



Undergraduate Research Symposium

6–8 pm, Wednesday April 11th, 2012

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2. **Baby on the hip: how do urban individuals carry infants?** J. SALLSTROM, C. WALL-SCHEFFLER.
3. **The effect of load-carrying and velocity upon footprint formation.** D. ARMO.
4. **Fancy footprints and loaded locomotion: accounting for human footprint variation while performing a load-bearing task.** E. WAGLER, D. MOORE, C. WALL-SCHEFFLER.
5. **A spring in your step: the spring-mass model and the energetic cost of running.** J. RATHKEY, E. CHUMANOV, C. WALL-SCHEFFLER.
6. **The relationship between preferred and optimal running speed.** P. SPENCE, J. RATHKEY, C. WALL-SCHEFFLER.
7. **Costly courtship: the energetic burden of walking together.** J. WAGNILD, C. WALL-SCHEFFLER.
8. **Does elongating the foot change walking? Effects on energetics.** M. N. MARSH, S. G. LAUTZENHEISER, P. A. KRAMER.
9. **Does elongating the foot change walking? Effects on knee height.** S. G. LAUTZENHEISER, M. N. MARSH, P. A. KRAMER.
10. **Functional inferences from the fourth metatarsal of *A. afarensis* AL 333-160.** P. MITCHELL, J. MONGE.
11. **A three-dimensional multivariate analysis of the proximal articular surface of the anthropoid cuboid, and its functional implications.** O. O. THOMAS, W. E. H. HARCOURT-SMITH.
12. **Three-dimensional quantitative analyses of calcaneal and cuboid joint morphology in eastern and western gorillas.** C. PRANG, M. W. TOCHERI.
13. **Interpretation of hominoid locomotor behavior through estimations of humeral torsion: a new method of calculation using 3D digital scans.** A. M. CLOUSE.

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Determining mitochondrial lineages of ancient Maya through ancient mtDNA analysis.

EDMUND ADJAPONG and NANCEY ELWESS. Department of Biology, SUNY Plattsburgh.

The primary objective of this on-going research is to determine the haplogroup lineages of ancient Maya from Tipu, Belize through the isolation of ancient mitochondrial DNA (ancient mtDNA). This research will contribute to current knowledge of ancient Maya and the migration routes that were taken to populate the new world. This study used teeth from twenty-three randomly selected skeletons that are a part of a collection of ~580 skeletons unearthed from a 16th and 17th century colonial cemetery in Tipu. The skeletons were unearthed by Dr. Mark Cohn and a dig team and currently belong to SUNY Plattsburgh. The samples of teeth went through the following DNA extraction protocol: polymerase chain reaction (PCR) was utilized to amplify the ancient mtDNA, and Hae III, Hinc II and Alu I were used to digest the ancient mtDNA. These enzymes were previously used by Angelica Gonzalez-Oliver (2001) in a study of Founding Amerindian Mitochondrial DNA Lineages in Ancient Maya From Xcaret, Quintana Roo, and test for four specific Amerindian Haplogroups (A, B, C and D). Of the twenty-three samples tested,

the results indicate that two individuals belong to haplogroup B, fifteen individuals belong to haplogroup C, and six individuals belong to haplogroup D. Haplogroup A is absent from the individuals tested thus far. Future plans include establishing haplogroups for the remaining ~580 skeletons and determining the sex of juvenile skeletons. This data will increase our genetic knowledge of the Maya and will also provide more knowledge about successfully extracting ancient mtDNA from preserved human skeletons.

The SUNY Presidential Grant funded this study.

The effect of load-carrying and velocity upon footprint formation.

DAVID ARMO. Department of Anthropology, University of Washington, Seattle.

Fossilized footprint trails are found around the world, including those of hominins, at Ileret in Northern Kenya and Laetoli in Tanzania, and those of anatomically modern humans, at the Severn River in Britain. Though these fossilized footprint trails have been extensively catalogued, analyses of the sites have been hampered by a lack of information concerning footprint formation. The effects of gait, velocity, load-carrying, substrate, and other

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factors upon footprints are not well documented.

This study attempts to resolve our lack of knowledge concerning the effects of velocity and load-carrying on fossilized footprints. Ten individuals, five men and five women walked 9.2 meters on a tiled surface with and without an additional load on their back equal to 20% of their body weight, and at three different speeds – self-selected walking, jogging, and running velocities. They stepped on an RSscan mat that dynamically records pressure, giving an electronic image of their footprint. These images reveal that while load-carrying has no visible effect upon footprint formation, velocity affects the contact area the arch of the foot makes with the ground. The arch has more contact area with the ground while running or jogging than while walking. There was only one volunteer with a p value over 0.05, with a $p = 0.212$. This information could allow us to determine locomotion velocity at particular sites, giving us a deeper context for these footprint trails.

Pace of dental eruption in young juvenile *Macaca mulatta*.

AMY ATWATER, ANDREA ELLER, TREVOR EDWARDS, MEGHANN WILKS, DYLAN MARTIN, ALEX BENGEL, FRANCES J. WHITE and

STEPHEN R. FROST. Department of Anthropology, University of Oregon.

The rate, or pace, of dental eruption can elucidate ecological and evolutionary relationships that sequence data alone cannot. However, dental eruption rates are difficult to determine for nonhuman primates especially for the earliest erupting teeth. Currently, ages of eruption for teeth prior to the first deciduous molar are unknown for *Macaca mulatta*.

The purpose of this study is to establish a more comprehensive pace of dental eruption among *Macaca mulatta*.

Using 35 captive rhesus macaques of known age from the Grand Collection, ranging from fetal to adult, we recorded the eruption stage of each deciduous and permanent tooth. The degree of tooth eruption above the alveolar margin was scored by at least three observers on a scale of 0 to 4, “0” representing non-eruption and “4” representing complete eruption to the occlusal plane. The more advanced eruption score was used whenever the right and left sides differed.

Results show that while many rhesus macaques are born with no sign of dental eruption, approximately 50% of our sample showed at least partial eruption in the upper and lower deciduous first and second incisors. At one to two months these teeth reached

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one-fourth to three-fourths of their complete eruption, but no new teeth had broken the alveolar plane. By eight months, the deciduous dentition was fully erupted. These results exemplify the difference in eruption pace among individuals of the same species and will help decipher the variety of factors that affect eruption rate in *Macaca mulatta*.

The effects of antemortem tooth loss and alveolar resorption on the gonial angle of the mandible and the temporomandibular joint.

RACHEL D. BELL. Department of Anthropology, Georgia State University.

The dentition is a very important source of information (e.g., diet, health and age) in human remains, and is therefore a key element in bioarchaeological and forensic analyses. The primary function of the dentition is to assist in mastication, or chewing. However, mastication affects far more than the dentition, such as the mandibular gonial angle and the temporomandibular joint (TMJ). The gonial angle is affected by changes in the masseter muscles, which are influenced by the loading of the dentition. Because the TMJ is also closely associated with these factors, I hypothesized that dental changes, specifically antemortem tooth loss (AMTL) and alveolar resorption,

should distinctly change the morphology of the TMJ. I examined the crania of 50 individuals of known age, sex and ethnicity from the William Bass Donated Skeletal Collection at the University of Tennessee, Knoxville. Preliminary results suggest that the gonial angle is much more indicative of AMTL and alveolar resorption than sexual dimorphism. I further examined the TMJ in a subset of these 50 individuals (n=21) with distinct patterns of AMTL and alveolar resorption. This subsample was separated into three groups: 1) symmetrical or no tooth loss, 2) asymmetrical tooth loss, and 3) completely edentulous. By examining degenerative changes on the superior surface of the mandibular condyles and the mandibular fossa, I found patterns that can suggest which side experienced the first or most extreme dental changes. This information, in addition to changes observed in the gonial angle, could improve forensic identification of edentulous and/or fragmentary individuals.

