

Abstracts of AAPA Poster and Podium Presentations

Anterior femoral curvature tracks decreasing mobility from Woodland to Mississippian.

AHMAD ABU DALOU. Department of Anthropology, Faculty of Archaeology and Anthropology, Yarmouk University, Irbid-Jordan

The trend of change in terrestrial logistic mobility has been investigated by several methods, including femoral midshaft shape as determined by external measurements, and cross-sectional geometry. This study used as index of anterior femoral curvature and one for shape of femur at the midshaft to test the hypothesis that mobility decreased with the shift from hunting and gathering to more intensive horticulture in North America. A sample of 72 femora from Woodland and Mississippian Periods were measured. Femoral curvature develops during childhood and adolescence from the more straight condition at birth. Findings showed that young people of the Woodland Period who participated in foraging and horticulture displayed a significantly greater degree of femoral curvature as adults than those of the Mississippian Period whose principal subsistence strategy was more intensive horticulture.

Sexual dimorphism in curvature was significantly greater in the Woodland than Mississippian, a pattern repeated with femoral midshaft shape, showing increased specialization of subsistence roles among the foragers. Males showed more anteriorly curved femora and antero-posteriorly elongated, oval femoral midshafts than females. Measurement of anterior femoral curvature as a proxy for mobility holds advantages over cross-sectional geometry since it requires neither sections, radiographs or computed tomography.

Evolving instructional practice: How do we research ourselves?

JERUSA T. ACHTERBERG and PATRICIA A. KRAMER. Department of Anthropology, University of Washington

Increasingly, federal research support is being directed toward improving the efficacy of educational strategies to promote science, technology, engineering and math (STEM) competencies in our students. This provides physical anthropologists an opportunity to research the effective teaching of evolutionary and scientific theory, but this requires us to evaluate our instructional practice within the context of student learning, an arena unfamiliar to most physical anthropology researchers. In order to explore novel delivery methods of hominid evolution content, we developed and tested a web-based laboratory used during the paleoanthropology section of an introductory course in biological anthropology in Summer 2009. The course syllabus included three laboratory sections focusing on hominid paleoanthropology, two of which students took using the in-class lab activities developed by the

regular instructor and the last using an online lab we independently developed.

Feedback was obtained from students ($n=21$) after each lab, and their responses and performance compared within and among students. The online lab exercises successfully allowed students to demonstrate their knowledge mastery of course STEM content, though without resolution, technical issues limit full-scale course adoption. Here, we use this project both as a case study to explore the broader themes of planning, execution, data-analysis and applications of researching physical anthropology instruction and as a vehicle to present methodological recommendations. If effective communication of the evidence and importance of hominid evolution to all students is the goal, our instructional practice must be driven by a body of sound research. This study was partially funded by a Huckabay Teaching Fellowship, University of Washington.

A comparison of traumatic injury patterns between a rural and an urban population from medieval Poland.

AMANDA M AGNEW¹, TRACY K BETSINGER² and HEDY M JUSTUS¹.

¹Department of Anthropology, The Ohio State University, ²Department of Anthropology, State University of New York, College at Oneonta.

Traumatic injuries can be used as general indicators of activity patterns in past populations. Agricultural populations are engaged in a laborious lifestyle, reflected in a variety of accidental and stress-related injuries from repetitive activities. Urban populations engaged in craft specialization may participate in repetitive activities; however, their overall lifestyle is arguably less intensive and the risk of accidental and stress-related fractures is diminished. This study tests the hypothesis that a rural, agricultural population will have a higher prevalence of accidental and stress fractures than a contemporaneous urban population engaged in craft specialization in medieval Poland (XI-XII c). Furthermore, these differences will be demonstrated in both males and females.

Traumatic injuries were recorded for 180 adults from rural Giecz (56 females, 104 males) and for 96 adults from urban Poznań-Sródka (36 females, 26 males). Injuries were recorded by skeletal element and grouped into three categories: stress, accidental, and violent. They were statistically analyzed by element and by body region (upper limb, lower limb, etc.). Statistical analyses reveal that Giecz had a significantly higher rate of vertebral stress fractures than Poznań-Sródka (chi-square, $p<0.05$) and is significant for males and females. Additionally, Giecz had a significantly higher prevalence of accidental rib injuries. These results support the hypothesis that an agricultural lifestyle was more laborious, leading to chronic injuries and fractures from accidents. The lack of significant difference in

prevalence of injuries in the extremities suggests that agricultural activities were especially stressful in the trunk region. This project was funded in part by the Global History of Health Project and an Ohio State University Alumni Grant.

The impact of weight on long bone cross-sectional geometry.

GINA AGOSTINI. Department of Anthropology, University of Massachusetts, Amherst.

Two key hypotheses in skeletal biology state that human behavior can be inferred from biomechanical action, and that bone shape can be altered by significant biomechanical stimuli. These have resulted in the development of methodology in which bone shape is used to infer past behavior related to activity patterns, such as mobility. However, biomechanical research shows significant differences in locomotion between overweight and normal weight individuals. If bone shape is mainly reflective of biomechanical stimuli, compensatory behaviors associated with weight could complicate skeletal analyses of activity. This project sought to evaluate the relationship between weight and limb bone cross-sectional geometry using a sample of 184 white males of known age, stature and weight in three BMI classes: underweight, normal weight and overweight. External mediolateral (ML) and anteroposterior (AP) diaphyseal dimensions were measured at five locations on both humeri and the left femur and tibia. After controlling for age, ANOVA results show a significant bilateral effect of BMI on ML dimensions of the proximal humeri and femur. T-tests confirm significant ML elongation in overweight individuals. Additionally, analysis of size-transformed variables also shows a significant BMI effect on ML dimension. These results suggest a relationship between weight and cross-sectional shape resulting from increased ML loading of proximal arms and legs in overweight individuals. This loading is consistent with altered movement patterns of overweight individuals reported in biomechanical research. While these results hold promise for skeletal assessments of weight, they also suggest weight (specifically obesity) can complicate behavioral analyses.

What if? Exploring the effects of sample composition on basic population structure.

NANCY J. AKINS. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Archaeological excavations in the American Southwest rarely recover more than a few human burials from any one site. When samples are small, as they invariably are, burials from nearby sites or even whole regions are often combined to address a variety of research questions. While this is necessary to further our understanding of the human biological and cultural history of the region, such combinations

are sometimes done without regard to the time periods and site types involved, how much of and what types of proveniences were excavated, or when and who did the analyses.

Researchers have used proportions and ratios of adults to subadults to infer aspects of general health, and have used ratios of males to females as evidence of warfare or raiding for women. This presentation examines how the excavation strategy at a single site could affect the age and sex distribution, and by extension, our interpretations of the biological and cultural history of the area. A fairly large sample (169) of burials from a Coalition and Classic period site in Santa Fe, New Mexico, is examined from several perspectives. Proportions of subadults, males, and females are compared by progressively adding to the sample based on criteria such as the sequence of burial removal, grid coordinates imposed on the site, and spatial clusters of burials.

Mummy's skin folds: A preliminary study.

KHUDOOMA S. AL NAIMI, Forensic Science Administration, General Directorate of Abu Dhabi Police, Ministry of Interior, United Arab Emirates.

Although Skin upfolds and downfolds are the most obvious mummy's signs, there is less anthropological attention directed to their examination and interpretation. Folds could be important in understanding the mummies biological, health, religious, cultural and taphonomic characteristics such as age, sex, nutrition, pathology, body size and weight, cause of death, time of death and burial ritual. There are also potential forensic applications. Skin folds are complex deformities of the soft and elastic skin after death that become permanent through mummification which preserve also the total skin area. Folds do not form randomly and they follow certain order in their construction which is unique for each mummy's condition. Several factors affect the formation of skin folds formation such as mummification process, age, sex, body weight, internal tissue architecture, burial position, body region, and skin rheological condition. In this study a Nubian child mummy skin folds were assessed through their axis orientation, including how each fold corresponds to each body part axis, in order to predict the mummy burial position, indicating that it was possibly resting on its left side during the desiccation process. The majority of the upfolds axes were observed to follow the direction of gravity, due the skin weight effect or to the direction of other stress forces. Classification of folds was attempted using the principals of geological folds techniques. Skin folds were useful in prediction the mummy's burial position. More research and standardization is needed in mummification skin folds studies.

Paleobiological inferences on cognition in apes and humans: Does encephalization reflect intelligence in fossil hominoids?

DAVID M. ALBA. Institut Català de Paleontologia, Universitat Autònoma de Barcelona.

Paleobiological inferences on general cognitive abilities (intelligence) in fossil hominoids strongly rely on allometric metrics of relative brain size (encephalization). This is however complicated by a decrease in allometric slopes at lower taxonomic levels and allometric grade shifts between subgroups. In hominoids, encephalization has been criticized due to the apparent lack of correlation between intelligence and encephalization and the fact that it presumably fails to reflect the higher intelligence of great apes. This has led some authors to advocate for the alternative use of absolute brain size.

The hypothesis that encephalization can be a good proxy for intelligence in hominoids is tested here. A significant correlation is found between intelligence data (taken from the literature) and encephalization metrics, but only at lower taxonomic levels. This indicates that higher-level slopes, resulting from encephalization grade shifts between subgroups, do not reflect functional equivalence of intelligence. This vindicates the old—but largely neglected notion—that lower-level encephalization metrics can be employed for making meaningful cognitive inferences. These metrics show, in accordance to intelligence rankings, that great apes are much more encephalized than both monkeys and hylobatids. A major shift towards higher cognitive abilities in hominoids is inferred to have been involved in the origins of the great ape and human clade. This agrees with the great-ape-like encephalization displayed by the fossil great ape *Hispanopithecus*, but not by hylobatids or the stem hominoid *Proconsul*. The similarly lower encephalization of *Oreopithecus* may be interpreted as a secondary reduction due to selection under insularity conditions. This work has been supported by the Spanish Ministerio de Ciencia e Innovación (CGL2008-00325/BTE), the Generalitat de Catalunya (Grup de Paleoprimatología i Paleontología Humana, 2009 SGR 754, GRC) and the National Science Foundation (RHO1-Hominid-NSF-BCS-0321893).

The relationship between hard and soft tissue: lessons for reconstructing virtual endocasts.

KRISTINA ALDRIDGE¹, YANN HEUZÉ², CHRISTOPHER PERCIVAL², JENNIFER STELLA², LISA G. HOWELL², IAN GEORGE¹, JEFFREY MARSH³, ALEX KANE⁴, TIMOTHY M. RYAN², and JOAN T. RICHTSMEIER². ¹Department of Pathology and Anatomical Science, University of Columbia, ²Department of Anthropology, Pennsylvania State University, 3St. John's Mercy Medical Center, St. Louis, ³St. Louis Children's Hospital, St. Louis, MO.

Virtual endocasts provide our only option for quantitative analyses of size, complexity, and evolution of the brain in fossil primate species. However, because fossils only preserve impressions of soft tissue on the internal bone of the cranial cavity, there is no way to validate natural or virtual fossil endocasts. This fact, together with the potentially confounding influence of other soft tissues such as blood

vessels and meninges, may impact the accuracy of endocast reconstructions and, thus, their structural and evolutionary significance. The purpose of this study is to assess the morphological congruence between endocasts reconstructed from 3D computed tomography (CT) images and 3D reconstructions of brains from the same individuals. To address this question, we use a unique dataset of 3D whole brain magnetic resonance (MR) images and 3D medical CT scans of the head acquired on the same day in a group of modern human juvenile individuals. Digital endocasts were produced from the CT data sets using a combination of manual and automatic segmentation methods and these 3D reconstructions were compared to 3D brain morphology reconstructed from whole brain MRIs. Our results suggest that areas located in closest proximity to the endocranial surface are well-represented in digital endocasts, as would be expected. However, we also find localized regions across the endocast surfaces that are particularly prone to error in part due to great inter-individual variation in visible surface details. We propose that interpretation of both natural and virtual endocasts must consider these factors in evaluating specific anatomical features. This study was funded by NIH grant R01 DE018500 and NSF grants BCS 0725227 and BCS 0523637

Trophic assessment of giant lemurs and associated fauna from Andrahomana Cave, Madagascar by LA-ICP-MS.

BRIDGET A. ALEX^{1,2}, KATHLEEN M. MULDOON^{2,3}, LAURIE R. GODFREY⁴ and STEPHEN J. KING^{4,5}

¹Department of Anthropology, Harvard University, ²Department of Anthropology, Dartmouth College, ³Department of Anatomy, Dartmouth Medical School, ⁴Department of Anthropology, University of Massachusetts, Amherst, ⁵Department of Anthropology, Stony Brook University

Accurate reconstruction of the diets of the recently extinct giant lemurs of Madagascar is key to understanding their evolution and extinction. Numerous methods have been employed in the reconstruction of extinct lemur diets. These include gross dental morphology, macro- and microwear analysis, stable isotope measurement, and the dissection of fecal pellets. However, these different methods have yielded inconsistent results. Using geologically appropriate fossil/modern comparisons, it has been shown that the ratio of paleoecologically-relevant elements, such as Sr/Ca and Ba/Ca, decrease from the bottom of the food chain to the top. Previous studies have used this pattern to assess the trophic level of extinct fauna, with varying success. In the present study, we measure Sr/Ca and Ba/Ca ratios in the enamel of giant lemur and associated faunal samples in order to reconstruct the trophic structure at Andrahomana Cave (early-mid Holocene), southeastern Madagascar.

We analyzed surface-collected ($n = 12$) and subfossil ($n = 3$) mammal teeth, including two giant lemur samples (*Archaeolemur majori* and *Hadropithecus stenognathus*), by laser ablation

inductively coupled plasma mass spectrometry (LA-ICP-MS). We found no evidence for ratio alteration over time, suggesting minimal diagenesis. Our results show mild segregation between carnivores, omnivores, and herbivores, but there is extensive overlap among species. The giant lemurs appear to separate from other fauna analyzed, which may indicate a diet distinct from the extant taxa in our sample. This study was funded by the Claire Garber Goodman Fund, Dartmouth College, to KMM.

Getting better with age? Testing the utility of transition analysis methods for forensic skeletal material of Hispanic origin.

BRIDGET FB ALGEE-HEWITT¹ and REBECCA J WILSON². ¹Department of Biomedical Sciences, Grand Valley State University, ²Department of Anthropology, University of Tennessee.

The multiple-trait, component scoring approach of Transition Analysis (TA) is a promising alternative to conventional age-estimation methods for individual, unknown, and fragmentary skeletal cases. TA provides measures of statistical certainty and flexibility in the use of indicators, and shows potential for its applicability to diverse populations. We previously demonstrated that the Traditional TA method performed very well for positively identified modern American forensic skeletal cases: age-estimates fell within an acceptable range of the true ages, were consistently repeated, and were not subject to significant inter-observer error in scoring. We also showed that the ADBOU age-estimation software improves the ease of implementing the statistical procedures, calculating the age estimates, and graphically displaying the results. Ongoing work on the Expert TA method of scoring multiple non-traditional, mostly presence-absence, age-progressive traits similarly produced accurate and repeatable adult age estimates. Refined testing of both TA methods is warranted, therefore, especially for modern minority populations.

We present results for estimating age-at-death using both TA methods for a multi-collection sample of mixed-sex/age Hispanic skeletons drawn from reference populations of forensic significance. We also report on inter-observer error and evaluate the ease of interpretability of the trait definitions and ADBOU scoring manual for cases of Hispanic identity. This project promises improvements to the quality and ease of obtaining age estimates for forensic cases by (1) evaluating the applicability of these methods to an untested demographic group, (2) providing tests of interpretability, repeatability and error, and (3) by obtaining reference materials for use as priors. This study was funded in part by a William M. Bass Endowment from the University of Tennessee, Knoxville.

Are primates particularly dexterous?: An examination of unimanual object manipulation in prosimian feeding.

KARI L. ALLEN. Department of Evolutionary Anthropology, Duke University.

Primates are popularly considered highly dexterous animals; however, prosimians and ceboids typically lack the complex manual skills of catarrhines, lent by digital independence and pollical opposability. Moreover, despite their documented ability for unimanual prehension, prosimians are anecdotally said to prefer grasping objects with their snout. Recently, Iwaniuk and Whishaw (2000) proposed that moderately skilled forelimb movements are "phylogenetically old" among mammals. Since Bishop's (1964) seminal paper on prosimian hand use, reports on grasping in non-primate mammals have accumulated in the literature. This warrants a re-examination of prosimian capabilities to identify salient differences from other animals.

Prosimians were observed during unrestricted feeding at the Duke Lemur Center. Species examined include: *L.catta*, *E. macaco*, *V.variegata*, *P. verreauxi*, *H.griseus*, *C.mediis*, *M.murinus*, *M.coquereli*, *N.coucang*, *N.pygmaeus*, *L.tardigratus* and *G.moholi*. Frequency and context of hand use in food manipulation were recorded. Results show that prosimians do use their hands frequently, though not exclusively, when approaching objects. Objects were visually identified; however, subjects often inspected food with snout prior to manual prehension. Prosimians were rarely observed to execute within hand object manipulation. Instead, the object was typically reoriented within the hand by use of the mouth. Bimanual manipulation occurred with large objects. While most rodents grasp object first with their mouth, subsequently repositioning their body to facilitate unimanual manipulation, direct unimanual grasping occurs in prosimians. This behavior has been documented for beavers, tree kangaroos, raccoons and rats; however, success and frequency of use is variable. These appear to represent convergent cases of dexterity in less dexterous lineages.

***Orrorin tugenensis* suggests a common origin for human-like precision grasping and bipedalism.**

SERGIO ALMÉCIJA¹, SALVADOR MOYÀ-SOLÀ² and DAVID M. ALBA¹. ¹Institut Català de Paleontologia, Universitat Autònoma de Barcelona. ²ICREA at Institut Català de Paleontologia and Unitat d'Antropologia Biòlgica, Universitat Autònoma de Barcelona.

Ever since Darwin it has been hypothesized that the origin of bipedalism was related to the freeing of the hands for manipulative purposes. Fossil remains of the early hominin *Orrorin tugenensis* (Kenya, ca. 6 Ma) enable to test this hypothesis, given the bipedal adaptations revealed by its femora and the availability of a complete distal pollical phalanx (BAR 1901'01). Here we provide a multivariate analysis of this phalanx in order to test whether bipedalism coevolved with enhanced manipulative behaviors. Our results reveal a typical human-like morphology in BAR 1901'01, together with features related to precision grasping, suggesting that bipedalism and human

manipulation originally evolved as part of the same adaptive complex. This supports previous hypotheses relating the origin of refined manipulation—unrelated to tool making—with the relaxation of locomotor selection pressures on the forelimbs. Furthermore, our analysis not only shows that human-like precision grasping is an ancient acquisition already present by the late Miocene, but remarkably indicate that the morphology of the *Orrorin* pollical distal phalanx is the most human-like among the available specimens in the fossil record (other than recent *Homo*). These results suggest that, starting from a human-like thumb pattern, some later Plio-Pleistocene hominin lineages became specialized in terms of hand robusticity. These conclusions suggest that we should be very cautious when making functional inferences from supposedly intermediate hominin forms, such as the Olduvai Hominid 7 hand. This work has been supported by the Spanish Ministerio de Ciencia e Innovación (CGL2008-00325/BTE), the Generalitat de Catalunya (Grup de Paleoprimatología i Paleontología Humana, 2009 SGR 754, GRC; predoctoral fellowship 2006 FI 00065; and travel grant 2008 BEI 00370), the National Science Foundation (NSF Award #BCS-0321893), and the European Commission's Research Infrastructure (SYNTHESIS).

Atlas of tooth development and eruption.

SAKHER J. ALQAHTANI, HELEN M. LIVERSIDGE and MARK P. HECTOR. Institute of Dentistry, Barts and the London School of Medicine and Dentistry, Queen Mary University of London.

The aim of this study was to develop a comprehensive evidence based atlas to estimate age using both tooth development and alveolar eruption for individuals between 28 weeks *in utero* to 23 years. This was a cross sectional retrospective study of archived material with the sample aged two years and older having a uniform age and sex distribution. Developing teeth from 72 prenatal and 104 postnatal skeletal remains of known age-at-death were examined from collections held at the Royal College of Surgeons of England and the Natural History Museum, London, UK (M 91, F 72, unknown sex 13). Data were also collected from dental radiographs of living individuals (M 264, F 264). Median stage for tooth development and eruption for all age categories was used to construct the atlas. Tooth development was determined according to Moorrees, Fanning and Hunt (1963). Intra-examiner reproducibility was calculated using Kappa on 755 teeth (65 individuals). Age categories were monthly in the last trimester, two weeks perinatally, three month intervals during the first year and every year thereafter. Results show that tooth formation was least variable in infancy and most variable after the age of 16 for the development of third molar. Initial tests of bias and accuracy of this atlas on 100 radiographs of children aged three to sixteen showed bias of 0.02 years and accuracy of 0.57 years. This study was funded by Ministry of Higher Education, Saudi Arabia.

Comparative methodology for examining enamel hypoplasias at the Gold Mine site (16RI13).

KATHLEEN ALSUP. Department of Anthropology, University of Tennessee.

The Gold Mine site (16RI13) is a Late Archaic/Early Woodland multi-component mortuary site in Northeast Louisiana with a notable amount of hypoplastic activity. With a sample size of approximately 100 individuals, 46% of the individuals have at least one hypoplasia on either the maxillary central incisor or mandibular canine. A comparison of three methods of estimating age at formation of enamel hypoplasias was conducted. These include two of the most commonly used macroscopic methods, a chart method and regression equations, as well as an approach utilizing data from histological studies. The technique derived from the histological data produced significantly older ages than the other two methods when utilizing the maxillary central incisor data. This has implications for the interpretation of causes of hypoplasia development within this population. No significant difference was found between the methods for the data on the mandibular canine. Interpreting the mean ages produced through the histological-data method, individuals from this population were most likely to develop hypoplasias around 4.09 years (central maxillary incisor) and 5.30 years (mandibular canine). These ages are older than those traditionally found in other studies investigating prehistoric North American populations. This is most likely caused by the use of different aging methods but may also be due to different underlying causes for hypoplasia formation, such as changes in subsistence strategies. The information gleaned from this biological data has important implications for understanding this period in Northeast Louisiana.

Population differences in the testosterone levels of young men are associated with prostate cancer disparities in older men.

LOUIS CALISTRO ALVARADO. Department of Anthropology, University of New Mexico.

Although there is evidence that greater exposure to testosterone is associated with an increased risk of prostate cancer, a recent meta-analysis of 18 prospective studies found no relationship between endogenous sex hormones and prostate cancer development. However, the reviewed studies were subject to methodological constraints that would obscure any potential relationship between prostate cancer and androgenic hormones. If prostate cancer risk is mediated by lifetime exposure to testosterone, then case-control studies that concentrate on endogenous sex hormones near the ages that prostate cancer is diagnosed would provide limited information on cumulative testosterone exposure across the lifespan. As such, an exhaustive literature search was completed to obtain testosterone values reported for study samples of younger men, along with prostate cancer incidences for the larger populations

from which the study populations were sampled. A novel analytical method was developed to standardize, organize, and examine 12 studies reporting testosterone levels for 28 population samples. Study populations were generally apportioned according to ethnicity and geographic residence: Americans of African, Asian, Caucasian, and Hispanic ancestry from several different regions within the United States as well as men from China, Germany, Japan, Kuwait, New Zealand, South Korea, and Sweden. Population differences in the testosterone levels of young men were significantly associated with population disparities in the prostate cancer incidence of older men (Spearman's rho=.634, $p=.002$). The positive association found here is consistent with the observed influence of testosterone on prostate cell proliferation.

Human sex chromosomes in oral and craniofacial growth.

LASSI ALVESALO. Department of Oral Development and Orthodontics, University of Oulu, Finland, School of Dental Sciences, University of Liverpool, United Kingdom
Determinations of tooth crown sizes and/or the thickness of enamel and dentin have been performed in Finnish Hailuoto population and individuals with sex chromosome anomalies, 45,X, 45,X/46,XX, 46Xi (Xq), 47,XXX, 46, XY females, 47,XYY, 47,XXY males and males with deletion of the Y chromosome (Kvantti-project). The results have demonstrated effects on growth of the genes on the human X and Y chromosomes. The Y chromosome promotes growth of both tooth enamel and dentin, whereas the effect of the X chromosome on crown growth seems to be restricted to enamel formation. Enamel growth is decisively influenced by cell secretory function and dentin growth by cell proliferation. The results have also indicated increase in permanent tooth root growth due to the X and Y chromosome effects, and that the various sex chromosomes anomalies are expressed in deviations in e.g. occlusal morphology and cephalometric craniofacial pattern. The location of tooth crown growth promoting gene on the Y chromosome is probably on long arm and on the X chromosome in the short arm. I have suggested that the effect of the Y chromosome is regulatory, at least on amelogenesis, and that especially the effect of the Y chromosome on growth by cell proliferations explain the expression of sexual dimorphism in size, shape and number of the teeth, and under the assumption of genetic pleiotropy, statural growth and sex ratio. It is of great interest that molecular studies have shown that loci for amelogenin, are both the X and Y chromosomes. The Kvantti research project has been supported mainly by the Emil Aaltonen Foundation, the University of Turku Foundation, the Academy of Finland and the Finnish Dental Society.

Evolutionary morphing.

NINA AMENTA¹, DEBOSHMITA GHOSH¹, ANDREI SHARF¹, F. JAMES ROHLF³, WILL HAROURT-SMITH², STEVE FROST⁴, DAVID WILEY⁵, KATHERINE ST. JOHN⁶

and ERIC DELSON². ¹Department of Computer Science, University of California at Davis, ²Department of Anthropology, Lehman College of City University of New York, ³Department of Statistics, State University of New York at Stony Brook, ⁴Department of Anthropology, University of Oregon, ⁵Stratovan Inc, Davis CA, ⁶Department of Computer Science, Lehman College of City University of New York.

Phylogenies for groups of living organisms are routinely constructed based on molecular data. These phylogenies generate hypotheses about the morphology of implied ancestor species, often in the form ancestral morphotypes.

We present some computer graphics visualizations of the crania of the hypothetical ancestors of the Old World monkeys, based on the crania of their living descendants. These reconstructions are based on geometric morphometric techniques using a large series of landmarks and semilandmarks on laser surface scans to estimate the morphology of ancestor species. Ancestral morphology is based on an estimated landmark and semilandmark configuration based on those of extant species weighted by phylogenetic distance using squared change parsimony. Phylogenetic distance is based on current molecular phylogenies from the literature and their estimated divergence dates. Our reconstructions of the basal ancestors clearly differ from the oldest fossils for the group. We consider several of the technical issues involved in integrating the fossil information into the morphological hypothesis, and we demonstrate how including the fossils improves the estimated morphology and can affect the inferences we draw from the tree. This study was funded by the NSF, grants number 0513660 and 0513894.

