggest an association between the presence of homosexuality and alternative gender roles across a wide range of populations. Conclusions must be tempered, however, by the fact that for most populations in the HRAF database, ethnographers do not mention alternative genders or homosexuality at all. Overall, these results demonstrate a need for greater resolution in ethnographic data on the subject of homosexuality and encourage further study of exclusive homosexuality as a key aspect of understanding the fundamental nature of human sexual behavior.

Evaluating 2D and 3D methods of measuring fluctuating asymmetry of primate skulls.

COLIN OLIVEIRA, LAUREN MOORE, DANIEL ARRAÑAGA, ASHLEY REDD, ANDREA ELLER, FRANCES WHITE and STEPHEN FROST. Department of Anthropology, University of Oregon.

Morphological fluctuating asymmetry (FA), particularly cranial FA, can be used as an indicator of past developmental instability or environmental stress. Primate FA has been measured using a variety of two and three dimensional methods either

directly from specimens or from images. We compared the effectiveness of three methods of calculating FA: Microscribe readings of three dimensional landmarks on the specimen, two dimensional landmarks measured from photographic superimposition using tpsDig, and linear distances using digital calipers on the specimen. We selected one *Macaca fuscata* skull that appeared highly symmetrical and one that appeared highly asymmetrical. Three observers used each of the three methods on the two skulls using 5 midline points and 7 bilateral points for 5 replicates. Measurements taken by each method were compared between the symmetrical and asymmetric specimen. The methods differed in preliminary statistical analysis. The FA values calculated from linear distances for the two skulls were not significantly different ($F=1.35$ df 1,28, $p=0.2554$) and the mean measure of symmetry was larger for the symmetrical skull than the asymmetrical skull (mean symmetrical 0.348, SE ± 0.025). When measured with both tpsDig and Microscribe methods, the FA values for the two specimens were significantly different (tpsDig $F=20.14$, df 1,18 $p=0.0003$; Microscribe $F=16.07$, df 1,18, $p=0.0008$) with mean values for the symmetrical skull were smaller than the asymmetrical skull. We conclude that both direct Microscribe measurement and tpsDig

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from photographs were reliable methods, but using linear distances measured on the specimen was an unreliable method of assessing FA.

Paleoenvironmental conditions at the Oligocene-Miocene boundary in Sumatra, Indonesia: environmental template for the evolution and dispersal of Hominoidea in Island Southeast Asia.

NATALIE O'SHEA¹, E. ARTHUR BETTIS III², YADI ZAIM³ and RUSSELL CIOCHON¹.

¹Department of Anthropology, University of Iowa, ²Department of Geoscience, University of Iowa, ³Institut Teknologi Bandung, Bandung, Indonesia.

Changing habitat availability combined with global and regional fluctuations in temperature and rainfall played an important role in how and why members of Hominoidea radiated into Southeast Asia. Environmental conditions during the period of primate radiation into what is now Island Southeast Asia are poorly constrained. There is a paucity of studied terrestrial records from this tectonically active region where much of the land area formed after the radiation of anthropoids began in earnest during the Oligocene. A stratified paleosol sequence from the Oligocene-Miocene

boundary in Sumatra provides a localized record of environmental changes as significant land areas emerged and joined with the Asian mainland. In this study, preliminary interpretations of changing environmental conditions during this critical time period based on morphological, geochemical and isotopic studies of the paleosol sequence indicate a mosaic of local environmental conditions in the lower reaches of a large river system. Stratified and laterally discontinuous successions of weakly expressed soils formed on natural levees and adjacent flood basins. Peats (coals) with clayey subsoils formed in poorly drained parts of flood basins downstream from the main channel system. Well expressed soils with evidence of clay translocation and chemical weathering formed on higher, more stable parts of the landscape. The absence of soil carbonate accumulations throughout the sequence suggests a persistently wet rainforest environment, an environment favorable to the dispersal of Hominodea.

Incremental growth lines in melatonin-deficient mice.