Handedness as a product of cerebral lateralization: the evolutionary adaptations behind hand preference in gorillas, siamangs and ring-tailed lemurs in captive and wild populations.

KYLEEN BRESLIN. Department of Anthropology, Colorado College.

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In humans, a species-wide right hand bias is well documented but hand preference is not well understood in other primate species. Many studies have examined handedness within individual primate populations but few have compared the levels of handedness between species. This study explored whether there is a spectrum of handedness in primates. Similar to Peter MacNeilage's (1987) "postural origins" theory, this study investigated the hypothesis that handedness developed alongside neurological capabilities. I hypothesize that the degree of right handedness will increase in species that rely heavily on kinship and communication for survival. For this reason, gorillas (*Gorilla gorilla*) and ring-tail lemurs (*Lemur catta*) should show a higher degree of handedness than siamangs (*Symphalangus syndactylus*), whose brains are more specialized for locomotion.

Data were collected on captive gorillas, siamangs, and ring-tailed lemurs over a 1 month period at the Cheyenne Mountain Zoo in Colorado Springs, Colorado. Wild ring-tail lemurs were observed over a period of 1.5 months at Beza Mahafaly Special Reserve in Madagascar. All of these populations were observed for hand preference using continuous focal sampling. Population-wide handedness trends were found. Gorillas demonstrated the

most pronounced right handed bias using their right hand for 55.6% of hand usages. Siamangs did not show a handedness bias and used both of their hands for 38.6% of actions. The wild ring-tailed lemur population showed a left hand biases, using their left hand for 39.1% of actions.

This study was funded by the Colorado College Venture Grand Fund as well as a contribution from the Colorado College Department of Anthropology's Kathleen A. Jones Memorial Fund.

Pace of early epiphyseal fusion in captive *Macaca*.

SAMANTHA BUCKLEY, ANDREA ELLER, SARAH WALKER and FRANCES J. WHITE. Department of Anthropology, University of Oregon.

Epiphyseal fusion is an important developmental indicator in all mammals. Among cercopithecids, the sequence of epiphyseal fusion is known but the pacing of these fusions is uncertain. The pace at which the fusion occurs is a window into the growth of an animal that the fusion sequence alone cannot provide. The pace and sequence of epiphyseal fusion in long bones are reported here from a sample of 23 *Macaca mulatta* from the UO Grand collection, consisting of captive juveniles of known age.

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We scored 33 epiphyses on 25 bones, including all major long bones, the pelvis, and metapodials. We scored the epiphyses as “0” if there was no fusion, “1” if the joint is fusing, and “2” if the epiphysis has completely fused to the diaphysis. All specimens were scored by two coders to ensure intercoder reliability. Only scores with full agreement were included. Because we scored epiphyses in the process of fusing, we are able to comment on the pace of fusion within *M. mulatta* more than previous studies.

Results indicate that metapodial fusion has begun by birth, but continues to fuse until 60 months. Our only explanation for their typical exclusion from fusion charts is because metapodials fuse so early. Additionally, by twelve months, five other epiphyses have begun to fuse: proximal and distal humeral epiphyses, proximal tibia, femoral head, and the greater trochanter. Our results agree with those previously reported by Cheverud (1981). Our sample is younger, allowing us to add new data especially on metapodial fusion.

Cranial consumption: a case study examining of calvarial tuberculosis in a Middle Mississippian ossuary burial.

TYLER CARGILL. Department of Anthropology and Sociology, The University of Southern Mississippi.

A diagnosis of tuberculosis in prehistoric skeletal remains is not uncommon and can most often be identified by the manifestation of rib lesions and destruction of vertebral bodies, resulting in kyphosis, as well as other elements with large amounts of cancellous bone, such as joint areas. However cranial lesions associated with TB are much less common. The cranial vault is usually affected only after the disease has travelled via the bloodstream from a primary site, such as the lungs, and then it causes lesions in the diploe.

This paper discusses a case of calvarial tuberculosis that was discovered in a Middle Mississippian (ca AD 1100-1300) ossuary burial from the Shady Grove site (22QU525) in Quitman County, Mississippi. Burial 43-5A, a young adult male, shows classic signs of tuberculosis in the vertebrae and ribs as well as on the sternum. However, he also had two severe circular lesions perforating the cranial table, along with several other smaller progressive lesions on the interior cranial surface. This pattern has been seen in several cases of tuberculosis identified in more clinical literature. Additionally, severe osteomyelitis is seen on the left clavicle, but this may be related to causes in addition to the tuberculosis. This individual was one of the few bundled burials in the ossuary. Had associated postcranial remains not been present,

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the diagnosis of tubercular lesions in the cranium likely not would have been made.

The effects of observer experience levels on reliability of scoring periostitis at Newton Plantation.

ALYSSA G. CARODINE and M. KATIE ROWE. Department of Sociology, Anthropology, and Social Work, Auburn University.

Periosteal lesions are primarily generalized bony responses to infection or trauma that are widely used as a measure of adaptive success in past populations. There is an immense amount of variability in the severity of the reactions, and the existing scoring methods of these are inherently subjective. We hypothesize that observer experience level, both with general skeletal features and with periosteal reactions themselves, can influence data sets. A study of this nature is designed to devise scoring methods that produce more valuable data about the patterns of health and adaptations to environmental stressors. We test this hypothesis by analyzing the effect of inter-observer error in scoring periostitis on the tibiae from a historic bioarchaeological series from Newton Plantation in Barbados. A group of 18 undergraduate observers with varying amounts of experience scored six tibiae using a 4 point scale as outlined in Steckel and Rose (2002:89).

Experienced observers (n=7; mean=3.43) consistently scored more of the tibiae with the same degree of severity that was assigned each sample than did inexperienced scorers (n=18, mean=2.00), a difference that was highly significant ($t = -3.191$; $df = 16$; $p = 0.006$). Our results suggest that the degree of the observer's experience has a significant effect on the reliability of the scores, which ultimately can pose problems in assessing the pathology of whole populations accurately. Future studies need to address the roles of intra-observer error in making generalizations about the lives of past populations.

Interpretation of hominoid locomotor behavior through estimations of humeral torsion: a new method of calculation using 3D digital scans.

ADÈLE M. CLOUSE. Department of Anthropology, University of Washington

Accurate estimations of humeral torsion can help reveal the nature of a paleospecies' locomotor behavior, but fossil humeri are usually fragmentary. Larson (1996) details a method to estimate the torsion of incomplete humeri from predictive equations. Larson concludes from her analysis of the record of humeral torsion among hominoids that the high degree found in both knuckle-walking apes and modern humans was independently

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derived, suggesting that knuckle-walking did not precede hominid bipedalism.