Gene flow and genetic admixture in three Brazilian afroderived populations.

CARLOS EDUARDO GUERRA AMORIM¹, CAROLINA CARVALHO GONTIJO², MARIA ANGÉLICA F. PEDROSA², GABRIEL FALCÃO-ALENCAR², NEIDE MARIA O. GODINHO³, RAFAELA C. P. TOLEDO², MARIA DE NAZARÉ KLAUTAU-GUIMARÃES², MARCELO R. LUIZON⁴, AGUINALDO L. SIMÕES⁴ and SILVIENE FABIANA DE OLIVEIRA². ¹Programa de Pós-Graduação em Genética e Biologia Molecular, UFRGS, Brazil. ²Departamento de Genética e Morfologia, Instituto de Ciências Biológicas, UnB, Brazil. ³Instituto de Criminalística de Goiás, Brazil. ⁴Departamento de Genética, Faculdade de Medicina de Ribeirão Preto, USP.

Remanescentes de quilombos (RQ) are rural afroderived communities spread throughout Brazil. We aimed to evaluate the impact of old and recent immigrations upon the genetic constitution of three RQs using data on 16 autosomal ancestry informative markers. Inferences about old migrations were done based on the parental contribution to each population, estimated with ADMIX3 and STRUCTURE 2.2.3, while the recent impact of the demographic movements was analyzed

comparing the same estimates for natives and immigrants separately. Additionally, we compared this data with information on uniparental contribution available in the literature. African contribution was estimated at 57 to 62% depending on the population considered. As expected, it was the highest contribution among the possibilities, although substantial non-African contribution (i.e. Amerindian and European) was also identified. Uniparental data suggests that women were the main Amerindian contributors, while men were mainly Europeans. The admixture at these populations might be occurring since early times, although a certain degree of isolation might have occurred during their foundation. The impact of the current gene flow seems not to be strong and could be associated with the homogenization of those populations and their neighbors. Despite this, a significant statistical difference was observed in African and European contributions due to recent migration in two of the three populations analyzed. The admixture estimates are in accordance to historical data about such populations and seems to be a profitable way to access the history of such communities, whose part of the history is still unknown. This study was funded by CNPq e FINATEC.

Spatial distribution of territorial boundary patrols by chimpanzees at Ngogo, Kibale National Park, Uganda.

SYLVIA AMSLER. Department of Sociology and Anthropology, University of Arkansas at Little Rock.

Chimpanzee males regularly patrol the boundaries of their territories in large parties, apparently seeking contact with members of neighboring communities. Such contact occasionally results in lethal aggression. Although the proximate and ultimate factors affecting when and whether chimpanzees patrol have been the focus of recent research, the spatial distribution of these patrols has received little attention. I investigated the factors affecting where chimpanzees patrol using observations of chimpanzees at Ngogo, Kibale National Park, Uganda collected between 2000 and 2006. In particular I assessed whether Ngogo chimpanzees responded to intruder pressure in the spatial distribution of their territorial boundary patrols. Over the long but not short term, chimpanzees patrolled more frequently in peripheral areas where they experienced more intercommunity encounters. However, in the most heavily patrolled areas, intercommunity encounter density and patrol density were also positively associated over the short-term. Intercommunity encounters were more often passively experienced than actively sought, and the ratio of active to passive encounters varied as a function of location, suggesting that the Ngogo chimpanzees defended some boundary areas more keenly than others. In sum, these results suggest that the Ngogo chimpanzees adjusted their territorial activities in response to different neighbors in various ways. This study was funded by the L.S.B. Leakey Foundation, the University of Michigan and the Little Rock Zoo.

Humeral bilateral asymmetry in two Florida archaic hunter-gatherers populations: Bay West and Gautier.

JENNIFER L. ANDERSON and HEATHER A. WALSH-HANEY. College of Professional Studies, Division of Justice Studies, Florida Gulf Coast University.

Humeral bilateral asymmetry may result from mechanical stress subjected onto the bone during development or later in life in response to habitual physical activity. Early clinical research performed on athletes presented the first evidence of "activity-induced" humeral asymmetry. Anthropologists continue to evaluate the frequency and degree of skeletal bilateral asymmetry to investigate the effects of activities that may occur as a result of social rank and/or division of labor among prehistoric peoples.

We examined two Florida Archaic hunter-gatherer skeletal samples (Gautier and Bay West) to determine if varying levels of bilateral asymmetry existed between these two groups and if the differences could be linked to expected differences in canoeing or hunting behaviors. The sample comprised 18 adult male humeri from each skeletal sample. We CT scanned each bone and used Image J to obtain the diaphyseal cross sectional properties. We analyzed all these data using SPSS statistical software (ANOVA and t-tests).

Our results indicated that bilateral asymmetry was significant for both groups ($P<0.019$). However, the Gautier sample expressed the least degree of humeral bilateral asymmetry. This finding suggests that the Gautier males may have focused less upon water transport and atlatl throwing. Furthermore, these results suggest that bilateral asymmetry can be used as an indicator of varying levels of activities and environmental stress.

Functional constraint: Variation in the human face demonstrates cranial modularity is expressed as invariance and taxon-specificity.

JOHN Y. ANDERSON. Department of Anthropology, University of New Mexico.

Attributes of response to function and internal organization suggest cranial modules can best be described as inherited patterns of integration, which possess a degree of canalization or invariance to change through time. Defined in this way modules may be expected to maintain shape within taxa, and exhibit change in response to new functional requirements across taxa. The hypothesis that the facial module would reflect these properties was tested in 4 craniofacial samples through the examination of their covariance structure using the Flury hierarchy. The Flury hierarchy provides a way to analyze covariance structure beyond simple equality or matrix similarity. Levels of covariance structure within matrices are compared for degrees of congruence through possession of shared principal components. Matrix comparisons range from unrelated through proportionality in an ascending

hierarchy of shared structural shape. Results across large samples presented here show the shape of the modern human face exhibits proportionality of structure across the axes of population and sex. Current evolutionary theory suggests this pattern represents that expected within species: within species most variation across the face is represented by an allometric increase in size, rather than reorganization of the shape itself. Conversely, across groupings of modern human and earlier hominoid and hominid groupings a divergent pattern is observed, across multiple species grouping the proportionality of matrix structure observed in modern humans breaks down with much less structural congruence. These results suggest the functional signal of modules can provide a robust way to examine and predict taxonomic relationships.

Early Eocene mammalian fossils from an extraordinarily rich new locality in the Great Divide Basin, Wyoming.

ROBERT L. ANEMONE¹, RON WATKINS², BRETT A. NACHMAN³, BILL MOORE⁴, WENDY DIRKS⁵, TIM HELD¹ and VICTORIA KERSBERGEN¹. ¹Department of Anthropology, Western Michigan University, ²Department of Applied Geology, Curtin University of Technology, ³Department of Anthropology, University of Texas, ⁴Department of Anthropology, Southern Illinois University, ⁵School of Dental Sciences, Newcastle University.

During recent fieldwork in Eocene deposits of the Great Divide Basin (GDB) of southwestern Wyoming, we located an extraordinarily rich fossil mammal locality. The locality (WMU-VP 2009-01) occurs in a fluvial sandstone in the Wasatch Formation. The stream responsible for these deposits accumulated numerous skeletal remains of mammals that had died on the floodplain and incorporated them into sandbars. The GDB has never been considered one of the richest of the sedimentary basins in the American West that have yielded significant remains of Eocene mammals. WMU-VP 2009-01 is unique for the Eocene of the GDB with respect to both its richness and its faunal composition. Twelve previous field seasons in the GDB have yielded 7500 cataloged mammals and 254 jaws with teeth from 100 localities, for an average of 75 mammals and 2.5 jaws per locality. Six days of surface collecting and dry screening (with 1/8 inch mesh screen) at WMU-VP 2009-01 yielded 400 jaws with teeth, 2250 teeth, and 1350 postcranial fossils of Eocene mammals. Early Eocene localities in this basin typically include a very characteristic Wasatchian fauna in which the primate *Cantius*, the perissodactyl *Hyracotherium*, and the condylarth *Hyopsodus* are extremely common. The new locality is unique in that each of these taxa are absent or very rare. In their place we find a diverse group of omomyids and condylarths (especially *Meniscotherium* and *Haplomylus*). This poster will present taxonomic identifications and their biostratigraphic and chronological significance, as well as taphonomic interpretations of this important new locality.

Evidence for abnormalities of the vertebral artery in cervical vertebrae. Are aneurysms and tortuosity of the vertebral artery being overlooked in palaeopathology?

DANIEL ANTOINE¹ and TONY WALDRON².

¹The British Museum, London, ²Institute of Archaeology, University College London.

During its course through the transverse foramina, two abnormalities of the vertebral artery, tortuosity and aneurysms, can produce lesions on the bodies of the cervical vertebrae. Part of the vertebral artery can become looped or coiled and the abnormal (or tortuous) segment may cause pressure defects in the adjacent vertebra. In addition to these tortuosity, the localized dilation caused by the weakening of the arterial wall in an aneurysm can also produce similar lesions. In both cases, the lesions usually have a smooth walled appearance, with a sclerotic margin that is visible on x-ray, and can involve the transverse or intervertebral foramen. Only three archaeological examples of such lesions have been reported in the literature, two from a 15th century medieval cemetery site in Britain and one from a Coffin period site in Japan dating to ca 1600 years BP.

Here we describe new examples of both abnormalities from the Kushite site of Kawa, Sudan, ca 800BC-400AD, including a possible case of bilateral lesions on separate vertebrae. One of these is likely to be due to an aneurysm, and the other, to tortuosity. The relatively discreet changes associated with these lesions may explain why few examples have been reported in the literature. Without the carefully examination of the cervical vertebrae, evidence for such abnormalities are likely to be missed.

Primates, pathogens, and evolution: A context for understanding emerging disease.

GEORGE J. ARNELAGOS and KRISTIN HARPER. Emory University.

The world is rife with potential pathogens. Of roughly 1000 species that are recognized as human pathogens, it is estimated that over half are of zoonotic origin and almost 20% are considered to be emerging or reemerging. The importance of zoonotic infections contracted from domesticated animals, such as goats, sheep, cattle, pigs, and fowl, as well as the peridomestic animals such as rodents and sparrows that develop permanent habitats near human dwellings, is well understood. Less appreciated is the important role that non-human primates play as a source of human disease. It has been estimated that roughly 13% of zoonotic infections are of primate origin; perhaps it is not surprising that pathogens are often able to cross to humans from their closest relatives. The same, of course, is true of transmission in the other direction, from humans to non-human primates. This is increasingly becoming a problem, as growing numbers of ecotourists and researchers serve as potential vectors of disease. Here, we present an analysis of major cross-species transmission events between human and non-human primates. The human practices that

facilitate such transmission are considered, as well as the evolutionary consequences of these events. Finally, the topic of emerging infections is addressed, in both human and non-human species, in light of patterns of contact, epidemiology, and evolution in response to pathogens.

HLA genes in Afro American Colombians (San Basilio de Palenque): The first free Africans in America.

ANTONIO ARNAIZ-VILLENA¹, RAQUEL REGUERA¹, CARLOS PARGA¹, PABLO GOMEZ-PRIETO¹, and CARLOS SILVERA².

¹Department of Immunology, University Complutense, The Madrid Regional Blood Center, ²Department of Genetics, Universidad del Norte, Barranquilla, Colombia.

An Afro-American semi-isolated Colombian population is studied for its HLA genes: San Basilio de Palenque community in Colombia northern mountains. This community represents the first free Africans in America; it was granted by the Spanish Crown in 1691 AD. Nowadays, they also speak the only extant Bantu-Spanish Creole language over the World; this people has been apart from neighbors and claims a direct African descent. In order to test this descent, their HLA genes were compared with African, Afro-American, Amerindian and worldwide populations by using genetic distances (DA), Neighbour-Joining dendograms and correspondences analyses. Arlequin, DISPAN and VISTA software were used for completing these computer calculations. San Basilio de Palenque relatively ethnic isolate is genetically close to other North and South Afro-Americans and to West Africa-Bantu speaking groups (Senegalese; Bubi, Guinea Gulf). Three HLA extended haplotypes are found specific in this population:

A*02-B*07-DRB1*0801-	A*02-B*15-DRB1*0302-
DQB1*0301,	A*02-B*15-DRB1*0302-
DQB1*0402,	A*01-B*51-DRB1*0301-
DQB1*0201,	A*68-B*15-DRB1*0102-
DQB1*0501;	this supports isolation.

Finally, only very little gene flow is found from either Amerindians or Europeans, as expected by historical records. In conclusion: this free Africans in America group has indeed been isolates and is directly descending from Africans and its language is the only extant Bantu-Spanish Creole in the World.

The 10kTrees Project: A new inference of primate phylogeny for comparative studies.

CHRISTIAN ARNOLD¹, LUKE J. MATTHEWS¹ and CHARLES L. NUNN¹.

¹Department of Human Evolutionary Biology, Harvard University, ²Bioinformatics Group, Department of Computer Science and Interdisciplinary Center for Bioinformatics, University of Leipzig.

The comparative method plays a central role in efforts to uncover the adaptive basis for primate behavior, morphology and life history traits. Using new phylogeny-based methods, it is now possible to incorporate evolutionary history directly into comparative research. However, the true phylogeny for a group of organisms is

never known with certainty. Here, we provide a new resource for conducting phylogenetic comparative studies of primates that uses Bayesian methods to account for phylogenetic uncertainty.

In the 10kTrees Project, we inferred primate phylogeny for 189 primate species based on five genes available in GenBank. We also included 29 constraints based on genomic insertions. We saved 10,000 phylogenies (with branch lengths) from Markov chains, in which trees were sampled in proportion to the likelihood of the data. Comparative analyses can be run on the posterior probability distribution of trees to control for phylogenetic uncertainty. The trees, data and details on the analysis are provided over the 10kTrees website (<http://10ktrees.fas.harvard.edu/>). At this site, users can download up to 10,000 trees drawn from the Markov chain sample. The trees can be pruned to the species of interest. The 10kTrees website thus provides an important new resource for comparative primatologists.

We plan regular updates to the dataset, trees and website. We are already working on Version 2 of the dataset, which will most likely include over 230 primate species and nine genes. We also expect that the 10kTrees website itself will evolve to provide more tools for primate comparative biology, including a taxonomic translation tool. This research was supported by the National Science Foundation and Harvard University.

Chimpanzee nest distribution and density in mixed forest habitats of Mainaro, Kibale National Park, Uganda.

GARY P. ARONSEN and SIMONE TEELEN. Department of Anthropology, Yale University.

Chimpanzee nest density data provides information on unhabituated community size and habitat use. Here, we report on standing nest crop counts from the site of Mainaro, located in southern Kibale National Park. Mainaro has multiple habitats, including old growth, replanted, and fragmented forest patches.

Data were collected from August 2007 through the present. Results indicate that the Mainaro site has a large community of chimpanzees, and density is highest within old-growth forest patches. Nest density and distribution varies with rainfall, either due to changes in decomposition or because of resource availability. There is an inverse relationship between old growth and replanted forest nest density, suggesting migration or movement within Mainaro. Forest patches with high fleshy fruit tree density and *Uvariodiplosis congensis* trees, a preferred resource of chimpanzees, have the highest nest density, while habitat DBH variation does not appear to have a significant effect on nest distribution.

These long term data allow for monitoring of population and distribution changes in relation to habitat restoration, climate change, and park management. For example, changes in rainfall may influence fruit production and nest distribution/decomposition, and successional forests will provide increased fleshy fruit distribution. Future work will corroborate

community structure with nest density data. This work was supported by the Great Ape Trust of Iowa, the L.S.B. Leakey Foundation, and the Yale Department of Anthropology.

Mitochondrial DNA variation at position 16189 and diabetes: Frequency amongst South Eastern Kenyan populations.

JUAN PABLO ARROYO¹, KEN BATAI² and SLOAN R. WILLIAMS². ¹Department of Anthropology, University of South Florida, ²Department of Anthropology, University of Illinois at Chicago.

Certain mitochondrial mutations have been suggested as risk factors for maternally inherited diabetes and metabolic syndrome. A substitution of thymidine for cytosine (T→C) at nucleotide position 16189 of the mitochondrial DNA (mtDNA) may be associated with insulin resistance and type 2 Diabetes Mellitus. An analysis of five Asian countries indicated an association, but a meta-analysis of European samples showed no association.

However, ethnic differences may underlie risk association in diabetes because genetic/environmental interactions influence many aspects of the phenotype. Consequently, two southeast African populations were surveyed for the mutation to examine prevalence in African populations. The mutation was found at low frequencies in the Kenyan populations, 8.61% in the Taita and 9.62% in the Mijikenda. In contrast, previous studies indicated frequencies of 31.0% in Asian and 9.2% in European samples. Thus, if this mutation at position 16189 does prove to be a risk factor for diabetes in some populations, the Kenyan groups will be relatively unaffected because of the mutation's low frequency in these populations. Before this mutation can be conclusively shown to elevate risk of diabetes, more detailed studies of its specific metabolic effects are required. If the 16189C variant does prove to be associated with diabetes risk though, its high prevalence in Asian samples and much lower frequencies in European and African groups suggest that its effects will be largely confined to Asian populations.

Interactions and proximities between adult male and immature mantled howling monkeys (*Alouatta palliata*) on Ometepe Island, Nicaragua.

ALISON ASHBURY. Department of Anthropology, University of Victoria.

In order to better understand the many factors influencing male parental investment among wild primates, this study investigated interactions and proximities between adult male and immature mantled howling monkeys (*Alouatta palliata*) on Ometepe Island, Nicaragua. Continuous and interval focal animal sampling was used to determine the kind, frequency, and duration of interactions between adult males and infants and adult males and juveniles, as well as to establish basic social spacing patterns. As predicted, it was found that males seldom interacted with infants or juveniles. Adult males exhibited tolerance

toward infants, but no active engagement, while adult male interactions with juveniles consisted only of brief agonistic exchanges. Adult males were significantly more likely to be closer to infants (≤ 10 m) as compared to juveniles. When in close proximity (≤ 3 m), adult males, immatures, and the immatures' mothers, were significantly more likely to be engaged in resting than other behaviours. The observed lack of adult male investment in immatures in these groups is likely to be the result of several factors all contributing to an extremely low degree of intragroup genetic relatedness and limited potential benefits of such interactions to the adult males, mothers, and offspring involved. The agonism between the adult males and juveniles, as well as the observed significant proximity patterns between the immatures, their mothers, and the adult males, is strongly indicative of efforts to limit direct feeding competition. These results, examined within the context previous studies, provide further insight into the complexity of factors influencing male parental investment.

Preliminary health assessment of eight skeletons from Isla San Lucas penal colony, Costa Rica.

KRISTINA ASTONE and MONICA FARALDO. Department of Anthropology, University of Miami.

Costa Rica maintained a penal colony on Isla San Lucas for 120 years. Both prisoners and guards were interred there. Our data were gathered as part of a multidisciplinary effort to preserve the site and interpret its history. We examined the skeletal remains of 8 individuals recovered during the summer of 2009. We scored 11 variables of skeletal pathology. Our analyses show a high frequency of dental caries (75%, N=6), with moderate dental attrition and antemortem tooth loss in 5 individuals. Stress-related lesions were scored for 5 individuals, as was osteoporosis in the vertebrae, patellae, and phalanges. There were indications of infectious and/or metabolic disease in the skull (caries sicca, porotic hyperostosis), long bones (rickets, periostosis), and pelvis (osteophytes). In sum, we found that poor dental health and bone disease were prevalent in this population. Sources of these pathologies may be poor nutrition, age-related degeneration, infection, or mechanical stress from hard physical labor. Some pathologies, like rickets, likely occurred before the individual came to the island as adults. Additional data may help us find markers that would distinguish guards from inmates, presuming that inmates did most of the labor and were poorly fed. Comparison with a contemporaneous mainland population can shed light on the degree to which life in the penal colony may have been more arduous. This work was supported in part by the University of Miami, Beyond the Book Scholarship (KA) and Museo Nacional de Costa Rica Departamento de Antropología e Historia.

Recording dimensions at the cervix of the tooth: Critique and modification of an existing method.

BRYAN AUBRY. Department of Anthropology, The Ohio State University.

In 2005, Hillson and colleagues proposed a new method for obtaining cervicometric data. Their method was developed using a sample of loose teeth, and problems were identified when this method was applied to mixed preservation dental material (*in situ* and loose teeth). Correct placement of the caliper tips at the mesial and distal landmarks was impossible for many *in situ* teeth. Their recommendation to rotate loose teeth to obtain the correct measurement resulted in large error estimates because all teeth could not be rotated. Additional problems were identified for the buccolingual dimensions of maxillary and mandibular molars, which, when applied as recommended, produces measurements that are not homologous across the tooth class (or even for specific molars) because of differential reduction in the distal cusps.

This study proposes modifications to the Hillson et al. (2005) method to refine the phenotype so that the measurements consistently record the same underlying genetic variation. The method proposed here can be applied to dental samples regardless of the preservation of the sample. To test for correlation between crown and cervical dimensions, data were recorded on 261 sub-adults. All teeth exhibiting a wear score above 2 on the Smith scale were excluded from analysis. On average, 180 crown and cervical measurement comparisons (both mesiodistal and buccolingual) were available for each tooth type. All crown and cervical comparisons were significantly correlated at the $p=0.01$ level with an average correlation coefficient of 0.76. These results clearly demonstrate the homologous nature of the crown and cervical dimensions. Research supported by the National Science Foundation, the Center for Latin American Studies (Ohio State University), and Alumni Grants for Graduate Research (Ohio State University).

Appendicular asymmetry altogether: gradients of directional asymmetry through the human upper limb.

BENJAMIN M. AUERBACH¹, D. TROY CASE², TRACY L. KIVELL³ and EVAN M. GAROFALO⁴. ¹Department of Anthropology, The University of Tennessee, ²Department of Sociology and Anthropology, North Carolina State University, ³Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, ⁴Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

Patterns of directional and total asymmetry in the human upper limb likely relate to function and to relaxed developmental constraints. For example, diaphyseal breadth dimensions exhibit the largest amount of asymmetry, while long bone lengths and articular breadths have considerably less total and directional asymmetry. Asymmetric magnitudes and directional biases exhibit proximal-distal patterns, though this has never been examined comprehensively among bones within the same sample. Thus, this study examines patterns of

directional asymmetry throughout the upper limb. Sixty length, articular breadth, and diaphyseal breadth osteometrics were obtained from 80 Terry Collection skeletons. Measurements were taken from clavicles, humeri, radii, five carpal bones, and all metacarpals and phalanges. Methods used are described by Auerbach and Ruff (2006. J Hum Evol 50:203-218).

A right bias was expected in all dimensions except clavicular length. If length asymmetries—which are decoupled from diaphyseal asymmetries—result from developmental perturbations, length total asymmetry was expected to increase distally. However, due to load distributions across the upper limb and load sharing within the hand, the greatest directional and total asymmetries in diaphyseal breadths were expected in the arm and to decrease distally.

Results indicate right-biased asymmetries in all proximal-distal length measures except the clavicle and some phalanges. Length total asymmetries increase from the clavicle to the carpal, but decrease in the metacarpals and phalanges. Breadth asymmetries are unexpectedly highest among the carpal bones. Correlations show hand bone asymmetries are independent of arm and forearm asymmetries. Functional and developmental correlates of observed patterns are further considered.

Comparison of the LB1 neurocranium to extinct hominins, normal and pathological modern humans.

KAREN L. BAAB. Department of Anatomical Sciences, Stony Brook University Medical Center

Researchers have argued that the small hominins from Flores, Indonesia (*Homo floresiensis*) are actually pathological modern humans based on both cranial and postcranial evidence. Subsequent analyses have contested these claims for the postcranial skeleton, but a detailed assessment of *H. floresiensis* cranial morphology as it relates to pathological modern humans is lacking. Here I report preliminary results comparing neurocranial shape among the LB1 (*H. floresiensis*) specimen, normal modern humans, pathological modern humans (including microcephalics and cretins), and Plio-Pleistocene hominins.

Three-dimensional neurocranial landmarks were collected from a large sample of extant (both normal and pathological) and extinct hominins using a Microscribe 3D digitizer. Data were superimposed using standard Procrustes-based methods and analyzed using principal components analysis (PCA) and linear regression.

The primary axis of shape variation separates all non-pathological and some pathological modern humans from fossil *Homo*, LB1, and select microcephalic individuals. While the neurocrania of some microcephalic *H. sapiens* converge on aspects of shape also seen in early human ancestors, including a low midsagittal profile, these two groups are well separated along PC 2. When the first two components are considered together (~42% of the total variance), the sole *H. floresiensis* specimen

groups with the fossil hominins and is most similar to the D2700 specimen from Dmanisi, Georgia in overall shape (as measured by Procrustes distance). The distinct shapes of microcephalic humans vs. fossil hominins and the greater affinity of LB1 with the latter are both consistent with similar analyses of endocast shape in these groups. This study was funded by NSF (BSC 04-24262, DGE 03-33415, DBI 96-02234), Stony Brook School of Medicine, LSB Leakey Foundation and Sigma Xi.

Characterizing 'kindergartens': nest use and infant parking strategies in *Varecia variegata*.

ANDREA L. BADEN^{1,2}. ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University; ²Centre ValBio, Ranomafana National Park, Madagascar

Ruffed lemurs (*Varecia variegata*) are unique in that they are the only large-bodied, litter-bearing primates known to park infants in nests throughout early development, often with other members of their cohort ('kindergartens'). Although reports of nest use are not new, little is actually known; this study is among the first to systematically document *V. variegata* nesting strategies (construction, use, reuse) in the wild. Continuous and instantaneous data were collected on five parous females from one *V. variegata* community in Ranomafana National Park, Madagascar. Females were observed from the first recorded mating until 10-weeks following birth (July–December 2008; N=1880 hours). Nest construction was documented and nesting trees were numbered, measured and mapped. Results suggest that females began nest construction almost immediately following mating, and continued construction until the day prior to parturition. A total of 152 nests (mean: 31.4/female) were sampled throughout the community. Females did not exhibit a preference for tree species, but had preferences for trees of mid-ranged DBH (χ^2 ; $p<0.001$) and height (χ^2 ; $p<0.001$). For two weeks following parturition, nest fidelity was high. First transfer typically occurred at three weeks, and nest transfers increased significantly with increasing infant age (Pearson's r ; $p<.001$). Nest re-use was frequent and females often 'borrowed' nests from neighbors. 'Kindergartens' were initially rare, but increased with infant age, and closely related females often parked infants together. Results suggest a far more complex strategy than was originally believed, and supports the hypothesis that parking serves to socialize infants living in a dispersed fission-fusion society.

