

COMMITTEE ON DIVERSITY



UNDERGRADUATE RESEARCH SYMPOSIUM

AAPA 84TH ANNUAL MEETING

6-8 PM WEDNESDAY MARCH 25TH, 2015

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Preliminary assessment of primate molar morphology using 2D geometric morphometrics.

KATHLENA ANDERSON, AMY BYERS, STEPHEN FROST and MICHEL WALLER. University of Oregon.

For this study we applied 2D geometric morphometrics (GM) methods to primate molars to determine how well primate dental morphology could be captured and if landmark based methods could distinguish between different primate groups. We wanted to evaluate this method because of its relatively simple application and ease of use. Occlusal digital photographs were taken of primate maxillary and mandibular molars; observers used sixty images of lower dentition from: five dermopterans, eighteen lorisiforms, thirty-two lemuriforms, seven tarsiers, and eight platyrrhines. These five major taxonomic groups were our basis for comparison. Two observers (AB, KA) then collected eleven 2D landmarks on lower molars. Landmarks were placed on the images using TPSdig, which were superimposed using generalized Procrustes analysis in MorphoJ. Superimposed landmarks were analyzed with principal components (PC) analysis to evaluate overall patterns of molar shape variation. Canonical variates analysis (CVA) was

used to examine differences among the groups. For the lower molars, the first two PCs accounted for 48% of variance and separated lemuriforms from haplorrhines with lorisiforms and dermopterans intermediate along PC1. The separation is driven by lemurs having buccally placed paraconids and larger but narrower talonids compared to haplorrhines. PC2 largely distinguishes dermopterans from primates, with the former having narrow trigonids and large hypoconulids. These initial results show that major groups were significantly distinct using CVA and PC and are encouraging in the application of 2D landmark based methods in distinguishing different primate groups; larger sample sizes should improve results.

Folate Receptor 1 (FOLR1) adjusted for hormonal status serves as a marker of folate nutrition.

ALLISON APLAND and MASAKO FUJITA. Department of Anthropology, Michigan State University.

Folate is an essential micronutrient needed for DNA synthesis and methylation. Foods rich in folate include legumes and milk, but legumes have lower bioavailability and much is lost in cooking. Folate receptor 1 (FOLR1) is a specialized binding protein for folate. High FOLR1 levels in

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blood serum have been shown to correlate with folate deficiency, indicating that FOLR1 may serve as a biomarker for studies in human ecological nutrition and reproduction. This has not been investigated fully, although inexpensive ELISA kits are commercially available, since earlier reports suggest that FOLR1 is under hormonal influence rather than folate nutrition. This study investigates if FOLR1 can be used as a marker of folate status by controlling for the effects of the lactation hormone prolactin or postpartum time among breastfeeding women. We hypothesized that FOLR1 levels would be high in women with no milk consumption. We used 2006 data from breastfeeding Ariaal women in Kenya. 24-hour dietary recall data were used to determine milk intake ($y=1/n=0$). Serum FOLR1 and prolactin were measured using ELISA. Regression models were used to examine the effects of milk intake on FOLR1, adjusting for age, BMI, and prolactin or postpartum time. In both the prolactin ($n=84$, $R^2=0.13$) and postpartum time ($n=126$, $R^2=0.24$) models, milk negatively predicted FOLR1 ($p<0.05$). Prolactin positively predicted ($p<0.01$), and postpartum time negatively predicted FOLR1 ($p<0.01$). These results indicate that serum FOLR1 is influenced by intake of bioavailable folate and may serve as a marker for

folate status after adjusting for prolactin or postpartum time.

Funding was provided by NSF DDIG #0622358, The Wenner-Gren Foundation, The Micronutrient Initiative, Michigan State University Provost Undergraduate Research Initiative Award and the College of Social Science Dean's Assistantship.

Effects of menstrual cycle phase on thermoregulation variation.

ERIN D. APPLE¹, KINDRA J. FISH¹, QUINTON L. QUELLETTE¹ and CARA M. WALL-SCHEFFLER^{1,2}.
¹Department of Biology, Seattle Pacific University, ²Department of Anthropology, University of Washington.

All endotherms regulate temperature to avoid reaching potentially harmful body temperatures. Human females have an interesting additional pressure because their body temperature varies along with their menstrual phases, though the temperature at which body functioning decreases does not change. Women have a higher core temperature during luteal phase due to the actions of progesterone on the hypothalamus. Thus, when women are most fertile, they are also at increased risk for overheating and potentially damaging their developing embryo. Women should thus have evolved physiological and/or behavioral strategies for

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negotiating the balance between maintaining mobility (e.g. heat increasing activity) and thermoregulatory homeostasis during luteal phase. Here we test physiological strategies of women (N=12) in different menstrual phases by monitoring their metabolic rate, core body temperature, and skin temperatures while they perform a series of rest and exercise bouts. During resting periods women in luteal phase maintained a narrower range of metabolic rates than women in follicular phase (luteal phase women maintained a 53.8% smaller range); additionally, luteal-phase women exhibited a smaller average change in core body temperature (luteal phase: +0.69%, follicular phase: +1.65%). Thus, women in luteal phase do appear to control key physiological variables more successfully than women in follicular phase. Part of the mechanism appears to be heat dumping as evidenced by dramatic increases in skin temperatures proximal to the heart (neck: 13.6%, bicep: 28.7%). It also remains likely that behavioral mechanisms are also utilized.

Preliminary analysis of postcanine enamel chipping among Neandertals and early modern humans: Implications for diet and bite force production.

MADELAINE C. AZAR, NAOMI A. JOHNSON and JOHN C. WILLMAN.
Washington University in Saint Louis.

Research on Neandertal and early modern human (EMH) diets has made many recent advances with stable isotope analysis, dental macrowear and microwear analyses, and the analysis of dental calculus, among other lines of research. We provide additional insights regarding the mastication of hard-objects in Late Pleistocene diets by assessing postcanine enamel chipping among late Neandertal (MIS 4-3) and EMH (~40-20 ka BP) groups. Bite force was calculated from chip dimensions following Constantino and colleagues (2010), and the percentage of chipped Neandertal and EMH teeth was compared to data from several human groups. We found that 37.1% (N=97) of Neandertal teeth and 30.3% (N=261) of EMH teeth exhibit enamel chipping, which is not exceptional in comparison to published postcanine chipping ratios for several recent human groups. The mean and standard error for Neandertal and EMH bite forces (in Newtons), calculated from chip dimensions, is 157.6 ± 34.2 (N=19) and 131.3 ± 18.4 (N=57), respectively. While previous analyses show that the capacity to produce much higher maximum bite force is possible among Neandertals and modern humans, the present study shows that near-

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maximum bite forces were not habitually produced to break-down hard inclusions in the diet for either Late Pleistocene group. However, high bite force production to manipulate (i.e., extramasticatory behaviors) or masticate pliable, or tough, materials that are less likely to cause macroscopic chipping cannot be ruled out. Ongoing research focuses on increasing the size and temporal spread of the sample as well as accounting for climatic and ecogeographic variability.

Funding was provided by the Washington University in Saint Louis and the Leakey Foundation.

Associations among television viewing, lifestyle, and cardiovascular health in an indigenous Siberian population.

TYLER M. BARRETT¹, MELISSA A. LIEBERT¹, WILLIAM R. LEONARD², LARISSA A. TARSKAIA^{3,4}, TATIANA M. KLIMOVA⁵, VALENTINA I. FEDOROVA⁵, MARINA E. BALTAKHINOVA⁵, VADIM G. KRIVOSHAPKIN⁵ and J. JOSH SNODGRASS¹. ¹Department of Anthropology, University of Oregon, ²Department of Anthropology, Northwestern University, ³Institute of Molecular Genetics, Russian Academy of Sciences, ⁴Department of Anthropology, University of Kansas,

⁵Research Institute of Health, North-Eastern Federal University.

Culture change has been linked to heightened psychosocial stress among indigenous populations undergoing political-economic transitions, which increases cardiovascular disease risk. However, much is unknown about how specific aspects of culture change contribute to this relationship. While shifts in media content and exposure have been implicated as a contributing factor to chronic stress in transitioning populations, the relationship between media and cardiovascular health has not been fully examined in this context. The present study investigates links between a style of life (SOL) scale and blood pressure, as well as associations between television viewing hours and myocardial infarction and stroke among 306 Yakut (Sakha) adults (153 men, 153 women) from Berdygestiakh, Sakha Republic, Russia.

After controlling for body composition, smoking, and alcohol consumption, SOL was positively correlated with diastolic blood pressure (DBP) among younger (18-49 years) men ($P=0.009$) and older (≥ 50 years) women ($P=0.028$) and showed a negative trend with DBP among older men ($P=0.054$). Further, greater television viewing hours was associated with an increased likelihood of previously experiencing stroke among older adults ($P=0.010$) and an

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increased likelihood of previously experiencing myocardial infarction among older men ($P=0.047$). The rapid change in television content that occurred alongside post-Soviet privatization makes media a particularly salient aspect of culture change among indigenous Siberians, and the present study suggests it may play a role in cardiovascular risk among the Yakut. Divergent relationships between age and sex groups indicate a potential cohort effect and possible discrepancies in how lifestyle factors impact men and women's cardiovascular health.

Support: NSF ARC-0802390; Northwestern University; University of Oregon; FSRI Institute of Health.

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

DANA E. BECKER¹, NATASHA A. CASTELLON-HINKLE¹, LAURA E. CIRILLO², ELAINE M. BURKE³, JULIE DING¹, REBECCA S. JABBOUR⁴ and GARY D. RICHARDS⁵. ¹Department of Integrative Biology, University of California, Berkeley, ²Department of Anthropology, California State University Chico, ³Department of Molecular and Cell Biology, University of California, ⁴Department of Biology, Saint Mary's College of California.

⁵Department of Biomedical Sciences, A.A. Dugoni School of Dentistry, University of the Pacific, San Francisco.

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

To test this hypothesis we CT-scanned a dry skull sample ($n=56$). The dentition was evaluated via construction of isosurfaces and volume-texture renderings. Individual ages were calculated as averages of the degree of calcification per tooth; eruption was not assessed (range 4.7-9.1y). We then created age groups using various combinations of teeth and assessed changes in the statistical output for 93 cranial dimensions. We also examined the impact of these groupings on sample configuration in morphospace using Morphologika.

Age estimates varied between the upper and lower dentitions ($\pm 0.9-1.4y$).

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

Funding provided by Undergraduate Opportunity Fund Grants to Dana E. Backer, Natasha A. Castellon-Hinkle, Elaine M. Burke, and Julie Ding.

Closing the gap: Stress as a contributor to racial/ethnic disparities in infant mortality.