This research examines Larson's methods for predicting humeral torsion in incomplete primate humeri. To do so, 3D external laser scans were used to analyze an independent collection of primate humeri and fossil casts, and regression equations were independently generated to compare with Larson's predictive equations. Once a specimen is digitally rendered, the x,y,z coordinates of any point of interest can easily be taken and analyzed with a high degree of precision; an improvement over the measurements taken using a torsionmeter or measuring calipers. The averaged torsion values predicted by regression equations developed from this new research sample produce values for AL 288-1 (124°) and Omo 119-2718 (127°), that are close to Larson's original predictions. This study supports Larson's conclusion that, parsimoniously, values through evolution would not go from high in a knuckle-walking LCA, to moderate among early hominids that also would have benefited from a high degree of torsion, then evolve again to high ranges among modern humans.

Size variability in the prosimian skeleton: testing for the effects of locomotion.

ETHAN L. FULWOOD and ANDREW KRAMER. University of Tennessee, Knoxville.

This study investigates intraspecific variability in the cranium and appendicular skeleton of 8 prosimian species: four lemurs (*Eulemur fulvus*, *Haplemur griseus*, *Lemur catta*, and *Varecia variegata*), 2 galagos (*Galago senegalensis* and *Otolemur crassicaudatus*), a loris (*Nycticebus coucang*), and a tarsier (*Tarsius syrichta*). Based on earlier studies conducted on a broad sample of 11 genera of catarrhines, postcranial appendicular variability was expected to be higher than cranial variability, and diaphysis variability higher than epiphysis variability. The impacts of muscular action on bone should be more apparent in the limbs than on the cranium, as the cranium is less directly involved in locomotion. Bone modeling should also be more important in determining the shape of the diaphyses of long bones than of the epiphyses. Developmental constraint is likely to minimize cranial and epiphyseal variability due to the requirements for precise matching at limb joints and safety factors in the cranium. Additionally, due to the importance of hindlimb dominated vertical clinging and leaping in prosimians (in which *G. senegalensis*, *H. griseus*, and *T. syrichta* are often classified as specialists, and all but *N. coucang* practice

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occasionally), hindlimbs were hypothesized to be more variable than forelimbs in this sample, the reverse of the observed catarrhine pattern. It was found that postcrania in these 8 species were more variable than crania ($Z = -2.34$, $p < .05$) and diaphyses more variable than epiphyses ($Z = -2.26$, $p < .05$). This may indicate that common developmental processes characterize variation in primates. Forelimb and hindlimb variability were not significantly different, however. This may indicate that prosimian limb use is relatively undifferentiated.

A genetic perspective on the evolution of longevity at the MP/UP transition.

AMY GOLDBERG^{1,2}, KATYA MACK^{1,3} and ABIGAIL BIGHAM¹. ¹Department of Anthropology, ²Department of Mathematics, ³Department of Ecology and Evolutionary Biology, University of Michigan.

Fossil evidence indicates a marked increase in longevity, or the number of individuals living to be potential grandparents, between Upper Paleolithic (UP) modern humans in Europe and earlier Middle Paleolithic (MP) Neanderthals. The cultural implications for bi-generational learning and timing at the MP/UP transition make this shift important to understand the uniqueness of the extended human lifespan and extensive

culture. Multiple adaptive explanations have been suggested to explain this demographic shift, but it remains unknown if biological and/or cultural/ecological differences allowed for the increase in the longevity observed in UP populations. Here, we test the null hypothesis: Neanderthals and modern humans do not differ significantly at longevity associated single nucleotide polymorphisms (SNPs). We compared 29 longevity-associated SNPs in the Neanderthal consensus sequence with a single modern human population, the CEPH European data from the HapMap. Next, we tested loci that differ in modern human populations and the Neanderthal consensus sequence for signatures of natural selection using standard statistical tests that detect departures from neutrality. Genes showing evidence of strong recent selection in the modern populations could indicate differences between modern humans and Neanderthals, or between modern humans and UP European populations. These results contribute genetic evidence for the evolution of longevity during the MP/UP transition.

Discrete dental variation and identity at Newton Plantation, Barbados.

MATTH GREENEMEIER. Department of Sociology, Anthropology, and Social Work, Auburn University.

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Largely due to the relative scarcity of representative 17th and 18th century osteological collections associated with the African Diaspora, biodistance investigations of the trans-Atlantic slave trade remain limited in nature. Yet this forcible migration of nearly 11 million people represents a period of burgeoning encounters between New and Old World populations as well as a prominent avenue of probable genetic exchange (Eltis 2000). In efforts to further expand upon biological understandings of identity for Caribbean slave laborers, partial permanent dentitions recovered from a MNI of 31 individuals interred within a slave cemetery at Newton Plantation, Barbados are scored for their exhibition of historically-indicated discrete dental variants, specifically for expression of the Sub-Saharan African Dental Complex. In doing so, rough regional affinities can be ascertained for specific skeletal materials, building up extant site formation and demographic research (Handler and Lang 1999; Handler 1998).

Through the application of intra-site nonmetric dental comparison, distinct burial features are assessed via standard χ^2 distributions for differentials in trait distribution, informing inquiries concerning burial grouping and genetic diversity during site formation. Additionally, current isotopic signatures of regional origins

for the interred individuals within this cemetery (Schroeder et al 2009) are compared with their corresponding discrete data sets via the Pearson product-moment correlation coefficient as a means of ascertaining probable ethnic identity within the historic Newton Plantation slave laborer community. Possible incongruities in expected rates of trait expression are reconciled through explanations of the site's history, as well as through broader trends of evolutionary forces such as genetic drift and the potential role of epigenetic factors in discrete dental variance.

Untangling history: discussion of the human remains excavated at the Spoonville site in western Michigan.

MEGAN GREENFELDER, GWYN MADDEN and JANET BRASHLER.
Department of Anthropology, Grand Valley State University, Allendale.

The human remains at the Spoonville Site were excavated in 1966 by Dr. Richard Flanders of Grand Valley State University as part of a salvage operation. Based on later finds from the nearby village and the burial goods from the mounds themselves, the site has been attributed to a Hopewellian culture. While archaeological findings have been published on the Spoonville Village site, relatively little is known about the mounds or the human remains. While the human remains

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contribute to our understanding of mortuary ritual in the region during the period, this research will also shed light on the discipline's historic issues with record keeping and curation.

Remains from mound one include one adult male age 35+ years and one indeterminate adult. The remains from mound two include one adult male 17-25 years of age, one indeterminate adult 25-35 years, one juvenile 10 years, another juvenile 5 years of age and one infant. The adult male and 10 year old juvenile display heavy green stains, likely associated with the copper spoon, 7 copper celts and double-pointed copper pin placed along the long axis of what appears to have been a double burial. Pathological change noted in the remains includes periodontal disease, carious lesions, arthritis, periostitis, possible spina bifida occulta, anterior torsion of a distal tibia, and asymmetry of the neural arches of the fifth lumbar and spinous process of the fourth lumbar vertebrae.

Examination of the human remains from the Late Woodland site of Knobloch, Michigan.

ROBERT A. HANKS, CAITLIN A. HOOP and GWYN D. MADDEN.
Department of Anthropology, Grand Valley State University, Allendale.