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The mid-trigonid crest of Neandertals and modern humans: Concordance between the enamel and dentine surfaces.

SHARA E. BAILEY^{1,2}, MATTHEW M. SKINNER² and JEAN-JACQUES HUBLIN².

¹New York University, CSHO, ²Max Planck

Institute for Evolutionary Anthropology, Leipzig.

The nearly ubiquitous presence of a continuous crest connecting the protoconid and metaconid of the lower molars (mid-trigonid crest or MTC) is one of several dental traits that distinguish Neandertals from modern humans. The frequency and expression of this feature have not been explored in a larger comparative context, and it is unclear whether it is a derived condition for Neandertals. This study examined variation in the MTC on the dentine surface 1) to avoid tooth wear issues; 2) to examine the developmental origin of this feature and 3) where possible, to evaluate the concordance between it and the outer enamel surface. The sample included 25 Neandertal, 65 contemporary modern human, 4 *Australopithecus africanus*, and 5 *Pan troglodytes* individuals. Results indicate that when present on the enamel surface the MTC is also present on the dentine surface, but that the reverse is not always true. Neandertals and modern humans differ in both frequency and expression of this trait. Every Neandertal molar showed some expression of the MTC, whereas it was present in very low frequency in contemporary modern humans. Moreover, the MTC originated most often from the median crests in contemporary modern humans making it a 'true' middle trigonid crest. However, in Neandertals the MTC most often originated from the mesial accessory crest of one or both cusps. Comparisons with *Australopithecus* and *Pan* suggest that the Neandertal condition is derived relative to apes and early hominins. Interestingly, fossil hominin molars from Irhoud and Mauer showed a non-Neandertal pattern. Research supported by EU FP6 Marie Curie Actions grant MRTN-CT-2005-019564 "EVAN" and by the Max Planck Society.

Breach birth in antiquity: A Nubian example from the Fourth Cataract region, Sudan.

BRENDA J. BAKER and MARTA DÍAZ-ZORITA BONILLA². ¹Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University, ²Department of Archaeology, Durham University.

Death from childbirth is sometimes invoked when women are simultaneously interred with a perinate, yet such assumptions often cannot be directly supported. A secure example of death due to complications of childbirth is reported from the Ginefab School site in northern Sudan. The sample includes 103 individuals from the Meroitic (c. 350 BC-AD 350) through Christian (c. AD 550-1400) periods. Remains of a woman in her late 20s to early 30s were discovered in 2009 in an undisturbed burial chamber from late Meroitic to Post-Meroitic (c. AD 0-550) tumulus. Between the woman's body and left forearm was the infracranial skeleton of a perinate, whose neck was atop her wrist and feet toward her elbow. Slumping of the torso caused the posterior of the perinate's left arm to rest atop the right side of the otherwise supine body. The lateral and basilar parts of the occipital were found partially under the woman's left ilium, suggesting that the

baby's skull had detached during decay. Removal of the woman's right hand from atop the pelvis, however, revealed the perinate's skull still within the pelvic cavity. Cranial development indicates an age of 7-8 fetal months. The position of the occipital squama against the pubes with chin tilted upward against the mother's left ilium indicates a breech delivery. Though representing up to 5% of births near term, evidence of breech birth in antiquity is rare. Other known cases and caveats in interpreting death due to pregnancy and childbirth are discussed. Fieldwork was conducted under licenses granted to Arizona State University by the US Department of Treasury, Office of Foreign Assets Control (Nos. SU-1897 & SU-2122). This research is based upon work supported by the Packard Humanities Institute (Award Nos. 07-1391, 07-1424, & 08-1472 [OFAC license No. SU-2071]) and The Regents of the University of California, and by the National Science Foundation (BCS-0647055).

Skeletal evidence for kneeling among prehispanic Zapotec women at the Mitla Fortress.

LINDSEY CADWELL BAKER¹, GARY FEINMAN² and LINDA NICHOLAS².

¹Department of Anthropology, Southern Illinois University, ²Department of Anthropology, The Field Museum.

In the eastern arm of the Valley of Oaxaca (Mexico) during the prehispanic era, xerophytic plants (such as maguey) had an important role in subsistence and craft production, namely fiber working. Recent archaeological excavations of domestic contexts at two Classic period sites in this region (El Palmillo, the Mitla Fortress) have yielded spindle whorls and bone tools that were associated with the manufacture of textiles. Modern Oaxacan women still utilize the backstrap loom for weaving cloth. This type of work commonly utilizes a habitual kneeling posture with hyperdorsiflexion of the toes, therefore individuals weaving in this manner should exhibit bony changes (e.g., kneeling facets) on the metatarsals and phalanges. Here we suggest that these kneeling facets are associated as much with the use of the backstrap loom as the grinding of maize, since both the Mitla Fortress and El Palmillo had little access to well-irrigated, flat terrain necessary for corn farming. During the 2009 field season at the Mitla Fortress, remains from nine probable adult males and four probable adult females were recovered; the subsequent analysis determined that all adult females show evidence of kneeling facets on one or more metatarsals, while none of the adult males exhibit this morphology. Furthermore, these kneeling facets are generally larger and more pronounced in older females. We interpret these data to support the existence of a sexual division of labor at the Mitla Fortress and the hypothesis that the observed morphology is likely associated with extensive use of the backstrap loom.

Asymmetry in facial musculature of rhesus macaques: Implications for evolution of laterality in facial expression.

MARK D. BALCENIUK¹, BRIDGET M. WALLER² and ANNE M. BURROWS^{1,3}. ¹Department of Physical Therapy, Duquesne University, ²Department of Psychology, University of Portsmouth, ³Department of Anthropology, University of Pittsburgh.

Lateralization of brain function has been recognized in humans with the right side of the brain being dominant for producing and perceiving facial expressions associated with emotions, and the left side of the face perceived as being more emotive than the right side. Such laterality in emotions and facial expressions in humans seems to share evolutionary precursors in chimpanzees but data are equivocal for similar lateralization in phylogenetically more distant species such as macaques. Also, it is not known whether laterality of facial expression and emotion is reflected in the anatomy of the facial muscles themselves. The present study was designed to assess this component of lateralization of facial expression production in the rhesus macaque (*Macaca mulatta*). Preserved heads of six adult male rhesus macaques (*Macaca mulatta*) were used in this study. Facial expression musculature was exposed bilaterally and the zygomaticus major muscles of the face were chosen for measurement due to their use in several facial expressions in rhesus macaques. These muscles were photographed on both sides of the face and area of each muscle was measured using ImageJ. Areas from the left and right sides were compared and directional tendencies were noted with the left zygomaticus major muscle typically having greater area than the right. Therefore, lateralization of facial expression may not be limited to humans and other great apes, but may also be shared with macaques. These findings demonstrate the utility in studying facial expression throughout the primate order, and not as unique to humans.

Endocranial shape asymmetries in hominids, including fossil hominins and extant hominids, assessed via skull based landmark analysis of 3D reconstructions from CT images.

ANTOINE BALZEAU^{1,2}, EMMANUEL GILISSEN^{2,3} and DOMINIQUE GRIMAUD-HERVÉ¹. ¹CNRS, UMR 7194, Département de Préhistoire du Muséum national d'histoire naturelle, Paris, ²Department of African Zoology, Royal Museum for Central Africa, Tervuren, Belgium, ³Université Libre de Bruxelles, Laboratory of Histology and Neuropathology, Brussels.

Asymmetries in brain shape, commonly known as petalias, consist in the extension of one cerebral hemisphere beyond the other and can be defined by two structural components: a larger lateral extent of one hemisphere relative to the other usually coupled with a larger frontal or caudal projection of one hemisphere relative to the other. A major issue in quantifying these petalias in endocasts is the definition of the endocranial surface midline because studies of human brain material show that most of the mesial surface of the left occipital lobe distorts

the midline and protrudes into the right side, making the midline identification and the corresponding left and right reference points' definition problematic. We therefore illustrate a new protocol based on unbiased skull landmarks definition in order to accurately quantify and compare brain shape asymmetries. This protocol is performed on 3D reconstructions from CT images. Our current sample is represented by >30 fossil hominins, 45 extant anatomically modern humans and 110 specimens of each sex of extant African great apes. We describe and quantify the positions in 3D of frontal and occipital projections in this large sample. This analysis complements our previous results and allows the grouping of fossil hominins and extant hominid species based on the degree of asymmetry of these projections. The pattern and extent of asymmetry of these petalias in great apes and in fossil hominins show considerable variations. Phylogenetic and possible functional implications of the observed inter-specific variation are discussed. This study was funded by the European Commission, contract number 029023.

Interior versus exterior edges: Their effect on home range, spatial ecology and feeding ecology of Milne-Edwards' Sifakas (*Propithecus edwardsi*) in Ranomafana National Park, Madagascar.

KATHERINE H. BANNAR-MARTIN¹ and SHAWN M. LEHMAN²

¹Department of Anthropology, University of Texas at Austin, ²Department of Anthropology, University of Toronto.

Forest edges are becoming a more abundant habitat feature as forest fragmentation and anthropogenic disturbance increases worldwide. Edge effects, measured as changes in vegetation structure and plant species richness from the edge into the forest core, pose potential constraints on primate ranging, dispersal and behaviour. Primates can mediate edge effects by adjusting their ranging behaviour with respect to both edge proximity and edge type. The effects of edge proximity and type on the ranging behaviour and feeding ecology of *Propithecus edwardsi* in Ranomafana National Park were investigated. Two edge types were distinguished: internal edges, located within continuous forest areas, and external edges, located on forest boundaries. Behavioural and location data were collected May to September 2008, and used with GIS to determine lemur distribution with respect to edge proximity and type. The highest proportion of range use and feeding events occurred within 250m of the edge: a positive edge response. The strength of the edge response differed between the two sites, with a stronger response in the external edge site. *P. edwardsi* in the external edge site also had a smaller home range, larger core range, and higher density. *P. edwardsi* show a positive edge response, however the strength of edge response appears to vary with edge type. Edges are complicated habitat features that reflect microhabitats with multidimensional characteristics (e.g. intensity, depth, height, location, age, etc). They can have long-term impacts on primate behaviour, and consequently

their role in primate ecology is fundamental to the conservation of primate populations.

Petrosal bone orientation, foramen magnum position, and the evolution of early hominids.

ALON BARASH, ELLA BEEN, and YOEL RAK. Department of Anatomy & Anthropology, Sackler School of Medicine, Tel Aviv University.

The posterior cranial fossa is one of the main structures within the cranial base that have gone through extensive modification during human evolution. Many authors suggest that these adaptations are either the product of our large brain or bipedal locomotion. Early hominids basicranium may represent either the changing morphology along the ape-human morphocline, or exhibit an in part autapomorphic feature unique to them. Here we present data from the internal part of the posterior cranial fossa, to support the second hypothesis.

We measured the angle of the superior petrosal sinus to the midsagittal, the position of the foramen magnum to the bi-poria line and three foramina within the basicranium. Our results indicate that while in humans and australopithecines the carotid canal has migrated to a more lateral position, the internal acoustic meatus and foramen ovale remained around the same position as in the primitive ape state. However, the orientation of the inner part of the petrous is about the same in apes and humans at around 50 degrees, while in early hominids the petrous is orientated more sagittally at around 40 degrees. This may be coupled with the known fact that the foramen magnum orientation to the bi-poria line in early hominids is actually more anterior projecting than in humans.

Our results indicate a distinct basicranial morphology of australopithecines that sets them apart from both modern humans and apes. The cause for this morphology is unclear and could be due to the biomechanical constraints of early hominids.

Plantar pressure during bipedalism and quadrupedalism in *Cebus*.

MARIN B.BARDEN¹, ROSHNA E. WUNDERLICH¹ and BRIGITTE DEMES². ¹Department of Biology, James Madison University, ² Department of Anatomical Sciences, Stony Brook University.

Cebus predominantly walk quadrupedally but use bipedalism to carry objects such as *syagrus* nuts or stones. Little research has examined foot biomechanics in nonhominoid primates who use bipedalism. Identifying similarities and differences among distantly related primates utilizing bipedalism will further our understanding of the fundamental biomechanical requirements of bipedalism and the evolution of human bipedalism and the modern human foot.

We compared plantar pressure distribution in two captive *Cebus apella* walking across a pressure mat quadrupedally and bipedally. Center of pressure trajectory, relative peak plantar pressures, and timing of pressure in the

midfoot and forefoot were compared during bipedal and quadrupedal walking. Simultaneous video data were used to assess speed.

Pressures are slightly higher during bipedalism than quadrupedalism in all regions of the foot. Peak pressures during bipedalism and quadrupedalism are higher on the lateral midfoot and metatarsals than the medial side, unlike the pattern in apes and modern humans who load the medial side of the foot early in stance. Contact time, however, in the medial forefoot is longer during bipedalism. During bipedalism, both contact area and contact time are higher in all regions except the first metatarsal, a region heavily loaded during toe-off in humans. Peak pressures in the forefoot are not significantly different during quadrupedalism and bipedalism, suggesting a similar propulsive function in both cases. These data show that *Cebus* increase load only slightly when shifting to bipedalism, and their foot functions similarly across gaits and does not show a pattern like that of the human foot.

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A comparative stereological analysis of neuron numbers in the human and non-human primate basolateral amygdala.

NICOLE BARGER¹, CYNTHIA M. SCHUMANN², JACOPO ANNESE³, CHET C. SHERWOOD⁴, LISA STEFANACCI⁵, PATRICK HOF⁶, and KATERINA SEMENDEFERI¹. ¹Dept. of Anthropology, University of California, San Diego, ²M.I.N.D Institute, University of California, Davis, ³Dept. of Radiology, University of California, San Diego, ⁴ Dept. of Anthropology, George Washington University, ⁵The Salk Institute For Biological Sciences, ⁶Dept. of Neuroscience, Mt. Sinai School of Medicine.

Though little comparative neuroanatomical data exist for structures comprising the "social brain", volumetric analyses suggest that one such structure, the amygdala, evidences internal reorganization in hominoids, specifically in its basolateral division, comprised of the lateral, basal, and accessory basal amygdaloid nuclei. Compared with other hominoids, humans possess a uniquely enlarged lateral nucleus. In contrast, the semi-solitary orangutan exhibits reduced basolateral volumes, due predominantly to decreases in accessory basal and basal nuclei. To further investigate these trends in amygdala reorganization, we counted neuron numbers for the basolateral division and basolateral nuclei using unbiased stereological methods (optical fractionator) on hand-traced, Nissl-stained histological sections. We sampled humans, all ape species, and long-tailed macaques using three to twelve individuals per species. Neurons in the human lateral and basal nucleus, respectively, were proportionately more ($p<0.001$) and less ($p<0.001$) numerous than in African apes. Contrasted with other apes, the orangutan basolateral division ($p<0.01$), basal ($p<0.01$), and accessory basal nuclei ($p<0.01$) contained proportionately fewer neurons. In macaques as in humans, neurons were most abundant in the lateral nucleus. Nonetheless, this similarity is likely due to a comparatively

smaller representation of neurons in the macaque basal nucleus ($p<0.05$) and not a larger proportion in the lateral ($p>0.05$). Given that neuronal and volumetric data agree, amygdala reorganization likely reflects evolutionary increases in specific neuronal populations rather than simply developmental increases in white matter, e.g., ancillary fibers of passage, further supporting the idea that coordinated changes between individual amygdaloid nuclei and highly connected cortical areas are of evolutionary origin. This study was funded by the NSF, Doctoral Dissertation Improvement Grant (#0726240), and The Wenner Gren Foundation.

Masticatory mechanics and the production of dental microwear.

CLAIRE BARRETT and PATRICK MAHONEY. Department of Anthropology, University of Kent.

This study explores differences in microwear orientation and length between molars in a sample of primates. It has long been known that the orientation of microwear striations indicate jaw movements during mastication. The size of microwear features also seems to reflect jaw size in humans. Therefore, if clear correlations could be established between microwear and masticatory mechanics these could be extrapolated to fossil hominin studies and add vital information about likely evolutionary grade placement for specimens known only by incomplete or purely dental remains. Dental impressions of first, second and third mandibular molars from *Pan troglodytes* ($n=11$) *Gorilla gorilla* ($n=5$) and *Papio Anubis* ($n=8$) were obtained. Resin casts were produced, and digital micrographs were taken of facet 9, using a scanning electron microscope. Micrographs were analysed using Microwear 4.02.

Results for second molars indicated differences in mean length of striations between the species. The mean striation length was $50.52\mu\text{m}$ for *Pan*, $64.63\mu\text{m}$ for *Gorilla* and $45.25\mu\text{m}$ for *Papio*. Striation orientation was found to be consistent within species, but varied between 118.55 degrees in *Pan* to 89.97 degrees in *Papio*. These findings indicate some differences between the species, which may relate to transverse movement experienced by different molars as well as bite force. Ongoing study with a larger sample size will examine microwear correlations with morphometric measurements across a range of primates. Findings should provide information as to whether microwear techniques can be applied in the analysis of fossil hominin taxa.

Encephalization and reproduction in lemurs: Higher metabolic rates in mothers and infants of larger-brain species reflect the cost of brain growth.

NANCY L. BARRICKMAN¹ and MAGGIE LIN². ¹Department of Anthropology, University of Waterloo, ²School of Medicine, University of Maryland.

The high cost of brain maintenance in adult primates is strongly suggested by studies that

show a trade-off between brain size and other expensive tissues such as the gut and studies showing a higher resting metabolic rate (RMR) in species with larger brain size. However, the energetic costs of brain growth can only be demonstrated with data on RMR in reproducing females and growing infants. In this study, we measured RMR in three lemur species: *Daubentonia madagascariensis*, *Propithecus coquereli*, and *Lemur catta*. We hypothesized that mothers and infants of species with higher degrees of encephalization will have higher RMR relative to body size during the early stages of growth.

RMR was determined by measuring oxygen consumption using the Sable System TR-1 package and scaling to body size. Three mother-infant pairs from each species were measured during gestation and at two, six, and ten months after birth. The results show that all three species have similar RMR during gestation. This finding is not unexpected given that all three species give birth to neonates with similar brain and body sizes. The lactating mothers and growing infants of the most encephalized species, *D. madagascariensis*, have the highest relative RMR at two and six months after birth. At ten months after birth, *P. coquereli* and *D. madagascariensis* have similar RMR. By this point, brain growth is nearly complete. These results suggest that the excessive metabolic energy in *D. madagascariensis* during growth is devoted to high costs of brain growth.

Regional variation in marine and terrestrial resource consumption in precontact central California: Stable sulfur, carbon, and nitrogen isotope analysis of human remains from the San Francisco Bay and Sacramento Valley.

ERIC J. BARTELINK¹ and BENJAMIN T. FULLER², ¹Department of Anthropology, California State University, Chico, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology.

Previous isotope research in central California has examined late Holocene (4500–200 B.P.) dietary variation among hunter-gatherers who occupied coastal, estuarine, and terrestrial ecosystems. Studies of prehistoric humans from the Sacramento-San Joaquin Delta, San Francisco Bay, and the Bay Area interior have revealed a high level of variation in the consumption of marine versus terrestrial resources. Stable carbon and nitrogen isotope data on human remains from Bay Area shellmounds indicates a temporal shift from a heavy marine diet to a diet more focused on terrestrial resources, providing support for archaeological resource intensification models. In contrast, human burials from the Delta and Bay Area interior provide little evidence for marine consumption, and instead suggest a diet focused on terrestrial and freshwater resources. This study evaluates regional variation in diet using isotopic analysis of human remains excavated from four Bay Area shellmounds, four sites in the Bay Area interior, and six sites from the Delta.

The main objective of this paper is to examine regional dietary patterning in prehistoric central California using stable isotopes of sulfur, carbon, and nitrogen of bone collagen. Skeletal remains from the Delta and Bay Area interior overlap significantly in carbon and nitrogen isotope values and show little inter-site variation; however, sulfur isotope values show patterning by site. Isotopic data from the Bay indicate heavy consumption of marine resources, and also show distinctive sulfur isotope values. The results are discussed in light of archaeological models of dietary change among human foragers from precontact central California. This study was supported in part by a Wenner-Gren Foundation grant #7163 and NSF grant BCS-0424292.

Survivorship and porotic hyperostosis in prehistoric West-central Illinois: A Paradox-appropriate methodology for inter-group comparisons of skeletal lesions.

JENNIFER M. BAUDER. Department of Anthropology, Binghamton University.

With the publication of *The Osteological Paradox* in 1992 came the increased recognition that the traditional methodologies for comparing defined groups of individuals on the basis of skeletal lesion frequencies was theoretically problematic. Simple counts of lesions do not account for heterogeneity of the risk of disease and death (frailty) and therefore are not comparable across samples. Few alternative methodologies that allow for comparison of skeletal samples in a manner congruent with the tenets of the *Paradox* have been proposed. This paper explores one alternative—the age specific comparison of the ratio of active to healed porous skull lesions in subadults from West-central Illinois, from the Middle Woodland through the Oneota horizons. Lesion activity is used here as a measure of relative individual frailty while a high ratio of active to healed lesions indicates low group survivorship and vice versa.

This methodology was used to test the hypotheses that factors such as increased population size/density and high levels of interpersonal violence would be associated with high frailty, as reflected by low survivorship. The results showed that survivorship measures did not always track as predicted—that is low survivorship measures were not always associated with large/dense populations or high levels of violence. This failure may be a result of the choice of porotic hyperostosis as the pathological indicator. These lesions are traceable to a number of etiologies each of which may have a distinct survivorship trend. These results highlight some of the difficulties of trying to conduct a *Paradox*-appropriate palaeopathological study. This study was funded by The Wenner-Gren Foundation, Grant # 7597.

Skeletal evidence of stress in Sonora, Mexico: A case study for how Aleš Hrdlička's collection techniques confound the osteological paradox.

HEIDI BAUER-CLAPP¹ and VENTURA PÉREZ², ^{1,2}Department of Anthropology, University of Massachusetts Amherst.

This project examines skeletal evidence of stress in Yaqui individuals ($n = 13$) collected in 1902 by Aleš Hrdlička in Sonora, Mexico, after a massacre of 124 men, women, and children by Mexican troops. Remains were examined for evidence of physiological stress, including cribra orbitalia, porotic hyperostosis, dental enamel hypoplasia and skeletal lesions. Data were also collected on healed or healing trauma. Results indicate pervasive stress among the Yaqui, with 77% ($n = 10$) displaying evidence of physiological stress and 31% ($n = 4$) displaying evidence of healed or healing trauma. Results will be discussed utilizing historical accounts of systematic oppression of the Yaqui by the Mexican government in the late 19th and early 20th centuries. In addition, two issues of bias in the sample due to collection techniques must be addressed. First, Hrdlička's notes from his collection process reveal that his choice of skeletal material was based on quality of preservation rather than desire to select a representative cross-section of the population. Whether by design or by accident all the remains collected were adult males, thus limiting our ability to document stress as experienced by women and children. Second, twelve individuals are represented by crania only, the thirteenth by only post-cranial remains, rendering our results a conservative estimate of the pervasiveness of stress within this population. These problematic issues confound the osteological paradox, demonstrating the complexity of understanding lived experience based on analysis of skeletal remains from archaeological collections.

Intraspecies volumetric comparison of insular regions based on cytoarchitectonics.

AMY L. BAUERNFEIND^{1,2}, PATRICK R. HOF³ and CHET C. SHERWOOD², ¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Department of Neuroscience, Mount Sinai School of Medicine.

Buried within the Sylvian fissure of primates is an area of neocortex called the insula. The cellular composition of the insula displays a gradient, transitioning from granular neocortex to agranular with an intermediate zone of dysgranularity. Additionally, apes exhibit a fourth region, the frontoinsular cortex (FI), not found in other primate taxa. Studies in humans indicate that the granular insula may produce an internal representation of the body's state, while the anterior agranular insula, and FI specifically, is involved in social awareness. Here, we examine the volumes of these cytoarchitectonic areas of insula in anthropoid primates. Because agranular cortex contains FI, we hypothesized that the volumetric extent of more anteroventral insular subregions would increase with phylogenetic proximity to apes. We measured insular subregions under high-power microscopy using stereologic methods. The volumes of insular subregions were measured in

three groups of primates (Platyrrhines, N = 2, *Alouatta caraya*, *Pithecia pithecia*; Cercopithecoids, N = 1, *Macaca maura*; and Hominoids, N = 2, *Pan troglodytes*, *Pan paniscus*). For apes, we include FI volume for comparison. Total insular volume increased at the power of 0.53 with increases in brain mass ($R^2 = 0.88$). The volume of dysgranular insula increased at the 0.49 power relative to brain mass ($R^2 = 0.80$). Comparisons between the two ape specimens indicate intergroup variability in volumetric extent of FI. Studying the cellular composition of insular cortex is an important step in quantifying differences in this brain region among primates, which might be related to the evolution of social cognition. This study was funded by NSF IGERT DGE-0801634 and the James S. McDonnell Foundation.

Pre-term, neonate, and infant death: Explaining high infant mortality in an otherwise healthy and robust Bronze Age population.

KATHRYN BAUSTIAN, DEBRA L. MARTIN and JENNIFER THOMPSON. Department of Anthropology, University of Nevada, Las Vegas.

Tell Abraq is significant because it is the largest prehistoric site on the southern coast of the Arabian Gulf. It was strategically important as an ancient port, regionally surrounded by large political centers. Commingled remains were located in a small tomb (6 m) used for a 200 year period (2200-2000 BC). The site was continually occupied from the 3rd millennium BC up to the 1st century AD. In the tomb were minimally 286 adults and 127 subadults. What is extraordinary is the number of pre-term (3rd trimester) infants (n=28, 22%), neonates (n=12, 9%), and infants under 2 years (n=46, 36%). The collection also yielded many children aged 2 to 5 years (n=32, 25%). This abundance of very young children is more startling in comparison to the very low number of subadults aged 6-18 (n=9, 7%). Differential preservation and burial practices of older children do not appear to be reasons for this low number. While we have reported elsewhere the adult portion of the population appears relatively robust and well-represented across age and sex categories, analyses using radiography, thin-sections, metric data, and paleopathology demonstrate that while there was some suffering from infection and failure to thrive (as suggested by poor cortical maintenance at the expense of growth in length), frequencies are not high enough to explain what placed premature and newly born infants and toddlers at risk. Cultural norms such as consanguinity, marriage and pregnancy at a young age, and benign neglect may be underlying factors contributing to poor infant outcomes.