AMANDA M. PAPAKYRIKOS¹, YONG WEN², CHRISTINE AUSTIN³, AKIKO KATO⁴, NANCY TANG⁴, MANISH ARORA⁵, XIU-PING WANG² and TANYA M. SMITH⁴.

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¹Department of Biological Sciences, Wellesley College, ²Department of Developmental Biology, Harvard School of Dental Medicine, ³Department of Environmental Health, Harvard School of Public Health, ⁴Department of Human Evolutionary Biology, Harvard University, ⁵Institute of Dental Research and Department of Oral Pathology, Westmead Hospital.

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.

Funded by the Howard Hughes Medical Institute, Harvard University, and the Harvard School of Dental Medicine.

Analysis of Daasanach growth in relation to ecology and subsistence strategy.

KRISTEN RAMIREZ¹ and BRIAN G. RICHMOND^{2,3}. ¹Department of Anthropology, The George Washington University, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Human Origins Program, National

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Museum of Natural History, Smithsonian Institution.

Body size is highly variable among modern human populations, as it is influenced by the interactions between genetic information and external nutritional and environmental variables during growth. Across traditional societies a relationship between life history strategy, relative adult body size, and extrinsic variables (e.g. ecology, subsistence strategies) has been documented and serves as a theoretical foundation to explain observed variability. However, individual populations are known to deviate from this pattern. Cross-sectional data on height and weight were taken from an ontogenetic sample of Daasanach individuals (n=223) from Ileret, Kenya to test the null hypothesis that the Daasanach conform to the expected growth timings and adult body size parameters for traditional populations of similar ecologies and subsistence strategies. Mean adult male body size was compiled from twenty previously studied traditional societies among which stature differed significantly among ecological groups. Our results indicate that Daasanach mean adult male height falls within the parameters for the group of ecologically similar populations (savanna, desert, dry forest; Z score=1.46), and falls beyond the group

of ecologically dissimilar populations (tropical and neotropical forest, coastal; Z score=4.04). However, the Daasanach obtained a lower percentage of adult stature and mass at age 10 compared to other populations, suggesting a delayed growth trajectory. Our results demonstrate that although the Daasanach males attain an adult stature consistent with predictions based on ecology, they may deviate from expected growth during juvenile development. Continued research is required to fully understand the relationship between body size and life history strategy.

This work was supported by the George Washington University's Luther Rice Collaborative Fellowship to KR, and NSF BCS-1128170 to BR.

Ancient DNA from the Late Woodland component of Schild archaeological site.

AUSTIN W. REYNOLDS¹. ¹Department of Anthropology, Indiana University, Bloomington.

Schild is a Late Woodland and Mississippian archaeological site (ca. 700-1200 AD) in the Lower Illinois River valley of western Illinois. The Late Woodland component of the site consists of nine burial mounds containing approximately 230 individuals.

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Previous work done on the Late Woodland material yielded mitochondrial DNA from 19 individuals and suggested a very high frequency (0.421) of haplogroup X. In this study I report on the mitochondrial haplogroups of individuals from mound 2 at the site to add to our understanding of the Late Woodland Schild population's relationship to other Late Woodland and Mississippian populations in the region and to test hypotheses regarding mortuary practices surrounding Late Woodland mound burials.

Thirty five individuals buried in mound 2 were tested for the presence of mitochondrial DNA using standard ancient DNA methods. Of these individuals, thus far only 20 have yielded sufficient mitochondrial DNA for sequencing. The mitochondrial HV1 was sequenced in 3 fragments and results were verified with multiple independent extractions and amplifications. Results suggest a significantly different haplogroup frequency distribution from the original Schild Late Woodland sample, with high frequencies of haplogroup C and no haplogroup X. The possibility that particular matrilineages were interred in specific mounds, and the implications for interpreting Late Woodland haplogroup frequencies and mortuary practices, are explored.

This study was supported by NSF grants BCS-0962749 and BCS-0925111.