The Knobloch site presents a large assemblage of human remains located along the Rabbit River in Allegan county, Michigan dating to the Late Woodland time period. Approximately 42,800 fragments were observed from this commingled deposit which included both cremation remains and primary inhumations. As this is a commingled deposit, traditional forms of analysis for the cremated remains were not applicable. All remains were observed visually for identification of age, sex, and pathology and when possible long bones were measured to assess stature. The minimum number of individuals for the deposit is 14, with 6 adults, four juveniles, three infants, and one fetus present. Pathological conditions noted include arthritis, healed fracture, periodontal disease and carious lesions. While the mixture of cremated remains and primary inhumations is not unusual for this period, no grave goods were found in association with the remains and thus cultural affiliation cannot be determined for repatriation purposes. Links between the Knobloch site and the Brainard Site, Bois Blanc Island's Juntunen site, and Fort Ancient Culture are drawn, though no definitive evidence can be found. Knobloch may represent a group of people influenced by crossroads of trade networks, which could lend some understanding to a cultural affinity as well as prehistoric trade patterns. As very little is known

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about this site and collection, next to nothing has been published in regards to Knobloch since its discovery in 1975.

Pelvic proportions in macaques (*Macaca*) and humans (*Homo*).

MARRISSA C. HARRISON¹ and PATRICIA A. KRAMER². ¹Department of Anthropology, University of Washington, ²Departments of Anthropology and Orthopaedics and Sports Medicine, University of Washington.

Pelvic morphology varies between quadrupedal and bipedal primates due to locomotor behavior. Flat, posteriorly oriented ilial blades and narrow bi-acetabular distances characterize terrestrial quadrupeds, such as macaques, while bipeds, like humans, have curved blades with wider acetabular distance. Due to the constraints of parturition, women have been shown to have wider bi-acetabular distances than men, but whether or not their interspinous distance or bi-iliac breadth is different remains to be determined.

The main objective of this study was to evaluate bi-iliac, interspinous, and bi-acetabular breadth in men and women, using macaques as a comparison group. Using Osirix imaging software, these pelvic dimensions were measured 3 times from the radiographs of 10 men, 10 women, and 11 adult

macaques. From the average dimensions, three ratios were calculated (bi-iliac breadth/interspinous distance (BI/IS), bi-iliac breadth/bi-acetabular distance (BI/BA), interspinous distance/bi-acetabular distance (IS/BA)). Sex and species differences were examined statistically using Stata (StataCorp, College Station, Texas).

As expected, the ratios in macaques were all significantly different than humans (all p 's < 0.001). While human bi-iliac breadth and interspinous distance was greater than bi-acetabular distance (all p 's < 0.001), monkeys showed nearly identical proportions in the three measurements. Between men and woman, women differed from men in bi-iliac/interspinous ratio ($p = 0.038$), but, unexpectedly, the sexes did not differ in the other two ratios.

Association between diet and incisor surface curvature in African cercopithecids.

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Understanding the relationship between tooth morphology and feeding ecology in extant taxa provides for

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more reliable interpretations of the primate fossil record. Recent studies by Deane (2005, 2008, 2009) suggest that frugivorous species, especially hard-object feeders, have incisors of relatively greater labial and mesiodistal curvature than folivorous species. The present study builds on the work of Deane and that of Schubert et al. (2010) to further test the relationship between diet and incisor surface curvature in an expanded sample of African cercopithecids.

We measured maxillary central and lateral incisors of adults in ten cercopithecoid genera, representing eleven species for which dietary information was available. We assigned each taxon to one of five diet categories. Points were recorded at one-millimeter intervals along the surface using a measuring microscope. We then fit polynomials to the data and determined the first derivative of the curve at each point. Logistic regression analysis on the first derivatives was used to test the ability of incisor curvature to predict diet type.

Preliminary results indicate that incisor curvature corresponded to diet category 78% of the time, with greater accuracy among taxa categorized as frugivores. The mechanism responsible for the functional association between incisor curvature and diet has not yet been determined; doing so will require

data on food material properties as well as the mechanics of incising different food types. Nevertheless, the predictive power demonstrated by this extant sample indicates that this element of incisor shape can be used to infer diet in fossil taxa.

Does elongating the foot change walking? Effects on knee height.

STEVEN G. LAUTZENHEISER¹, MISTY N. MARSH¹ and PATRICIA A. KRAMER^{1,2}. ¹Department of Anthropology, University of Washington, ²Departments of Orthopaedics and Sports Medicine, University of Washington.

Homo floresiensis diverges from the traditional morphological form associated with bipedalism because their foot is long compared to their femur. Here, we examine the effect on gait parameters of lengthening the foot of modern humans to proportions like that seen in *H. floresiensis* (ratio of foot to fibular length of 0.87). We hypothesize that the swing knee will need to be raised to allow the longer foot to clear the ground.

Eight women aged 18-30 years participated. A foot extension device (FED) was created to lengthen the feet of each participant. The women walked for a total of 30 trials at slow, preferred and fast velocities both with and without the FED. An 8-camera

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Qualisys system was used to measure the 3D trajectories of markers placed on standard anatomical landmarks. The trajectory of the patella marker was analyzed to determine if the knee moved higher while wearing the FED than in normal gait.

The height that participants raised their right leg when wearing the FED was not significantly different from that seen in normal gait ($p = 0.446$). These results tentatively indicate that there is no significant change in the kinematics while walking with an extended foot. Future work will include the analysis of more anatomical markers and larger sample sizes.

Y-chromosome microsatellite variation: another perspective on Mijikenda and Taita origins.

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Historians write that the Mijikenda and Taita ethnic groups of southeastern Kenya claim shared origins through migration from a legendary homeland to the north, commonly referred to as Singwaya. Linguistically, both groups are Bantu-speaking, and most likely

migrated from southern Somalia or Tanzania as part of the Bantu migrations around 3,000 BC. Despite these similarities, contention remains amongst surrounding groups and the Mijikenda and Taita themselves regarding shared origins. Both groups have recounted different oral histories that conflict with the story of Singwaya and their supposed homogeneity. The purpose of our study is to assess the likelihood of shared origins by measuring the genetic homogeneity of the Mijikenda and Taita groups. To accomplish this, we used the heterozygosity formula and examined alleles from 16 different loci from Y-chromosome microsatellites in 15 individuals (8 Mijikenda and 7 Taita). We found that no allele was shared by every individual, showing that the groups are diverse within and without. Further analysis indicates that the Mijikenda and Taita groups are considerably similar to other Bantu-speakers and populations from the Horn of Africa. These results suggest that Singwaya may be a shared cultural construct, formulated in solidarity when faced with colonial rule, and that factors such as marriage with nearby groups has occurred for a significant time. Overall, the study demonstrates that results found from the Y-chromosome microsatellites are in accordance with the data procured from the recent mtDNA studies and adds to the body of data on Y-

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chromosome studies of East African populations.

This study was funded by a UIC Liberal Arts and Sciences Undergraduate Research Initiative grant to Leathem.

Examining the relationship of dorsal pubic pits in regards to sex and age.

CHEYENNE LEWIS. Department of Anthropology, The George Washington University.

The correlation between so-called “scars of parturition” and parity has long been debated within physical anthropology. Studies have shown that parity and dorsal pubic pits are not conclusively correlated; however, the effects of sex and age have not been thoroughly examined.