JAZMIN BRANCH¹ and MICERE KEELS². ¹Washington University in St. Louis, ²Department of Comparative Human Development, University of Chicago

Despite national improvement in infant health status, the racial/ethnic gap has remained the same and has even widened in some cases. While previous studies show a relationship between

racial/ethnic infant health disparities and maternal stress, little is known about the effects of stress on disparities in maternal health. The purpose of this study was to examine racial/ethnic differences in maternal well-being factors. We hypothesized that Black women would have higher percentages of the stress indicators such as cadmium levels, bacterial vaginosis, and poor mental health.

We analyzed data from the 2001-2010 National Health and Nutrition Examination Survey (NHANES) conducted by the CDC. The sample consisted of 842 U.S. born pregnant women, ages 20-45 who self identified as non-Hispanic Black, non-Hispanic white, or Mexican American. We conducted Poisson regression analyses, logit regression analyses, and multivariate regression models to test for differences in stress indicators by race.

With Black women as the reference, both Mexican American (0.83/0.42) and White women (0.76/0.78) had lower odds ratios for bacterial vaginosis and cadmium toxicity respectively. Based on the coefficients from the Poisson regression test, the likelihood of having poor mental health was lower for Mexican American (-0.18) and White women (-0.0025). This study contributes to the scarce knowledge on stress as a factor of maternal health and

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potentially helps with the direction of identifying social indicators of adverse birth outcomes, maternal health, and infant mortality.

A preliminary study of cortical and trabecularized porosity distribution in human and quadruped ribs.

AMY BROWN, MARY E. COLE and SAMUEL D. STOUT. Department of Anthropology, The Ohio State University.

Human ribs provide a simple model of bending. During inspiration, ribcage expansion tenses the cutaneous cortex with low strains and compresses the pleural cortex with comparatively high strains. Frost's mechanostat model predicts more bone resorption, including more cortical and "trabecularized" porosity, in low-strain regions. This study compares ten human ribs and four ribs each from dogs, pigs, and deer. Consistent with our previous study, the tensed cutaneous cortex of human ribs has significantly higher percentages of "trabecularized" porosity ($p = 0.007$), the huge pores that coalesce near the endosteum, compared to the less porous pleural cortex. The cutaneous cortex displays a higher mean area ($p = 0.013$) but not frequency ($p = 0.441$) of "trabecularized" pores. In contrast, quadruped pleural and cutaneous cortices showed no significant

differences in any type of porosity. Relative Cortical Area, a metric of bone's resistance to compression, is significantly reduced by total porosity in ribs of deer ($p = 0.001$), dogs ($p = 0.000$), and pigs ($p = 0.001$) but by both total ($p = 0.000$) and "trabecularized" ($p = 0.019$) porosity in humans. Significantly more of the whole cortex consists of "trabecularized" porosity compared to cortical porosity in human ribs ($p = 0.028$) but not deer ($p = 0.430$), dog ($p = 0.715$), or pig ($p = 0.500$) ribs. The caudal-cranial motion of the quadruped ribcage may introduce a complex bending environment that obscures expected microstructure. Pleural/cutaneous porosity differentiation may indicate the upright ribcage orientation and lack of dynamic rib loading characteristic of bipedalism.

Biocultural components influencing high birth and retention rates in the American Anabaptists.

MORGAN CAIRNS. Florida State University.

North American Hutterites, Mennonites, and Amish share an ancestral root to Eastern European Anabaptists; however, after immigrating across America they branched into three unique colonial groups. Collectively, the three populations face similar biological obstacles that are commonly attributed

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to genetic drift, including low genetic variation, high recessive disorder rates, and high spontaneous abortion rates. While these obstacles are widely supported by genetic data, including human leukocyte antigen analyses, the three groups continue to have high population growth with retention rates between 85-90%. This study integrated ethnographic data and genetic analyses from all three populations to study how cultural elements develop to overcome genetic obstacles. The results attributed population growth rates to cultural emphases on high social responsibility, individual empowerment, and low social tension as well as the taboo nature of contraception, medicalization of pregnancies, and the religious encouragement to build large families. The goal of this study was to illustrate the complex relationship between culture and biology in an effort to understand how biological factors can be overcome through the development of social practices and traditions.

Dietary analysis of a rural Maya community in the Caves Branch River Valley, Belize using carbon and nitrogen concentrations and stable isotope values of dental calculus.

EMILY A. CHAMBERLAIN¹,
AMANDA R. HARVEY¹, SIMON R.
POULSON² and G. RICHARD SCOTT¹.

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This research assessed stable carbon (C) and nitrogen (N) concentrations and isotopic values in human dental calculus to understand dietary practices of the Maya from the Caves Branch Rockshelter (CBR) in the Caves Branch River Valley, Belize. CBR is a funerary site of a small rural agricultural community with multiple burial episodes dating from Late Preclassic (300 BCE-30CE) to the Late Terminal Classic (600-900CE) (Wrobel, 2008). Isotopically heavy values of $\delta^{13}\text{C}$ were expected due to the traditionally maize-rich diet of the Maya. Calculus samples were obtained from 28 males and females, and analyzed for C and N concentrations and $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values using elemental analysis - mass spectrometry, after methods detailed by Scott & Poulson (2012) and Poulson et al. (2013). As suggested by Eerkens et al. (2014), molar C/N concentrations over 12 were omitted for a quality control criterion consistent with an absence of post-depositional alteration. C/N molar ratios obtained from the sample ranged from 8.2-11.9. The mean $\delta^{15}\text{N}$ value of +8.5‰, consistent with a diet of plant domesticates supplemented by deer and riverine

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fish, is similar to collagen isotopic studies from other Maya populations. $\delta^{13}\text{C}$ values were isotopically lighter than expected for a maize-rich diet, with a mean value of -15.2‰. Previous collagen $\delta^{13}\text{C}$ studies in the Maya region document varied levels of maize consumption during different periods and in different regions. $\delta^{13}\text{C}$ values obtained in this study suggest the mortuary sample from CBR may not have switched to a maize-rich diet like other Maya sites.

Milk and maternal environment: Differences in milk sIgA infection response in Tibetan mothers living at high and low altitudes in Nubri, Nepal.

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Women living in highly pathogenic environments tend to have higher secretory Immunoglobulin-A (sIgA) in their breast milk, possibly providing infants born in these environments with some degree of protection against infectious disease, especially gastrointestinal illness. This has yet to be investigated in populations in a

wide range of ecological conditions. Here, we tested for differences in milk sIgA levels between mothers nursing sick and healthy infants living at high and low altitudes in the Nubri Valley, Nepal.

Milk samples were collected from 67 mothers nursing offspring under 2 years of age, living in 6 villages, 3 high (<10,000 ft) and 3 low (<10,000 ft) altitudes. Infants living in low altitude villages had more diarrheal illness (39.1% versus 15.9%; $p < 0.025$); longitudinal research in Nubri also identified higher mortality rates among low altitude infants and children. Milk sIgA was measured with ELISA. Data were analyzed using a linear regression adjusting for maternal parity and infant age.

Mean milk sIgA was 774.6 ± 400 $\mu\text{g/mL}$. Mothers living at higher altitudes had slightly though not significantly, higher sIgA (785.2 ± 410.9 $\mu\text{g/mL}$) compared to low altitude mothers (754.3 ± 387.2 $\mu\text{g/mL}$). Mothers nursing sick infants in the high altitude sample had higher mean sIgA levels than mothers nursing healthy infants in that environment; in the low altitude sample, mothers nursing sick infants had lower mean levels of sIgA than mothers nursing healthy infants. We hypothesize that lower milk sIgA levels may be a contributing factor to increased

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morbidity and mortality observed in low altitude villages.

Daily energy requirements of Shuar forager-horticulturalists.

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Differences in lifestyle and diet cross culturally have often been associated with variation in energy expenditure and obesity. Empirical measurements suggest that average daily energy expenditure is similar across most populations regardless of lifestyle, but that traditional subsistence farming populations may be somewhat elevated. Here, we measured total energy expenditures, TEE (kcal/day), among traditional Shuar forager-horticulturalists in Ecuador in order to test the hypothesis that subsistence farmers have greater energy demands than industrialized populations.

TEE was measured in 15 adults (8 women, 7 men; age range 18-60 y) living in a relatively remote Shuar village, using the doubly labeled water, DLW, method. After providing a baseline urine sample, subjects ingested a 67 g (women) or 73 g (men) dose of DLW (6% ²H₂O, 10% H₂¹⁸O); urine samples were then collected every 2 - 5 days to track isotope enrichment over a 10 - 14 day period. Isotope enrichments were determined via cavity ring down spectrometry at the Human Evolution and Energetics Lab at Hunter College, and used to calculate mean TEE for each subject. As predicted, TEE among Shuar men and women was elevated relative to body size, as assessed by fat free mass, compared to adults in the US and Europe. These results are similar to the elevated TEE observed in some subsistence farming populations.

Optimization of DNA extraction from dried blood spot samples for use in a telomere length assay.

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As part of the World Health Organization's study on global AGEing and adult health (SAGE) to determine patterns and determinants of aging, dried blood spots (DBS) are being collected from adults in six countries in regions of different economic development for various biomarker assays, including measurement of telomere length (TL). Before measuring TL or other DNA-based biomarkers, it is necessary to assess DNA quality obtained from DBS under various conditions. First, we tested if storing DBS at -20°C allows for adequate DNA preservation to recover optimal amounts of high-quality genomic DNA when compared to -80°C. As DBS collected from fingerpricks vary in size, we also considered the size of DBS (25uL vs. 50uL) to determine whether size affects the quality and quantity of the DNA extracted. Preliminary results indicate that 3.2mm (1/8") punches from 50uL DBS yield nearly twice the amount of extractable DNA as 3.2mm punches from 25uL DBS. Additionally, DBS stored in a -80°C freezer yield approximately 47% more double-stranded DNA than DBS stored in a -20°C freezer. Lastly, we plan to determine the minimum quantity of DNA (three, four or six 3.2mm DBS punches) necessary to perform a

successful TL assay. Methodological issues are key considerations in epidemiological research. This study will allow for optimal collection of DBS for DNA extraction as well as downstream use of the DNA in assays such as the TL assay.

Support: NIH R01-AG034479; University of Oregon.

Analysis of intraspecific communication plasticity in captive female orangutans (*Pongo pygmaeus*).