The effect of forelimb mass distribution on the function of arm swinging during human bipedalism.

M. KATHERINE SAYRE and LIZA J. SHAPIRO. Department of Anthropology, University of Texas at Austin.

Arm swinging is an inherent part of human bipedalism, but its function in locomotion has not been as extensively studied as the function of the hindlimbs. The evolution of human bipedalism was accompanied by an increase in hindlimb length relative to forelimb length, while the decrease in relative length of the forearms altered the distribution of mass in that limb. Although it has been demonstrated that adding mass to the forelimb decreases shoulder rotation and increases pelvic-shoulder lag time (Pontzer et al., 2009), the objective of this study was to determine the effect of changes in forelimb mass distribution on those same parameters. We hypothesized that more distally-placed mass would increase the forelimb's moment of inertia, resulting in decreased shoulder rotation and increased pelvic-shoulder lag time, relative to more proximally-placed mass. We also hypothesized that increasing speed would exaggerate

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these effects. We measured shoulder rotation and pelvic-shoulder lag time in ten healthy female young adults walking and running under five conditions: control, no arms (arms folded across the chest), and mass added to the elbows, wrists, and hands. Preliminary results indicate that adding mass to the forelimb decreases both shoulder rotation and lag time, in both walking and running. Altering the location of the mass does not appear to significantly affect either shoulder rotation or lag time, in walking or running. These results may have implications for understanding the functional influence of changes in forelimb mass distribution that occurred during the evolution of human bipedalism.

This research was supported by the UT Austin College of Liberal Arts Rapoport-King Thesis Scholarship and NSF BCS 0647402.

A comparative analysis of the dental health of two Middle Woodland assemblages in the lower Illinois Valley.

MEGAN SCHWALENBERG.
Department of Sociology and
Archaeology, University of Wisconsin -
La Crosse.

The Gibson and Ray sites are located in the lower Illinois Valley and dated to

the Middle Woodland period, ca. 50 B.C. - A.D. 400. Through the examination of 48 skeletons from these sites, this study compared the dental health between the two sites in terms of dental pathologies and their potential correlation to sites, sex, and/or age-at-death. Information on dental attrition, caries, abscesses, and other dental pathologies was collected from a sample of 24 adults from each site, and estimation of sex and age-at-death were established with two age groups: young adults (20-35) and middle-to-old adults (35-50+). Preliminary results show that there is no correlation between caries rates and site but a weak correlation between abscess rates and site. A statistically significant difference ($p < 0.05$) was found in abscess and caries rates between the young and middle-to-old adults, while no correlation was found between the sexes. These results suggest there was little to no dietary difference between the sites and that poor dental health was prevalent among middle-to-old adults. Since the individuals from both sites date to the Middle Woodland, it would be expected to find comparable rates of dental pathologies between the two samples as a result of similar diets. This information provides insight into the dental health of the Middle Woodland people during the transition from hunting-and-gathering to horticulture in the lower Illinois Valley

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and a baseline that can be utilized by other researchers for comparison to later maize agriculturalists in the region.

Y-genotyping of haplogroups E and J in the Yemeni population.

TIMOTHY SCOTT¹, AIDA MIRO-HERRANS^{2,3}, SHANNON MCNULTY³, VASSILIKI PAPASTAVROS¹ and CONNIE J. MULLIGAN^{1,2}. ¹Department of Anthropology, University of Florida, ²Genetics Institute, University of Florida, ³Genetics and Genomics Program, University of Florida, ⁴Department of Biochemistry and Molecular Biology, University of Florida.