In this study the effects of sex and age on dorsal pubic pitting were examined using a sample of white and black individuals (n=100) from the Terry Collection (Smithsonian Institution National Museum of Natural History). Pelves from individuals with known sex and age-at-death were examined qualitatively for presence versus absence of dorsal pitting. Furthermore, degree of pitting was scored using a scale of 0-2. Data were broken down into four categories: females, males, adults 45 years old and younger, and adults over 45 years old. The frequency

of pitting in each category was used to determine the relationships between the pitting stage and sex and age. A Mann-Whitney U test was used to examine the differences between males and females and between the two age groups. The results suggest that pitting is more strongly associated with females than males (only one male pelvis exhibited pitting). Also, there was no significant difference between the two age groups within females which suggests that age does not have an effect on the degree of pitting. The results of this study seem to support older studies on these pits; however, an increase of the sample size will help strengthen these findings.

This research was funded by the Lewis N. Cotlow Field Research Fund, Department of Anthropology, The George Washington University.

Rates of Neandertal introgression in genic versus intergenic regions of the human genome.

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The Neandertal genome project recently estimated that 1-4% of the genetic material found in non-African populations is the result of the

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introgression of Neandertal genes. When populations that were previously isolated admix, incompatibility at the genic level can often result in distinctive patterns of introgression. It can be predicted that intergenic regions will be more likely to introgress into a population than protein coding changes when two populations or species have lowered hybrid viability or fertility. As coding changes are more likely to be associated with inviability and infertility due to epistatic interactions between gene products, these regions are less likely to be exchanged between diverging populations. Coding regions, therefore, should show an earlier divergence time than intergenic regions. To test this hypothesis, we looked at Neandertal introgression in five genic and five intergenic regions from six geographically distinct modern human populations (Han Chinese, Gujarati Indian, Italian, Puerto Rican, Japanese, and CEPH Europeans). We chose regions with similar recombination rates that did not show strong departures from neutrality. Using maximum likelihood estimation, we calculated the time to the most recent common ancestor (TMRCA) for each of the 10 regions separately based on human-Neanderthal-chimp sequence alignments. Our results highlight the patterns of introgression for intergenic and coding regions in different human

populations while expanding our understanding of Neandertal population dynamics and raising new questions about human-Neandertal admixture.

Does elongating the foot change walking? Effects on energetics.

MISTY N. MARSH¹, STEVEN G. LAUTZENHEISER¹ and PATRICIA A. KRAMER^{1,2}. ¹Department of Anthropology, University of Washington. ²Department of Orthopaedics and Sports Medicine, University of Washington

Homo floresiensis exhibits lower limb morphology that is different from that of *Homo sapiens*, leading some to conclude that gait would be different between the two species. For instance, the ratio of foot to fibular length in *H. floresiensis* is smaller than the ratio in modern humans, even after differences in body size are accounted. This increased foot length in *H. floresiensis* is thought to lead to a reduction in energy efficiency.

In this study we artificially lengthened the feet of 8 women aged 18-30 years so that their ratio of foot to fibular length was similar to that of *H. floresiensis*. This was accomplished by creating a foot extension device (FED). Participants walked unshod on a treadmill at five self-selected and randomized velocities. Each velocity

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was maintained for five minutes, with a four-minute rest period between velocities while the volumetric rate of oxygen consumption (VO_2) was assessed with a SensorMedics Vmax29 metabolic cart. We then increased the foot length with the FED and the participants walk at three self-selected velocities.

The cost of transport (CoT) curve for each participant was calculated from their normal and FED walking trials. Walking with the FED did not change CoT ($p > 0.05$). From this result, we conclude that lengthening the foot to the proportion seen in *H. floresiensis* does not change walking energetics.

Functional inferences from the fourth metatarsal of *A. afarensis* AL 333-160.

PAUL MITCHELL and JANET MONGE. Department of Anthropology, University of Pennsylvania.

The recently reported Hadar AL 333-160 fourth metatarsal allows new insight into pedal function in *A. afarensis*. Published data on this specimen were compared against a large ($n > 400$) sample of humans, eastern and western gorillas, common and pygmy chimpanzees, orangutans, baboons, and proboscis monkeys in order to test whether its morphology indicated obligate bipedality as evidenced by the presence of pedal

arches and measures more similar to humans than other primates.

AL 333-160 metatarsal length, base, midshaft, and head circumference, and estimated body weight were analyzed using narrow allometry. The AL 333-160 specimen has a notably short fourth metatarsal length and a large base circumference relative to other taxa. Its head circumference falls between humans and great apes and its midshaft circumference corresponds to specimens with similar body weights. These novel analyses suggest considerable weight transfer in the lateral foot and metatarsophalangeal joint mobility between great apes and humans. The hypothesis that the fourth metatarsal indicates obligate bipedality due to the presence of a longitudinal or transverse pedal arch is supported neither by the comparison of AL 333-160's torsion and base-diaphysis angles to the comparative sample, nor by the equally prevalent observation of ectocuneiform contact facets on fourth metatarsal bases of both humans and baboons. Although these traits have been associated with obligate bipedality, it is likely that they are compatible with multiple locomotor patterns. Overall, this research suggests that the localized anatomy of single fossil elements, while informative, cannot reliably indicate total locomotor patterns.

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Variation of dental calculus in captive macaques.

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Dental calculus in nonhuman primates varies with diet, ecology, and immune health. As in humans, monkeys with excessive dietary carbohydrates can accumulate calculus buildup over time, although there is little information on variation of this dental pathology within nonhuman primates. Focusing on the variance between sexes and species, we scored the presence and severity of dental calculus in 91 skeletal specimens of captive adult *Macaca mulatta* (N=33) and *Macaca fascicularis* (N=58). An adult only sample was established to partially control for variance in calculus due to age, adult defined as erupted M3. Calculus was scored on each tooth from 0 to 3, with 0 as “none present” and 3 indicating “over 50% of surface affected”. Each side was scored independently. Missing teeth were evaluated for apparent causation of tooth loss. Most teeth exhibited some degree of dental

calculus, but all four incisors were the most heavily calcified in both species. The anterior labial surfaces were the most impacted. The frequency of premortem canine removal in our sample prevented us from examining this trait in neighboring dentition. The least calcified were the M3s, probably due to the difference in eruption time between the incisors and the molars. We performed a one-way ANOVA on the total sample, and found no significant difference in calculus buildup between females and males for either species. We did find differences between the two species ($F = 27.63$, $p < 0.0001$) with *M. fascicularis* exhibiting significantly more calculus. This difference may be attributable to varying captive conditions and diet.

Intra- and inter-observer reliability of MSM at Newton Plantation.

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Musculoskeletal stress markers (MSM) are attachment sites on bone that show remodeling in response to loading from muscle, tendons, and ligaments. MSM are widely used to explore habitual activities and mechanical stresses caused during life. In this study we examine intra- and interobserver reliability of MSM in an osteological

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collection from Barbados (Newton Plantation) following methods in Villotte (2006). Factors such as variation in consistency across experience levels were also explored.