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Orangutans are large-brained animals with slow life histories inhabiting a rapidly changing physical environment (Krutzen et al, 2011). Social plasticity, or the adjustment of social behavioral expression to the nuances of daily life, is an important facet of primate communication because it responds to the selective pressures that make one form of communication more advantageous over another when utilized in specific social situations (Oliveira, 2012). In this study examining social plasticity of orangutan communication as a function of sex, I compared the time budgets of communicative behaviors among female Bornean orangutans (*Pongo pygmaeus*) at the Lowry Park

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Zoo. Sex-based social plasticity was defined as a behavioral difference between same-sex and opposite-sex interactions. Data collection included 100 hours of video recorded observations and frame-by-frame analysis using focal animal sampling. Communicative behavior differed significantly between same-sex and opposite-sex interactions ($\chi^2=22.817$, $df=1$, $p<0.01$). When interacting with same-sex conspecifics, females spent most of their time utilizing tactile communication (87.5%), followed by visual communication (12.5%). When interacting with males, females spent most of their time utilizing visual communication (67.1%), followed by tactile communication (32.9%). No significant auditory communication was observed (<1%). I conclude that female orangutan communication exhibits sex-based social plasticity. I propose that this plasticity is a behavioral adaptation resulting from sex-specific social selective pressures.

The effect of bone length and shape on bone strength in the Longshanks mouse.

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Anthropologists have long been interested in the relationship between bone strength and morphology, as these traits are functionally related to primate locomotion. The length, shape, and strength of a bone must scale with one another in order to maintain the bone's safety factor. The Rolian lab has been selectively breeding a line of mice ("Longshanks") to have longer tibiae relative to body mass compared to a control cohort. Previous research has demonstrated that the length increase in the Longshanks tibiae resulted in a slight negative allometric change in the bone's shape and cross-sectional dimensions, which may lead to a reduction in the strength of the bone.

The ability of a bone to resist bending is closely related to its cross-sectional dimensions and length. Here we tested the hypothesis that the strength of the Longshanks tibiae has been reduced due to the change in shape and length of the bone. We predicted that, due to their more gracile appearance, the Longshanks tibiae would require lower bending forces to break. Tibiae were dissected from sex-balanced groups from two independent selected lines ($n=56$), and a control line ($n=29$). The bones were tested for strength using a

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three-point bending apparatus, and were broken in the medio-lateral direction. Results indicated that the tibiae in the Longshanks mice required 20-30% less force to break. This research provides insights into the relationship between bone length and strength under directional selection, with implications for the evolution of bone structural adaptations in primates.

Examining sex differences in human rib microstructure: A histological study.

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Currently, there is no consensus on how osteons vary due to sex. As a result, histological methods differ in their reliance on sex-specific variables. The purpose of this study is to quantify the effect of sex on bone microstructure and improve bone histology identification methods. For this study, histological cross-sections (~20 μm) were obtained from the left sixth rib mid-shaft of 30 individuals (17 females, 13 males) housed at the Forensic Anthropology Center at Texas State (FACTS). The following histological variables were collected: Intact Secondary Osteons (N.I.On) per mm^2 , Fragmentary Secondary Osteons

(N.Fg.On) per mm^2 , Osteon Population Density (OPD) per mm^2 , Osteon Area (On.Ar) mm^2 , Osteon Circularity (On.Cr) mm^2 , Osteon Perimeter (On.Pr) mm^2 , and Haversian Canal Area (H.Ar) mm^2 . Variables were compared with known sex and age to quantify the relationship between sex and osteon remodeling and were analyzed using both an independent T-test and Mann-Whitney U-test. There were no significant differences between the sexes for any of the variables tested ($p > 0.05$). Results indicated that males less than 50 years of age showed a significant difference in On.Pr ($p=0.046$) when compared to males over 50. Females under 50 years of age compared to females over 50 years of age displayed no significant differences in On.Cr and H.Ar, however, On.Ar ($p=0.042$) and On.Pr ($p=0.044$) showed a significant difference. These results will give scholars in the field a clearer understanding of how sexual dimorphism affects bone microstructure and will contribute to the development of more accurate methods in biological anthropology.

Did medieval leprosy confer protection to plague? An immunological approach.

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Chronic infectious disease such as leprosy, endemic in Medieval Europe, could have generated individuals with different immunological profiles affecting their fate when facing a plague outbreak. Two hypothetical and conflicting scenarios are proposed: a) individuals suffering leprosy presented a weak immune system not allowing them to mount a proper immune response to plague; and b) chronic leprosy infection could have generated a "hyper-immune" state conferring some immunity to plague. In this preliminary *in vitro* study, we tested if exposure to one microbial species (*Mycobacterium leprae* or *Yersinia pestis*) can shift the immune response when the same cells are exposed to other species. The experimental protocols involved a two-day experiment, where human peripheral blood mononuclear cells (PBMCs) from healthy donors were exposed to the corresponding pathogen lysates. The expression of key immune proteins (TNF α and IFN γ) involved in the immune response against both pathogens was measured by enzyme-linked immunosorbent assay (ELISA). Our preliminary results showed higher expression of IFN γ when PBMCs were exposed first to leprosy lysates and sequentially (day 2) to plague lysates (LP/YP vs YP/YP). When PBMCs were exposed to leprosy lysates (day 1) and then re-exposed to leprosy lysates (LP/LP) they expressed

more IFN γ , partially supporting the hyper-immune hypothesis. These preliminary results do not allow us yet to accept any hypothesis but show an immune activation induced by leprosy lysates. As future direction in this project, we propose new experimental protocols that will include different stimuli and to consider the polarized immune status in leprosy.

Facial shape in trigonocephaly: a metric and geometric morphometric assessment.

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Archaeologically, individuals with prematurely fused sutures are plentiful, excepting those with trigonocephaly. When coupled with the fact that clinical descriptions are limited to late fetal-early postnatal stages, this leaves knowledge of later-

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stage growth changes unknown. We hypothesize that shape changes seen in the face of trigonocephalics are driven by anterior brain malformations and that with growth this results in a cascading series of morphological changes in the face that spare the nasal capsule.

A trigonocephalic skull deriving from Santa Rosa Island (CA-SRI-24: 1500-1650 AD) and housed at UC Berkeley (PHMA) was compared to 43 skulls from the Institute for Craniofacial Study, UOP. Developmental ages of 8.0 years and 6.0-8.0 years \pm 24 months were assessed for the trigonocephalic and normal skulls, respectively. Landmark data comprise 93 points collected from normal skulls with a Microscribe 3D digitizer and from a CT scan of the trigonocephalic using Amira 5.5. Facial shape was explored using Principal Components Analysis on Procrustes-aligned shape variables.

Metric and geometric morphometric analyses confirm that the nasal capsule is essentially normal. Alternatively, significant narrowing and wedging of the frontal result in increased frontal and orbital heights, demonstrating compensatory changes in the anterior cranial fossa and lateral face, respectively. Upper facial elongation is associated with an increased breadth of the lower face, while lower face length shows only slight involvement.

Causative factors resulting in trigonocephaly are obscure. Consideration of endocranial shape, along with the results above, supports suggestions that brain malformations may underlie the complex trigonocephalic phenotype.

Impact of gestational alcohol exposure on offspring glucose availability.

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Despite public health campaigns alcohol consumption persists in ~8% of pregnancies. The most common developmental impairment due to gestational alcohol exposure is intrauterine growth retardation and low birth weight. In the current study, we tested whether administration of alcohol [2g/kg/day, (E2); 6g/kg/day, (E6); with isocaloric maltodextrin administered to the pair-fed control groups of sprague-dawley rats, PF2 and PF6 respectively] on gestation day 6 (GD6) through GD19 would alter offspring glucose production and storage during postnatal development. Our study ties into the Barker hypothesis, which states that hostile

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intrauterine conditions are correlated with low birth weight as well as chronic conditions later in life. At PD80, all offspring maintained post-weaning on a high fat diet exhibited increased serum glucose levels, decreased hepatic glycogen stores, and decreased hepatic fructose-1, 6-bisphosphatase activity. At PD80, E6 offspring maintained on a low fat diet exhibited increased hepatic glycogen content. In contrast, maintenance post weaning on a high fat diet resulted in elevated fructose-1, 6-bisphosphatase activity in the E6 group as well as suppressed hepatic glycogen content in the E6 and PF6 groups. In summary, high dosage gestational alcohol exposure predisposes mature offspring maintained on a high fat diet to dysregulation of glucose production and storage. This dysregulation may be the tipping point for a variety of chronic metabolic disorders. The extrapolation of animal model data combined with epidemiological studies underscores the importance of human intrauterine conditions in relation to physiological adaptations with long-term health consequences for exposed offspring.

Dietary change following social transition at Karystos, Greece.

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We test the null hypothesis of no change in diet, evidenced by oral health, at Karystos, Greece from the Classical to the Early Roman Period. To test this hypothesis, dental caries, abscesses, and premortem tooth loss were recorded in 106 skeletons. Sixty-four individuals had teeth for observation of dental caries, while only 60 had mandibles or maxillae to assess abscessing and premortem loss. Statistically significant differences (Kolmogorov-Smirnov) in age distributions between all samples made direct comparisons of prevalence unwise. Thus, odds ratios were calculated for variation in oral health through time, while controlling for age. Odds ratios indicate that oral health improved from the Classical to Hellenistic periods (7.46 higher risk of caries and 1.14 higher odds of abscessing in the Classical than the Hellenistic period), but declined into the Early Roman period (6.8 higher odds of dental caries, 5.5 higher odds of abscessing, and 4.77 times higher risk of premortem tooth loss in the Early Roman than the Hellenistic period). These results do not support the null hypothesis, but correlate well with the agricultural progression of Karystos. Karystos was primarily an agricultural village consisting of several dozen

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small farmsteads during the Classical period, at which time Karystos established colonies throughout the Mediterranean, possibly receiving tribute from these colonies. During the Roman period, Karystos transitioned to larger plantation farming, and became a major food supplier to Athens. This may have resulted in lower quality diet for the local populous. The impacts of social change on food quality will be discussed.

This research was supported by the University of Northern Colorado's (UNC) Undergraduate Research Stipend and Summer Support Initiative awarded to McIlvaine.

Methodological considerations for the use of dried blood spot samples in population-based research.

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Collection of high quality biological samples represents a limiting factor in large scale, cross-cultural studies of human health. These limitations make dried blood spots (DBS) an ideal and

minimally invasive solution for the collection of blood. However, little research has been conducted to address important methodological questions such as how biomarker results obtained from DBS are affected by the number of freeze-thaw cycles, sample extraction point (i.e., punch location used within the DBS), storage conditions (-20°C or -80°C), length of drying time, blood spot size, and single vs. double drop collection. In order to address this, we designed a biomarker validation sub-study of the World Health Organization's Study on global AGEing and adult health (SAGE) that evaluated the effects of these factors on the measured concentration of C-reactive protein (CRP). Specifically, we collected DBS samples from 9 adults and tested the effects of the following factors on CRP measurement: 1) drying time (4hrs, 8hrs and overnight); 2) number of freeze-thaw cycles (2, 4 and 8 cycles); 3) punch location (inner vs. outer region of the spot); 4) storage conditions; and 5) drop collection technique. Preliminary results suggest that CRP concentrations of inner punches are 19% less concentrated than outer punches. Identifying the effects of different DBS card processing conditions on downstream biomarker assays has important implications for their use in cross-cultural studies of human health and aging.