In the context of understanding human migration, Yemen represents an essential location along a southern migration route for the colonization of non-African regions. The predominance of J haplogroups in the Arabian Peninsula and notable frequency in European populations, combined with a prevalence of the African E haplogroup across multiple continents, suggests these two haplogroups are ideal for understanding the diffusion of humans between Europe and Africa. Y-genotyping of 50 randomly sampled Yemeni male individuals revealed low genetic diversity in the region, while

featuring a strong prevalence of M-267-defined J1 subhaplogroup, comprising 82% of the sample population. Analysis of these results in conjunction with frequency data representing regions across Europe and Asia suggests multiple conclusions: (1) The majority of Yemeni Y chromosome diversity is described by only haplogroups E and J, suggesting a long-term population history characterized by small size and geographic isolation, (2) southern Arabia is a good candidate for the origin of subhaplogroup J1, (3) J1 spread northward throughout the northern Arabian Peninsula as well as southern Europe. Furthermore, while there exists a significant frequency of subhaplogroup E1b1 in the southern Arabian Peninsula as well as throughout southern Europe, the subhaplogroup is virtually nonexistent in northern Arabia; (4) this result supports two separate migrations of E1b1 from Africa and restricted gene flow between southern Arabia and Europe. Yemen provides insight into the peopling of regions as humans dispersed from Africa.

Natural history museum visitors' understanding of human evolution.

SHAYE SMITH, Department of Anthropology, Colorado College, Colorado Springs.

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Recent polls indicate that only 15% of Americans accept secular evolution as the cause of human origins and less than 10% possess a functional understanding of evolutionary concepts (Gregory 2009; Newport 2012). Many studies have investigated natural history museum visitors' understanding of evolution but few have examined understanding of human evolution in particular. Data were collected over a five-day period at the National Museum of Natural History in Washington, DC. Ninety-six museum visitors participated in an exit survey in the Hall of Human Origins. Fifty percent of visitors subscribed to a young earth creationist or intelligent design belief. Visitors' answers to questions pertaining to information presented in the exhibition and their understanding of the principles of evolution as the basis of human origins were scored for accuracy. Relationships were found between acceptance and understanding, with those who accepted secular evolution scoring on average 79%, those who believed in intelligent design scoring on average 70%, and those who believed in young earth creationism scoring on average 41%. Results indicate that visitors held several misconceptions about evolution, e.g. new traits that arise in populations are always beneficial (54%) and adaptations arise in response to need or an intentional effort to change

by individuals (68%). Because natural history museums house the objective scientific knowledge and fundamental evidence for evolution, they play an important role in educating the public. However, as these results indicate, personal beliefs influence visitors' ability to understand the principles of evolution as the basis of human origins.

Geographic and seasonal variation in the decomposition of pig carcasses in western New York using accumulated degree-days.

JESSICA J. STABELL. Department of Anthropology, Buffalo State College.

Understanding the process of decomposition is integral to accurately estimating the postmortem interval (PMI), which provides time since death for recovered remains. As decomposition is more temperature-dependent than time-dependent, the recently developed method of accumulated degree-days (ADD) is a more objective approach in assessing decomposition processes through summation of average daily temperatures. ADD is hypothesized to be region and season specific, as temperatures and weather vary by season and location. This study was the first in western New York, undertaken to determine if ADD indices differed throughout season and region, by comparing results to published studies

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in Canada. Research was conducted during summer and fall of 2012 using domestic pigs (*Sus scrofa*). Climactic data and stages of decomposition were recorded in daily observation sessions using photographs and field notes. Minimum and maximum temperatures were taken every 24 hours. ADD indices for both seasons are comparable in all decomposition stages except dry decay, likely the result of a drought during summer. Dry decay was reached at ADD 519 in summer and ADD 556 during fall; increased precipitation in fall extended the duration of liquefaction throughout dry decay. Differences in dry decay and liquefaction between summer and fall indicate that seasonal weather influences decomposition. ADD temperatures were higher than those in Canada, signifying ADD indices from Canada are not applicable to western New York. Based upon these results ADD is season and location specific, necessitating ADD research within each season and region to provide an accurate PMI estimate.

The functional role of the gluteus maximus during running.

BONNIE J. SUMNER, RICHARD G. ELLIS and RODGER KRAM.
Department of Integrative Physiology,
University of Colorado.