Fifteen markers from the upper and lower body were examined and data was collected from Auburn University students (n=22). Experience levels were differentiated by categories of osteological and MSM experience as well as education level. A t-test comparing binary responses showed no significant differences between scores made by inexperienced and experienced observers. The authors hypothesized overall inexperienced observer scores to be similar and overall experienced observer scores to be similar, but that the two groups would be different from each other. The results show that the two groups scored alike; thus, our initial hypothesis was rejected. Although self-reported confidence levels were low, we found replicability to be high. The t-score was found to be $t(15) = -0.46$, $p > 0.05$. Our results suggest that scoring is consistent at most markers for both inexperienced and experienced observers, despite the difference in background. The results of this study show the effect of observer experience on MSM scoring, contribute to improving the effectiveness of MSM scoring methods, and therefore improve anthropologists' abilities to

assess activity patterns in populations.

Midfacial porosity in *Macaca mulatta* and *Macaca fascicularis*: comparisons of wild and captive populations.

RACHEL PETERSON, ANDREA ELLER, FRANCES J. WHITE and STEPHEN R. FROST. Department of Anthropology, University of Oregon

Skeletal samples of captive primates are often considered less useful to researchers because captivity introduces many variables. Few studies have detailed differences between captive and wild skeletal traits, though understanding morphological effects are useful for understanding the dynamic responses of bone. Midfacial porosity in captive macaques is common, though minimally in wild populations, but its causes and origins are unknown. We compared the prevalence and severity of midfacial porosity between species, wild and captive populations, and geographic region using samples from the University of Oregon's Comparative Primate Collection and the American Museum of Natural History.

We examined 110 *Macaca mulatta* and 61 *Macaca fascicularis* from wild and captive populations. The Porotic Hyperostosis scoring guide from the Standards for Data Collection from Human Skeletal Remains (1994) was used to score porosity of the palatine,

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nasals, pre-maxilla, maxilla, supra-orbital margin, zygomatic arch, and the greater wing of the sphenoid. Scoring was a 0-2 scale, "0" representing no porosity and "2", heavily porous. Data were analyzed using two-way ANOVAs. Wild *M. mulatta* displayed a greater significance in porosity than captive ($F = 20.420$, $p < 0.001$). *M. fascicularis* had a significant interaction of age and sex ($F = 8.030$, $p < 0.001$), where older males exhibited more porosity and youngest females exhibited less. Differences were significant in *M. mulatta* by country of origin ($F = 2.840$, $p < 0.0254$). Results show that midfacial porosity varies by geographic region and showed patterned pathological differences between wild and captive *M. mulatta* but not *M. fascicularis*.

Three-dimensional quantitative analyses of calcaneal and cuboid joint morphology in eastern and western gorillas.

CODY PRANG¹ and MATTHEW W. TOCHERI². ¹Department of Anthropology, University of Delaware, ²Human Origins Program, Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

The recent discovery and description of *Australopithecus sediba* from South Africa has renewed interest in the evolution of the foot in Plio-Pleistocene

hominins, as its morphology suggests that early bipeds may have been more diverse in their locomotor repertoires than previously thought. Interpreting the fossil record depends on an accurate understanding of the relationship between bony morphology and locomotor function. Among extant hominids, gorillas are diverse behaviorally, ecologically, and in their locomotor habits, offering an opportunity to understand postcranial morphological diversity in closely related living taxa. Although all gorillas are primarily terrestrial knuckle walkers, western gorillas are characterized by a greater degree of arboreality than eastern gorillas. In this paper, we use laser scans and a three-dimensional methodology to test the hypothesis that western gorillas have more mobile calcaneocuboid and cuboid metatarsal joints than eastern gorillas, increasing mobility in the midfoot and facilitating arboreal locomotion. Our comparative analyses of the calcanei and cuboids of 51 eastern and 29 western gorillas confirmed our functional predictions. Western gorillas have cuboids that exhibit statistically significantly more concave fourth metatarsal facets and larger calcaneal processes, and calcanei with correspondingly deeper cuboid facets than eastern gorillas. These results have implications for understanding hominid pedal evolution and the ways in which

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natural selection alters bony anatomy in response to ecological, behavioral, and locomotor demands.

A spring in your step: the spring-mass model and the energetic cost of running.

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Modern runners and likely hominin hunters minimize energy expenditure by completing tasks at a speed where metabolic cost is minimal. The efficiency of the energetic exchange between kinetic energy and the elastic energy stored in the overall musculotendon system of the lower limb was studied by modeling the runner as a point mass (body mass) atop a spring (lower limb length-LLL).

Metabolic and kinematic data were collected on runners (n=8) at six self-selected speeds on a treadmill. The LLL for each runner was defined as the length between the lateral malleolus and the greater trochanter of the right limb. Change in LLL was measured across stance phase and standardized among runners as a percentage of the

resting LLL. The deviation of the model system from its natural frequency was determined. Using previously published metabolic data, the energetic efficiency of the system was analyzed both as a function of speed (CoT) and as a function of time (CoL).

The optimal CoT predicted by speed correlated highly with the optimal CoT predicted by relative change in LLL ($R^2=0.969$) while deviation from the natural frequency was positively correlated with speed ($R^2>0.82$). The accuracy of the spring motion, demonstrated by the optimal relative change in LLL of $8.17\% \pm 0.61\%$, in predicting the optimal CoT determined by speed substantiates the hypothesis that the driving force behind the CoT is the efficiency of the spring. Furthermore, the CoL increased with the increased deviation from the natural frequency, a deviation requiring the input of additional energy.

Virtual anthropology.

MATTHEW C. S. REID. Department of Anthropology, University of California, Santa Cruz.

Implementing 3D laser scanning and virtualization of skeletal materials, Virtual Anthropology was applied to osteological education. Complete and fragmentary skeletal elements were

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imaged and the data imported into digital modeling software, creating accurate models for anthropological education and research. Virtual tools and interactive 3D models allow students access to learning materials outside of the classroom and laboratory setting, at little to no cost to the student. Through 3D printing, utilizing the Z Corporation inkjet printer binder into a powder matrix process, highly accurate, full-color, replicas can be created. These models can augment or replace actual osteological specimens, and can even be provided for students to keep through laboratory component fees.

The accuracy of the scans and 3D prints was checked through measurements and physical inspection. After scanning, the digital 3D models were measured in Geomagic to compare height, width, and length measurements of the original bone. Height, width, and length measurements between the original specimen and digital scans varied between ~1.5mm to ~0.40mm. Measurements of the 3D printed models showed that they differed from the originals by ~1.1 to ~0.3mm. The full color printing process provided increased depth and accuracy to the models. Print time and print cost compared to quality is equal to or better than traditional reproduction methods. The price per performance

and accuracy of the Virtual Anthropology process allowed the project to be highly successful.

Advice and practices on protein-rich foods during pregnancy in agro-pastoral communities in northern Kenya.

MARIANA RENDON. Department of Anthropology, Michigan State University.