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Pasmo in the postpartum: Are there differences in cortisol and nutrients of the milk from Filipino women with and without a culturally bound syndrome associated with postpartum stress?

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Many women report considerable stress during the postpartum period and frequently report concerns about psychosocial stress altering milk composition. All adults can experience a culturally bound syndrome known as pasmo, which may be a culturally appropriate way of expressing postpartum depression when occurring in the postpartum period. Milk samples were collected using standard protocols and frozen immediately. We investigated the association between pasmo and human milk cortisol levels in 104 women from Cebu, Philippines. Milk samples were analyzed using a modified commercially available EIA kit. ANOVA was used to test for differences in milk cortisol and nutrients in women with and without pasmo. For women with pasmo, milk

cortisol averaged $0.701 \pm 0.437 \mu\text{g/dL}$ compared to $0.724 \pm 0.581 \mu\text{g/dL}$ for women without ($p=0.41$); these differences were not significant. Similar analyses were conducted for milk fat, sugars, protein and energy – we found no differences in milk nutrients by maternal pasmo status. These findings show that the culturally bound syndrome of pasmo, as a condition associated with perceived maternal stress, does not impact milk cortisol levels or nutrients. Previous research has shown that infant temperament can be affected when exposed to biologically active components in milk (such as cortisol). These findings are important because this is the first clear evidence showing no effect on perceived stress and cortisol in milk. While pasmo is not postpartum depression as PPD is understood in the United States, these findings do suggest that conditions associated with perceived maternal stress may not influence milk cortisol or nutrients.

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Sodium decontamination of skeletal samples. hypochlorite of pulverized

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Contaminant DNA continues to be of significant concern in validating ancient and forensic DNA studies. One method of addressing the problem of contaminant DNA is to pre-treat skeletal remains with sodium hypochlorite (bleach), which is capable of breaking down DNA. Although multiple decontamination protocols using sodium hypochlorite exist, there is no consensus on which particular method is optimal. In 2007, Malmström and colleagues proposed a relatively extreme protocol that involved soaking pulverized bone and tooth samples in a 0.5% sodium hypochlorite solution. The authors claimed this method removed 99% of contaminant DNA while only losing 77% of endogenous DNA.

This study evaluates the efficacy of this protocol via a comparison to a standard 6% sodium hypochlorite soak of whole (i.e., non-pulverized) remains. Bone and tooth remains from pig (*S. scrofa*) and cow (*B. taurus*) were purposely contaminated with human DNA via extensive handling. Then, samples were either pulverized (as described by Malmström et al. 2007) or kept whole (as described by Kemp and Smith 2005)

and subjected to bleach treatments of varied durations. Extractions were amplified and analyzed for the presence of contaminating human DNA as well as endogenous pig or cow DNA. Results indicate that pulverization prior to bleach treatment does remove exogenous DNA contaminants, but with great loss of endogenous DNA. We therefore recommend that pulverization prior to bleach treatment should be conducted only when all other decontamination options have failed.

This research was funded by a William M. Bass Endowment through the Department of Anthropology, University of Tennessee, Knoxville.

Captive female bonobos (*Pan paniscus*) tend to be more social during tool use than males.

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Tool use occurs in several non-human species, including primates. Within the genus *Pan*, chimpanzees (*P. troglodytes*) exhibit tool use both in the wild and in captivity. Tool use in bonobos (*P. paniscus*) has been documented in

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captivity and is suggested to occur in the wild. Recent comparative studies on chimpanzees and gorillas propose that social tolerance may facilitate the acquisition of tool use behavior in great apes. We previously reported that captive bonobos use tools in smaller social groups than gorillas and chimpanzees suggesting that number of neighbors does not play an integral role in tool use acquisition in bonobos. Here we investigate sex and age differences in these small social groups. Data were collected on 39 days between June and August 2011. Subjects were 16 bonobos housed at the Columbus Zoo and Aquarium, where an artificial termite mound was placed in their outdoor exhibit and baited on a daily basis. All-occurrences of tool use at the mound and individuals present were video-taped and coded. Party size and composition were later determined for each fishing bout. Females fished in larger groups (avg.=1.8 individuals) than males (avg.=1.3 individuals) ($n=9$, $F=4.38$, $p<0.05$). While there was no difference between adult and subadult males, adult females fished in significantly larger groups than subadult females ($n=5$, $F=26.03$, $p < 0.0001$). These results support previous knowledge of bonobo sociality in that females are more socially cohesive and males tend to be more solitary.

Comparison of measures of inter-individual affiliation among ring-tailed lemurs (*Lemur catta*).

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Primatologists use a number of behavioral measures to assess patterns of affiliation and aggressions in groups of primates. These patterns can, however, vary greatly within a species with behavioral context. Lemurs, for example, are well known for the importance of context in the variation of aggression in feeding and non-feeding contexts as seen in both female dominance and female feeding priority. This study examined whether there are also variations in affiliation between feeding and non-feeding contexts. One of these measures, grooming, is widely accepted as a mechanism for social bonding, but it is not an appropriate measure for affiliation during feeding. We therefore used co-feeding as a measure of affiliation during feeding. We then used a non-parametric multivariate statistical comparison to see if the patterns of affiliation are consistent between these two contexts.

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We studied a group of semi-free-ranging ring-tailed lemurs on St. Catherine's Island, Georgia and collected 188 hours of behavioral data. Observations used focal animal sampling and all occurrence sampling of social behavior. We calculated indices for grooming and co-feeding for all possible pairs of individuals. A Mantel test was used to determine the correlation between the two affiliative measures. We found a significant correlation between our measures ($r = 0.7509$, $t = 8.635$, $p < 0.0001$). These results demonstrate that affiliation patterns seen in non-feeding contexts are consistent with affiliation during feeding.

Dental variation within the Tlaxcala population: A quantitative and qualitative analysis for sexual dimorphism.

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This paper investigates the presence of sexual dimorphism within a twentieth-century sample from San Pablo, descendants of the sixteenth-century Tlaxcaltecan population, using dental anthropological methods. Fifty-one dental casts were examined, using conventional odontometric methods and the ASUDAS scoring system dividing the study into two parts; a quantitative section and qualitative

section. This research uses proven methods to add to the knowledge base created by O'Rourke and Crawford's 1976 study, and the on-going debate of sexual dimorphism. The hypotheses of this study predict inequalities in both quantitative and qualitative traits between male and female dentitions indicating potentially statistically significant levels of sexual dimorphism. Results show that the Buccolingual (BL) of M2 on the lower right side, the Mesiodistal (MD) of M1 on the lower right side, BL of M1 on the lower left side, and the MD of M2 on the upper right side were dimorphic. As well as double shoveling of I2 on the upper right side, the size of CUSP 5 of M1 on the upper right side, and the size of CUSP 5 of M2 on the lower right and left side. Understanding differing levels of sexual dimorphism in this population will enrich our overall understanding of human variation, while becoming a reference for bio-archaeological analyses of ancestral populations and/or current forensic cases.

O'Rourke, D.H., and M.H. Crawford. *Odontometric Analysis of Four Tlaxcaltecan Communities*. The Tlaxcaltecan: Prehistory, Demography, Morphology, and Genetics, edited by Michael H. Crawford. Lawrence: University of Kansas, 1976.

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The rarest of the rare: World variation of Uto-Aztecan premolars.

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Uto-Aztecan premolars are characterized by the distobuccal rotation of the paracone and presence of a fossa at the intersection of the distal occlusal ridge and distal marginal ridge. Initially, the trait was associated with Uto-Aztecan speakers in the American Southwest, but researchers have noted rare appearances in other Amerind groups in North and South America. From data collected by C.G. Turner II, descriptive statistics were calculated for samples throughout the world. Observations were made on 7279 individuals, with 40 individuals expressing the trait. Uto-Aztecan premolars were most common in American Indian populations (38/3633; 1.05%). The trait was also found in single individuals from Kodiak Island, Alaska and Australia. In the Turner database, there were no European, Northeast Asian, Southeast Asian, or Pacific occurrences. In New World populations, Uto-Aztecan premolars were more common in North America

(34/2987; 1.14%) than South America (4/646; 0.62%). In North America, the trait was most prevalent in samples east of the Mississippi (7/364; 1.92%), followed by Mesoamerica (4/233; 1.71%), the American Southwest (20/1680; 1.19%), California (2/182; 1.1%), and Northwest Coast (1/228; 0.4%). In South America, it was most frequent in the west (3/374; 0.80%). The trait is not exclusive to Uto-Aztecan speakers as the name implies, but it is not randomly distributed. The trait is concentrated in American Indians. Interestingly, it was not observed in Eskimo-Aleut or Asian populations who otherwise show numerous parallels with American Indian tooth morphology.

Assessment of food use in wild *Otolemur crassicaudatus* using fecal analyses: Implications for understanding ecology and health.

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Galagos are among the World's least studied primates. In 2013 a comprehensive study on the ecology, biology, and behavior of the galago began at the Lajuma Research Center, Limpopo Province, South Africa. As part of this broader study, dental and health analyses of the thick-tailed bushbabies (*Otolemur crassicaudatus*) at Lajuma (n=23) indicate a pattern of frequently broken maxillary canines (>90%), each with accompanying decay and apical abscesses, with males and females displaying an equal frequency (> 90%) of this pathology. Previous wild studies suggest that this primate species frequently uses gums as a winter food source, often requiring an individual to gouge tree bark to access the gums. We tested this hypothesis by collecting *Otolemur* fecal samples (n = 11) between July 24 and 29, 2014 to assess this population's feeding ecology and the foods items consumed. Fecal analyses were conducted by AAH and SDJ. Among the foods present in these fecal samples were seeds, bark, and most surprising, ant exoskeletons (Family Formicidae). The presence of bark in the Lajuma fecal samples indicates gum feeding and suggests that the use of the stout maxillary canines to gouge tree limbs in order to access gums leads to the high frequency of canine damage in this population. The surprisingly high frequency of ant remains in these fecal

samples indicates that during the challenging winter season, this population of > 1kg strepsirrhine primate utilizes social insects as a common food source. These data illustrate how a combined dental ecology approach, combining health, dental and ecological analyses, can provide a more detailed understanding of the ecology and behavior of this lesser-studied primate species.