Skeletal evidence for widespread juvenile scurvy at Butrint, Albania.

JARED BEATRICE, CAROLYN HURST and TODD FENTON. Department of Anthropology, Michigan State University.

Scurvy is a nutritional deficiency caused by inadequate amounts of vitamin C in the diet. While relatively low prevalences and isolated cases have been reported among ancient European skeletal samples, lesions consistent with this disease are present in a surprising 39% (22/56) of subadults dating to the Late Roman to Early Medieval period from the site of Butrint in southern Albania. The skeletal evidence for scurvy includes abnormal porosity or proliferative bone in the greater wing of the sphenoid, the temporal fossa of the frontal, the internal aspect of the mandibular ramus, the superior orbits, the cranial vault, the posterior maxilla, the hard palate, and cranial bossing in the area of the parietals. The most likely explanations for the prevalence of juvenile scurvy at Butrint are: the unavailability of sources of vitamin C, such as citrus fruits or vegetables; leaching of vitamin C from foods as a result of cooking or long term storage; or malabsorption due to diarrheal disease and parasitic infection. The possibility of the presence of anemia in some of these individuals cannot be ruled out based on the morphological variation observed in the orbital lesions. Considering the cultural and ecological context of Butrint as a city in decline during Late Antiquity, the possible co-occurrence of skeletal indicators for scurvy and anemia is in accordance with new models that implicate the synergistic effects of multiple variables that ultimately stem from broad changes in the living environment.

Why male orangutans do not kill infants.

LYDIA H. BEAUDROT¹, SONYA M. KAHLENBERG² and ANDREW J. MARSHALL^{1,3}. ¹Graduate Group in Ecology, University of California-Davis, ²Department of Biology, Bates College, ³Department of Anthropology, University of California-Davis.

Infanticide is widespread among mammals, is particularly common in primates, and has been shown to be an adaptive male strategy under certain conditions. Although no infanticides in wild orangutans have been reported, several authors have suggested that infanticide has been an important selection pressure influencing orangutan behavior and the evolution of orangutan social systems. We critically assess this suggestion. We begin by investigating whether orangutans have been studied for a sufficient period to detect infanticide. There are strong positive correlations between site duration and cumulative infanticides at well-studied chimpanzee and gorilla sites, but not for orangutan sites. We also calculate maximum orangutan infanticide frequencies for ten orangutan study sites by calculating the probability of zero infanticides having been observed at a site based on its duration. Next we consider whether orangutan females exhibit the counterstrategies typical of other mammalian females. We find evidence against three and require additional data to evaluate two. We assess predictions based on the hypothesis that orangutan females bond with "protector males" to prevent infanticide. We find evidence against six predictions and require additional data to evaluate four. Lastly, we

discuss socioecological reasons why orangutan males may not benefit from infanticide. We conclude that there is limited evidence for female counterstrategies. Aspects of orangutan paternity certainty, lactational amenorrhea, and ranging behavior may explain why infanticide is not a strategy regularly employed by orangutan males. We therefore suggest that infanticide may not have posed a strong selective force on orangutan behavior or social systems. This work was supported by a NSF Graduate Research Fellowship to LHB.

Why are pygmies small? An anthropometrical and anthropogenetical question.

NOEMIE BECKER¹, PAUL VERDU^{1,2},

ETIENNE PATIN³, ALAIN FROMENT¹,

YVES LEBOUC⁴ and EVELYNE HEYER¹.

¹Eco-Anthropologie, UMR 7206 CNRS - MNHN- Université Paris Diderot, ²Department of Human Genetics, University of Michigan, ³Human Genetics of Infectious Diseases, ⁴Système IGF/CCN.

Pygmy populations from central Africa have the shortest stature worldwide. The name "pygmy" indeed comes from the Greek "pugmaios" that is a measure of length. This reduced stature has been the subject of numerous endocrinological studies and many evolutionary hypotheses have suggested that this phenotype was an adaptation to the rainforest (hot, humid and dense environment), to alimentation or due to life history trade-offs (high mortality).

We have anthropometrical data for a sample of more than 1000 individuals from 7 pygmy populations and 3 neighbouring farmer populations from Gabon, Cameroon and Central African Republic. DNA samples are also available for a large number of individuals. The analysis of anthropometrical data shows that all pygmy groups have a male mean stature under 160 cm (this was used in the definition settled by Cavalli-Sforza in 1986) and that a high variability exists between various pygmy populations. Verdu et al. (2009) published a genetic analysis based on neutral microsatellites on the same populations and found that pygmies present a variable admixture proportion with non-pygmy. Comparing this data with our anthropometrical data at the individual level we find a strong correlation between level of admixture and stature, thus strongly supporting the existence of a genetic component in pygmy short stature. We developed a candidate-gene approach to search for such genetic factor and will present current results on various genes located in the GH-IGF1 axis.

Predominant collagen fiber orientation data support the multi-domain load hypothesis in the chimpanzee femur.

ADAM B. BECKSTROM, JOHN G. SKEDROS, CASEY J. KISER, and KENDRA E. KEENAN. Dept. of Orthopaedics, Univ. of Utah School of Medicine.

Different load 'domains' can exist between regions of the same bone, and these domains correlate with differences in habitual load complexity. Evidence that 'habitual load

'complexity' defines these domains derives from strain gauge analyses showing general differences in the magnitudes of their neutral axis rotations (Skedros et al., 2009). The hypothesis that multiple domains can exist between regions of the same bone is important because the adaptability of cortical bone between these regions may not be equivalent. We have reported data supporting multiple load domains in the proximal human femur; this conception helps in understanding stress transfer in femoral prostheses and age-related increases in fragility fractures. We tested this multi-domain load hypothesis in the chimpanzee femur. Distributions of habitual strain-modes (e.g., tension, compression, shear/torsion) can be quantified as variations in predominant collagen fiber orientation (CFO) in thin sections. CFO was quantified in eight adult chimpanzee femora at: 1) mid-neck, 2) base neck, 3) sub-trochanteric (80%), 4) proximal shaft (70%), and 5) mid-shaft (50%). Sections were embedded, ultramilled, and imaged under circularly polarized light. Results showed: 1) bending in the neck that was in an unexpected direction (i.e., tension in the inferior cortex and compression in the superior cortex; compare to results of Kalmey and Lovejoy, 2002, BONE), 2) medial-lateral (compression-tension) bending in the proximal diaphysis, and 3) torsion at mid-diaphysis. Therefore, at least three load domains exist. Recognizing the existence of multiple load domains enhances awareness that these regions are likely also subject to differences in developmental constraints and functional adaptability.

Sacral orientation in hominid evolution.

ELLA BEEN, ALON BARASH, MEDLEJ BAHA and SMADAR PELEG. Department of Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv.

Sacral orientation has a significant role in the erect posture of humans. Therefore, discovering the nature of sacral orientation is of considerable evolutionary importance. Pelvic incidence (PI) determines sacral orientation within the pelvic girdle, and was found to be highly correlated to lumbar lordosis in humans. Although PI is well established in modern humans it has not been explored in non human primates (NHP) or in extinct hominids. The goals of this study are to establish standard PI for non human primates and to explore the evolution of PI in extinct hominids.

Sacral orientation of the pelvis of 60 NHP, 60 modern humans and 9 extinct hominids was measured, using PI.

Our preliminary results indicate that PI in NHP ($33^\circ \pm 10$) is significantly lower than the PI in modern humans ($54^\circ \pm 12$). The PI of *Australopithecine* (44°) is greater than PI of NHP, but smaller than modern humans. The PI in early *H. sapiens* (55°) is similar to modern humans.

The sacrum in NHP is oriented more parallel to the pelvis while in humans the sacrum is anteriorly (ventrally) tilted. The sacrum of *Australopithecine* is more tilted than in NHP, but is still more parallel to the pelvis than in modern humans. The orientation of the sacrum

of early *H. sapiens* resembles that of modern humans. Our results indicate that the evolution of sacral orientation in hominids occurred in at least two stages.

Internal phalangeal morphology: Adaptations to loading in primate locomotion.

DANA L. BEGUN. Department of Anthropology, Department of Biomedical Engineering, University of Michigan.

Much attention has been paid to bone adaptation on the external and whole-bone level. In order to fully understand the osteo-adaptive response to different forces it is imperative to also consider internal bone structure and material properties. This study analyzes the reliability of using internal geometries of phalanges to infer primary locomotor behaviors. It would be expected that the regions that must resist the most stress during locomotion will have thicker cortices and/or further placement of bone from the axis of motion.

The proximal and intermediate phalanges of 5 different primate species—all adult male—were scanned with an *in vivo* micro-computed tomography (μ CT) system. The species used were chosen based on primary locomotor patterns and to minimize phylogenetic factors. Baboons ($n=2$) represented palmar walkers. Chimpanzees ($n=3$) were used for knuckle-walkers. Gibbons ($n=3$) represented brachiators. Gorillas ($n=3$) were examples of a combination pattern employing both arboreal hanging and knuckle-walking. Finally, humans ($n=3$) were scanned as a control, with phalanges that are not incorporated in locomotor behavior.

External forces were approximated and using force diagrams estimations of high-force regions were identified. Algorithms were applied to measure second moment of area (I) and polar moment of area (J). Analysis shows significant differences between locomotor groups in placement and thickness of cortical bone in the diaphyseal region. These results suggest that internal phalangeal geometrics are a useful tool for estimating locomotor patterns. If reliable, this technique may also be used to further illuminate locomotor patterns of non-extant species.

New catarrhine fossils from Rudabánya (Hungary): Evidence for sympatric primates in a late Miocene swamp forest.

DAVID R. BEGUN¹, MARIAM C. NARGOLWALLA¹ and LÁSZLÓ KORDOS².

¹Department of Anthropology, University of Toronto, ²Geological Institute of Hungary.

New specimens recovered in 2009 from Rudabánya provide very rare evidence in the European Miocene of a primate community and the nature of this sympatry. Postcranial specimens clearly attributable to *Rudapithecus*, based on size and morphology, were found within 10 centimeters of an *Anapithecus* cranium, at precisely the same elevation and in the same sediment. While we can't prove that these individuals lived together, the premise of the reconstruction of fossil communities depends on the assumption that fossils found in

close association probably represent sympatric organisms, unless taphonomic evidence suggests otherwise. The black clay level in which these specimens were recovered is a low energy deposit with evidence of low transport distances and fairly rapid burial, based on the completeness of specimens, their preservation, and the frequent association of specimens representing partial skeletons. The new *Anapithecus* specimens include two nearly complete associated maxilla and mandibles and a partial cranium, found within centimetres of several large *Rudapithecus* hand bones. *Anapithecus* is siamang sized and monomorphic in body mass. *Rudapithecus* is strongly dimorphic, with males being small *Pan* sized. Both taxa are frugivorous. Dental morphology indicates differences in food acquisition, but we believe the unique combination of body mass and dimorphism differences between these taxa allowed their close association. Given the samples from Rudabánya and the patterns of dimorphism, we speculate that *Anapithecus* may have been territorial with relatively small ranges and multifemale groups while *Rudapithecus* probably ranged more broadly in multimale/multi-female groups. This research funded by NSERC, the AvH Foundation, the National Geographic Society and the University of Toronto.

The role of nutrients in the selection of food items by black howlers (*Alouatta pigra*) in Southern Belize.

ALISON M. BEHIE and MARY S.M. PAVELKA. Dept of Anthropology, University of Calgary.

Factors that determine food selection by primates are influenced by their digestive physiology, nutritional requirements and the availability of the food items. Previous studies on food have found that, because leaves are low in protein, folivorous primates select food items high in protein and low in digestion inhibiting fiber. As the most folivorous new world monkeys, howler monkeys should also select food items high in protein and low in fiber in order to avoid protein deficiency. However, the diet of the black howler (*Alouatta pigra*) contains between 40- 50% fruit annually, and it has been suggested that without this fruit they may become energy deficient. This study aims to determine what nutrients are important for food selection in the population of black howlers in Monkey River, Belize. Using focal animal sampling we collected feeding data on four groups of monkeys from 2001-2007. Samples of ingested food items were collected, dried and sent for nutritional analysis. A Pearson correlation found that howlers select food items high in sugar ($r = 0.539$; $p = 0.002$), which may be reflective of their preference for fruit. However, when fruit is not available, monkeys still select for leaves high in sugar ($r = 0.476$; $p = 0.014$) regardless of their protein and/or fiber content. Mineral content was found to have little effect on food choice. This suggests that unlike other folivores, simple sugar rather than protein and/or fiber is the important nutritional factor determining food selection.

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Taphonomy and paleoecology of the A.L. 333 hominin fossil assemblage, Hadar, Ethiopia.

ANNA K. BEHRENSMEYER¹ and ELIZABETH H. HARMON². ¹Department of Paleobiology, Smithsonian Institution, ²Department of Anthropology, Hunter College of the City University of New York.

The ~3.2 Ma A.L.333 locality has yielded over 270 *Australopithecus afarensis* specimens representing an estimated 18 individuals. This unusually large concentration of hominin remains is hypothesized to represent geologically instantaneous preservation of a contemporaneous group. We use geological, taphonomic, and anatomical evidence to reconstruct the history of the assemblage in order to test this hypothesis.

The *in situ* hominin remains were buried in silts representing low-energy deposition in a shallow swale at the top of a small channel. This abandoned channel would have formed a seasonally moist, vegetated corridor across a more open depositional plain. Surface-collected specimens have a range of matrix types (silt, carbonate, fine to coarse sand) and preservation modes (texture, color, mineralization) indicating burial in variable local sedimentary and chemical conditions. The estimate of 18 individuals, based on analysis of cranial/dental remains, includes nine adults, 2 sub-adults, and 7 very young including an unworn deciduous incisor. Bone modification features indicate some scavenging and weathering prior to burial. Skeletal parts are biased against axial relative to cranial and appendicular elements, suggesting carcass processing by a felid predator. Sedimentary context, spatial concentration, skeletal part representation, and lack of abrasion indicate that the hominins died near where they were buried. The combined evidence supports the A.L.333 assemblage as a temporally restricted sample of a hominin population but argues against death in a flood. Alternative possible causes of spatially and temporally focused mortality include serial predation, disease or poisoning, followed by surface exposure and burial in a seasonally wet channel swale.

Butchered but not eaten? New evidence from the analyses of cut-marks on human remains at Gough's Cave (Somerset, England, 14,700 cal BP).

SILVIA M. BELLO. Department of Palaeontology, The Natural History Museum, London.

The suggestion of nutritional cannibalism has always been hard to prove through osteological analyses. This is mainly because the presence of cut-marks on human remains can be associated not only with cannibalism (with consumption of the body), but also with other ritual practices (such as defleshing) which do not involve consumption of the body. One of the more used

criteria to demonstrate cannibalism is the similarity of butchery signs on human and animal remains from the same archaeological context.

Human bones have been recovered at Gough's Cave (Somerset, England, ~ 14,700 cal BP), found in association with a rich late Pleistocene fauna and Upper Palaeolithic artefacts. Numerous cut-marks have been observed on human and non-human remains. This study aims to compare the micromorphology of cut-marks on human and non-human remains found on same anatomical elements in order to test the hypothesis of nutritional cannibalism. The micromorphological characteristics of cut-marks have been analysed using a new technology (Alicona 3D InfiniteFocus imaging microscope and associated software), which allows quantification of vertical variations in the surface structure. Results of this analysis seem to indicate that human bodies were butchered by the same type of tools used on other animals at Gough's Cave, but applying a greater force. The hypothesis of a different technique employed for butchering human and non-human carcasses raises questions on the interpretation of nutritional cannibalism at this site. This study is a contribution to the Ancient Human Occupation of Britain Project (AHOB), special thanks go to the Leverhulme Trust for their financial support of this project.

A symmetric virtual reconstruction of OH5.

STEFANO BENAZZI¹, FRED BOOKSTEIN^{1,2}, DAVID S. STRAIT³, BRIAN RICHMOND⁴, PETER LUCAS⁵, PAUL DECHOW⁵, CALLUM ROSS⁶, IAN GROSSE⁷ and GERHARD W. WEBER¹. ¹Department of Anthropology, University of Vienna, ²Department of Statistics, University of Washington, ³Department of Anthropology, University at Albany, ⁴Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ⁵Department of Biomedical Sciences, Texas A&M Health Science Center, Baylor College of Dentistry, ⁶Department of Organismal Biology and Anatomy, University of Chicago, ⁷Department of Mechanical and Industrial Engineering, University of Massachusetts.

The OH 5 cranium is one of the best preserved fossils of *Paranthropus boisei*. But the cranium was found as two main portions that do not have direct contact: the reconstructed face and a large portion of the neurocranium. Tobias, who carried out a physical reconstruction of the cranium in 1967, considered the reconstruction reliable and without deformations but showing asymmetries mainly in the neurocranium. Nevertheless the reconstructed cranium shows some anomalies, owing to the positioning of the upper calvariofacial fragment. There is a downward displacement of this portion, which introduces differences between the orbits in shape, size and position.

Here we propose a virtual reconstruction of OH5, combining geometric morphometric methods and CAD techniques to solve these long-standing problems. Starting from a CT scan of OH5, a semi-automatic segmentation

method was used to completely remove the plaster. The upper calvariofacial fragment was separated from the lower facial fragment and realigned using superposition of their independent midsagittal planes. Some minor missing parts of the right hemiface were subsequently reconstructed using NURBS surfaces and subsequently mirrored using the midsagittal plane to arrive at an exactly symmetrical facial reconstruction. A symmetric neurocranium was obtained by Procrustes superimposition of the original and its reflected relabelling version. The further alignment used the midsagittal planes and a reference shape (KNM-ER406) to estimate a highly reduced list of degrees of freedom, limited to only three parameters of rigid motion.

The outcome of this reconstruction is a symmetric representation of OH5, obtained using a highly replicable approach. Supported by National Science Foundation Physical Anthropology HOMINID program (NSF BCS 0725219, 0725183, 0725147, 0725141, 0725136, 0725126, 0725122, 0725078) and the European Union FP6 Marie Curie Actions MRTN-CT-2005-019564 "EVAN".

Using discriminant function analysis as a hypothesis-generating technique.

RICHARD L. BENDER, PAUL SANDBERG, and DENNIS P. VAN GERVEN. Dept. of Anthropology, University of Colorado at Boulder.

Discriminant function analysis (DFA) is a multivariate statistical technique for assigning unknown cases to predefined groups, and for quantifying group differences. It can also be used as an explorative, hypothesis-generating technique. However, it has rarely been used to evaluate group differences in dietary composition. We apply DFA to dietary composition data for 614 children from 25 low-income rural and urban elementary schools. The discriminant functions are then used to explore rural-urban differences in dietary composition.

First, we use DFA to classify the 614 individuals into rural and urban groups based on 12 dietary component scores. 94% of rural subjects (n=409), but only 27% of urban subjects (n=205), are correctly classified. Rural and urban individuals are not readily distinguishable by dietary composition. Next, we pool the individuals by school and calculate mean scores for the 12 dietary components. In this case, DFA correctly classifies 100% of the 25 schools into rural and urban groups. Rural and urban schools are readily distinguishable by dietary composition.

Taken together, these seemingly contradictory results suggest a testable hypothesis: in this sample of low-income schoolchildren, rural and urban diets are very similar in composition. However, a small proportion of the urban children have markedly different diets. These individuals are relatively evenly distributed among the urban schools, with the result that rural and urban schools, but not individuals, can be distinguished by dietary composition. Thus, DFA can be used to generate hypotheses that

may not otherwise be apparent during preliminary analysis of a multivariate dataset.

The genetic legacy of indigenous Caribbean peoples: Evidence from autosomal and mitochondrial data.

JADA BENN TORRES¹, ANNE STONE², STANLEY HOOKER³ and RICK KITTLES³. ¹Department of Anthropology, University of Notre Dame, ²School of Human Evolution and Social Change, Arizona State University, ³Department of Medicine, Section of Genetic Medicine, University of Chicago.

Archeological evidence suggests that autochthonous peoples began to migrate into the eastern island chain in the Caribbean, known as the Lesser Antilles, as early as 7200 years BP. Upon the arrival of Europeans, an estimated 2-4 million people lived on these islands. Within 32 years of contact, the native populations had virtually disappeared from the region due to European-introduced disease, abuse, and genocide. This lead many scholars to conclude that indigenous Caribbean people had become extinct. However, small pockets of indigenous communities have survived and are present today on several Lesser Antillean islands. Furthermore, ethnohistoric data suggests that gene flow occurred between autochthonous peoples and enslaved Africans beginning in the colonial period.

In this study, we examine the genetic legacy of autochthonous Caribbean peoples from the Lesser Antilles in contemporary African-Caribbean populations as evidenced from mitochondrial data and novel autosomal data. A total of 516 individuals from eight Caribbean islands were typed for 109 ancestry informative markers and a subset of individuals were also typed for their mitochondrial haplogroup. Mitochondrial haplogroups indicate that 5% of the sample has indigenous ancestry while admixture estimates from autosomal markers show 4% indigenous ancestry. Both lines of data suggest that despite the dramatic post-contact decline in population size, indigenous Caribbean people have made notable genetic contributions to contemporary African-Caribbean populations. Furthermore, these genetic contributions vary according to the genetic system typed and across the islands.

Sex differences in dental attrition and consumption in Hadza hunter-gatherers.

JULIA C. BERBESQUE¹, FRANK W. MARLOWE¹, AUDAX MABULLA² and ALYSSA N. CRITTENDEN³. ¹Department of Anthropology, Florida State University, ²Archaeology Unit, University of Dar es Salaam, ³Center for Academic Research and Training in Anthropogeny (CARTA), University of California, San Diego.

Despite the sexual division of foraging labor among hunter-gatherers, the sharing of male and female foods is assumed to result in virtually the same diet for males and females. This study investigates the link between patterns of attrition across age and sex cohorts with behavioral data on diet composition in a contemporary hunter-

gatherer population, the Hadza of Tanzania. We used two sets of data for this analysis; casts of dentition, and coded behavioral data on observed consumption. Casts of the upper dentition (full arcade) were made from molds taken from 94 adult individuals (49 women and 45 men) and scored according to the Murphy dental attrition scoring system. Observations of behavior were collected by instantaneous scans conducted once an hour, with 13 scans performed per day. A total of 29,803 person scans were collected over a period of 11 years. Consumption of particular food types were documented in behavioral scans. Despite the widespread practice of food sharing among the Hadza, females in older age cohorts demonstrated significantly greater occlusal wear than cohort-matched males. We show that these sex differences in occlusal wear map onto sex differences in consumption patterns and diet composition. This research was supported by NSF grants 0544751, 0242455, and 0650574 to F.W. Marlowe.

AluHunter: A new computer program for large-scale identification of Alu-elements for use in primate phylogeny.

CHRISTINA M. BERGEY. Center for the Study of Human Origins, Dept. of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

Alu elements are short interspersed elements (SINEs) which are nearly free of homoplasy and are of a known ancestral state, making them ideal for use in phylogenetic inference. *AluHunter* is a new program that screens large quantities of DNA sequence for recently-inserted Alu elements via computational data mining and comparative analysis, resulting in a large dataset of taxon-specific Alu elements. In a pilot study, the program gathered over 118,000 Alu elements from all baboon (*Papio*) sequences in NCBI GenBank. Eliminating the markers that are fixed in Catarrhines, it then selected and designed primers for those that are potentially phylogenetically-informative within the genus. In the laboratory, these 3,000 Alu elements are now being characterized in samples from locations throughout the range of baboons, allowing the inference of baboon phylogeny to a higher degree of certainty than ever before.

Highly automated, the program searches for Alu elements in any newly-submitted GenBank sequence and maintains a database of those it finds. This real-time database of all Alus in GenBank will be useful for examining questions about Alu distribution in the genome, both overall and by Alu family. Additionally, it will allow the identification of homoplastic Alu insertions that could result from incomplete lineage sorting or hybridization. With sufficient sequence, it will eventually be possible to infer an Alu-based phylogeny with data mining and comparative analysis alone. Presently, the database is a valuable resource for researchers searching for polymorphic Alu elements to characterize. This study was funded by NSF grant number BCS0715281.

Cranial diversity of human skeletal remains from Serra da Capivara, Northeastern Brazil: Implications for the origin of the Native Americans.

DANILO VICENSOTTO BERNARDO¹, WALTER ALVES NEVES¹ and NIEDE GUIDON². ¹Laboratório de Estudos Evolutivos Humanos, Universidade de São Paulo, Brazil, ²Fundação Museu do Homem Americano, São Raimundo Nonato, Brazil.

The cranial morphology of six prehistoric human skulls from Serra da Capivara, Piauí, Brazil was assessed under a global comparative perspective. The specimens are dated to either the Early or the Late Holocene. The multivariate analyses conducted (Principal Components and Discriminant Functions) showed that the specimens from this region of Brazil are resolved in two very distinct and distant groups in the morph-space. When their cranial morphologies were compared to the World cranial variation, one group exhibited a clear association with Australo-Melanesians and Africans, while another exhibited a clear association with nowadays Asians and Native Americans. These results are congruent with the idea that The Americas were successively settled by two different populations, but both coming from Asia. This study was funded by FAPESP, grants numbers 08/58729-8 and 04/01321-6.

Lemurs, hormones, and the pace of life histories: IGF-I and somatic growth in *Lemur*, *Eulemur*, *Propithecus*, and *Varecia*.

ROBIN M. BERNSTEIN¹, HABIBA CHIRCHIR², and NICOLAAS H. FOURIE². ¹Department of Anthropology, Center for the Advanced Study of Hominid Paleobiology, George Washington University, ²Hominid Paleobiology Doctoral Program, George Washington University.

Primate life history patterns, including growth rates and duration of developmental stages, have been shaped by ecological, social, and reproductive variables. Lemurs are broadly characterized by relatively rapid postnatal growth rates and a general absence of sexual size dimorphism. Breeding seasonality and photoperiod length are thought to be especially important factors shaping lemur ontogenies. Insulin-like growth factor-I (IGF-I) plays an important role in somatic growth and the onset of sexual maturation, and further, has been shown to regulate growth in response to environmental cues in other animals. Here, we examine IGF-I levels during ontogeny in lemurids and indriids for their relationship to size, rate and duration of growth, with a particular focus on the juvenile period.