Food taboos are potential sources of nutritional stress and frequently occur at critical times during a woman's reproductive years. Previous studies have shown that pregnant women in developing countries commonly report food taboos for protein-rich food items such as milk, meat and eggs. Given the importance of a well-balanced diet for maternal nutrition, understanding such practices is important. Our objective was to examine the type and source of food advice pregnant women received and their association with women's food practices, with a focus on protein-rich foods. Retrospective interview data on dietary advice and food avoidance during pregnancy from reproductively aged women in Ariaal communities in northern Kenya were used. The data comprised 148 women who had received advice related to protein-rich foods such as meat, milk and beans from specific advisors. We evaluated the associations between dietary advice, source of advice and

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food avoidance practices using descriptive statistics and chi-square tests. There were two contrasting types of advice, either to consume (46%) or to avoid (54%) protein-rich food(s) during pregnancy. Food avoidance practices were more consistent with the advice to avoid protein-rich foods. Of those who were advised to avoid protein foods, 77% reported behavior concordant with this advice. In contrast, among those who were advised to eat protein-rich foods, only 42% reported food behaviors consistent with this advice. Further studies should strive to understand the community's attitudes, beliefs, and knowledge on pregnancy and maternal nutrition in order to understand women's practices regarding food.

This study was funded by the NSF DDIG #0622358; the Wenner-Gren Research Grant #7460; the Micronutrient Initiative and the Provost's Undergraduate Research Initiative at Michigan State University.

Post-European contact Native American female and male population histories inferred from the analysis of mitochondrial DNA and Y-chromosomes.

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Mitochondrial genomes, which are maternally inherited, and Y-chromosomes, which are paternally inherited, can be used to infer the population history of females and males, respectively. Addressing the question of the effects of European contact in Native American communities, we extracted DNA from buccal swabs/saliva from nearly 100 individuals from three First Nation communities in British Columbia, Canada. Specifically, we determined the mitochondrial DNA haplogroup by sequencing the Control Region of the mitochondrial genome. In addition, we determined the Y-chromosome haplogroup by genotyping diagnostic SNPs using ABI Taqman assays. Our results show a consistent pattern for all three populations where Y-chromosomes inferred to be of European origin are in higher frequency relative to mitochondrial genomes inferred to be of European origin. The results suggest that following European contact, European males admixed with Native American females in higher frequency than European females admixing with Native American males in British Columbia. This interpretation of the DNA analysis agrees with documents

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and accounts of the history of British Columbia.

Left-handedness in a captive bonobo group.

TABATHA ROOD, KLAREE BOOSE and FRANCES WHITE. Department of Anthropology, University of Oregon.

Although originally thought of as a uniquely human evolved trait associated with language, studies have now shown population-level right-handedness in chimpanzees, bonobos, and gorillas. This study observed handedness in 14 captive bonobos (*Pan paniscus*) at the Columbus zoo presented with an artificial, baited termite mound. Data was collected from narrated videotapes taken June 29, 2011 - August 31, 2011. Handedness was recorded for 592 fishing and poking bouts. Following prior published studies, handedness was defined from the percentage of bouts that were performed with only the left hand, with 60% or more being left-handed and 40% or less being right-handed. This study group showed a left hand bias among individuals; 9 with left-handed bias (66.7% to 100% of tasks) and 6 with right-handed bias (39.4% to 0% of tasks). The group showed more left-handed (n=311) than right-handed (n=281) bouts, with 93 bouts involving both hands. Right-handed bouts were longer in duration, averaging 113 seconds, with left-

handed bouts averaging 79 seconds. The frequency of left and right-handed bouts by individuals was compared to an expectation calculated from the 60% right-handed and 40% left-handed criteria from previous studies using a Replicated Goodness of Fit test and found to be significantly different ($G=37.743$, $p<0.001$) with significant heterogeneity ($G=171.649$, $p < 0.001$). We conclude that this group of bonobos is predominantly left-handed with significant inter-individual variation.

Baby on the hip: how do urban individuals carry infants?

JESSICA SALLSTROM and CARA WALL-SCHEFFLER. Department of Biology, Seattle Pacific University.

Infant carrying is a substantial cost of reproduction. Added mass of a child correlates with increased energy expenditure that has the potential to reduce energy reserves for male and female carriers. Ethnographic evidence suggests that pair-bond energetic strategies exist, and can be benefitted by overall decreased energy expenditure by a female. We expect that couples would make child-carrying decisions that maximize their inclusive reproductive output. As child carrying is correlated with an increase in recovery time from a single reproductive event for a female, we

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expect males to contribute to childcare by carrying older and heavier children to allow women some energy savings.

The present study assesses whether individuals show sexual division of labor with regard to child carrying strategies. To this end, 558 individuals carrying children in Seattle were surveyed on multiple parameters, including age and sex of child, carry position, and dyad relationship. Men carried male infants significantly more than they carried female infants ($p < 0.001$). Women carried female infants significantly more than they carried male infants ($p < 0.001$). As male infants often are heavier than female infants, this would be an energetically advantageous decision. Likewise, men were more often the carriers of older children ($p = 0.045$). These results suggest that couples are making energetically efficient choices in these instances. Child carrying strategies impact child development, with regard to reduction of infant anxiety, and increased spatio-temporal awareness. Sex differential carrying may provide useful insight into these fields of study.

Y-genotyping of the J haplogroup in Yemeni samples.

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MULLIGAN¹. ¹Department of Anthropology, ²Department of Genetics and Genomics, ³Department of Biology, University of Florida.

Yemen, with its key location in the Arabian Peninsula along a southern migration route out of Africa, represents a significant area of interest with respect to human migration. The prevalence of J haplogroups in the Arabian Peninsula and high frequency in European populations, suggests this group is ideal for understanding the European contribution and diffusion into the Arabian Peninsula and Africa. To facilitate the examination of genetic patterns in southern Arabia, Y-genotyping was employed to analyze 265 male samples, collected throughout Yemen. Specifically, 35% of samples were found to carry the J-12f2a-defining single nucleotide polymorphism, while 15% pertained to the DE-YAP-defined group, with the remaining 45% belonging to the F-M89 group. These J haplogroup samples were further genotyped to classify them into specific J haplotypes. After observing the resultant categories, the relative frequencies of each were compared with those of surrounding regions. Our results help illustrate the phylogeographic processes that shaped current genetic variation in Yemen with implications for a better understanding of the evolutionary history of the Arabian Peninsula.

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Differential immune responses in human populations: Searching for evolutionary clues.

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In recent years, surveys using general continental-based samples have documented variation among human populations in the distribution of genetic polymorphisms affecting the expression of key proteins (cytokines) involved in the immune response. This suggests that the differential expression of immune genes could explain the variance in population immune responsiveness. Our current hypothesis proposes that the expression of cytokine in different humans has been driven by pathogen selection; thus, specific antigens (pathogens) should trigger different cytokine expression and specific cytokine genetic make-ups should account for that differential expression. To address this hypothesis we conducted a preliminary *in vitro* study on human peripheral blood mononuclear cells (PBMC) from healthy donors (n=5, Caucasians), testing the effects of pathogenic antigens on the expression phenotypes for different cytokines when cytokine

genetic information is taken into consideration. The cytokine polymorphisms analyzed were: TNF α (-308A/G); TGF β 1 (codon 10T/C, codon 25C/G); IL-10 (-1082 A/G, -819T/C, -592A/C); IL-6 (-174C/G); and IFN γ (+874 T/A). PBMC were stimulated *in vitro* with either lipoarabinomannan-LAM (lipopolysaccharide from *Mycobacterium* wall) or lipopolysaccharide-LPS (a general proxy for bacterial infection). Cytokine expression was measured by ELISA and Luminex technology. Preliminary results show that despite similar genotypic backgrounds for the cytokine polymorphisms analyzed, cytokine production varied among donors, suggesting significant phenotypic plasticity among humans when exposed to the same pathogenic antigens. We suggest that both genetic variation and phenotypic plasticity within the immune system observed in humans were shaped by differential exposure to and co-evolution with infectious disease over the course of human evolution.