Skeletal 2nd/4th proximal hand phalangeal length ratios are associated with facial proportions in adult males.

BRIANNA HOFFMANN and ROBERT G. FRANCISCUS. Department of Anthropology, University of Iowa.

Studies have demonstrated the effects of the prenatal environment on growth in the digits of the hand and facial development in humans. The ratio of the second and fourth digit ratios is inversely related to prenatal testosterone (PT) levels in utero and is sexually dimorphic, with lower ratios in men (higher PT levels) and higher ratios in females (lower PT levels). This ratio has been linked to facial development in male adults and subadults, with the association of wider faces and lower digit length ratios demonstrated through the study of soft tissue measures, using standardized facial photographs and

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scans of the hand. Other research has used the ratio of second and fourth hand proximal phalangeal (PP) length, highly correlated with digit length, as a means of predicting the social behaviors of extinct hominin species. However, the association between digit ratio and face shape has not been investigated using skeletal remains. This study explores the relationship between 2PP:4PP ratios and facial width and height using skeletal material of modern adult males. Digit ratios were calculated from the second and fourth proximal phalanges (PPs) of the right hand, while measures of bizygomatic breadth and nasion-prosthion height were used to determine facial height and facial width. Preliminary results support the hypothesis that lower 2PP:4PP ratios are related to both absolutely and relatively wider faces in males. Our results also provide a baseline from which to further explore these developmental dynamics and various social implications in fossil hominins.

This research was supported by the Iowa Center for Undergraduate Research.

Metatarsal variation in morphology of the hallux in non-human primates.

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Terrestrial and arboreal environments present different locomotive challenges for non-human primates. This study focuses on interpreting how those challenges impact the degree of proximal facet concavity of the hallux in New World and Old World monkeys. The study uses measurements of halluces from 34 monkeys (*Alouatta*, *Cebus*, *Lagothrix*, *Cercopithecus*, *Macaca*, *Miopithecus*, and *Papio*) stored at the University of Oregon, and 2 (*Macaca* and *Saimiri*) at Central Washington University, using both traditional caliper methods and a MicroScribe three-dimensional digitizer. For the MicroScribe data I recorded nine landmarks, five on the proximal articular surface and four on the distal. Caliper measurements followed Marchi (2010). Monkey species were placed into four locomotor groups from least to most arboreal. Regressions of MicroScribe data principal component scores from EVAN's Toolbox (Phillips et al. 2010). Locomotion alone was significant, however size was a confounding variable. There was a significant correlation for locomotion and monkey size class combined ($F(9, 28) = 27.64$, $p < 0.001$, $R^2 = 92.90$, $R^2 \text{ Adjusted} = 89.54$) Size was the primary explanation for this variation, when looked at separately ($F(7, 29) = 26.40$, $p < 0.001$, $R^2 = 89.36$, $R^2 \text{ Adjusted} = 85.98$). While the results of my study do

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show a difference between monkeys with extremely curved proximal articular surfaces and those with a flatter surface, it was difficult to correlate it to locomotion alone. The relationship between the relative flatness of the surface and allometry needs to be further explored. (230 words)

Funding Provided by the Ronald E. McNair Postbaccalaureate Undergraduate Program.

Fluvial transport of human remains in the Three Rivers of Allegheny County, PA.

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Over the years, studies of fluvial transport of human remains have been conducted on a variety of different rivers. This study uses the fluvial model from Bassett et al. (2002) and applies it to the Allegheny, Monongahela, and Ohio Rivers in Allegheny County, Pennsylvania. The aim is to create a database of river victims, analyze time and distance human remains travel as well as any relationship between these factors, and also to create a model of fluvial transport for the three rivers of

Allegheny County that can be used for future investigations.

A total of 147 cases were collected for all aqueous deaths in the county. Variables were separated into two categories; demographic data and river dynamics. Of the 147 original cases, 80 cases were complete for the demographic data and river determination of where the remains were found. Of these 80, only 26 had complete data sets for the temperature and preservation aspect of this study.

Analysis shows that most victims are between 20 and 49 years, comprising 37.5% of the 80 victims. The younger age ranges suffer from more accidents, which decrease with age. Suicides increase with the age. A Chi-square analysis was performed in SPSS for sex and manner of death, age range related to manner of death, and condition of preservation and length of time in river. No significant differences were discovered. No further analysis could be made for transportation as there was no data available for any of the 80 viable cases for this study.

Assessing error in dental measurements: A comparison of resin and plaster casts to dental enamel.

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The present study examines error rates in the measurement of dental breadth (buccolingual dimensions) on dental enamel as opposed to resin and plaster casts. Previous research comparing plaster casts to real teeth has shown little difference between buccolingual measurements. Due to the growing use of resin casts by anthropologists, real teeth and plaster cast measurements are also compared to resin cast measurements for the purpose of this study.

Measurements of forty canines and forty first molars representing anterior and posterior teeth, respectively, were collected from a modern Italian sample. Dental impressions were made using a high-resolution polyvinyl siloxane compound (Affinis), commonly used by dental anthropologists because of its dimensional stability. Casts were made of gypsum plaster (Denstone) and an epoxy resin (EpoFix). Each buccolingual dimension was recorded five times consecutively using Hillson-Fitzgerald calipers, and all measurements were averaged to minimize intraobserver error. Following Kieser (1990), a paired t-test was used to compare measurements taken on real teeth and each cast to

calculate t-values using a 95% confidence interval.

Preliminary results from a sub-sample of the eighty specimens indicate that there was no significant difference in buccolingual measurements between both casting materials and the real teeth. While plaster casts were generally easier to measure than resin casts (due to opacity and texture), both materials are otherwise comparable when collecting odontometric data. These results suggest that either material is well suited for accurate measurements of dental breadth.

Scaling relationships among sacral and pelvic articular surfaces in hominoid primates.

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The relationship between relative joint size and positional behavior in hominoid primates has received considerable attention, particularly with respect to the roles that orthograde and bipedalism play in joint size. Bipedality causes greater forces to be applied to hindlimb joints; hence bipedal primates are expected to respond with increases in pelvic joint size.

This study compared the scaling relationships among acetabular diameter, sacral body surface area, and

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auricular surface area for extant (*Pongo pygmaeus*[n=12], *Gorilla gorilla*[n=26], *Pan troglodytes*[n=35], *Homo sapiens*[n=38]) and extinct (*Australopithecus afarensis*[n=1], *Australopithecus africanus*[n=2], *Homo erectus*[n=2], *Homo heidelbergensis*[n=1]) taxa. Sex-specific data were log transformed and examined using least-squares regression. Results confirm that bipedal primates exhibit relatively large pelvic joints. Among living hominoids, all three joints scale closely with body mass, although acetabular diameter has the highest r-squared value (0.993). For a given acetabular diameter, humans have a relatively large sacral body area compared to nonhuman hominoids and early australopiths. This corroborates the hypothesis that increases in hindlimb joint size preceded increases in vertebral body area among bipedal hominins.

Auricular surface area also correlates strongly with acetabular diameter (r-squared=0.967). However, some hominins (KNM-ER 3228, *H. erectus*; SH1, *H. heidelbergensis*) have a smaller auricular surface area than expected for their acetabular diameter. BSN49/P27, a possible female *H. erectus*, does not follow this pattern of a having a small auricular surface. Soft tissue structures such as ligamentous reinforcements may play a role in mitigating loading

across the sacroiliac joint in bipeds, and this should be the subject of future investigations.

Differences in grooming behavior and nearest neighbor spacing distances of male and female adult olive baboons (*Papio anubis*) in Tarangire National Park.

RISA LUTHER. Department of Anthropology, Macalester College.

Within many primate species, especially baboons, a complex and well-developed social structure is in place where rank and social status of an individual impacts their overall fitness. In baboons, females remain in their matrilineal troop and males often emigrate multiple times throughout their lifetime. These living arrangements place high value on social behaviors, such as social grooming, and social interaction in the troop among females. It is therefore expected that adult female baboons will spend more time in social grooming and close physical contact with others, and less time in auto-grooming than adult males. To test these hypotheses, behavioral observations were conducted on opportunistically found troops of *Papio anubis* over 23 days in Tarangire National Park, Tanzania. Group scans of grooming were conducted, and adult male and female baboons were

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randomly selected for focal follow observations. The scan samples showed adult females social grooming nine percent more than males and males spent three percent more time auto-grooming. In focal follow data only small differences in time allocation were observed, but followed trends similar to the data of the scan samples. Due to female matrilineal tendencies, these trends were expected; females put time and energy into social grooming to preserve their rank. Social grooming has less of an impact among males, but remains necessary to develop friendships (impacting rank) and consorts. Variability in their rank is impacted by immigration and emigration which predicted a higher display of auto-grooming.

Pliopithecoid species number at the Late Miocene fossil locality of Rudabánya, Hungary.

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Within-site primate diversity was low during the Miocene (23-5.3 mya) of Eurasia. Only two Miocene sites (La

Grive-Saint-Alban and Lufeng-Shihuiba) preserve definitive evidence of more than two sympatric primate species. Rudabánya, Hungary is a 10 million year old fossil locality with a sympatric hominoid and pliopithecoid, *Rudapithecus hungaricus* and *Anapithecus hernyaki*, respectively. Two specimens of *Anapithecus* differ in aspects of molar size and shape from the other *Anapithecus* specimens, suggesting that there may be more than one species of pliopithecoid represented at Rudabánya. To address this possibility, we tested the null hypothesis that metrical variation in the pliopithecoid molar sample does not exceed the variation of a comparative extant primate sample. We collected odontometric data from occlusal photographs of Rudabánya pliopithecoid molars (n=29) and from a comparative sample of four catarrhine species (*Cercopithecus aethiops*, *Gorilla beringei*, *Hylobates lar*, and *Pan troglodytes*). We used these data to compare variation in six dental metrics between fossil and extant samples, resulting in 24 comparisons. We resampled the comparative data with 1000 iterations at the sample size of the fossil sample and compared the coefficient of variation between the fossil and extant samples. The null hypothesis was rejected in 17 out of 24 comparisons (p<0.05). These results suggest that the pliopithecoid sample

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at Rudabánya may represent more than one species.

Development of social bonds through play among captive juvenile and adult bonobos (*Pan paniscus*).