We quantified IGF-I levels in archived serum samples obtained from the Duke Lemur Center, using enzyme immunoassay. This mixed longitudinal sample set (N = 214) includes eight species from four genera (*Lemur*, *Eulemur*, *Propithecus*, *Varecia*). Using growth records, we constructed mass growth curves, compared them to patterns of IGF-I levels, and analyzed IGF-I levels for differences among sexes and

species. IGF-I levels are significantly correlated with increases in mass during ontogeny across species. While *Lemur*, *Eulemur*, and *Propithecus* have similar IGF-I levels throughout growth, levels of IGF-I in *Varecia* are significantly lower. Female IGF-I levels in all taxa are significantly higher than male levels. These results have implications for understanding variation in ontogenetic patterns within and among species, and for understanding how shifts in the pace of life history are regulated. This study was funded by NSF DGE-0801634.

From ritual use to dietary staple: Maize consumption and oral health within Mississippian Period of East Tennessee

TRACY K. BETSINGER¹ and MARIA OSTENDORF SMITH². ¹Department of Anthropology, State University of New York, College at Oneonta, ²Department of Anthropology, Illinois State University.

Oral health has been clearly linked to dietary patterns and variation in populations. Sex and status-based patterns of consumption may be reflected in variation in dental health. Previous research of maize agriculturalists from eastern Tennessee has shown that differences in oral health and diet are predominantly related to differences of status, rather than gender. However, many other regional studies of maize agriculturalists have demonstrated higher rates of dental pathological conditions in females, resulting from their higher consumption of cariogenic foods. In this study, we test the hypothesis that the high-status group from the Dallas site, a late Mississippian (AD 1300-1600) maize agricultural population, will have higher rates of dental pathology than the low-status group. Additionally, we test the hypothesis that males and females will demonstrate comparable prevalence rates of these conditions, based on earlier studies of populations from this region.

Dental pathological conditions, including dental caries and antemortem tooth loss were documented in the dentition of 59 adults (26 females (7 high-status, 19 low-status), 27 males (9 high-status, 18 low-status)). Statistical analyses indicate that the low-status group has a significantly higher rate of severe carious lesions than the high-status group (chi-square, $p < 0.05$), suggesting a greater consumption of cariogenic foods in the former. Analyses further revealed no differences between males and females, regardless of status level, reflecting a similar dietary pattern. These results further corroborate a regional pattern in the upper Tennessee River drainage area.

Danger in the black of night: Are diurnal primates more at risk during the new moon?

LAURA R. BIDNER. School of Human Evolution and Social Change, Arizona State University.

Many predators of diurnal primates hunt primarily at night. As diurnal primates' visual acuity decreases in low light levels, it follows

that on nights with the least amount of moonlight, primates should face the highest levels of risk from nocturnal predators. Moonlight levels vary broadly with moon phase (i.e. full, waning, new, and waxing moons), so it is expected that predator activity near the sleeping sites of diurnal primates should increase during the new moon.

For this study, the locations of two female radio-collared leopards (*Panthera pardus*) were monitored relative to a troop of habituated chaema baboons (*Papio hamadryas ursinus*) at Loskop Dam Nature Reserve, South Africa for eight months. The number of leopard locations near the baboon troop's preferred sleeping site differed significantly by moon phase. The leopards were located near the sleeping site far more often on mornings during the new moon than during any other moon phase period. This suggests that risk of attack by nocturnal carnivores may indeed be higher for diurnal primates during the dark nights of the new moon. However, it is not clear if baboons perceived an increase in risk during this period. Neither the baboon troop's use of sleeping sites nor their diurnal antipredator behaviors differed significantly by moon phase. While this research indicates that nocturnal risk for diurnal primates likely varies with moon phase, it also highlights the need for more extensive nocturnal monitoring of diurnal primates and their predators in order to detect patterns of nocturnal risk and risk perception. Funding from the following sources is gratefully acknowledged: Leakey Foundation, NSF (BCS-0550918), Wenner-Gren Foundation (Gr-7365), Sigma-Xi, American Society of Primatologists, Arizona State University, and American Association of University Women.

Analysis of exome variation from 24 Maasai individuals.

ABIGAIL W. BIGHAM¹, SARAH B. NG², EMILY H. TURNER², DEBORAH A. NICKERSON², JAY SHENDURE² and MICHAEL BAMSHAD³. ¹Department of Pediatrics, The University of Washington, ²Department of Genome Sciences, The University of Washington, ³Departments of Pediatrics and Genome Sciences, The University of Washington.

Next generation sequencing is becoming a more accessible means to decipher and characterize patterns of human genetic diversity. While the routine sequencing of full human genomes continues to be prohibitively expensive, the cost of sequencing all protein-coding regions (i.e. the "protein-coding genome" or "exome", ~1% of the human genome) is a cost-effective method for discovering genetic variation. As part of a larger project to understand natural selection and human demographic history, we carried out targeted capture and multiplex sequencing of the exomes of 24 Maasai from sub-Saharan Africa. From these data, we identified known and novel variants in comparison to dbSNP, predicted the functional effect for all non-synonymous SNPs using PolyPhen, and calculated diversity indices including heterozygosity and nucleotide diversity (π). We applied standard tests that detect departures from neutrality to look for

signatures of natural selection. These tests include Tajima's D , Fu and Li's F^* and D^* , and Fay and Wu's H . Finally, we compared the patterns of nucleotide diversity for the Maasai to exome data for three additional populations including Europeans, West Africans, and East Asians using F_{ST} . These data along with the continued characterization of East African exomes will 1) expand our knowledge of human demographic history 2) refine our understanding of regional patterns of natural selection, and 3) aid in the performance of genetic associations studies in East Africans that are currently hampered by a lack of understanding of the patterns of variation. This study was funded by the National Institutes of Health/National Heart, Lung, and Blood Institute (NHLBI) & National Institutes of Health/National Human Genome Research Institute (NHGRI)

Preference for delivery medium: podium presentation

Craniofacial variability and diachronic changes from early medieval to recent period in central European population: 3D geometric morphometric comparison.

LUCIE BIGONI¹, JANA VELEMINSKA¹, KRISTINA KRCHOVA¹, JOSEF PROKOP² and PETR VELEMINSKY³. ¹Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Prague, ²Department of Physical Electronics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, ³Department of Anthropology, National Museum, Prague.

The purpose of this study was to monitor diachronic variability in the shape of skulls within the territory of Central Europe from the Early Middle Age until the present. We posed the question whether we can prove that the most typical evolutionary changes of anatomically modern man, the development of neurocranial globularity and decreased facial convexity, can be observed in the medieval-current period. Our argument is based on detailed craniometric analysis of the skull as a whole, but also on the shape microevolution of the various facial parts of the skull.

The study sample consisted of 185 medieval and 133 identified skulls from the first half of the 20th century. The three-dimensional coordinates of 11 midline and 15 bilateral ectocranial landmarks were digitized using a MicroScribe G2X contact digitizer. The set of coordinates were submitted to multivariate (MANOVA) and geometric morphometric methods (GPA, shape PCA and TPS).

In the direction of medieval-recent period the neurocranium shortened and widened, while the face and forehead became narrower. Marked facial flattening is produced by a strong retrusion of the upper jaw. Orbita in recent skulls are more rounded, and the orbit aperture is positioned in a slightly sagittal direction. The nasal aperture is relatively narrower, and the nasal bones are more prominent. The palate is deeper in recent skulls in the region of the os palatinum, while the anterior part is flatter. This observed facial morphology is much less pronounced but similar to the Czech Upper

Paleolithic skulls from Předmostí and Dolní Věstonice. This project was supported by a grant from the Grant Agency of the Czech Republic (GAČR, project 206/07/0699), by research grant MSM 0021620843 from the Ministry of Education, Youth and Sports of the Czech Republic, and by Centralized Development Project C37/3 from the Ministry of Education, Youth and Sports of the Czech Republic.

Dental variation in Holocene humans from Kenya, East Africa.

WENDY BLACK and REBECCA R. ACKERMANN. Department of Archaeology, University of Cape Town.

Previous work on Holocene dental variation in Africa has focused on certain groups (i.e. Congo, Gabon, Ghana, Nigeria, Cameroon and South Africa), with relatively less attention given to other regions. Part of the reason for this is that material from other sites is fairly scarce, not well-documented, and too often poorly preserved. There are, however, exceptions to this. Holocene remains from Kenya were collected from a number of sites in and around the Lake Turkana, Elmenteita and Naivasha lake basins in the early part of the 20th century. To date, no detailed metric or non-metric dental analyses of any of these remains have been conducted. This study describes the location and current condition of this Holocene dental material from various localities, and presents an analysis of non-metric trait variation in the sample (N=84).

Dentition was scored for a suite of dental morphological attributes, including 39 common crown, root and intra-oral osseous traits. Results demonstrate that the Kenya material exhibits, among others, high frequencies of traits such as shoveling, Tome's root and deflecting wrinkle, while comparative results have revealed trait similarities between this material and data from both recent West and South Africa samples. Additionally, certain traits such as the canine mesial ridge and lower molar seventh cusp occur at frequencies comparable to those seen in the KhoeSan populations of southern Africa. Such dental trait associations suggest that the Kenya material has close affiliations with the sub-Saharan African dental complex and may offer new insights regarding connections among African phenotypes.

Exposure to parasites and development of immune response? Age profile of immunoglobulin E (IgE) in the Shuar of Eastern Ecuador, the Tsimane of Bolivia, and the U.S. NHANES.

AARON BLACKWELL^{1,2}, J. JOSH SNODGRASS¹, MICHAEL GURVEN², HILLARD KAPLAN³, FELICIA MADIMENOS¹, MELISSA LIEBERT¹ and LAWRENCE SUGIYAMA^{1,3}. ¹Department of Anthropology, University of Oregon, ²Department of Anthropology, University of California, Santa Barbara, ³Center for Evolutionary Psychology, University of

California, Santa Barbara, ³Department of Anthropology, University of New Mexico.

Immunoglobulin E (IgE) is implicated in resistance to helminths and allergic response. Although studies have noted elevated IgE in populations with high helminth infection, the age and sex patterning of IgE in these populations has not been fully described. Here, we describe IgE in the Shuar of Ecuador (n=163), the Tsimane of Bolivia (n=329), and the U.S. 2005-2006 NHANES (n=8,336). These populations differ significantly in IgE (all p<.001): Tsimane have the highest (geometric mean = 6,298 IU/ml) followed by Shuar (1,196 IU/ml) and NHANES (60 IU/ml). In all groups, males have significantly higher IgE levels than females (all p≤.02). IgE levels are lowest early in childhood, increase, and the decline during puberty. To examine the development and subsequent decline of IgE, we fit a polynomial function of ln(age) and population on ln(IgE). The variation is best described by a common intercept at birth followed by different rates of increase, resulting in significant population differences through most of the life span. The model predicts peak IgE for Tsimane at ~6 years, for Shuar at ~9 years, and for the U.S. sample at ~12 years. The difference in peak IgE may reflect the phenomena known as "peak shift" whereby both infection and immunity peak earliest in populations with the highest disease transmission rate. Finally, although IgE declines with age in Tsimane and NHANES, in Shuar there is an increase past age forty, possibly reflecting changes in market integration and disease exposure experienced in the lifetime of these individuals. NSF BCS-0824602, NSF (BCS-0422690), NIH/NIA (R01AG023119-01), UCSB Center for Evolutionary Psychology (NIH 5DP1O000516-04 to Leda Cosmides).

Population genetic structure and landscape genetics of the endangered Central American Squirrel Monkey (*Saimiri oerstedii*).

MARY BLAIR^{1,2} and DON J MELNICK^{1,2}. ¹Dept. of Ecology, Evolution and Environmental Biology, Columbia University, ²New York Consortium in Evolutionary Primatology.

Central American Squirrel Monkeys (*Saimiri oerstedii*, Primates: Cebidae) are endangered primates that have experienced severe habitat fragmentation in the Central Pacific region of Costa Rica. Restricted gene flow and changes to population genetic structure have been documented in other primates and social mammals experiencing severe habitat fragmentation. In order to examine the effects of habitat fragmentation on gene flow in *S. oerstedii*, 350 fecal samples were collected non-invasively from 22 *S. oerstedii* troops in the Central Pacific region of Costa Rica and analyzed using population genetics methods. We also used landscape genetics methods to characterize localized gene flow patterns for *S. oerstedii* and correlate those patterns with measures of landscape heterogeneity. We expected significant population genetic structure in *S. oerstedii* due to the degree of habitat

fragmentation and their sex-biased dispersal patterns, and indeed our results show some population structure. However, because *S. oerstedii* are secondary forest specialists, some types of anthropogenically-modified habitat do not represent barriers to dispersal, which is also reflected in our results. Our results further suggest that studies of primate ecology and evolution should explicitly consider landscape heterogeneity, especially as primate habitats are increasingly lost and modified. We recommend ways to develop and refine landscape genetics methods for primates in order to inform future studies of the influence of heterogeneous landscapes on primate ecology, population divergence, and evolution. This study was funded by NSF Award No. BCS-0847912, Columbia University, an International Primatological Society (IPS) Research Grant, an American Society of Primatologists (ASP) Conservation Small Grant, and the Margot Marsh Biodiversity Foundation.

Are all measures created equal?: Comparison of direct, photographic, and radiographic measurements of pelvic bones.

KATHLEEN A. SATTERLEE BLAKE. University of Pittsburgh.

Osteometric data has been obtained not only from skeletal material, but also from radiographs and photographs. However, are the measurements resulting from these three methods interchangeable? This study tests the hypothesis that these methods of evaluation of skeletal material are equal to one another. I will also evaluate the ease of distinguishing measurement landmarks in all three methods. The following study of a Jordanian collection housed at the University of Pittsburgh evaluated 9 bilateral measurements taken from adult and subadult pelvis (n=18). Measurements for each element were taken from bone, radiographs, and photographs. Sliding and spreading calipers and angle rulers were used for direct bone measures. The photographic and radiographic images were measured with ImageJ freeware from NIH, with the scale set for each image. Results show that all three measurement methods are highly consistent, as correlation coefficients strongly positively correlated. Regression and scatterplot analysis of direct measurements compared to radiograph measurements, and then direct measurements to photograph measurements, also support the null hypothesis. Measures taken from radiographs, while consistently larger in value, did not vary significantly. Landmark determination was problematic in radiographs of adult pelvis as pubic and ischial length landmarks were not assessable. The subpubic and sciatic notch angles were cumbersome to measure on skeletal material, while these angles could be easily evaluated in photographs and radiographs. This study has implications for those developing methods for aging and sexing skeletal material, for comparing existing studies, or for making comparisons with repatriated collections with radiographs or photographs.

Timing of estrus in brown mouse lemur females from Ranomafana National Park,

southeastern Madagascar: Implications for reproductive strategies.

MARINA B. BLANCO^{1,2}, LAURIE R. GODFREY¹ and PATRICIA C. WRIGHT^{2,3}.

¹Department of Anthropology, University of Massachusetts, Amherst, ²Centre ValBio Research Station, Ranomafana, Madagascar,

³Department of Anthropology, Stony Brook University.

The small-bodied, nocturnal mouse lemurs (*Microcebus* spp.) occupy a wide variety of habitats in Madagascar, from rainforest to spiny thicket. They are long day seasonal breeders and females undergo estrus at the end of the dry season, after prolonged reproductive quiescence. Captive studies of gray mouse lemurs have indicated endogenous regulation of reproduction. Although some have suggested social modulation of reproduction through olfactory cues, other studies have not found a correlation between age, parity or social conditions and estrous synchrony among females.

We present observations of wild brown lemur females (*n*=30) captured at Ranomafana National Park (rainforest) during the reproductive seasons of 2005 to 2008. Reproductive condition was assessed by abdominal palpation, body mass gain and nipple development. Estrus was determined through vaginal smears. The timing of estrus within seasons does not correlate with female body mass or age. The “periodicity” of inter-annual estrous intervals ranges from 352 to 377 days and averages ~365 days, which is consistent with endogenous regulation entrained by photoperiod.

Because female mouse lemurs begin their reproductive season in relatively “poor” body condition (i.e., lowest annual body masses) and in unpredictable habitats, their reproductive success is expected to vary. Indeed, despite their endogenous regulation of estrous onset, mouse lemur females do vary in the number of litters they have per season and their expression of seasonal torpor. This variation is manifested both within and between species and it bears testimony to a previously unrecognized “opportunism” in reproductive strategies. Grant support: MMBF/CI Primate Action Fund, The Rufford Foundation to MBB, and NSF BCS-0721233 to P.C.Wright, L.R.Godfrey, and J. Jernvall.

Deformed or not deformed, that is the question: Quantifying cranial deformation.

SAMANTHA H. BLATT and PAUL W. SCIULLI. Department of Anthropology, The Ohio State University.

There is an amount of subjectivity when classifying deformed versus non-deformed crania. Visual classification and seriation of a sample is the first step. In populations that show a gradual continuum from non-deformed to highly deformed crania, discriminant function and principal component analysis may further assist in the classification of ambiguous crania using metric data. This study considers the procedures and utility of identifying deformed

crania and attempts to define the most useful craniometrics for determining artificial deformation. The sample is comprised of 49 crania from the Lakeview Heights (*n*=32), Berryhill (*n*=6), and the Carty (*n*=11) sites in central Ohio. All sites date to approximately 2700-2300 B.P. The combined sample consists of 37 non-deformed crania and 12 deformed crania of adult males, females, and individuals of unknown sex. Both forms, non-deformed and deformed crania, were included from each site. Thirteen standardized cranial measurements were taken of each skull and discriminant function analyses were performed in SAS 9.1. Plots indicate an overlap of each measurement between form types, but forms do not exceed certain values and therefore are identifiable from each other. Although deformed crania occasionally score as non-deformed, non-deformed crania infrequently scored as deformed. Significance of length and breadth measurements attest to the likelihood that all of the deformed crania display fronto-occipital deformation (as opposed to annular). Though a larger sample size is needed, based on these results discriminant function can be used to classify ambiguous crania into either non-deformed or deformed types.

Cross-sectional geometries in Plio-Pleistocene hominins and their relevance to taxonomic assignments.

MICHELE M. BLEUZE and ANDREW J. NELSON. Department of Anthropology, The University of Western Ontario.

Long bone cross-sectional properties describe structural modifications that are generally attributed to loading history. Differences in cross-sectional geometries among Plio-Pleistocene hominins have been used to sort fossils into functional (i.e. locomotor) groups. Although the full extent of femoral cross-sectional geometric variation in Plio-Pleistocene hominins is unknown, some researchers have suggested that differences in cross-sectional morphology, and by extension locomotor behavior, may be valuable for taxonomic identification. This study examines femoral cross-sectional geometries in East African pre-Homo erectus and H. erectus to examine how well they follow taxonomic assignments.

UPGMA cluster analysis is used to assess similarities and differences among fossil samples. In the proximal femur, the *Paranthropus* samples do not form a single group, but instead form two clusters. In the midshaft femur, early Homo and H. erectus form a cluster. The taxonomically debatable KNM-ER 1807 is grouped with KNM-ER 1592, a *Paranthropus* specimen. KNM-ER 736, which is generally regarded as H. erectus, is grouped with KNM-ER 1807 and KNM-ER 1592.

If the taxonomic attributions of the fossils are valid, the results of this study suggest that the formation of functional groups based on cross-sectional geometries are not completely congruent with taxonomic assignments. This may indicate a wide range of intra- and inter-species variation in cross-sectional geometries, which alludes to locomotor variability within and between species. These results may also

indicate the need to revise some of those taxonomic attributions. This study was funded by The University of Western Ontario Graduate Thesis Research Award

Sub-adult survival and the ‘invisible fraction’: The contribution of juveniles to the heritability of fitness in female macaques.

GREGORY E. BLOMQVIST. Department of Anthropology, University of Missouri.

Heritability of fitness is an important parameter for evolutionary studies, but it is controversial and difficult to estimate this quantitative genetic statistic. I compare two single generation proxies of individual fitness estimated from demographic information (lifetime reproductive success, LRS; and individual finite rate of increase, individual lambda) and lifespan for the female members of a free-ranging population of rhesus macaques (*Macaca mulatta*).

All three variables have moderate heritabilities ($\lambda = 0.36$, $LRS = 0.38$, $\text{lifespan} = 0.43$) that are consistently depressed when non-reproductive individuals are censored from the analysis. This reduction suggests there is a relatively large genetic component to variation in juvenile survival and commencement of reproduction in this population, which may be related to relatively benign, homogeneous environmental conditions. Any time gaps in modeling an animal's life cycle can introduce similar inaccuracies in heritability of fitness proxies, although the direction of error is likely to vary with environmental conditions. Genetic correlations between the three variables were all indistinguishable from +1 implying no independent genetic variation. The similarity of heritability estimates for lambda and LRS and strong genetic correlations are attributed to the dominance of adult lifespan in determining fitness for female macaques which are slow-reproducing by mammalian standards. Heritabilities of both proxies should be estimated when possible because of the different information they may provide, particularly in taxa with larger litters. Research supported by University of Illinois Graduate College and University of Missouri. Cayo Santiago and the Caribbean Primate Research Center (CPRC) are supported by the University of Puerto Rico and National Institutes of Health (NIH). The genetic database of paternities was used in this research under agreement with its creators who were funded by National Science Foundation, Guggenheim Foundation, University of Berlin, Deutsche Forschungsgemeinschaft, Medizinische Hochschule Hannover, NIH and CPRC.

The ecological importance of abundance in early hominids.

RENÉ BOBE. Department of Anthropology, University of Georgia.

A central ecological attribute of a species is its relative abundance in an ecosystem. Most ecosystems are characterized by having few abundant species and many rare ones. Among Pliocene and early Pleistocene East African mammalian communities, hominids were relatively rare, but quantification of hominin

relative abundance is hampered by taphonomic issues and field collection methods. Here I describe collection methods carried out in the Turkana Basin of northern Kenya (Koobi Fora Formation), in the lower Omo Valley of southern Ethiopia (Shungura Formation), and in the Afar region of northern Ethiopia (Hadar Formation) that provide empirical data on hominid relative abundance. The samples include more than 4,000 systematically collected fossil vertebrates, and indicate that hominids typically constitute a very small proportion of the fauna on fossiliferous exposures. Although the relative abundance of fossil vertebrates collected on surface exposures does not translate directly into relative abundance in paleocommunities, these results indicate that hominids must be treated as rare taxa. A quantitative estimate of hominid relative abundance is critical in evaluating first and last appearance dates, and therefore patterns of turnover and diversity. In considering rare taxa, there is great uncertainty that a first or last occurrence datum constitutes a true origination or extinction event rather than an artifact of sampling. Thus, estimates of relative abundance are critical for our understanding of patterns of human evolution during the Pliocene and Pleistocene.

The particulate size of cremated remains.

KATELYN BOLHOFNER. University of Florida.

As the number of commercial cremations conducted in the United States rises, forensic anthropologists have been increasingly called upon to aid in the investigation of cases involving allegations of commingling, questioned identity, and negligence. These cases have brought to light the need for new data and fixed parameters concerning the state of human remains immediately following cremation. New types of post-cremation processors are making forensic analysis of cremated remains more difficult because of their efficiency in reducing recognizable skeletal fragments to microscopic particles. Beyond a general understanding of expected total weights, ratio patterns with regard to the size of the particles produced by these processors and their correlation with length of pulverization have not been previously recorded. This study establishes basic expectations of the ratios of the various particulate sizes produced by standard cremation and processing by a rotary blade processor for the manufacturer-recommended length of time. Further, the research presented here reveals consistent changes in expected ratios of these particulate sizes and shows a definite correlation between pulverization time and the resulting particulates available for analysis. As predicted, 4mm particles made up the lowest percentage of the total weights, and were never found to be over 14.37% of a sample processed for 30 seconds. It is with this sample that the most significant decrease was found in correlation with time spent in the processor: 4.52% at its greatest, and 3.31% on average. Particles of 2mm and 1mm consistently sustained little change when processed for an additional 30 seconds. This study was funded by

the University Scholars Program at the University of Florida and by a Wentworth Travel Scholarship.

Inter-individual differences in male vocalization behaviour within *Lemur catta* troops.

LAURA BOLT. Department of Anthropology, University of Toronto.

Lemur catta has a large vocal repertoire for a strepsirrhine, with 22 distinct adult vocalizations. Although past studies have described behavioural contexts and spectral characteristics of these vocalizations, no studies to date have investigated vocalization rates in *L. catta*. Focal sampling data were collected from October–December 2008, on 12 males aged one or older from 3 free-ranging, provisioned *L. catta* troops on St. Catherines Island, USA. Male membership in groups ranged between 2 and 6. Vocalization rate differences were compared among group males, and correlated against natal or non-natal status.

Within the two largest troops, males showed significant differences in overall vocalization rate (chi-square: largest group, n=6 males, p=1.035E-07, 2nd largest group, n=4, p=0.01916). Male vocalization rate ranged between 5.55% and 38.96%. In the largest troop, the males showed significant differences in affiliative, agonistic, and antipredator vocalization rates, while in the second largest troop, males showed significant differences in agonistic vocalization rate (p<0.05 for each rate). Overall, there was also a significant difference between natal and non-natal males in the frequency of agonistic and antipredator vocalizations (p<0.05 for each), in the context of a “vocalization activity budget”, which focuses specifically on percentages of vocalizing time, rather than total focal time. Non-natal males allocated a greater number of their vocalizations to agonistic calls, and fewer to anti-predator calls. There appear to be strong inter-individual differences in male vocalization behaviour within *Lemur catta* troops. These findings are significant because they suggest male troop members show differential participation in vocal communication within groups. This study was funded by the American Museum of Natural History, the Edward J. Noble Foundation, and a Canada graduate scholarship from the National Sciences and Engineering Research Council of Canada.

Dental development timing in *Pan paniscus* with comparisons to *Pan troglodytes*.

DEBRA BOLTER¹ and ADRIENNE ZIHLMAN². ¹Department of Anthropology, Modesto College, California, ²Department of Anthropology, University of California, Santa Cruz.

Dental eruption provides markers of growth and is one component of a chimpanzee's physical development. Dental markers help characterize transitions between life stages, e.g., adolescent to adult. Most of what we know about the timing of development in chimpanzees derives from *Pan troglodytes*. Much less is known

about the sister species, *Pan paniscus*, with few in captivity and a restricted wild range in central Africa. Here we report on the dental eruption timing for female captive *paniscus* whose ages are known and range from birth to age 11.7 years (n=6). Some observations were made during life; remainder observations were made at death, both gingivally and on skeletons after dissection.

Newborns have no teeth emerged. By 10 months, all but the second molars and canines are emerged. For permanent teeth, results show by 6.8 years, I1, P4 and M1 are fully erupted with M2 almost into full occlusion, while P3 is just erupting. By 7.3 years, P3 is fully erupted, I2s and mandibular Cs are fully erupted with maxillary Cs just emerging. M3s had not emerged through the gingiva by 7.9 years, but were partially erupted 7 months later, at 8.5 years. By 11.7 years, M3s were in full occlusion and first reproduction had occurred. In the wild, *paniscus* first reproduction occurs around age 14-15 years. We hypothesize that physical growth in captive *paniscus* is accelerated, a pattern similar to *troglodytes*.