The relationship between preferred and optimal running speed.

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Humans display a curvilinear relationship between cost of transport (COT, kcal/km) and speed when running. When the COT is at a minimum, that speed is known as the optimal speed. During walking, humans have been found to spontaneously prefer their optimum. Here we investigate whether people spontaneously prefer their optimal speed while running.

Metabolic data were collected on four male runners who ran on a treadmill at five preselected speeds in addition to a speed they preferred at which they “would be comfortable running for an hour”. These speeds were run in a randomized order on three different days. At the end of each session, participants were asked to re-select their preferred running speed. When selecting the preferred speed, participants were blinded to the speed display on the treadmill. For each participant, a polynomial regression was fit to the three day average of COT as a function of speed to determine the optimal running speed.

The metabolic data demonstrated a strong curvilinear relationship ($R^2 > 0.94$) suggesting an optimal running speed. A paired t-test comparing average optimal speeds and preferred speeds was used to analyze the relationship between the two. Using the similarity hypothesis, our

data were found to be significant ($p < 0.05$).

These findings suggested that runners tend to prefer speeds near their energetic optimum. Our data suggests that humans may have the ability to sense mechanical and/or physiological variables in relation to running speed. This ability could have resulted from selection for a fine-tuning mechanism sensitive to change in energetic expenditures.

A three-dimensional multivariate analysis of the proximal articular surface of the anthropoid cuboid, and its functional implications.

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Though recent research associates a component of mid-foot mobility to the tarsometatarsal joints, the calcaneocuboid joint (CCJ) is still strongly linked to both mid-foot rigidity and/or mobility across anthropoid primates. The CCJ can vary greatly in morphology and function, from the stiff locking mechanism found in humans, to the highly mobile joint found in *Pan*. However, CCJ

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morphological variation across Anthroidea and its relationship to locomotion and phylogeny is relatively poorly understood. This study statistically tests the differences in morphology of the cuboid proximal articular facet across extant anthropoid primates.

Laser scanning was used to capture 3D surface data from the cuboids of *Homo*, *Pan*, *Gorilla*, *Hylobates*, *Papio*, *Mandrillus*, *Erythrocebus*, *Macaca*, *Colobus*, *Alouatta*, *Ateles*, and *Brachyteles*. Landmarking software was then used to place a patch of 49 landmarks and semi-landmarks across the proximal articular surface to capture shape information. After superimposition, the landmark data were analyzed using principal components analysis.

Results show that there is a clear separation between hominoids and non-hominoids across several axes. Size accounted for under half of the variance (43.95%) on Principal Component One (PC1) and little or no variance on all other PCs (under 7%). The results also show that there is a separation between terrestrial and arboreal quadrupeds, as well as among the different arboreal taxa. A further analysis excluding modern humans resulted in even more nuanced differences among the nonhuman primates becoming evident. These preliminary results show that a

landmark-rich and carefully targeted analysis can be informative even with relatively localized anatomical features.

Fancy footprints and loaded locomotion: Accounting for human footprint variation while performing a load-bearing task.

EMILIE WAGLER, DAVID MOORE and CARA WALL-SCHEFFLER. Department of Biology, Seattle Pacific University.

Human footprint fossils have provided essential evidence into the evolution of human bipedalism as well as the social dynamics of their makers, including estimations of speed, sex and group composition. Generally such estimations are made by comparing footprint evidence with modern controls; however, previous studies have not accounted for the variation in footprint dimensions coming from load bearing activities. It is likely that a portion of the hominins who created these fossil footprints were carrying a significant load, such as a small child, that caused variation in the footprint which could extend to variation in any estimations concerning the footprint's maker. To identify significant variation in footprints due to load-bearing tasks, we had participants (N=5) walk at a series of speeds carrying a 20kg pack on their back, side and front. Paint was applied to the bare feet of each participant to create footprints that

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were compared by stride length, foot length and foot width. Both foot length and width increased at all loads as compared to each individual's unloaded control, reaching significance for foot width ($p=0.004$ for front loaded, $p=0.056$ for back loaded; $p=0.115$ for side loaded). The implications of footprint variations have the potential to alter claims made regarding the traits estimated using fossil footprints and the evolution and locomotion of ancient human populations as a whole.

Costly courtship: the energetic burden of walking together.

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

Prior research shows that each individual has an optimal walking speed – a speed that has the lowest energy expenditure for a given distance. Any deviation from that optimal speed (faster or slower) results in increased energy expenditure. The optimal walking speed has been shown to increase with increasing mass and lower limb length and is therefore susceptible to sexual dimorphic variation, with males in any given population having faster optimal walking speeds. This study examines which speed will be chosen when individuals of varying stature, mass,

and sex walk together. We hypothesize that the male will adjust his pace to accommodate the female's pace, and that holding hands will compromise the preferred speeds of both individuals. Individuals ($N=18$) walked around a track alone, with a significant other (with and without holding hands), and with a friend of the same and opposite sex while their speeds were recorded every 100m. Our findings suggest that male partners will walk at a significantly slower pace, matching the females' pace ($p=0.021$). Additionally, hand-holding causes both individuals to walk slower than either of their optimal speeds (for males, $p=0.016$). Significant pace adjustments appears to be limited to dating or married partners because paces of friends walking together did not significantly change ($p>0.05$). These findings have implications for energetic strategies within populations because the male carries the energetic burden by adjusting his pace (7%) so that the female is spared the increased caloric cost required to walk together.

Linear enamel hypoplasias at Newton Plantation, Barbados: a comparative study in Caribbean slave health.

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Bioarchaeology of the African Diaspora offers insight into undocumented aspects of slave health, which can be studied from a developmental perspective through linear enamel hypoplasias (LEH), an indicator of systemic metabolic stress. We assessed LEH in 29 burials from Newton Plantation, Barbados (ca. 1660-1880), the largest known African Caribbean cemetery. At 0.2069, LEH rate per mouth is consistent with former studies by Corruccini et al. (1985) and Shuler (2005). We found neither rates between Barbadian-born (0.2491; n=17) and African-born individuals (0.2857; n=7) ($\chi^2 = .727$; $\phi = .178$) or between females (0.2857; n=7) and males (0.2; n=10) ($\chi^2 = 1.255$; $\phi = .212$) to be significant nor was average age-at-death at 20.88 years (n=6) in individuals with LEH versus 20.29 years (n=23) for individuals without LEH. Peak age-at-formation for the pooled sample was 4.5 to 5.0 years of age. Compared to other enslaved and free African populations (Catocin Furnace, Clifts Plantation, First African Baptist Church, and Remley Plantation), Newton has a lower LEH rate and later age-at-formation. This lower rate could be attributed to antemortem tooth loss, poor preservation (especially subadults), or death before formation of permanent dentition as is suggested by the mean age-at-death for this sample at 19.95 years (Shuler, 2011). Differences in timing of onset of LEH

may be relevant when considering the weaning hypothesis (Blakey, 1994) and other cultural practices. While LEH rates may suggest that generalized childhood stress at Newton was lower than expected, this indicator must be placed in context with the aforementioned studies of health and historical accounts.

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