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Play behavior is common in most social species, but usually is primarily a behavior that defines the juvenile life-history stage and is rare to absent in other age groups. Play in bonobos (*Pan paniscus*) is unusual in that it occurs throughout all ages. Traditionally, researchers thought the primary benefit of play was physical development. However, more recent research suggests that social benefits, such as the creation and maintenance of social bonds, may be just as, if not more important. We explore the social benefits of play in bonobos by examining the development of play relationships in juvenile-adult dyads at the Cincinnati Zoo. Most studies on play focus on juvenile-juvenile dyads, but at the Cincinnati Zoo, juveniles are separated from one another and only have adults as potential play partners. This provided the unique opportunity to observe juvenile-adult interactions and to measure how the interactions

developed as the juveniles aged. We observed a male and female juvenile from Feb - Aug 2014, and found that their preferred play partners were also their preferred partners for all other social interactions, supporting the hypothesis that play is an important component in the creation of social bonds. Hinde's indices demonstrated that both the juvenile and adult partners were equally responsible for initiating play interactions (average = 0.025). This supports the hypothesis that play provides important social benefits to adults as well. We discuss the potential impacts the social composition in this captive environment may have on the social development of the juveniles.

An investigation into the lack of climatically-driven variation in internal nasal fossa breadth.

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Previous studies have analyzed variation in recent and fossil human samples using a series of linear skeletal measurements, concluding that populations from cold and/or dry climates have narrower, taller, and

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deeper nasal cavities than populations from hot, humid climates. This pattern has been suggested to reflect a climatological adaptation. However, these studies did not find significant differences in internal nasal fossa breadth (INFB), defined as the greatest distance between the lateral walls of the nasal cavity, at the inferior portion of the nasal cavity in modern humans. A methodological issue with measuring INFB is the metric only measures the widest point of the internal nasal cavity. Therefore, INFB may not be a good indicator of the average breadth of the nasal cavity from anterior to posterior, which is hypothesized to be physiologically relevant for climatic adaptation. To test this hypothesis, we assembled a sample of CT scans of 25 living humans and, for each individual, measured the maximum nasal cavity breadth on each of 100-150 coronal slices spanning the anterior-posterior extent of the nasal cavity. Using the measured maximum breadth from each slice we calculated an average nasal cavity breadth and compared it to the maximum INFB for each individual. Regression analysis revealed an R^2 of .908 indicating that INFB is a good reflection of the average breadth of the nasal cavity anterior to posterior. These results do not support our hypothesis, and suggest that selection may be stronger on the

middle and upper portions of the nasal cavity.

An interspecific comparison of variance in sex-based developmental markers.

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Sexual dimorphism varies with the degree of male-male competition among anthropoid primates. Changes in relative body size of both sexes are well known during ontogeny, but less is known about how osteological developmental markers vary under differing levels of sexual selection. The intensity of male-male competition is reflected in a species' body size sex ratio: humans (*Homo sapiens*) have been reported to have a 1.2 ratio, while rhesus macaques (*Macaca mulatta*) have a ratio of 1.6. We predict greater directional selection for larger bodies and canine size in macaque males compared to macaque females and humans. We also predict this selection results in greater growth marker variation among macaque males than in these other groups.

We documented dental eruption and epiphyseal fusion in 292 *M. mulatta* skeletal specimens and compared the data to more than 25,000 individuals

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using published human population data.

Two-way ANOVAs without replication were used to test whether species had similar variation in dental eruption and fusion time. The two species had significantly different eruption variation (males $F=33.71$, $df=15,1$, $p < 0.0001$; females $F=119.06$, $df =15,1$, $p < 0.0001$) with macaques being more variable than humans. The two species also had different ranges in fusion time ($F=7.28$, $df=13,1$, $p < 0.05$) with macaque males being more variable than human males.

The results support our prediction that macaque males show the greatest variation in these growth trajectory markers. Interspecies comparisons of developmental plasticity such as this study allow for valuable inferences on how growth variation is affected by sexual selection.

Acknowledgements to Andrea Eller for her guidance, the University of Oregon, University of California at Davis, and Caribbean Primate Research Center for the use of their skeletal collections in addition to my family, friends, and colleagues for all their support through my research.

Examination of primate conservation knowledge amongst college students.

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In Northeast Ohio, there is a lack of knowledge regarding threats to biodiversity, especially among college students. Having a more knowledgeable community should mean students would be more willing to take action regarding conservation. The present study was conducted to evaluate Youngstown State University students' knowledge of non-human primates, including threats to them and conservation efforts to preserve them.

A 23 question survey was administered to two experimental groups ($N=55$) and one control group ($N =23$). The students represented a variety of different majors (31 in total) and all class levels. All three groups had class lectures by the professor (LRL) and a pre-test and a post-test was administered. The survey focused on knowledge of primates, threats to their survival and activities related to conservation. In addition, a student (JM and AS) presented 12 minute lecture focused on primate conservation was given to the experimental groups.

Post-test results between the experimental and control groups show significant differences regarding interest in conservation. Interest in conservation was 19% higher in the experimental groups after the student

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presentation on primate conservation, in contrast to the control group with only professor instruction. Also of interest is divided along college lines, data show STEM students were more knowledgeable but less interested in primate conservation, while non-STEM students were less knowledgeable but more interested in the subject.

This study shows a need for a conservation General Education Course (GER) at the freshman level at Youngstown State University.

Spatial height preferences across age/sex classes in wild *Cebus Capucinus* at Estacion Biologica La Suerte, Costa Rica.

CODY MOSER. Florida State University.

Understanding heights utilized by individual primates in the rainforest canopy has the potential to yield new information regarding the evolution of risky behavior amongst separate age/sex classes. A social group of various-aged white-faced capuchins (*Cebus capucinus*) (N=24) was observed in northeastern Costa Rica. By splitting the rainforest canopy into five multiple-meter sections and taking individual instantaneous scan samples, assessments were made on the differences between height preference and age/sex classes in the troop, as

well as height-related vigilance patterns in adult males, and patterns of non-foraging behaviors in juveniles. Juveniles spent a higher percentage of scan samples at levels closer to the ground than other age/sex classes (i.e., 20.71% vs 9.11% for adult females and 14.10% for adult males), and while on the ground, they were engaged exclusively in foraging behavior. Males exhibited vigilance behavior more often lower to the ground (16.67%) than higher in the canopy (1.52%). This finding differs from some accounts in the literature that show a correlation between vigilance and the detection of extra-troop conspecifics. The results of this study suggest that much variability may exist in capuchin height preferences, with effects from age/sex class, possible sources of terrestrial predation such as snakes or dogs, seasonality factors such as an abnormally long period of rain during the wet season, and demographic shifts occurring in the social group beginning with the disappearance of the alpha male and a recent birth in the troop that may have caused individuals to be wary of human observers.

Robusticity in the axial skeleton: An example of the rib.

MICHELLE MURACH, STEPHEN H. SCHLECHT and AMANDA M.

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Skeletal robusticity, (total cross-sectional area relative to bone length) reflects the biological relationship between longitudinal growth and transverse expansion. Many have found robusticity to covary with several morphological traits (e.g., cortical area) and tissue-level properties (e.g., cortical tissue mineral density) throughout the appendicular skeleton. These traits play a critical role in determining whole bone stiffness and strength, a direct reflection of the bone's ability to functionally adapt to its loading environment. However, the relationship among traits has yet to be investigated in the axial skeleton. We used the rib to preliminarily explore how these traits associate among one another. Cross-sectional images from midshaft of ribs 4-6 from 40 individuals (9 females, 31 males) between 17-48 years of age were analyzed to obtain total area (Tt.Ar), cortical area (Ct.Ar) and section modulus (Z). Curve Length (Cr.Le) was used as a proxy for bone length in calculations of rib robusticity (Tt.Ar/Cr.Le). Preliminary results reveal significant ($p < 0.01$), positive relationships between robusticity and Ct.Ar ($R^2 = 0.172$), Z_{PLEURAL} ($R^2 = 0.532$), and $Z_{\text{CUTANEOUS}}$ ($R^2 = 0.416$) that improve slightly with adjustment for age, but not body size. These results

indicate that slender ribs have less bone tissue and less resistance to bending, as has been shown in long bones of the extremities, but may be affected differently by body size than appendicular bones. Regardless, robust bones having a functional advantage over slender bones is consistent throughout the skeleton. Future analyses will incorporate whole bone bending stiffness and tissue-level properties as a source of functional compensation.

Relationship between birth weight, age at menarche, and progesterone levels in adolescent girls.

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Several studies have found a positive association between birth size measures (e.g. birth weight, ponderal index) and age at menarche, and between birth size measures and adult ovarian hormone levels. Few studies, however, have investigated the relationship between birth size and ovarian hormone levels in adolescence. Adolescence is a critical developmental period that impacts reproductive function in adult life. In this study, fifty-seven adolescent girls (age 14-17) completed a demographic and health survey in which they reported birth

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weight and age at menarche (in years). The average age at menarche was 12.4 years (SD 1.33); the range of birth weights was 1.077-4.706 kg. Twenty-one of the surveyed subjects collected saliva on each day of one full menstrual cycle from which we obtained salivary progesterone levels. Progesterone is an ovarian hormone that is important for reproductive function, and it has been shown to have a negative association with age at menarche. We investigated the effects of birth weight on age at menarche and progesterone levels, hypothesizing a positive correlation between birth weight and age at menarche and a negative correlation between birth weight and progesterone levels. We failed to reject the null hypotheses as preliminary results yielded no significant correlation between birth weight and age at menarche or between birth weight and adolescent progesterone levels. These results contradict previous findings in the literature and are an important attempt in determining the degree to which birth size influences reproductive factors in adolescence, which can impact reproductive and overall health outcomes in adulthood.

Prehistoric use of *Ammotragus lervia* in Taforalt Cave.

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A useful means of assessing the emergence of modern human behavior comes from the reconstruction of subsistence strategies: here we look at remains of hunted animals in order to infer diet and behavioral flexibility of early modern people. We use *Ammotragus lervia* molar remains found in Sectors 8 (N=11; 7 had undamaged outer edges) and 10 (N=5) of Taforalt cave in Morocco. The teeth from Sector 8 represent the oldest Iberomaurusian in the Yellow series and continuing up into the base of the Grey; these deposits could be as old as 20,000 years ago. The teeth from Sector 10 are also of Iberomaurusian age and are associated with a cemetery.

A. lervia was a primary prey source for the entire range of populations using Taforalt--as evidenced by its presence throughout the assemblages. We used standard dental cementum analysis to determine the season and age of death of this prey animal. In Sector 8, the

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majority (70 %) of the hunted sheep were prime adults, suggesting a typical modern-human approach to hunting. All adults were killed at the transition between winter and spring. In Sector 8, there is a single late summer individual, but it is an old (opportunistic?) kill. In Sector 10, 60% of the specimens were adult, again all killed at the winter-spring transition. The only kill occurring in late summer was extremely young, and perhaps thus opportunistic. Thus, the results from Tatoralt suggest extremely organized and regulated hunting strategies, from at least 20,000years ago.