Enlargement of the gluteus maximus (GMAX) during human evolution has been proposed to be an important adaption for endurance running, however its specific functional role during running is not fully understood. To provide insight to this we assessed the gluteal muscles contribution to propulsion and counteracting trunk pitching, forces which are significantly greater during running than walking. We measured EMG amplitude while increasing or decreasing the need to control trunk pitching with external devices that either increased the torso's moment of inertia or the hip extensor torque and also while increasing and decreasing the need for propulsion by providing a constant aiding or hindering horizontal force. We hypothesized that the inferior and superior GMAX EMG would be the most active when the need for propulsion was increased and that the superior GMAX would be most active when the need for trunk pitch control was increased. We found the inferior GMAX significantly increased in activity when forward trunk pitch increased. We also found that the GMAX is a key contributor to propulsion during running while only the inferior GMAX contributes when there is a high demand for propulsion in walking. Our data suggests that the large size of the GMAX reflects its role in part to its contribution to propulsion

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and 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 running and a minor propulsive role during walking.

Gradient, burden, burden/mass ratio and cadence in women: correlated with cost of transport.

SIMONE VIJGEN¹, JENNIFER EYRE² and PATRICIA A. KRAMER¹.
¹Department of Anthropology, University of Washington,
²Department of Anthropology, New York University.

Even though many women engage in subsistence activities that require movement in varied terrains, little is known about the effects of burden and gradient on the energy expenditure of women. Additionally, it remains unclear which anthropometric characteristics predict variability among women in these situations.

To address this issue, 10 women walked on a treadmill for 14 randomized trials, divided into 2 or 3 testing sessions. Each trial consisted of different combinations of three variables. Women walked at self-selected slow, medium, and fast velocities; at gradients of 0, 5%, and

10%; and with and without a 10 kg burden carried in a backpack. Walking trials lasted 5 minutes, with 4 minutes of resting between each trial. VO₂ and VCO₂ were measured using a Sensormedics Vmax 29c metabolic cart, and standard anthropometrics such as body mass, stature, and limb segment lengths were measured. Cadence was also determined during each trial. Cost of transport (CoT) was calculated as the average VO₂ of the last 2 minutes of the 5-minute trial divided by velocity.

Gradient ($p < 0.001$), burden ($p = 0.004$), mass ($p < 0.001$), and burden/mass (0.019) were positively correlated with CoT ($r^2=0.71$), while cadence ($p < 0.001$) was negatively correlated. Our analysis shows that these variables predict variability within individuals ($r^2= 0.72$) better than among individuals ($r^2=0.64$). Stature ($p=0.52$) and lower limb length ($p=0.28$) were not predictive.

Future work should investigate how additional anthropometric measurements, such as crural index, interact with gait and terrain characteristics (burden, gradient, etc).

Cross-sectional morphology of the australopithecine hard palate.

MEGAN E. VOSS¹, CHERYL A. HILL² and RACHEL A. MENEGAZ¹.
¹Department of Pathology and

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Anatomical Sciences, University of Missouri School of Medicine,
²Department of Basic Medical Sciences, University of Arizona College of Medicine – Phoenix.

The vertically thickened hard palate of *Paranthropus*, like many other derived craniodental features in this species, has been explained 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. We hypothesize that if the hard palate in *Paranthropus* was subject to greater masticatory stresses relative to the same structure *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 ($p \leq 0.05$) 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. Thus, variation in the hard palate of australopithecines is consistent the observed craniodental variation, suggesting a divergence in dietary material properties and masticatory behavior between the two genera.

Costly courtship: the energetic burden of walking together.

JANELLE M. WAGNILD and CARA M. WALL-SCHEFFLER. Department of Biology, Seattle Pacific University.