New insights into Native American origin from nuclear DNA sequences.

SANDRO L. BONATTO¹, NELSON J. R. FAGUNDES² and FRANCISCO M. SALZANO². ¹Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil; ²Department of Genetics, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

Coupled with several independent lines of evidence, mitochondrial DNA and Y chromosome uniparental markers have contributed profoundly to our knowledge about the peopling of the New World. However, these single loci are not able to recover the full demographic history of populations, since previous genetic history is usually lost after severe population bottlenecks. This may help to explain why very few are known about the demographic history of the founder population during the period before the bottleneck and expansion associated with entrance into America and after the divergence from Asian populations. These single loci limitations could be partially circumvented with the analysis of a large number of informative and independent nuclear loci. To date, however, the few resequencing studies with native American and Siberian populations analyzed too short or too few loci. We are using previously published information and new resequencing data of a large number of nuclear loci from Native Americans and Siberians together with recently developed analytical methods to better understand the demographic history of the founder population of the Native Americans. This study was funded by CNPq and CAPES.

From outer to inner structural morphology. The integration of the third dimension in the visualization and quantitative analysis of fossil dental remains.

LUCA BONDIOLI¹, PRISCILLA BAYLE², CLÉMENT ZANOLLI^{2,3} and ROBERTO

MACCHIARELLI^{2,4}. ¹Sezione di Antropologia, Museo Nazionale Preistorico Etnografico "L. Pigorini", Rome, ²Département de Préhistoire, UMR 7194, MNHN Paris, ³Forschungsinstitut Senckenberg, Frankfurt am Main, Germany, ⁴Département Géosciences, Université de Poitiers, France.

Methodological advances in dental anthropology have shown that reliable information for assessing evolutionary pathways and phylogenetic relationships, adaptive strategies, age- and sex-related patterns of variation, and timing and patterning of development in extinct hominid taxa is hidden within the dental crown and root(s). The extraction and decryption of this record may help to shed light also on various aspects of fossil life-histories, including fluctuating health conditions and seasonally-related individual-environment relationships.

In addition/alternative to histomorphometry, which can be used only very parsimoniously in paleobiology, the increasing use of noninvasive analytical techniques (such as those based on microfocal X-ray computed tomography) capable to virtually explore, to extract, to "clean", and to finely render at varied resolutions the even noisy signature hidden in fossil specimens, has recently opened new promising research perspectives in the field. Notably, this implies the 3D (vs. 2D) imaging of mineralized tissues and the surface/volumetric (vs. linear) characterization of their structural variation.

Nonetheless, a reliable investigative shift from outer to inner dental morphology does not only require new, advanced techniques (and technologies), but also new fundamental concepts and questions concerning what (and how) should be rendered and characterized (both qualitatively and quantitatively) in routine analytical protocols. In this perspective, together with the need to extensively report extant/recent variation, a long-term methodological work still waits dental paleoanthropologists.

By using a large fossil sample, we explore taxonomic-related variation in deciduous dental tissue proportions and quantify dentine thickness topography by means of morphometric maps of virtually unrolled tooth roots. This study was funded by French CNRS, Univ. of Poitiers (Centre de Microtomographie), ESRF (Grenoble), EU FP6 Marie Curie Actions MRTN-CT-2005-019564 EVAN, Deutscher Akademischer Austausch Dienst, EU TNT Project, Nespos Society (Mettmann).

Maturation and social organization: males grow more slowly in multi-male groups of Phayre's leaf monkeys.

CAROLA BORRIES and ANDREAS KOENIG. Department of Anthropology, Stony Brook University.

Social influences on the speed of male maturation have been reported for a wide range of animal species, including nonhuman primates. Male orangutans are perhaps the most prominent primate example, because the flanged status can be delayed for decades. In most primate species, however, males might

circumvent social constraints on growth by dispersing from their natal group. We investigated social influences on male maturation in wild Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*); a species in which males regularly mature and breed in their natal group while females disperse. Because half of the groups in the population at Phu Khao Wildlife Sanctuary (Thailand) were one-male and the others multi-male, we could investigate the influence of social organization on male growth. Since the year 2000, the maturation process of individually identified males had been documented. Age at weaning was defined via nipple contact. The size (head-body length) of males was rated monthly to assess subadult (at least adult female size) and adult size. While age at weaning (n=21) and age at subadulthood (n=10) was not affected by social organization, males became adult significantly later in multi-male groups (MWU-test, P<0.04, n=9) likely because they remained subadult significantly longer (MWU-test, P<0.01, n=10). Major injuries and the presence of male peers both had no effect. These data indicate that male Phayre's leaf monkeys growing up in multi-male groups face significant disadvantages. In the future, we hope to investigate the proximate mechanism of this delayed maturation and the potential consequences for male reproductive success. Supported by the National Science Foundation (BCS-0215542, BCS-0542035), the Leakey Foundation, National Geographic CRE, and Stony Brook University.

Looking for natural selection in the American continent.

MARIA CÁTIRA BORTOLINI¹, TÁBITA HÜNEMEIER¹, VICTOR ACUÑA ALONZO^{2,3}, ANDRÉS RUIZ-LINARES⁴, LUANA MACIEL¹, VANESSA RODRIGUES PAIXÃO-CORTES¹, PATRICIA ASHTON-PROLLA¹, SAMUEL CANIZALES-QUINTEROS³ and FRANCISCO MAURO SALZANO¹. ¹Department of Genetics, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; ²Molecular Genetics Laboratory, Escuela Nacional de Antropología e Historia, Mexico City, ³Unit of Molecular Biology and Genomic Medicine, Universidad Nacional Autónoma de México, Mexico City, ⁴Department of Biology, University College London.

Even considering that many alleles are eliminated or fixed due to stochastic events, it is expected that part of the molecular diversity found in Native Americans is the result of variable selective pressures in different geographical regions, each with its own ecosystem. To investigate this problem we studied two genes and one conserved noncoding sequence of known functional importance, using TaqMan and sequencing assays: ABCA1 (plays a key role in cholesterol efflux), p53 (a master sensor of stress signal), and HACNS1 (a transcriptional enhancer) in a large Native American sample ($\geq 4,000$; 36 tribes from North, Central and South-America). At ABCA1 locus we verified the presence of an

autochthonous allele (*230C*) which reinforces the role of Beringia in the American prehistoric colonization. Several analyses, including the relative extended haplotype homozygosity test, indicated that (*230C*) may have contributed to the adaptation of Amerindians after expansion from Beringia, but today, due to recent life style changes, it may be related to metabolic diseases. Additionally, we observed that the *Arg72* allele at the *p53* locus, associated in Asia with high fitness levels (adaptation to low temperatures and embryo implantation) occurs, in high frequencies, in Amerindians. Finally, the 13 human-specific substitutions in HACNS1, earlier related to a gain of function in our species, are fixed and no new mutation was identified in all Native American individuals investigated. This result reinforces the idea that this region is highly constrained in different human populations, a finding that cannot be fully explained by a neutral model of evolution. This study was funded by CNPq and CAPES.

Diet and ranging patterns of the tufted capuchin *Cebus apella* in a Bolivian mixed forest fragment.

MIRTE BOSSE¹, KIMBERLY DINGESS^{2,3} and JACINTHA ELLERS¹. ¹Department of Animal Ecology, Vrije Universiteit Amsterdam, ²Anthropology Department, Indiana University Bloomington ³WCS Bolivia Research Associate.

The tufted capuchin *Cebus apella* is among the most omnivorous primate species worldwide. Forest fragmentation can cause home range restriction, and access to fruiting trees can be limited for primates in forest fragments. Therefore they may switch to other dietary items in order to maintain their daily nutritional requirements. This is the first study on the ranging and feeding behavior of *C. apella* in Bolivia and describes the influence of habitat restriction in a seasonal mixed forest fragment on diet and ranging patterns of the species. Group location and dietary diversity was recorded during continuous focal sampling. Dietary composition was obtained by feeding bout observation and fecal analysis. Our results show that home range size was smaller than the total available habitat and biased towards subtropical moist forest compared to dry (chaqueño) forest. Ripe fruit was the main component of the capuchins diet. Time spent on fruit was relatively longer and more evenly distributed. In addition to fruit, diet consisted of animal and vegetable matter to a total of 123 different observed dietary items. The capuchins became more insectivorous at the end of the wet season when fruit availability dropped. Home range size was smallest in the wet season (54 ha), and largest in the dry season (87 ha). Subtropical forest was visited significantly more and chaqueño significantly less than expected and this preference was strongest in the wet season. Vegetation type in the available habitat is probably a key factor in the survival chances of capuchins in fragmented areas. This project was financially supported by the Becker-La Bastide fonds, the Vereniging voor Christelijk Wetenschappelijk Onderzoek and the Dr. Christine Buisman Fonds.

New fossil evidence on the structure of the plesiadapiform hand skeleton: Implications for the evolution of grasping in primates.

DOUG M. BOYER¹, STEPHEN G.B. CHESTER² and JONATHAN I. BLOCH³. ¹Department of Ecology and Evolution, Stony Brook University, ²Department of Anthropology, Yale University, ³Florida Museum of Natural History, University of Florida.

Extant primates have specialized grasping hands and feet. The earliest well-preserved fossil euprimates (Eocene adapiforms) also have long fingers relative to their metacarpus and a moderately divergent pollex (22-40°), consistent with a prehensile grasping hand. However, their metacarpal (MC) distal ends are convergently arranged, and the pollex of at least European adapids was "pseudo-opposable" with little mobility at the trapezium-MCI joint. The MCI of plesiadapid plesiadapiforms (stem-primates) has been described as more divergent (54°) and immobile. Most plesiadapiforms have euprimate-like prehensility, but articulated specimens have been lacking and it has been unclear whether they exhibited convergent metacarpals or a more specialized parallel arrangement like extant primates.

We use the first known articulated metacarpal series of a plesiadapiform, that of a late Paleocene micromomyid *Dryomomys szalayi*, to evaluate the identification of bones in a contemporary skeleton (not articulated) of the plesiadapid *Plesiadapis cookei*. Comparison to micromomyid metacarpals reveals that plesiadapid metacarpals previously identified as MCII are actually MCV. Thus, evidence originally marshaled for a rigid MCI-MCII articulation is now lacking. Articulating the carpus and metacarpus of *P. cookei* reveals that there was little mobility at the trapezium-MCI joint, and much lower pollical divergence (18°) than estimated previously. Such divergence is still quite high when compared to non-primate eucarchontans. This study also reveals a convergent MC arrangement in plesiadapids as well as other primitive similarities to adapiform euprimates. These results suggest that relatively few evolutionary changes with major functional significance separate early euprimate manual grasping from that of stem-primates. This study was funded by the John F. Enders Fellowship, Yale University (SGBC); a National Science Foundation Dissertation Improvement Grant (BCS-0622544), Evolving Earth Foundation, American Society of Mammalogists (DMB).

The willing cuckold: Optimal paternity allocation, infanticide and male reproductive strategies in mammals.

RYAN H. BOYKO and ANDREW J. MARSHALL. Department of Anthropology, University of California, Davis, Graduate Group in Ecology, University of California, Davis.

Infanticide is believed to be an adaptive strategy in many mammalian taxa. A number of authors have modeled aspects of infanticide and its potential impact on social systems, but limited

attention has been paid to identifying the full range of conditions under which infanticide should be favoured or the variety of potential effects that infanticide may have on male mating strategies. While most authors focus on infanticide by new male immigrants, natural selection should favour infanticide under a wider range of conditions, including sometimes by potential fathers. Here we model male decisions about whether to commit infanticide and explore how infanticide risk may affect optimal male mating strategies. Infanticide risk coupled with imperfect infanticide protection in a population creates a fitness landscape with two adaptive peaks, one representing complete paternity certainty and the other which represents a compromise between maximizing paternity and minimizing infanticide risk. Which of these adaptive peaks represents the fitness-maximizing global optimum depends on a population's socioecology and characteristics of the male. In many ecological contexts, males may adaptively reduce their paternity probability to reduce the risk of infanticide. Explicit consideration of this possibility may enhance our understanding of the dynamics of mammalian intrasexual and intersexual competition in a number of ways.

Gender, BMI, and migration: A meta-analysis of populations of the East-Asian diaspora.

JEFFREY BRADY and LORENA MADRIGAL. Department of Anthropology, University of South Florida.

A question that has vexed human biologists for years is whether migrants have better health measures than non-migrants (Gage, 2000). Numerous methodological problems with comparing the biological well-being of migrants with non-migrants make this question difficult to answer. Here we present results of a meta-analysis of the BMI of populations of East-Indian descent who reside in and out of India. Data were collected from the literature and from our own work with Indo-Costa Ricans. We tested for differences in the prevalence rate of obesity (BMI >=30) with Cochran-Mantel-Haenszel statistics, controlling for gender, age, and urban-rural environment. We restricted our analysis to papers published after 1989.

Comparing female urban samples of subjects 18+ years of age, we found that the prevalence of obesity is lower in non-migrant East-Indians than in migrants who reside in England ($\chi^2=78.2$, $p< 0.0001$, $n= 577$), Singapore ($\chi^2=33.4$, $p< 0.0001$, $n=1008$), and Australia ($\chi^2=16.05$, $p< 0.0001$, $n=275$). Subjects 30+ years of age showed similar significant results. The same comparison in males yielded significant results when Indian residents were compared with migrants of age 30+ residing in England ($\chi^2=16.3$, $p< 0.0001$, $n=1042$) and migrants of age 18+ residing in Singapore ($\chi^2=6.3$, $p<0.04$, $n=1248$), but not with migrants of age 18+ residing in Australia ($\chi^2=2.45$, $p>=0.11$, $n=484$).

Our study indicates that migrants suffer from an increased prevalence rate of obesity than do non-migrants. However, our data also indicate

that the genders experience this BMI increase at different levels. Any questions regarding the health of migrants and non-migrants should control for gender, age, and social factors. This study was funded by a grant from The USF globalization center and the USF Patel Center.

Assessment of dental health and stress patterns of juveniles in an African-American population from Newburgh, New York.

MELANIE J. BRASOR¹ and KENNETH NYSTROM². ¹Department of Anthropology, University at Albany, ²Department of Anthropology, University at New Paltz.

Recent excavations in the city of Newburgh, New York have uncovered 106 burials associated with an early to mid 19th century African-American cemetery. It was during this time period that the gradual emancipation of enslaved Africans was occurring. Of the 106 burials, 99 individuals were able to be analyzed in the laboratory and 30 of those individuals were identified as juveniles. This poster focuses on the health and stress patterns of these juveniles. Frequency of dental pathologies, such as caries, calculus, linear enamel hypoplasias, and other enamel defects were recorded. Results indicated that 56% of the juvenile subsample had dental pathologies. Caries were found in 30% of the sample, while 16% of the sample had linear enamel hypoplasias. Seventy-six percent of the individuals with dental pathologies displayed numerous non-linear hypoplastic defects, while 13% of the subsample exhibited severe enamel defects indicative of a systemic illness. This study indicates that children who lived and died young in this population experienced levels of stress that were adequate enough to leave indelible marks on enamel surfaces. The occurrence of other dental pathologies indicates a diet rich in cariogenic foods coupled with insufficient dental care. A possible factor contributing to inadequate health care could be emancipation: despite manumission, African-Americans in Newburgh still experienced poor health due to prejudice and discrimination. This research was supported by the Graduate Student Organization Research Grant at the University at Albany.

Variation in toll-like receptor function in old world monkeys, apes and humans.

JESSICA F. BRINKWORTH^{1,2}, SANNA M. GOYERT³ and JACK SILVER³. ¹Department of Anthropology, City University of New York, ²New York Consortium in Evolutionary Primatology, ³Department of Microbiology and Immunology, Sophie Davis School of Biomedical Education, City University of New York.

Pathogens are a major selective force driving the evolution of mammals. Divergence in primate geographic distribution, social behaviour and landscape exploitation has led to differences in pathogen exposure, parasite load and infectious disease risk between primate populations. To test if catarrhines have evolved divergent innate immune responses to infectious

agents, we challenged whole blood of four primate species with pathogens thought to be prevalent in particular primate evolutionary environments. Fresh whole blood from *Papio* sp., *Macaca mulatta*, *Pan troglodytes* and *Homo sapiens* was acquired from commercial sources, shipped at 4C overnight and challenged with microbial components representing various pathogen-associated molecular patterns (PAMPS). We selected PAMPS from Toll-like receptor-detected pathogens that are unevenly distributed across primate species and are associated with specific primate habitats (i.e. *Mycobacterium*, *Yersinia pestis*, *Bacillus anthracis*). After 1.5 hour of stimulation, red blood cells were hemolysed and white blood cells were centrifuged. RNA was extracted using the Qiagen RNeasy mini kit and reverse transcribed using Qiagen Sensiscript RT. Immune responses were assessed by measuring cytokine and chemokine induction by Elisa and Real Time quantitative PCR. Differences in cytokine response may reflect differences in primate disease ecology. Results of these studies will be discussed in the context of historical primate pathogen exposure. This study was funded by the National Science Foundation (#BCS-0752297) and Wenner Gren Foundation (#7845).

The quantification of bovid tooth morphology and its implications for reconstructing past hominin environments.

JULIET K BROPHY. Texas A&M University.

Fossil bovids are widely recognized as valuable ecological indicators, useful for reconstructing paleoenvironments associated with early hominin remains. Taxonomic identification of bovid remains in the Plio-Pleistocene fossil deposits of South Africa is based predominantly on dental remains, usually isolated teeth. However, factors such as age, sex and degree of occlusal attrition of teeth often render taxonomic identification difficult. In addition, teeth of closely related bovid taxa can be particularly difficult to diagnose at the species level. Given that closely related bovid species often have diverse ecological requirements, incorrect identification of bovids recovered from fossil sites can have significant ramifications when reconstructing environments. This study tests a method for accurately identifying bovid teeth using Elliptical Fourier Analysis in order to standardize their identification. The project involves: digitizing the occlusal surface of a tooth; calculating an average outline for each tooth, per species; and statistically comparing the quantified tooth shape to other closely related bovids. The quantification results are used to assess morphological variation both intra- and inter-specifically. Alcelaphines are typically the most common bovid recovered from fossil sites in South Africa, and statistical results indicate that modern alcelaphine teeth are consistently correctly classified. Preliminary examination of alcelaphine teeth from Coopers Cave reveals the presence of the *Connochaetes taurinus*, in a form indistinguishable from modern wildebeest, demonstrating a relatively early pan-African distribution for this grassland

specialist. These findings will have significant implications for our current understanding of the ecological and habitat preferences of the robust australopithecines in South Africa. This study was funded by Texas Academy of Science and Texas A&M University.

Japanese-Americans show enhanced blood pressure responsiveness compared to European Americans when reporting negative moods: The Hilo women's health study.

DANIEL E. BROWN¹, LYNETTE L. SIEVERT², LYNN A. MORRISON¹ and ANGELA M. REZA². ¹Department of Anthropology, University of Hawaii at Hilo, ²Department of Anthropology, University of Massachusetts at Amherst.

Women of Japanese-American (JA, N=46) or European-American (EA, N=88) ethnicity aged between 45-55 years participated in a 24-hour ambulatory blood pressure (BP) monitoring study. During waking hours diaries were used in which mood was reported every 20 minutes at the time of BP measurement. BP was converted into z-scores for each individual. There were no significant ethnic differences in the frequency with which negative moods (anxiety, anger, sadness) were reported (JAs 21.9%, EAs 23.6%, $\chi^2 = 1.9$, ns), and there was also no ethnic difference in the severity of mood (mild, moderate, very) reported at times when a negative mood was noted ($\chi^2 = 4.6$, ns). There was a significant elevation of both systolic BP and diastolic BP when a negative mood was reported, and a significant interaction effect between ethnicity and negative mood report (analysis of variance: for SBP: negative mood report: F=64.9, p < 0.001; interaction: F=6.4, p=0.01; for DBP: negative mood report: F=69.8, p < 0.001; interaction: F=4.5, p < 0.05). During times when a negative mood was reported, JAs had significantly greater elevations of z-scores of systolic BP than EAs (0.30 versus 0.17, t=2.03, p < 0.05) and neared significance levels for diastolic BP (0.30 versus 0.19, t=1.85, p=0.06). BP of JAs in this sample therefore appears to be more sensitive to experience of negative moods than their EA age-mates, and this may be related to the generally high rates of hypertension in Japanese and JA populations. Supported by NIH MBRS S06 GM08073.

Sex-specific responses to naturally-occurring and simulated intergroup encounters.

MICHELLE BROWN. Columbia University.

Playback experiments are a means of assessing the impact of animal signals through the control of relevant variables and may be particularly useful for studying infrequent behaviors such as intergroup encounters (IGEs). To determine whether playback experiments can successfully emulate IGEs, I recorded and played the calls of six neighboring groups of mangabeys in Kibale National Park (n = 72 trials); I then compared the playback results to concurrent observations of naturally-occurring IGEs.

I evaluated male and female behavior according to whether any individual of either sex

approached the speaker. Crossed random effects logistic regression models (where the random effects are the identities of the focal and caller groups) indicate that the odds of a male or female approaching the speaker are affected by the size of the focal group, the calling group's location within its home range, and plant food abundance (males: Wald chi²=9.80, p=0.020; females: Wald chi²=8.35, p=0.039). By contrast, the model for naturally-occurring IGEs indicate that (1) male approaches are affected by the presence of females with peak sexual swellings, important food items, and the number of males in the focal group relative to the opposing group (Wald chi²=10.44, p=0.0337), and (2) female approaches are not significantly affected by any known variables. These discrepancies between the results of natural and simulated IGEs may stem from the fact that playbacks occur in a greater range of circumstances than natural IGEs; thus playbacks may expose larger behavioral patterns that cannot be determined through natural observations. This study was funded by the National Science Foundation, grant number 0824512; the Felcher-Bazerman Fund; the Leakey Foundation; Columbia University; and the International Primatological Society.

Brain shape and human variation: from integration to cognition

Emiliano Bruner¹, Manuel Martín-Löches², Roberto Colom³ ¹Centro Nacional de Investigación sobre la Evolución Humana, Burgos (Spain); ²Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos, Madrid (Spain); Universidad Complutense, Madrid (Spain); ³Universidad Autónoma de Madrid (Spain);

Brain shape is the result of the integration between functional factors associated with neural physiology (from metabolism to cognition) and structural factors associated with the morphogenetic relationships between brain and braincase. During evolution, some changes are supposed to be the result of specific adaptations, while others may be secondary consequences of this biological network. We have investigated the covariation between cortical and subcortical cerebral components in one-hundred modern humans, and the correlations between morphological variations and cognitive performance in a large set of psychometric tests and cognitive tasks. Results suggest a limited level of integration between the neural elements, with limited sexual or size effects. Posterior subcortical areas reveal some interesting features in relation to morphogenetic factors and in association with the parietal cortical profile. Psychological scores show a moderate but significant correlation with brain shape variation, suggesting a large individual component but at the same time possible biological relationships between brain form and cognition. This is particularly interesting when the extinct human variation is considered, taking into account the large neurocranial differences within the human genus.

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60485, Ministerio de Ciencia e Innovacion (MICINN), Spain.

Finding Vikings in the Danelaw: An osteological and isotopic analysis of the Masham Anglo-Scandinavian cemetery.

JO L. BUCKBERRY, JANET MONTGOMERY, NAOMI NEALE and JACQUELINE TOWERS. Archaeological Sciences, University of Bradford, UK.

Historical, artefactual and place-name evidence all indicate that a large number of Scandinavian migrants moved to eastern England in the ninth century AD, formally settling in an area that became known as the Danelaw. However, only a handful of characteristically Scandinavian burials, identified by cremation, barrows or the presence of Scandinavian grave goods, have been found in the region. Current evidence suggests that the majority of Scandinavian settlers quickly adopted local Christian burial customs, thus leaving Scandinavians indistinguishable from the Anglo-Saxon population.

Excavations in Masham, Yorkshire revealed part of a small cemetery of west-east aligned unaccompanied burials, but no evidence of a church. Radiocarbon dates indicate that the cemetery was in use during to the seventh to eleventh centuries AD, encompassing the period of Scandinavian settlement of the Danelaw. The population consisted of males and females, adults and children with a range of palaeopathological conditions were commonly seen in this period. Carbon and nitrogen isotope analysis of bone collagen indicates the group enjoyed a similar diet without any C4 plant or marine protein.

Oxygen and strontium isotope analyses were undertaken to identify first generation Scandinavian migrants in the community. The range of $\delta^{18}\text{O}$ within the Masham population is broadly consistent with Yorkshire; however there was separation of males and females within the data set. Many individuals were probably local to Masham, but strontium ratios indicated the presence of individuals who did not originate in eastern England but from a region of radiogenic rocks, such as those of Norway or Sweden. This study was funded by Harrogate Borough Council

Conflicting mitochondrial and Y-chromosomal phylogenies indicate complex evolutionary history of *Papio* baboons.

ANDREW S. BURRELL^{1,2}, CLIFFORD J. JOLLY^{1,2}, JANE E. PHILLIPS-CONROY³ and TODD R. DISOTELL^{1,2}. ¹Center for the Study of Human Origins, Anthropology Department, New York University, ²New York Consortium in Evolutionary Primatology, ³Department of Anatomy and Neurobiology, Washington University School of Medicine.

Recent molecular systematic studies of *Papio* have - for technical and logistical reasons - been based solely on mitochondrial DNA. The resulting phylogenies display widespread discordance between mitochondrial haplotype and diagnostic phenotypic features, possibly due

to asymmetric gene flow between baboon species (i.e., 'mitochondrial capture'). These studies also give only weak and inconsistent support for the 'north/south' split within *Papio* suggested by morphological data. Here we report a very strongly supported mitochondrial phylogeny of *Papio* as well as a nuclear phylogeny based on Y-chromosomal genes. Our mitochondrial phylogeny, in agreement with previous studies, shows considerable haplotype versus phenotype discordance within *Papio*. This tree also strongly supports the splitting of *Papio* into a northern clade consisting largely of *P. anubis*, *P. hamadryas*, and *P. papio*, and a southern clade composed of *P. cynocephalus* and *P. ursinus*. These two groups are inferred to have split ~1.7 Ma.