Analysis of humeral trochlear angles as possible biological sex characteristic in the Archaic Windover Population.

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When crucial parts of skeletal remains are not present or are too fragmentary, determining biological sex can be extremely difficult. To solve this problem, recent studies have suggested alternative methods for determining sex from skeletal remains. One of the most promising methods is by using the trochlear angle found on the humerus. The trochlear angle is of particular interest due to the dramatic

variation noted between individuals and possibly between the sexes. Research performed thus far has shown significant variation in this angular trait with females having much higher angles than males. This paper uses the geometric morphometric software TPSDig2 as a new technique for evaluating trochlear angles from photographed dry humeri as a possible determination of biological sex. The sample used is comprised of the right and left humeri of 42 individuals (17 female/23 male/2 unsexed subadult) from the archaic population of Windover, Florida. Preliminary results have shown that female left trochlear angles are on average higher than both male right and left angles, but are not statistically significant. Analysis of asymmetry indicates that both sexes have higher trochlear angles on the left than on the right side. This paper also evaluates occupational stresses, handedness, and pathologies as possible theories behind why this difference between the sexes may occur in this archaic population.

Minimal VO₂ of women walking burdened on gradients in urban environments.

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Oxygen consumption (VO₂) increases rapidly with increasing velocity, burden, and incline but the relationship of VO₂ with decline is more complex. For unburdened conditions and while walking at normal velocities, VO₂ is lower on a shallow decline than it is on a flat surface, but at approximately -10% VO₂ is believed to reach a minimum. Beyond -10%, steeper declines induce higher VO₂. Whether or not this relationship is similar for burdened conditions remains unknown.

In order to understand at which gradient the minimal energy expenditure of walking occurs in burdened and unburdened conditions, we assessed the VO₂ of ten females (ages: 22-40) with a portable Cosmed K4b² device. Participants walked at three self-selected velocities (slow, normal, and fast) on five gradients in an urban community setting (0%, +/- 7.5%, +/- 12.4%) burdened (10 kg) and unburdened. All trials were randomized. We performed a linear regression controlling for repeated measures to determine the best predictive equation for VO₂. The first derivative of our equation was used to find the minimal VO₂.

With the covariates velocity, burden, gradient, and gradient squared included (all $p < 0.000$), our equation explains 79% of the variation in VO₂ ($r^2=0.79$). Our minimal VO₂ occurs at approximately -13.5%, a steeper slope than previous work found. This suggests that walking outside on naturally occurring hills may be different than walking on a treadmill in a laboratory. In order to explore this further, more research on walking outside the laboratory should occur.

Bioarchaeological analysis of Solcor 3: The impact of differential foreign connections on biocultural aspects of life in the Atacama Oases, North Chile.

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The Atacama oases located in Northern Chile's arid landscape saw the development of long-term agropastoral societies, which were highly influenced by the Tiwanaku polity during the Middle Horizon (AD 500-1000). During this period, the oases received an increase in overall health and socioeconomic wealth; however, it

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is not clear how individual ties to foreign cultures shaped their access to resources. In this study we examined the association of burial goods from funerary assemblages at Solcor 3, a cemetery with an abundant presence of foreign burial offerings and a series of biocultural markers of lifestyle as evidenced by stature, dental caries, cranial modification, and trauma. Burials were sorted into categories depending on the presence of foreign burial offerings: Tiwanaku, Foreign, and Local. Prevalence of the biocultural markers between them were compared using chi-square and ANOVA tests. Results indicate that no significant differences existed between these categories when stature, trauma, or cranial modifications are considered ($p > 0.05$ for all tests). Caries prevalence is significantly lower among the Tiwanaku Males than Foreign ($p=0.02$) or Local individuals ($p < 0.01$), but no differences are observed among females. These results suggest that there was differential access to less cariogenic food items, such as meat, between individuals associated with Tiwanaku offerings and those who were not. However, no other differences were observed in susceptibility to violence, social identification (as reflected by cranial modification), or nutritional status, which indicates that these individuals were more likely to have benefited

from exchange networks at an interregional level.

Planning abilities of wild chimpanzees (*Pan troglodytes troglodytes*) in tool using contexts.

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Planning is a type of problem solving in which an appropriate course of action for the future is devised by means of mental computation. Advantages of such skills in tool use include conserving effort in gathering tools, achieving closer alignment to an efficient tool design, and increasing foraging efficiency. Chimpanzees (*Pan troglodytes troglodytes*) in the Goulougo Triangle use several tool types to harvest termites, including fishing probes, puncturing sticks, and perforating twigs. Planning behavior associated with different tool types has not previously been examined in detail. We hypothesized that method of procurement (i.e., brought to the termite nest, gathered at the nest, or borrowed from others) differed by tool type. Also, we predicted that certain tool types were more likely to be transported in multiples than others. Twenty-five hours of video recording

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chimpanzee visits to termite nests were systematically screened for tools (>1,100 events) and the procurement of these artifacts. Most tools brought to nests were fishing probes, which are manufactured from herbaceous material and typically used during a single visit. In contrast, a higher relative proportion of wooden puncturing tools were acquired at the nests. Tools transported to nests in multiples were most often fishing probes, perhaps in anticipation that a single probe might not be viable throughout an entire foraging bout or might be transferred to another chimpanzee. Mature chimpanzees brought tools to nests more often than did immatures. The next step in this research is to conduct broader comparative examinations of planning in the wild.

An examination of skeletal injuries at Tombos, Sudan: Investigating the effects of sociopolitical changes on violent and accidental trauma in Nubia.

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This study investigates the rates and modes of injury through the analysis of skeletal remains from the site of Tombos at the Third Cataract of the Nile in Sudan during the Napatan time

period (~750 - 660 BC). The region in which Tombos is situated was under Nubian control during the Napatan period. Our comparative sample from Tombos dates to the New Kingdom period (1550 - 1050 BC), during which Nubia was colonized by Egypt. Through the analysis of traumatic injuries in skeletal remains we can explore the interaction between two distinct cultures. We analyzed adult crania and limb bones from 30 intact burials and commingled remains with a MNI of 53. The limb bones and crania were examined for Myositis ossificans, fractures, and dislocations and were recorded according to bone type and side. The Napatan sample injury frequencies are: Crania - 6.3%, Humerus - 4.2%, Radius - 5.9%, Ulna - 12%, Femur - 1.02%, Tibia - 7.8%, Fibula - 1.3%. These rates are higher than the New Kingdom sample, which are: Crania - 1.4%, Humerus - 1.4%, Radius - 2.9%, Ulna - 4.9%, Femur - 1.4%, Tibia - 1.6%, Fibula - 1.5%. Evidence of violence, ascertained via cranial injuries and forearm fractures indicates a slight increase in interpersonal violence over time at Tombos. Additional higher frequencies may be related to the hypothesized change in daily activities and subsistence, as indicated by skeletal markers of activity from the New Kingdom Egyptian colonial rule to the Nubian Napatan policy.

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Investigating the accuracy of commercially-available genetic athletic tests.

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A number of companies market genetic tests claiming to shed light on an individual's athletic performance potential. These tests are based on research that identified polymorphisms that may affect phenotypes related to athletic performance, such as muscle strength/development, fatigue levels, and maximal oxygen uptake (VO₂ max). However, the role of specific genes is still widely debated, and there is no conclusive evidence supporting the overwhelming influence of any particular gene. Therefore, the value of these tests is uncertain.

To help evaluate the accuracy of claims made by genetic athletic testing companies, we administered the "Athletic Panel" test sold by Warrior Roots to four professional mixed martial arts athletes from a nationally recognized training facility. The test analyzed nine genes suggested to

impact athletic performance (*ACTN3*, *MCT1*, *HIF1*, *ADRB2*, *DIO1-D1a/b*, *NOS3*, *PPARGC1A*, and *ACE*). Additionally, we surveyed the athletes and their coaches regarding the athletes' performance in areas reportedly addressed by the Warrior Roots test, such as speed, strength, and endurance. Survey responses and professional fight results were compared both qualitatively and quantitatively with genetic test results to assess the degree to which an athlete's genes and training regimen affected their performance.

We found that genetic test results alone do not predict an athlete's strongest and weakest performance factors. Survey results and fight outcomes reveal that age, training regimen, and diet also matter. Genetic testing companies ignore these complexities, instead focusing and capitalizing on the genetic factors alone, which contributes to misunderstanding of the influence of genetics upon athletic potential.

Grant sponsor: University of Texas at Austin.

Telling the whole story: How dental microwear texture analysis can add to the archaeology of the Fort Ancient individuals.

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In 1891, Warren K. Moorehead excavated Fort Ancient Native American skeletal remains from Taylor's Mound and Village Site in southwestern Ohio. The site consists of an extensive village area with burial mounds and gravel knolls. The archaeological evidence and high prevalence of dental pathological lesions support a reliance on maize-based agriculture. Hence, dental microwear texture analysis was expected to directly document this subsistence strategy.

High-resolution dental casts were scanned with a white-light confocal profiler. One occlusal surface scan was taken with a 100x objective lens, totaling a work area of 204x276 μm . Resultant data from individuals that preserved microwear ($n=8$) were characterized using SSFA software programs and compared to a variety of hunter-gatherer and agricultural samples in the DENTALWEAR project database.

Average anisotropy and complexity values were significantly higher than documented agricultural groups. In fact, the microwear data were most similar to documented foraging

groups. Foragers are generally smaller, mobile groups that obtain diverse food resources while migrating; this is unlike collectors who establish permanent settlements and rely on stationary food resources more than gathering. These results indicate that the Fort Ancient individuals sampled here may not have relied primarily on a maize-based agricultural subsistence strategy. Despite archaeological and skeletal evidence that point to a more permanent, agricultural settlement, this group may have been more flexible with their diet and, at times, relied more on foraging strategies.

This study was funded by the Loyola University Chicago's LUROP Mulcahy Scholars Program.

Regional variation in human population size and culture in Early and Mid-Holocene Peru.