Prior research has compared the speed choices that individuals make when walking alone versus in groups. It has been shown that groups tend to walk more quickly than individuals, and that group walking speed is subject to sexually dimorphic variation such that male-male dyads walk faster than female-female dyads, while mixed dyads walk at an intermediate speed. It has been hypothesized that there is a correlation between relationship status and interpersonal walking distance such that dyads with a closer relationship will walk in closer

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proximity to each other and will consequently walk more slowly. This study examines the speed choices that mixed dyads of varying relationship statuses make when walking alone and together. We hypothesize that the walking speed of a mixed dyad will approach the optimal walking speed of the female because the male will adjust his pace to accommodate hers. Individuals (N=22) walked around a track alone, with a significant other, and with a friend of the same and opposite sex while their speeds were recorded every 100m. Our findings suggest that if a mixed dyad is in a dating or married relationship, males will walk at a significantly slower pace to match the females' paces ($p=0.009$). If the mixed dyad is comprised of friends or acquaintances, the pair compromises speed such that the male slows down ($p>0.2$) while the female speeds up ($p>0.4$). These findings have implications for the role of reproductive investment in the mobility strategies of populations because deviations from optimal speeds have energetic consequences.

Alternate light source imaging for tattoo detection: case studies on a South American mummy.

ALICE WANG. Department of Anthropology, University of California Los Angeles.

Tattooing may not be immediately visible on mummified remains. The effects of desiccation and other processes can darken the skin, reducing the contrast between tattoos and the surrounding skin. In cases of suspected tattooing in which inspection in visible light is not sufficient, alternate light source imaging can be used to determine whether tattoos can be visualized in different spectra of light. The goal of this research is to establish a non-invasive and non-destructive methodology for detecting the presence of tattooing on mummified remains using alternate light source imaging. Infrared reflectography (IFR) and ultraviolet fluorescence (UVF) were employed in this ongoing study to test the efficacy of these methods in detecting possible tattooing on an unprovenienced South American mummy from the UCLA Osteological Collection. Preliminary results include several circular areas that demonstrate the presence of an unknown substance on the surface of the arm. Further study is being conducted to determine the nature of these spots. These methods are of interest to research on the roles of tattooing in body modification and medical practices in past societies because they improve the visualization capabilities of tattoo imaging.

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An analysis of stature in the Mississippi Basin during the transition to agriculture.

J. ALYSSA WHITE. Department of Sociology, Anthropology, and Social Work, Auburn University, Auburn.

This study compares terminal stature across settlement types in the Lower Mississippi Valley (LMV) with those of the central Tombigbee River Valley, from the Late Woodland to Mississippian periods. Terminal stature serves as a proxy to better understand the relationship between general childhood growth and the transition to agriculture. Adult height, which is arguably one of the best indicators of childhood health, has not been previously explored in the LMV. Terminal height was assessed for 64 individuals using regression formulae tailored for North American populations (Auerbach and Ruff, 2010). Neither females ($n=22$; $F= .882$; $df=21$; $p=.469$) nor males ($n=42$; $F=.537$; $df=41$; $p=.660$) differed significantly between settlements (mound sites, villages, farmsteads, and encampments) regionally. However, in both sexes, encampments showed a trend of shorter stature, while mound inhabitants exhibited greater stature. Comparing LMV to Tombigbee River region sites revealed no significant difference in male ($n= 42$; $t=1.652$; $df=40$; $p= .106$) or female ($n= 22$; $t=$

$.712$; $df= 20$; $p= .941$) terminal stature. Within the context of earlier health studies from the LMV and Tombigbee valleys, the results suggest local variability in health and differential reliance on maize and other wild grains across the regions. This study highlights the importance of more accurate and universal methods of stature estimation. Furthermore, biological analyses in the Mississippi Basin provide a better understanding of societal change and its effects on nutrition.