The Y-chromosomal tree, however, shows no north/south split, but rather places *P. papio* as basal within *Papio*. Each species has its own unique Y haplotype and (outside of hybrid zones) these haplotypes correspond to phenotypes. This Y-chromosomal pattern supports the hypothesis that asymmetric male-mediated gene flow has led to widespread mitochondrial capture within *Papio*.

The conflicting mitochondrial and Y-chromosomal topologies suggest that while the mitochondrial phylogenies do provide insight into the evolution of *Papio*, they should not be relied upon exclusively. More nuclear genetic data are needed to understand patterns of divergence and reticulation in the evolution of these primates. This grant was funded by NSF grant #BCS-0452835.

Spinous process morphology and positive identifications: A validation study.

ALYSSA BUTLER, HEATHER WALSH-HANEY, NICOLE WEBB, KATY SHEPHERD and CHRISTEN HERRICK. College of Professional Studies, Division of Justice Studies, Florida Gulf Coast University.

In medical examiner and coroner settings, a positive identification of an unknown decedent often relies upon the comparison of the decedent's postmortem radiographs to the in-life (antemortem) radiographs of the "believed to be" individual. Antemortem radiographs of the head and thorax are the most widely available, largely due to their diagnostic value. As such, disproportionate numbers of positive identifications are established through the identification of idiosyncratic characteristics involving vertebral spinous processes. Because a dearth of literature examining the validity of such comparisons exists, we test the accuracy of the method by comparing 9 antemortem radiographs from 9 individuals with 25 postmortem radiographs (from 25 individuals including the 9 individuals from the antemortem samples) from a medical examiner setting.

In order to test interobserver error and misidentification associated with radiograph quality, five observers ranging in experience (B.S. and PhD) independently compared and evaluated the spinous processes of the cervical and thoracic vertebrae in the antemortem and postmortem radiographs. Each observer evaluated the shape and contour of the spinous

processes using the following rubric: 0 = no match, 1 = probable and 2 = positive. Irrespective of degree, our results demonstrated that spinous process morphology accurate 80% of the time while validating this approach as a method of exclusion.

Evaluating ancestry based on craniometrics. A comparative study between Fordisc 3.0 and CRANID6 using crania from St. Leonard's Church, Hythe.

HANNAH BUTTERFIELD¹ and MARIE LOUISE JØRKOV^{2,3}. ¹University of Bournemouth, ²Copenhagen City Museum, ³Laboratory of Biological Anthropology, Copenhagen University.

The ossuary at St. Leonard's Church in Hythe, England contains approximately 2000 crania dating back to the 14th and 15th centuries, however, little is known of their origin. The initiation of establishing a biological profile for the individual crania ($n = 40$) has been undertaken using the statistical computer programmes CRANID6 and Fordisc 3.0. Utilising Discriminant Function Analysis (DFA) CRANID6 and Fordisc 3.0 determine the likely ancestry of an unknown crania based on known population samples. CRANID6 is based upon population data obtained by Howells and Wright and Fordisc 3.0 provides DFA using Howells population data and a separate analysis using data from the University of Tennessee Forensic Data Bank. The results obtained from the DFA using CRANID6 and Fordisc 3.0 were found to be significantly different using the chi square test ($p < 0.05$). CRANID6 found 80% of the Hythe sample to be most similar to individuals of Caucasoid ancestry; however Fordisc 3.0 resulted in only 50-67% of the Hythe sample being categorised as having Caucasoid ancestry. Further statistical analysis undertaken on Howells' European population samples found the Hythe sample to closely resemble crania from Zalavar, Hungary. It can be concluded that in the analysis of a possible European cranial sample, Fordisc 3.0 should not be used, due to the lack of European population samples. CRANID6 is the most appropriate DFA program to use. However it should be used with caution and combined with anthroposcopic analysis.

Biodistance between four Louisiana archaeological sites dated 800 B.C. to A.D. 1250, with a note on methods.

STEVEN N. BYERS¹ and REBECCA SAUNDERS². ¹Information Technology Services, Central New Mexico Community College; ²The LSU Museum of Natural Science, Louisiana Museum of Natural History.

Research was performed to determine if there is skeletal biological data to support prehistoric migration into Louisiana as suggested in some interpretations of the archaeological record. Presence or absence was scored for 29 cranial non-metric traits on over 400 highly fragmented individuals from four sites: Little Woods and Lafayette Mounds (dated in the period from 3000 to 2100 B.P.), Crooks (2100 to 1550 B.P.),

and Greenhouse (1550 to 1200 B.P.). Because the fragmentary nature of the remains made it difficult to obtain large sample sizes, in-migration/genetic isolation was tested by computing exact probabilities of independence in contingency tables constructed for all traits by site. In addition, the Mean Measure of Divergence (MMD) was calculated on a smaller number of more frequent traits. The results of both computations indicated that there is no statistical reason to believe that genetic intrusion from outside populations occurred at these four prehistoric sites. These analyses call attention to several methods in statistics that can be of use to researchers faced with analyzing similar small sample sizes. The Freeman-Halton extension of Fisher's Exact Test allows for the exact probability of independence for contingency tables with more than two rows and columns; this is very helpful when small sample sizes make the use of more common methods (e.g., Chi-square) problematic. In addition, statisticians have shown that multiple tests on related samples are valid when the Bonferroni criterion and False Discovery Rate are used to modify the Type I error rate.

Utilizing mtDNA to look at cold cases: Who were the people in the Jackson Street burials?

JENNIFER F. BYRNES¹, ESTHER J. LEE², D. ANDREW MERRIWETHER² and JOYCE E. SIRIANNI¹. ¹Department of Anthropology, University at Buffalo, ²Department of Anthropology, Binghamton University.

The Jackson Street Burials were excavated in 1997 after being discovered during work on a road construction site in Youngstown, NY. The eleven burials (five adults and six children) excavated have no known history of which could either be deduced from the physical evidence or found in past burial records. Based on the likely association of artifact assemblage and the history of Fort Niagara, the cemetery was used sometime between the late 1700s and 1840. The east/west orientation of the burials and preliminary analysis suggested these individuals to be of European ancestry.

In order to further gain insight into the identity and relatedness of these unknown individuals, we extracted DNA from teeth of each individual and sequenced the control region of the mitochondrial DNA following standard procedures. Results show that six individuals (burials 3-6, 8, and 9) have Native American ancestry. Two individuals (burial 8 & 9) have the exact same haplotype. Burial 2 seems to be of European origin and we were unable to resolve burial 7, while three samples (burials 1, 10, and 13) failed to produce successful DNA results. The genetic analysis suggests some conflicting results with regards to ancestry when compared with the original assessment. This study draws attention to problems that can arise from archaeological deductions and to the utilization of genetic analysis, which can validate or reject old conclusions to further our understanding. This study was funded by the Graduate Student Association Mark Diamond Grant Fund, grant number Sp-08-04.

Rudimentary pedal grasping in mice and implications for terminal branch arboreal quadrupedalism.

CRAIG BYRON, HAWLEY KUNZ, STEPHANIE LEWIS and DANIEL VANVALKENBURG. Department of Biology, Mercer University.

Here we use an outbred laboratory mouse strain (ICR/CD-1, Charles River Laboratories, Inc.) to model a type of pre-primate locomotion associated with rudimentary pedal grasping. Ten male mice were assigned to either control or climbing groups ($n=5$ per group). Climbing mice lived within a specialized terrarium that included ~7.5 m of thin branches (5 and 10 cm long) with a thickness of 3.3 mm, arranged in a reticulated canopy of thin substrates. Food, water, and a nest site were placed among the branches. To discourage mice from palmigrade or digitigrade locomotion the floor of the terrarium was flooded with a few centimeters of water. Climbing mice were placed in this setting upon weaning and reared for 3 months until they were mature in size. Litter, and age-matched controls were also maintained for comparison with climbers.

Climbing mice quickly acclimated to the requirements of the fine-branch model using the foot and tail for grasping and balance. At maturity, climbing and control mice exhibited significant morphological differences ($P<0.05$). For climbers, these include: longer tails, greater angle of the femoral neck, decreased crural index, smaller joint surfaces in the elbow and ankle, and a slender heel. It is hypothesized here that observed hindlimb plasticity is functionally related to rudimentary grasping arboreal quadrupedalism. Furthermore, these results support the hypothesis that pedal grasping was a transitional step, acquired within Plesiadapoidea, that led to the later fine-branch invasion by Euprimates.

This study was funded by using a seed grant from Mercer University.

Anthropological genomics: Old dogs learn new tricks.

GRACIELA S. CABANA¹, LORENA M. HAVILL². ¹Department of Anthropology, University of Tennessee, ²Department of Genetics, Southwest Foundation for Biomedical Research.

A comprehensive understanding of the patterns and processes of adaptation and evolution in humans and other primates, past and present, has been the primary goal of bioanthropological investigations since the mid-20th century. A significant component of this bioanthropological project has been to reveal the fundamental genetic underpinnings of observed biological variation. Because of this, molecular-based studies have gained increasing currency within our discipline, and the field of "anthropological genetics" came into its own in the late 1980s and 1990s. Though apparent methodological and theoretical plateaus were reached by the end of the last decade, the present genomic era has presented us with a new landscape of opportunity.

The implications of high throughput generation of genomic data and powerful analytic programs and bioinformatic resources for the field of anthropological genetics have been tremendous. At a theoretical level, researchers are redressing long-standing issues of anthropological import, such as human variation, population structure, and selection, and their relationships to human evolutionary history, phenotype (including population affinity), disease susceptibility, etc. Anthropologists now move in novel and advanced directions while forging new inter- and intra-disciplinary collaborations. As the same time, these novel technological resources present their own challenges, including the need for additional training, a renewed understanding of bioinformatics, and higher-level funding. While anthropologists and geneticists are repositioning themselves to meet these challenges, we will discuss some of these dual challenges and opportunities as we move into a genomic era.

Factors influencing testosterone concentration in a captive population of genetically variable male baboons (*Papio* sp.).

JOSEPH CALIFF¹, JEFFREY ROGERS², LAURENCE GESQUIERE³ and CLIFFORD J. JOLLY¹. ¹Department of Anthropology, New York University and New York Consortium in Evolutionary Primatology (NYCEP), ²Human Genome Sequencing Center, Baylor College of Medicine and Southwest National Primate Research Center, ³Department of Ecology and Evolutionary Biology, Princeton University.

It is generally, and reasonably, assumed that species-specific behavioral traits are associated with distinctive hormonal profiles, and that the latter have evolved under the influence of natural selection. While social and environmental factors acting upon hormone levels have been extensively investigated, the identity, and even the existence, of genetic factors directly influencing hormone levels have not been established. Consequently, the hypothesis that hormonally-mediated behavioral diversity evolved by natural selection, though plausible, remains untested. As a first step in this direction, this project tests whether a significant proportion of variation in testosterone concentration is attributable to genetic variation in a captive population of baboons (*Papio* sp.) housed at the Southwest National Primate Research Center in San Antonio, TX. Fecal samples ($n=947$) from 250 pedigree, adult males were collected, and testosterone was extracted and measured by radioimmunoassay in the Altmann Laboratory (Department of Ecology and Evolutionary Biology, Princeton University). Using variance components methods implemented in the SOLAR statistical package (and incorporating variables such as age, weight, and dominance rank as covariates in the analysis), pair-wise comparisons between fecal testosterone concentration and relatedness among individuals in the pedigree demonstrate that inter-individual differences in minimum and mean testosterone levels are highly heritable ($h^2_{min}=0.692$, $p<0.001$; $h^2_{mean}=0.604$, $p<0.001$) in this population. While this finding in itself neither

supports nor disproves the role of natural selection in the evolution of hormonal profiles, it strongly suggests that genetically determined variation, the necessary condition for selection to occur, is present in male baboons. This research was funded by the National Science Foundation (BCS-0827570), Rotary International (Walter D. Head Foundation), the New York Consortium in Evolutionary Primatology (NYCEP), and the Center for the Study of Human Origins (CSHO) at New York University.

Evaluating the emergence of tuberculosis in South Africa.

TESSA J. CAMPBELL¹ and REBECCA R. ACKERMANN¹. ¹Department of Archaeology, University of Cape Town.

Tuberculosis is the leading cause of mortality in South Africa today. While in Europe and North America the topic has received much attention, little is known about the emergence of tuberculosis in southern Africa. Based on observations by early settlers, explorers and missionaries, numerous texts suggest that the disease was imported with European contact. However, these observations are sometimes contradictory to one another and to local oral histories. To date, the contribution of the archaeological record to this question has not been well-evaluated. Here we present preliminary results from a larger project that aims to identify possible cases of tuberculosis in the archaeological record of South Africa, in order to contribute to broader understanding of when and where the disease first emerged and how it spread.

Skeletal collections of historic and earlier Holocene material housed in institutions throughout South Africa were examined. Preliminary evaluation of 665 specimens has revealed five cases of possible tuberculosis infection: three show pathology of the vertebrae, one of the radius and one of the ribs. Three of these specimens are from the late 1800's and derive from mining and port towns where tuberculosis is known to have been well established by this time. The remaining specimens were unearthed from rural contexts, with at least one specimen dated to the late 1700's (possibly earlier). This is a particularly interesting observation because European contact with this population was thought to be limited at this time. The presence of tuberculosis in this region possibly indicates declining rural conditions. This study was funded by the Wenner-Gren Foundation Wadsworth African Fellowship.

Phylogenetic relationships of the mangabey inferred from analyses of multiple independent loci.

ANGELO P. CANEDO^{1,2}, ANDREW S. BURRELL^{1,2}, EVELYN JAGODA³, CHRISTINA M. BERGEY^{1,2}, ANTHONY J. TOSI^{1,2}, and TODD R. DISOTELL^{1,2}. ¹Center for the Study of Human Origins, Department of Anthropology, New York University, ²New York Consortium in Evolutionary Primatology, ³Edgemont Senior High School.

The Old World monkey tribe Papionini includes seven genera: *Macaca*, *Papio*, *Theropithecus*, *Mandrillus*, *Lophocebus*, *Rungwecebus*, and *Cercocebus*. Within the Afro-papionins, there are two broad morphological grades: small bodied, short faced 'mangabey' including *Cercocebus*, *Lophocebus*, and *Rungwecebus*, and large bodied, long faced 'baboons' including *Mandrillus*, *Papio*, and *Theropithecus*. However, these morphological grades do not reflect phylogeny, as Afro-papionins form two clades, one consisting of *Cercocebus* and *Mandrillus*, the other of *Lophocebus*, *Papio*, *Rungwecebus*, and *Theropithecus*. The relationships among genera within these clades are unclear, and hybridization and genus-level paraphyly may be common, possibly reflecting multiple instances of the independent evolution of baboon-like lineages from mangabey-like ancestors.

To test this, we have assembled the largest comparative molecular dataset of the Afro-papionins to date. This consists of data from multiple independent loci, including mitochondrial and Y-chromosomal sequence data and dozens of Alu elements, derived from a large sample set that includes representatives of peripheral species such as *C. sanjei* and *C. galeritus*. Current analyses of these data reveal strong support for the *Cercocebus/ Mandrillus* and *Lophocebus/ Papio/ Rungwecebus/ Theropithecus* clades identified in previous studies. Also as seen previously, there is incongruence between trees derived from different gene sequences. Preliminary analyses reveal inconsistent support for the paraphyletic placement of *Mandrillus* within *Cercocebus*, and there is no clear resolution of the relationships among *Lophocebus*, *Papio*, and *Theropithecus* clade. Given the conflicting signals from the sequence data, we are generating candidate Alu markers using a novel bioinformatics program to further clarify the phylogenetic relationships within each clade. This grant was funded by NSF grant #BCS-0715281 and the Wenner-Gren Foundation for Anthropological Research.

The locomotor repertoire of early *Homo*: Insights from chimpanzee variation.

KRISTIAN CARLSON^{1,2}, RICHARD WRANGHAM³, MARTIN MULLER⁴, RICK SUMNER⁵, MARY ELLEN MORBECK⁶, TOSHISADA NISHIDA⁷, ATSUSHI YAMANAKA⁸ and CHRISTOPHE BOESCH⁹. ¹Institute for Human Evolution, University of the Witwatersrand, Johannesburg. ²Department of Anthropology, Indiana University, Bloomington. ³Department of Anthropology, Harvard University, ⁴Department of Anthropology, University of New Mexico, ⁵Department of Anatomy and Cell Biology, Rush Medical College, Chicago, ⁶Department of Anthropology, University of Arizona, ⁷Japan Monkey Centre, ⁸Department of Oral Anatomy, Kagoshima University Dental School, Japan, ⁹Max-Planck Institute for Evolutionary Anthropology, Leipzig.

One of the unresolved issues in paleoanthropology is the extent to which postcranial morphology of early *Homo* evinces

adaptations for arboreal versus terrestrial positional behavior. A paucity of early *Homo* postcrania, and the incomplete nature of associated skeletons attributed to *H. habilis* (e.g., OH62), propagate the controversy. A recent study of relative limb strength (Ruff, 2009) has swung the pendulum back towards inferring a significant arboreal component in the locomotor repertoire of early *Homo*. The goal of this project is to embrace variation in chimpanzee postcranial morphology in order to examine these recently attributed arboreal adaptations, and determine whether particular chimpanzee communities offer more insight than others.

Using computed tomography (CT) and commercial imaging software, we acquired cross-sectional data from humeral and femoral diaphyses of 40 adult chimpanzees originating from several habituated communities (i.e., Gombe, Kibale, Mahale, and Tai). Using proxy measures of limb strength, or relative rigidities, several properties of the chimpanzee limb bones were compared to equivalent properties of OH62 humeral and femoral diaphyses following estimated lengths of the latter. In overall femoral to humeral rigidity at estimated midshafts, OH62 falls within the 95% confidence interval of the collective chimpanzee sample, similar to the recent study by Ruff (2009). However, OH62 approaches regression lines of certain chimpanzee communities more closely than others. We offer potential implications of these similarities according to associated life history, habitat, and locomotor repertoire information of these communities, which we suggest may be useful for further understanding locomotor adaptations of early *Homo*. Research partially supported by the L.S.B. Leakey Foundation and U.S. National Science Foundation.

Energetic significance of food processing: A case study in tubers.

RACHEL N. CARMODY, GIL S. WEINTRAUB and RICHARD W. WRANGHAM. Department of Human Evolutionary Biology, Harvard University.

All human societies regularly process their foods by both thermal and non-thermal means. This feature distinguishes us from other species, and may even be compulsory given our evolutionary commitment to a high-quality diet. Yet our understanding of the functional significance of food processing remains limited, particularly with regards to energy. In this study, we conducted feeding trials in a model animal to investigate the relative effects of cooking and pounding on the energy value of tubers. Adult male CD-1 mice ($n = 17$) were fed yams in four treatments, based on a within-subjects study design: raw/whole, raw/pounded, cooked/whole, cooked/pounded. Repeated-measures ANOVA revealed that cooking, but not pounding, improved energy gains as indexed by change in body mass. Whereas mice lost weight on raw treatments (whole: -4.3 ± 0.4 g; pounded: -3.8 ± 0.6 g), they gained weight on cooked treatments (whole: 0.1 ± 0.4 g; pounded: 0.2 ± 0.3 g). Post-study preference tests further support the superior effects of cooking. Fasted

mice presented with equal rations of all treatments preferred cooked treatments in 17 out of 17 cases. Our results indicate that, in contrast to thermal methods, non-thermal processing likely contributes little to energy gain in humans reliant on starch-rich plant foods. Key implications for human evolution are discussed. This study was supported by the Goelet Fund of the Peabody Museum at Harvard University, Harvard College Research Program, and a NSF Graduate Research Fellowship.

Genetic and functional variation at the human relaxin promoters.

SARAH J. CARNAHAN and MICHAEL I. JENSEN-SEAMAN. Department of Biological Sciences, Duquesne University.

Birth of a large-brained infant through a pelvis remodeled for bipedal locomotion makes parturition especially difficult in humans. Birth is a highly regulated process requiring coordinated actions of several hormones on multiple tissues. One of these hormones, relaxin – a peptide hormone encoded by two genes, *RLN1* and *RLN2* – helps prepare the body for birth through degradation of the cartilaginous joint of the pubic symphysis allowing for expansion of the pelvic inlet, and by widening and softening the cervix. Proper regulation of relaxin is essential for birth; studies have indicated that serum relaxin levels may be correlated with risk of preterm labor. The promoter regions have a complex, dinucleotide microsatellite repeat ~800 base pairs upstream from the putative start of transcription in both relaxin genes. Recent studies of other genes have shown that variation in microsatellite length results in differences in transcriptional regulation, with resulting phenotypic changes. In order to assess the functional consequences of genetic variation at these genes we first characterized the patterns of variation in a global sample of 44 humans. We then cloned seven different promoter haplotypes into luciferase reporter constructs, followed by transient transfections into human cell lines to quantify the relative strength of transcriptional induction.

We found fourteen different microsatellite repeat sizes in the promoter of *RLN2*, and no variation in *RLN1*. Transfection assays revealed differences in transcriptional activity between *RLN1* and *RLN2*. Moreover, different haplotypes at *RLN2* varied in transcription levels, with a trend for longer repeat lengths to more strongly drive transcription. This study was funded by: The Wenner-Gren Foundation for Anthropological Research.

Relative limb strength in *Paracolobus chemeroni*.

STEVIE CARNATION¹, IAN J. WALLACE¹ and MASATO NAKATSUKASA². ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Laboratory of Physical Anthropology, Department of Zoology, Kyoto University.

The holotype of *Paracolobus chemeroni* is an associated skeleton from the Pliocene of Kenya that has been described as having several features intermediate between arboreal colobines and terrestrial cercopithecines. This suggests that *P. chemeroni* was more terrestrial than most extant African colobines. To test this hypothesis, cross-sectional geometric properties were calculated from CT-scans, and relative humeral to femoral diaphyseal strength was assessed and compared to both extant arboreal colobines and terrestrial cercopithecines {e.g. *Papio* (20), *Macaca* (25), *Nasalis* (10), *Colobus* (18), *Trachypithecus* (10), *Presbytis* (10)}. Previous research has shown that, compared to cercopithecines, colobines have lower humeral to femoral strength proportions, reflecting their comparatively weak humeral diaphyses and propensities for leaping. These differences in strength proportions probably relate to the more even distribution of substrate reaction forces on the forelimbs and hind limbs of terrestrial monkeys. Results indicate that *P. chemeroni* humeral to femoral strength is “intermediate”, falling below the lower quartile of cercopithecine variation and above the upper quartile of colobine variation. If femoral strength is considered alone, *P. chemeroni* is close to the median of both colobines and cercopithecines, whose values are virtually identical. However, humeral strength in *P. chemeroni* approaches the upper limits of colobine variation. This implies that the intermediate humeral to femoral strength proportion in *P. chemeroni* is driven by elevated humeral strength compared to extant colobines. These results are consistent with the hypothesis that *P. chemeroni* had a diverse locomotor repertoire and frequently engaged in terrestrial behavior.

Shape variation and morphological integration in the atlas and axis of anthropoids and their functional implications.

KATE CARTER. Department of Anthropology, New York University.

The functional morphology of the basicranial-cervical vertebrae complex is critical for understanding head posture and range of motion in primates, but there have been no previous attempts to understand the interrelation of the entire complex from a comparative and functional perspective. To do this, 3-D landmarks and semilandmarks on the cranium, atlas and axis of nine anthropoid species were collected and analyzed using geometric morphometric methods. Variables relating to cranial position and orientation were extracted from the landmarks and their degree of covariation with atlas and axis shape variables was quantified using 2-block partial least squares analysis. The results show that the atlas and axis complex is significantly integrated, but that the shape of the odontoid process and corresponding facet on the atlas are more tightly correlated with one another than either is with other developmental centers on the vertebrae. The shape of both the atlas and the axis differs significantly among the taxa sampled, with the largest shape variance

accounted for by the anteroposterior orientation of the transverse processes and the angle of orientation along the superolateral plane of the superior articular facets. Variability in orientation of the transverse processes implies differential attachment of the muscles associated with lateral movement of the cranium and this is also reflected in correlated differences in condylar and superior articular facet orientation. These findings may have implications for understanding shape variation in the atlas and axis of early hominins in relation to head posture and locomotion. This study was funded by a George Maker Research Grant through New York University.

Morphometric analysis of the primate auditory ossicles.

YASMIN CARTER¹ and MARY T. SILCOX².

¹Department of Anatomy and Cell Biology, University of Saskatchewan, ²Department of Anthropology, University of Winnipeg.

Hearing plays a vital role in the life of primates and an understanding of the anatomy of the auditory ossicles is necessary for analyses of hearing sensitivity. Morphometric studies conducted on the auditory ossicles of primates are rare. A landmark-based analysis was conducted on ultra-high resolution X-ray computed tomography (UhrCT) scans of twenty-six primate auditory ossicle chains. The resulting data were subjected to Euclidean distance matrix analysis (EDMA). The results of these investigations demonstrate that morphological differences are measurable between the species and the haplorrhine-strepsirrhine split is well reflected. Clustering into biological families was strong and the data, once scaled to a geometric mean, reflected the accepted taxonomy. Unexpected morphometric outliers included: *A. calabarensis*, with a bulbous ossicular chain and shortened manubrium and *T. bancanus*, with mediolaterally constricted bodies. The auditory ossicles of the aye-aye, *D. madagascariensis* are unique in form; the largest in both the principal coordinate axis scores and centroid size analysis with a long thin malleus and a laterally constricted incudal body. *Daubentonia's* unique method of ‘hunting’ would seem a likely cause of the outstanding shape differences, although this remains impossible to establish without further study. The EDMA method provided unanticipated information regarding the articulation angles of the ossicular chains, specifically regarding *V.v. variegata*. The results of this study suggest that aspects of primate ossicular morphology display measurable interspecific differences and the tested morphometric technique is useful for making functional inferences on primate hearing. This research was supported by an NSERC discovery grant to MTS and the Canadian Research Chairs program, the Manitoba Graduate Scholarship, the Anthony Arnhold Fellowship and the University of Manitoba Department of Anthropology to YC.

Absence of bipedal morphology in a postural biped.

AAPA ABSTRACTS

MATT CARTMILL and KAYE BROWN.
Dept. of Anthropology, Boston University.