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During the mid-Holocene, Peru was a center of rapid cultural change, with multiple domestication hotspots, increased sedentism, and complex funerary practices. These complex processes, particularly their regional variation in timing and intensity, are not well understood. We use

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archaeological, climatic, and environmental data to divide Peru into three distinct regions: the coast, highlands and Amazonia. We analyze over 900 radiocarbon dates associated with human occupation from first colonization more than 12,000 years before present to 2,000 ybp, calibrated in OxCal with the ShCal13 curve. These data represent the largest compilation of C14 dates for the time period and region to date. We use summed radiocarbon probability densities (SPD), which represent the density of radiocarbon dates over time, as a proxy for population size to identify inter-regional movements of people and potential barriers to occupation. The radiocarbon data establishes residence and abandonment patterns of the coast and highlands. For the highland region, we demonstrate a rapid decline in population size around 6,500 ybp. We correlate the timing of the decline with climatic drying and low lake levels. To test whether the decline was due to a bottleneck or migration, we compare the highland SPD to that of the coast. Notably, there is a marked increase in the density of radiocarbon dates along the coast at the same time, suggesting migration of people from the arid highlands to the marine-resource rich coast. The migration hypothesis is further supported by evidence of domestication and cultural change along the highlands and coast of Peru.

Paleodietary reconstruction of *Paralouatta varonai* through dental wear analysis.

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Paralouatta varonai is an endemic Cuban platyrrhine represented by a nearly complete skull lacking portions of the face and anterior dentition. It is one of five extinct taxa of Greater Antillean monkeys. Current literature debates its evolutionary relationship as either a relative of the folivorous genus, *Alouatta*, or a member of a separate Greater Antillean clade. The goal of this project was to create a molar wear sequence in order to better understand what ecological niche it filled and to potentially provide a better understanding of folivorous behavior in *Alouatta*. Molar structures vary based on the different proportions of fruit, leaves, and insects that comprise the majority of the diet. Folivorous species tend to have large teeth relative to body size with well-developed shearing, crushing, and grinding while frugivores/omnivores have relatively smaller teeth with poorly developed shearing, crushing, and grinding features on their molars. To assist in the explication of dietary niche of *P. varonai*, we reviewed the dental topography and molar wear of 33 molar specimens at various stages of

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wear. Using 3D laser scanning, we developed 3D models of molars and collected measurements of the surface areas of the crown, occlusal surface, and the dentin exposure. We also employed a qualitative wear sequence to examine changes occurring during dental attrition. Dentition was compared with a sample of extinct and extant platyrrhines and molar wear patterns were found to differ from those of the potentially related genus *Alouatta* suggesting a non-specialized diet as found in *Alouatta*.

Do kinematics signal energetic optimality? Evidence from human walking studies.

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Previous research has indicated that humans have an “optimal” speed (a speed at which cost of transportation is lowest), and that people preferentially choose to walk around this speed; however, it is unknown how people gain the real time feedback necessary to determine optimality. Gait kinematics have been indicated as a potential feedback mechanism and here we evaluate energy and kinematics on humans walking at multiple inclines.

Participants (n=5) were evaluated in two trials in which they walked at four different speeds on both a level and 12% incline, while their energy consumption was monitored; participants identified preferred speeds for each grade at the end of each trial. Posterior video data were analyzed to determine step width and contact time using Kinovea software. Stride length was calculated from stride frequency measured during each speed.

People were better able to detect their optimum speed at the incline. Stride length increased linearly with speed nearly identically (slopes 4.5% different) for both the level ($R^2=0.93$) and inclined ($R^2=0.90$) conditions. Contact time decreased linearly nearly identically (slopes 10.8% different) for both the level ($R^2=0.96$) and inclined ($R^2=0.90$) conditions. Neither stride length nor contact time showed curvature or other cues as to identifiable optimality. Step width showed a wide variation between and within each participant, with a greater coefficient of variation for the incline condition (21.5% increase) and for speeds away from the optimum (34% at the incline). It is thus possible that increased variation gives an indication of energetic cost while walking.

Comparing visitor effect in a mixed species enclosure.

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The purpose of this research is to compare how visitor presence affects the space use and behavior of different primate species. This study was conducted at the St. Louis Zoo on an indoor mixed-species group of four white-faced saki monkeys (*Pithecia pithecia*) and two golden lion tamarins (*Leontopithecus rosalia*). Scan sampling at five-minute intervals was used to record the height, distance from glass, and behavior of each animal as well as the number, volume level, and interaction level of human visitors. The number of visitors was highly correlated with the sound level in decibels ($\rho = 0.66$) and with the interaction level ($T = 0.72$) with a Spearman and Kendall's Tau-b respectively. This suggests that the number of visitors can be used as an indicator of overall visitor invasiveness to study the effects of visitor presence. A general linear model analysis showed decreases in resting behaviors were linked with increasing visitor intensity ($p = 0.023$) for the group. Decreased resting behavior could be indicative of stimulating effects of visitor presence. Stimulation in a generally unchanging captive environment can be enriching, but in excess could also have negative stress-

linked effects. The saki monkeys showed an increase of use of the highest spaces with increasing visitor presence. This may imply greater sensitivity to visitor presence in saki monkeys than in tamarins. The difference between species could also be confounded by the small sample size of two tamarins, one of which was hand-reared and shows more human centric behavior.

Introduction to a Kinda Baboon (*Papio kindae*) study site and study group.

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The Kasanka Baboon Project was initiated in July 2010 by Anna Weyher to investigate the yet unstudied Kinda baboon (*Papio kindae*) in its natural habitat. A wild group of Kinda baboons in Kasanka National Park, Zambia was habituated over a 6-month period. Formal data collection began in January 2011 and continues through to the present. Environmental data including rainfall, temperature, and humidity are collected year-round to illustrate the interaction between the baboons and their habitat. Behavioral data is also collected year-round and demonstrates female philopatry with a

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linear dominance hierarchy between females and a much less structured hierarchy among non-natal adult males. Similar to other studies of baboons, the group spent on average 10% of their time in social activity; however, unique from other female-bonded baboon species, the Kinda females spend a significantly larger proportion of time in social interactions with males. GPS and scan data provide insight into the baboons' diet, movement patterns, day range, home range, and habitat use. From the data on potential available habitat, one would expect the group to spend 36% of their time in grassland and 27% of their time in Miombo woodlands. Instead they show a clear preference for woodlands, spending only 1% of their time in grasslands and 54% in woodlands, making Kindas a Miombo woodland baboon quite different from other savannah species. These findings demonstrate the vast differences between Kindas and other baboon taxa and lay groundwork for future studies examining male-female relationships, infant development, and male-infant interactions.

Scaling relationships and functional morphology of hominoid metapodials.

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Developmental integration of autopod features make it likely that genetic modifications in one domain could produce parallel changes in the corresponding domain. This study investigates scaling relationships between metacarpals and metatarsals in hominoids, by comparing the length and robusticity in extinct (*Ardipithecus ramidus*, *Australopithecus sediba*, *Hispanopithecus*, *Pierolapithecus*) and extant (*Hylobates*, *Pongo*, *Gorilla*, *Pan*, *Homo*) taxa.

Despite variation in locomotive modes, there is a strong relationship ($R^2 = 0.93$) between metacarpal and metatarsal length in non-human primates. Humans differ from other sampled hominoids in that metacarpal length is shortened compared to metatarsal length. Furthermore, while non-human hominoids have similar ratios of metacarpal:metatarsal robusticity, human metapodial robusticities are not correlated, perhaps related to variation in activity among humans. The human third metatarsal also departs from the non-human pattern in being significantly more gracile than expected, which may be a result of the longitudinal arch and unique weight transfer in the human foot.

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This study also examines the relative size of the proximal tuberosity of the fifth metatarsal. Regression of the geometric mean of the tuberosity on average body mass reveals a strong relationship among non-human taxa ($R^2 = 0.99$), but humans have a much more expanded tuberosity. This expansion increases the area of contact between the base of the lateral metatarsal and the ground, perhaps functioning to better dissipate the load associated with the lateral shift of body weight during bipedalism.

These data illustrate that while many autopod features are conserved across hominoids, humans display significant departures from these patterns.

Changing skeletal stress following social and political disruption at Karystos, Greece.

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This study tests the hypothesis that disease prevalence increased at the Greek mother city of Karystos after colonies were established and cultural contact increased through time. To test this hypothesis, bony changes that result from disease, including cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia (LEH), and

periostitis were scored and recorded in 106 skeletons from Karystos, Greece. These bony changes are considered “non-specific” indicators of disease because they are caused by general physiological disruption, and not diagnostic of any specific diseases. The data revealed a nonspecific increase in skeletal stress through time. Specifically, prevalence of cribra orbitalia (19% to 41%; $n=38$; $X^2 p=0.15$), porotic hyperostosis (16% to 33%; $n=37$; $X^2 p=0.21$), LEH (67% to 82%; $n=32$; $X^2 p=0.31$), and periostitis (33% to 41%; $n=49$; $X^2 p=0.58$) increased from Classical/Hellenistic periods to the Roman period (with no change between the Classical and Hellenistic periods). Despite non-significant changes in skeletal stress through time, the consistent pattern of increased skeletal stress into the Early Roman period suggests there may have been a biologically significant difference in disease burden between these time periods. During the Early Roman period Euboean cities were revolting against the Athenian empire and Romans forced local people to pay tribute. This social and political change may have caused the cities on Euboea (including Karystos) to lose some of their resources. With diminished resources, the people on the island of Euboea may have become more susceptible to disease. The

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impacts of small sample sizes and migration will also be discussed.

This research was supported by the University of Northern Colorado's (UNC) Summer Undergraduate Research Stipend to Wharry, and a UNC Summer Support Initiative Grant to McIlvaine.

New methods to infer medial longitudinal column morphology in the hominin foot.

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The medial longitudinal arch of the human foot is a hallmark of obligate terrestrial bipedalism, but detecting its presence from isolated or fragmentary fossils can be challenging. Often individual variables are used to infer the presence of an arch, however it is made up of multiple elements. A combined evidence approach could therefore provide a powerful tool for analyzing medial column morphology and therefore detecting arch presence in fossil hominin pedal remains.

Here we report combined linear and angular morphometrics of the bones that form the medial column of the foot – the talus, calcaneus, navicular, medial cuneiform and the 1st metatarsal. The comparative sample includes extant hominoid genera (*Pongo*, *Gorilla*, *Pan* and *Homo*) and fossil hominin specimens representing several known taxa (*Australopithecus afarensis*, *H. habilis*, *H. floresiensis*, *H. neanderthalensis*). Facet angular data were collected from laser surface scans using best-fit algorithms in Geomagic software, while linear measurements were taken using a combination of calipers and computer software tools.

Preliminary results show that functionally relevant metrics of the medial column, when analyzed in combination using multivariate statistics, result in a distinct separation between modern humans and extant great apes. We infer that these results are in part due to the presence of a medial longitudinal arch in humans. Analysis of fossil remains (OH 8, StW 573 and an *Au. afarensis* composite) indicates that there is considerable variation in hominin medial column morphology. This approach may prove useful as a future analytical tool when considering fossil hominin pedal assemblages.

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