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Baldwin, Avionna	[19]	(p6)	avionna.baldwin@gmail.com
Baratz, Caroline	[29]	(p6)	cybaratz@optonline.net
Boyd, Derek	[27]	(p7)	dboyd0412@gmail.com
Bray, Joel	[7]	(p8)	bray.joel@gmail.com
Brazeau, Nicholas	[31]	(p9)	nbrazeau@college.harvard.edu
Canington, Stephanie	[23]	(p10)	slc0008@tigermail.auburn.edu
Clark, Melissa	[20]	(p10)	clark.1772@buckeyemail.osu.edu
Crane, Adam	[44]	(p11)	adacrane@umail.iu.edu
Cudmore, Rebecca	[28]	(p12)	cudmore@uoregon.edu
DeRosa, Kate	[41]	(p13)	klderosa@eden.rutgers.edu
Engel, Jessica	[6]	(p14)	jre11b@my.fsu.edu
Ferry, Matthew	[8]	(p14)	13mferry@gwmail.gwu.edu
Fried, Ian	[26]	(p15)	irfried@emory.edu
Fulwood, Ethan	[14]	(p16)	cdarwin1701@gmail.com
Gardiner, Joanna	[11]	(p17)	gardinjz@gmail.com
Golembiewski, Amber	[33]	(p18)	ajgolemb@umd.umich.edu
Griffin, Stephen	[12]	(p19)	stg2e@mtmail.mtsu.edu
Harrison, Allyson	[36]	(p19)	allyharr@umd.umich.edu
Hays, Lindsey	[13]	(p20)	lindsey_hays6@mymail.eku.edu
Holtzman, Shelby	[5]	(p21)	sholtzma@umd.umich.edu
Ischinger, Sara	[9]	(p22)	ischinsb@gmail.com
Jones, Amanda	[45]	(p22)	jones.aman@uwlax.edu

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Kasabova, Boryana	[15]	(p23)	kasabb@u.washington.edu
Kennedy, Alexandra	[4]	(p27)	apkennedy@stkate.edu
Kozma, Elaine	[17]	(p24)	kozma.elaine@gmail.com
Kralick, Alexandra	[22]	(p25)	akralick@gwmail.gwu.edu
Lambert, Andrew	[38]	(p26)	alambert9@siu.edu
Lautzenheiser, Steven	[16]	(p27)	lautzs@uw.edu
Lovstad, Molly	[4]	(p27)	mrllovstad@stkate.edu
Magaro, Jude	[30]	(p28)	quarkyphysics@gmail.com
McNulty, Shannon	[42]	(p35)	
Moore, Lauren	[18]	(p29)	
Oliveira, Colin	[18]	(p29)	oliveira@uoregon.edu
O'Shea, Natalie	[40]	(p30)	natalie-oshea@uiowa.edu
Papakyrikos, Amanda	[24]	(p30)	apapakyr@wellesley.edu
Papastavros, Vassiliki	[42]	(p35)	
Ramirez, Kristen	[32]	(p31)	kramirez@gwmail.gwu.edu
Redd, Ashley	[18]	(p29)	
Reynolds, Austin	[43]	(p32)	awreynol@umail.iu.edu
Sayre, Katherine	[2]	(p33)	katie.sayre@utexas.edu
Schwalenberg, Megan	[25]	(p34)	schwalen.mega@uwlax.edu
Scott, Timothy	[42]	(p35)	tatscott@ufl.edu
Smith, Alexander	[31]	(p9)	
Smith, Shaye	[37]	(p35)	Shaye.Smith@ColoradoCollege.edu

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Stabell, Jessica	[39]	(p36)	jessicastabell09@gmail.com
Sumner, Bonnie	[10]	(p37)	bonniesumner1@gmail.com
Vijgen, Simone	[1]	(p38)	simonev@uw.edu
Voss, Megan	[21]	(p38)	mevcn6@mail.missouri.edu
Wagnild, Janelle	[3]	(p39)	jwagnild@spu.edu
Wang, Alice	[35]	(p40)	alice.y.wang@ucla.edu
Wheeler, Valerie	[13]	(p20)	
White, Alyssa	[34]	(p41)	jaw0038@tigermail.auburn.edu
Wilhelm, Brittany	[11]	(p17)	