Most explanations for the origin of hominin bipedality cannot be comparatively tested, because there are no other striding bipeds among mammals. However, there are other mammals that stand bipedally for long periods of time. One such is the gerenuk (*Litocranius walleri*), an African gazelle that browses while standing bipedally, with extended hips and knees and a marked lumbar lordosis. Despite these behavioral resemblances to humans, Richter's (1970) extensive comparative study of gerenuk anatomy found only one apomorphy specifically related to bipedality -- namely, a reduction in the lumbar spinous processes, which permits that lumbar lordosis. Our data show that gerenuks lack two other features -- an expanded cranial sector of the acetabular semilunar surface, and "wedging" of the lumbar vertebral bodies -- that we had expected from their bipedal positional behavior. We infer that even prolonged and extensive postural bipedality results in little or no postcranial remodeling, unless selection favoring the maintenance of efficient quadrupedal locomotion is relaxed. This conclusion undercuts theories, such as Hunt's (1994) "postural feeding hypothesis," that portray early hominin postcranial apomorphies as having originated as adaptations to bipedal feeding postures rather than to bipedal locomotion.

Localized hypoplasias of the primary canines from the Early and Middle Holocene Gobero Site.

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

The developmental etiology of enamel hypoplasias is multifaceted and based, in part, on the complex geometry of dental development. One form of defect, localized hypoplasia of the primary canine (LHPC), is particularly difficult to reconcile with current knowledge of odontogenesis. LHPC are enamel defects found on the labial surfaces of deciduous canines (primarily mandibular) and have been described in multiple clinical and archaeological contexts. Here, we extend the geographic and chronological distribution of LHPC to the Central Sahara Desert where these defects are documented among Early Holocene foraging and Middle Holocene pastoral communities that lived near a freshwater lake. We focus on describing the distribution and frequency of these defects, and evaluating how these data may contribute to debates about their etiology and use as markers of generalized stress.

LHPC were rare in the maxilla (1/19 teeth) and more common in the mandible (8/19 teeth). Eighty-three percent of Early Holocene subadults demonstrate at least one LHPC, while 20% of Middle Holocene subadults demonstrate at least one LHPC. Such a high prevalence rate is comparable to Upper Paleolithic Europeans. However, the presence of unilateral LHPC expression, as well as defects on maxillary canines, suggests the etiology of LHPC is not

easily explained by current explanatory models (Lukacs, 1999; Skinner and Newell, 2003). Based on these results, we suggest that the etiology of LHPC has not been fully resolved, and that its use as an indicator of generalized stress in prehistoric populations is more complex than previous research might indicate. This work was supported by the Wenner Gren Foundation for Anthropological Research (GR7747) and the National Science Foundation (0820805).

Evaluation of features of the innominate for sex estimation.

ANA M. CASADO and PAUL W. SCIULLI. Department of Anthropology, The Ohio State University.

The sex of an individual is a basic biological attribute as well as a source of variation that must be taken into consideration in human population studies. Skeletal samples present unique problems for the estimation of adult sex. The only biological features that consistently represent the individual are osseous elements, but these elements may be fragmentary or poorly preserved. Methods that yield accurate sex estimates for skeletal samples will thus make a significant contribution to the study of past human populations. The present study evaluates characteristics of pelvic morphology (Bruzek 2002) for discriminating adult males and females in Late Prehistoric Ohio Valley Native American skeletal samples. The skeletal samples are from the 17th century C.E. Grantham site (N = 42) located in Northeastern Ohio and the 15th-16th century C.E. Buffalo site (N = 78) in Northern West Virginia. The pelvic characteristics used are: pre-auricular surface, greater sciatic notch, composite arch, inferior pelvis, and ischio-pubic proportions. Various aspects of each characteristic are also assessed. A logistic discrimination analysis using SAS 9.1 for Windows XP evaluates the utility of each characteristic in sexing the individual. Results indicate that non-pubic bone features of the pelvis, as defined by Bruzek (2002), are not efficient estimations of sex in these Native American populations.

Forensic evidence of "kill and overkill" in Colombia.

DIEGO ALEJANDRO CASALLAS. Technical Investigation Unit, Attorney General's Office.

The armed conflict in Colombia has been an ongoing problem in the last fifty years. Thousands of both civilian and combatant victims have lived at different times of the country's modern history. This scenario has left behind scenes of death and violence that have been analyzed from various standpoints, including psychological, anthropological, political, and even religious aspects.

During the last three years, skeletal remains have been analyzed by the lab of the Technical Investigation Unit. Consequently, the context of extreme violence suffered by the victims as a result of this war has been established. Visible evidence of barbaric and neglectful treatment of human beings has been found. Victims usually

belong to the opposing side of the executioner. The bones of the enemy are marked with traces of the so-called "kill and overkill" methods, aimed at the physical, political, and moral extermination of persons both involved and unininvolved in the war.

The collection of evidence of this type of injuries, plus its contextualization, analysis, and interpretation, contribute to the search for truth. This helps understand a disproportionate context where thousands of people have died as a result of extreme violence that goes beyond the death of a human being. These criminal activities touch the boundaries of senselessness and barbarianism. However, evidence description, analysis, and understanding are a step forward towards the integral reparation of the social elements who have been affected by this type of violence. We acknowledge the contribution of the information provided by the Technical Investigation Unit of the Attorney General's Office of Colombia.

Long-term trends in diurnal primate densities in natural and plantation forests at Kakamega Forest, Kenya.

JULIE CASH¹, PETER J. FASHING¹, NGA NGUYEN¹, PATRICK LUTESHI² and WINSTONE OPONDO². ¹Dept. of Anthropology, California State University Fullerton, ²Kakamega Environmental Education Programme (KEEP), Kakamega Forest, Kenya.

Long-term field studies are critical to improving our knowledge of primate population dynamics. This knowledge is especially important in areas where habitats are altered or degraded by human disturbance like in tropical rainforests. Few studies have documented long-term population trends among primates inhabiting rainforests undergoing disturbance. During two periods (1997-98; 2006-09) over a 12-year span, we conducted line-transect censuses at Isecheno in Kakamega Forest, Kenya to examine long-term changes in group densities of the three diurnal primate species, black-and-white colobus (*Colobus guereza*), blue monkeys (*Cercopithecus mitis*) and redtail monkeys (*Cercopithecus ascanius*). Isecheno, while not currently commercially logged, suffers from some anthropogenic disturbances. However, we found that group densities in all three monkey species had increased or remained stable over the study period (1997-2009: *Colobus guereza* 11.1-11.9 grps/km²; *Cercopithecus mitis*: 4.2-5.1 grps/km²; *Cercopithecus ascanius*: 4.0-3.9 grps/km²). Between 2006-2009, we conducted additional line-transect surveys in a heavily utilized ~70-year old plantation forest located ~500 meters from the natural forest. We found that while *Cercopithecus mitis* and *Cercopithecus ascanius* group densities in the plantation forest were half those found in the natural forest, *Colobus guereza* group densities were similar in the two habitats. Our results indicate that the three monkey species in the natural forest at Isecheno have remained stable or increased over the past 12 years despite the low-to-moderate disturbance occurring there. Our results also suggest that *Colobus guereza* may be better able adapt to plantation forest habitat than *Cercopithecus* spp., a result

consistent with *C. guereza*'s reputation for unusual ecological flexibility. This study was funded by Cal State Fullerton Faculty Development Center, L.S.B. Leakey Foundation, and Wenner Gren Foundation.

Assessment of musculoskeletal stress markers in the hand.

LISA A. CASHMORE and SONIA R. ZAKRZEWSKI. Centre for the Archaeology of Human Origins (CAHO), Archaeology, University of Southampton, UK.

The response of bone to the action of muscle can be quantified through the analysis of musculoskeletal stress markers (MSM). Analysis of such markers has been used to answer questions regarding occupational activities and organisation in past populations. Within the upper limb, MSM analysis has also been used to determine bilateral asymmetry and hand preference in archaeological samples. Studies of upper limb MSM have focused exclusively on the morphology of the arm, and particularly the humerus. MSM sites in the hand have been conspicuous by their absence from this research. This absence appears to result from methodological problems associated with studying the small bones of the hand and the presumed lack of variation in MSM morphology.

To address these issues, a presence/absence system was developed for 12 sites of muscle insertion and origin on the metacarpals and phalanges. This scoring method was then applied to a sample of 65 *Homo sapiens* from the medieval site of Écija, Spain. This analysis found that variation in hand MSM was such that asymmetry between the left and right hands could be identified. Comparisons with humeral MSM data from the Écija sample indicated that patterns of asymmetry differed between the humerus and the hands. This suggests that using humeral MSM development as a proxy for MSM expression across the upper limb as a whole, is misleading.

This study highlights the viability of MSM analysis in the hands and supports a more comprehensive approach to MSM analysis, one which includes data from the hand. This study was partially funded by the British Academy Centenary Project: From Lucy to Language - The Archaeology of the Social Brain and a British Association for Biological Anthropology and Osteoarchaeology (BABAO) Small Research Project Grant.

Implications of reduced mortality risk for late Pleistocene humans.

RACHEL CASPARI¹, SANG-HEE LEE² and ADAM VAN ARSDALE³. ¹Department of Sociology, Anthropology and Social Work, Central Michigan University, ²Department of Anthropology, University of California at Riverside, ³Department of Anthropology, Wellesley College.

Demographic changes in human evolution provide a compelling link between biology and culture. In previous work we suggested that the pattern of adult mortality changed recently in

human evolutionary history, and may be a pivotal part of the success of modern humans. Here we examine further evidence for this shift and its demographic and behavioral implications.

In this paper, survivorship curves for two large fossil samples from Krapina and Atapuerca (SH) are compared, and analyzed in the broader context of changing patterns of adult survivorship assessed using OY ratios (older/younger adults). In contrast with these earlier samples, late Pleistocene humans demonstrate significantly lower levels of young adult mortality. Stochastic demographic models based on these data suggest that while the high mortality levels characteristic of earlier groups are potentially consistent with stable population theory, the number of sustainable demographic profiles is greatly expanded in the late Pleistocene. These results have implications for the expanding human biocultural niche, and may help explain behaviors associated with the archeological record of late Pleistocene human groups and the success of modern human populations.

Quantifying variation at the occipito-cervical articular surfaces using 3D scanning technology.

ERIC CASTILLO and CHRISTOPHER DUDAR. Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

Reuniting disassociated crania and postcrania can be imprecise, especially from multiple individuals. Cranial-postcranial unity is often achieved by comparing qualitative aspects of the occipito-cervical (OC-C1) interface. The morphology of occipital condyles generally mirrors the articular facets of the C1, and thus their surface areas (SA) are hypothesized to have a close correspondence. To test this hypothesis, we measured SA across a diverse sample of 36 individuals from the physical collections at the National Museum of Natural History, Smithsonian Institution.

The articular surfaces of OC-C1 were digitized using a NextEngine HD™ laser desktop scanner, and isolated by removing the non-articular 3D mesh. ScanStudio™ software was used to measure SA based on the polygons within the 3D mesh. Caliper measurements were also taken at maximum anteroposterior length (APmax) and maximum mediolateral length (MLmax) for both sets of the right/left OC and C1.

A predictive model was developed by plotting the relationship between OC versus C1 SA measurements. Joint surfaces were analyzed according to ipsilateral articulations as well. Least-squares linear regressions were fitted to each distribution, yielding Pearson's R ranging between 0.78 to 0.95.

Caliper measurements yielded Pearson's R ranging between 0.51 to 0.86.

The surfaces of the occipital condyles were found to be significantly larger than the corresponding C1 facets ($p < 0.05$). Results also indicate that digital SA comparisons provide a better predictor of OC-C1 match than using simple caliper measurements. Comparing

SA offers a means for predicting OC-C1 unity, or for verifying a match made by conventional qualitative assessments.

How people lived in Imperial Rome: A multivariate approach.

PAOLA CATALANO¹, VALENTINA BENASSI², CARLA CALDARINI², FLAVIO DE ANGELIS³, ALESSIA NAVA² and WALTER PANTANO². ¹Soprintendenza Speciale per i Beni Archeologici di Roma – Anthropology Service, Rome, ²External collaborator of Anthropology Service, Soprintendenza Speciale per i Beni Archeologici di Roma, ³Department of Biology, University of Rome.

A valuable contribution to the understanding of how people lived in Imperial Rome is provided by the anthropological analysis of large Suburbium necropolis like Castel Malnôme, Collatina, Casal Bertone, Via Padre Semeria and Osteria del Curato (Rome, Italy). The demographic profile were outlined by sex determination and age at death estimation, according to classical methods. The oral health was analyzed: caries, tartar and abscesses have been scored. Moreover inflammation processes were noted and fractures and injuries were also taken into account. The application of the correspondence analysis allowed us to explain the huge amount of qualitative data related to an overall sample of 1048 individuals from the five necropolis. While the experience of the operators is critical to better understand the features of a single site, the comparison between different necropolis is complex and only the statistical analysis of the raw data can overcome this difficulty. The five cemeteries are unlinked themselves, and three of them (Castel Malnôme, Casal Bertone and Osteria del Curato) lie to the "extremes", reflecting the peculiarities of the single sites. Castel Malnôme is strongly influenced by a discrepancy in sex ratio and by the presence of injury and biomechanical stress markers. The necropolis of Casal Bertone is instead characterized by the high frequency of infants. Better conditions existed at Osteria del Curato, while Collatina, was characterized by the presence of a wide range of social classes. The cemetery of Via Padre Semeria takes place in an intermediate position, reflecting the lack of characteristic qualitative variables.

Oxygen, carbon, and nitrogen isotope analyses of Middle/Late Archaic populations from the Lower Ohio River Valley.

ERICA N. CHAMBERS¹, CHRISTOPHER W. SCHMIDT² and MARK R. SCHURR³.

¹Department of Anthropology, The Ohio State University, ²Department of Anthropology, University of Indianapolis, ³Department of Anthropology, University of Notre Dame.

The details about the environmental context and dietary exploits of humans inhabiting the Lower Ohio River Valley during the Middle/Late Archaic are restricted, mainly due to the variety of contexts in which human remains are discovered. Populations were becoming increasingly sedentary as humans found

innovative ways to interact with the land and draw from local resources.

In this study, human bone and tooth enamel samples from 17 individuals from four archaeological sites were analyzed to determine the relationship between oxygen, carbon, and nitrogen isotope data. Oxygen isotope analysis of human tooth enamel carbonate provides insight into climatic variations and water source utilization. Carbon and nitrogen isotopic analyses of bone collagen are important for investigating the dietary construct of prehistoric humans.

Oxygen isotope signatures are tightly constrained ($\mu = 27.12$; $\sigma = 0.67$); however, there are population based differences, most likely indicative of consumption from different water sources. Carbon isotope signatures are reflective of dietary reliance on plant or animal resources utilizing a C₃ photosynthetic pathway for all four populations ($\mu = -20.29$; $\sigma = 0.42$). Nitrogen isotope signatures are reflective of terrestrial-based dietary resources ($\mu = 8.35$; $\sigma = 0.96$); yet the populations cluster in ways similar to those seen in the oxygen isotope signatures. In combination, the carbon and nitrogen isotopic signatures indicate exploitation of terrestrial plant and animal resources. The oxygen isotopic signatures indicate consumption from different water sources, despite each site being located along the Ohio River or its tributaries.

From Modern Humans to Neandertal Ancestors? Comparison of the locomotion of anatomically modern humans and Neandertals: A feasibility study.

TARA CHAPMAN¹, SERGE VAN SINT JAN, FEDOR MOISEEV¹, STEPHANE LOURYAN^{1, 2} and MARCEL ROOZE¹.

¹Laboratory of Anatomy, Biomechanics and Organogenesis (LABO), Faculty of Medicine, Université Libre de Bruxelles (ULB), Belgium,

² Department of Radiology, ULB Erasme hospital, Belgium.

Do Neandertals walk in the same way as modern day humans? This presentation details a feasibility study which analysed whether Neandertals had a similar bipedal gait to anatomically modern humans. CT scans of original bones from Spy II and casts from Kebara 2 and Neandertal 1 were analysed to obtain three-dimensional (3D) bone morphology from medical imaging data. Spatial locations of well-defined skeletal landmarks were virtually palpated on each bone. From these landmarks spatial transformations between Neandertal 1, Kebara 2 and Spy II were performed to reconstruct a 3D skeletal model of two lower limbs and a pelvis. An in-vivo human motion squatting model was then registered to the reconstructed 3D models, including a 6 DOFs mechanism at both knee and ankle joint levels. The same method was applied on the skeleton of a bonobo (*Pan paniscus*) to test and validate the adopted experimental paradigm. Early results seemed to show that Neandertals had similar knee joint morphology to modern day humans and bipedal gait is likely to be similar as no obvious difference could be found in their respective motion representation. The bonobo data showed major differences. The study was

performed using a customised software interface called LhpBuilder.

A histological study of crown formation in human deciduous teeth.

FRED CHEN¹ and SCOTT SIMPSON².

¹Department of Biology, Case Western Reserve University, ²Department of Anatomy, Case Western Reserve University School of Medicine.

A useful property of enamel is its incremental [circadian ('daily increments') and circaseptian (striae of Retzius)] matrix deposition by the enamel-secreting ameloblasts that is readily visible by light microscopy. In a cross-sectioned tooth, the striae appear as near-parallel lines running from the DEJ to the external surface of the tooth. In the event of a systemic disturbance, this regular enamel matrix formation is disrupted creating distinctive pathological striae of Retzius or Wilson Bands. At birth, a pathological striae, known as the 'neonatal line', is formed in the deciduous teeth. Although research has been conducted on the developmental chronology of the permanent dentition, little histologically-based research has been done on the developmental schedule of the deciduous teeth.

Here, we examined the enamel developmental geometry in a number of deciduous dentitions with the goal of developing a histologically-based schedule of deciduous dental crown development. On the cross-sectioned teeth, daily secretion rates were measured and were consistent with those reported in the literature. Enamel thickness, measured up to the neonatal line and after the neonatal line, gave the amount of time necessary to form the crown before and after birth, respectively. Results from this study are useful in forensics, allowing investigators to determine the age at death of individuals, and in the study of the life histories of individuals, particularly with determining times of illness and stress during the development of the teeth. This study was conducted through the Summer Program in Undergraduate Research (SPUR) funded by the Howard Hughes Medical Institute (HHMI).

Hallucal metatarsal of euarchontan mammals.

STEPHEN G.B. CHESTER¹, DOUG M. BOYER², JONATHAN I. BLOCH³, ERIC J. SARGIS^{1,4}, RACHEL L. JACOBS⁵ and BIREN A. PATEL⁶. ¹Department of Anthropology, Yale University, ²Department of Ecology and Evolution, Stony Brook University, ³Florida Museum of Natural History, University of Florida, ⁴Division of Vertebrate Zoology, Peabody Museum of Natural History, ⁵Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ⁶Department of Anatomical Sciences, Stony Brook University.

The uniquely specialized grasping foot of euprimates is reflected in the morphology of the entocuneiform and first metatarsal (Mt1). At least one plesiadapiform, *Paleocene Carpollestes*, shares this morphology. Previous

studies suggest that the entocuneiform and Mt1 of non-carpoletid plesiadapiforms are similar to that of the most basally divergent treeshrew, *Ptilocercus*, in having a prehensile, slightly divergent hallux, and less powerful grasping than that of euprimates. We describe the first complete Mt1 of a micromomyid plesiadapiform from the early Eocene of Wyoming and compare it to a sample of fossil and extant euarchontans, including all other plesiadapiforms (stem-primates) for which Mt1 is known and a new sample of *Ptilocercus*. Dimensions of Mt1 were quantified by taking linear and angular measurements on photographs and virtual reconstructed surfaces created from microCT scans. Results of principal coordinate analysis on Mt1 shape variables (interarticular length, midshaft diameter, proximal articular surface length, peroneal process length and width, and physiological abduction angle) show that plesiadapiforms, treeshrews, and dermopterans are similar to anthropoids, whereas extant prosimians and Eocene adapoids plot separately. The most basal known plesiadapiform Mt1 (that of *Tinimomys*) is most similar to *Ptilocercus*, which may reflect the ancestral euarchontan condition. However, the degree of torsion at the distal end of Mt1 of *Ptilocercus* is greater than that of non-carpoletid plesiadapiforms and *Tupaia*, but less than in *Carpolestes*. These preliminary analyses provide additional support for the hypothesis that non-carpoletid plesiadapiforms and *Ptilocercus* had similar pedal grasping mechanisms, but also reveal that *Ptilocercus* may have greater opposability. This study was funded by the John F. Enders Fellowship, Yale University (SGBC); National Science Foundation Dissertation Improvement Grant (BCS-0622544), Evolving Earth Foundation, American Society of Mammalogists (DMB), and a National Science Foundation Grant (EF-0629836) (JIB, EJS).

Complete mitochondrial DNA sequences lend insight into the evolutionary history and biogeography of Central American squirrel monkeys.

KENNETH L. CHIOU¹, JASON A. HODGSON^{1,2,3}, LUCA POZZI^{1,2,3} and ANTHONY DI FIORE^{1,2,3}. ¹Department of Anthropology, New York University, ²Center for the Study of Human Origins, New York University, ³New York Consortium in Evolutionary Primatology.

The origins and biogeographic history of Central American squirrel monkeys (*Saimiri oerstedii*) remain enigmatic, in part because phylogenetic relationships among currently recognized species and subspecies are poorly understood. Here, we use complete mtDNA sequences to evaluate the phylogenetic history of *S. oerstedii*. We focus on two questions: First, which South American squirrel monkey is the sister group to *S. oerstedii*? Second, what is the age of the last common ancestor of modern *S. oerstedii* and how does that date relate to the timing of formation of the Panamanian isthmus (ca. 3.5 Ma)?

We generated complete mtDNA genomes for three *S. oerstedii* individuals sampled from

across the species' geographic range, as well as for *Saimiri* from several populations from which ancestral *S. oerstedii* may have evolved. We used long-range PCR to amplify sequences in large, overlapping segments to minimize chances of inadvertently sequencing nuclear copies of mitochondrial pseudogenes ("numts"). Sequences were aligned with additional primate genomes mined from Genbank. Included taxa were selected on the basis of suitability for constraining nodes using fossil dates. Bayesian analyses allowing for variance in evolutionary rate among branches and uncertainty in fossil divergence estimates were used to infer phylogenetic relationships among *Saimiri* taxa. Guyanese *S. sciureus* was robustly confirmed as the sister taxon of *S. oerstedii*. Using well-supported fossil dates to constrain nodes, we estimate the divergence of Central and South American *Saimiri* at 0.8-1.2 Ma. Our results suggest that *Saimiri* spread to Central America well after the formation of the Isthmus of Panama. This research was supported by the Barnet and Phyllis Liberman Research Scholar grant from New York University.

Hand biomechanics and trabecular architecture in hominoid metacarpals.

HABIBA CHIRCHIR^{1, 2}, BRIAN G. RICHMOND^{2, 3}, NICOLE L. GRIFFIN⁴, MASATO NAKATSUKASA⁵, ANGEL ZEININGER⁶ and RICHARD A. KETCHAM⁷.¹ Hominid Paleobiology Doctoral Program, Department of Anthropology, The George Washington University, ²Center for the Advanced Study of Hominid Paleobiology, The George Washington University, ³Human Origins Program, Smithsonian Institution, ⁴Department of Evolutionary Anthropology, Duke University, ⁵Laboratory of Physical Anthropology, Graduate School of Science, Kyoto University, ⁶Department of Anthropology, University of Texas at Austin, ⁷Department of Geological Sciences, University of Texas at Austin.

Interpretations of locomotor behavior among Plio-Pleistocene hominins have been hotly debated, particularly concerning when hominins ceased arboreal climbing as a significant component of their repertoire. Much of the debate is grounded in disagreements over how to interpret primitively-inherited, ape-like morphology. Here we propose an alternative approach by focusing on aspects of skeletal morphology that may be sensitive to variation in activity during growth. This study investigates trabecular bone morphology in the metacarpal heads of higher primates that differ in hand function during habitual locomotion. Specifically, we test the hypothesis that trabecular bone will be most dense (bone volume/total volume) and anisotropic in regions loaded most stereotypically. We CT scanned the heads of third metacarpals of a sample (n=10) of *Pan troglodytes*, *Pongo pygmaeus*, *Papio*, and *Homo sapiens* at the HRXCT facility at the University of Texas, Austin. Using QUANT3D, we quantified the trabecular bone structure in dorsal, central, and palmar volumes of interest (VOIs) in each metacarpal. Our results generally support the

hypotheses. Bone density and anisotropy vary significantly across taxa in the dorsal region of the head. Notably, *Pan troglodytes* metacarpals have significantly greater bone density in the dorsal region, which is loaded during knuckle-walking, compared with those of *Pongo pygmaeus* that use hand postures rarely involving extended metacarpo-phalangeal joint. These results suggest that trabecular structure in hominin fossils may help resolve current debates about their functional behavior. Grant Sponsorship: NSF DGE-0801634; NSF BCS-0521835; The Wenner-Gren Foundation Wadsworth Fellowship; Leakey Foundation Baldwin Fellowship

Accelerated evolution of the oxytocin receptor system in Callitrichine primates.

CHI-HUA CHIU^{1,2} and ELIZABETH GENNE-BACON¹. ¹Department of Genetics, Rutgers University, ²Department of Anthropology, Kent State University.

The oxytocin receptor system is an evolutionarily conserved pathway that is implicated in a large range of mammalian social and reproductive behaviors. Oxytocin (OT) is a nine amino acid hormone that is strongly associated with social behaviors such as monogamy, maternal bonding, social recognition and trust. Oxytocin signaling occurs through the oxytocin receptor (OTR), a seven transmembrane G-coupled receptor. We have completed a molecular evolution study of the oxytocin receptor system in primates (apes, Old World monkeys, and New World monkeys). Evolutionary sequence analyses revealed evidence for accelerated evolution of the OTR gene in New World monkeys as a group, as well as continued evolution in the callitrichines. Interestingly, several amino acids of the OTR in callitrichines are changed in otherwise functionally conserved regions. Similarly, a change in the otherwise deeply conserved OT nonapeptide sequence was detected in five New World monkey species. These findings pave the way for functional studies including quantitation and localization of oxytocin receptors in adult brain tissues for a comparative range of primates with focus on the callitrichines. The overarching goal of this study is to identify genetic factors that underlie the unique reproductive and social behaviors of callitrichine primates.

C-reactive protein across the menstrual cycle: Variation in inflammation and its impact on ovarian and endometrial function in a sample of Canadian women.

KATHRYN B. II. CLANCY¹, ANGELA R. BAERWALD² and ROGER A. PIERSON.

¹Department of Anthropology, University of Illinois, Urbana-Champaign, ²Department of Obstetrics, Gynecology and Reproductive Sciences, College of Medicine, University of Saskatchewan.

C-reactive protein (CRP) is a biomarker of chronic inflammation, and has been shown to vary with body mass index and cardiovascular disease, as well as psychosocial and

immunological stress. Few studies have addressed how CRP varies through the menstrual cycle. However, as both ovulation and menstruation are inflammatory in nature, we hypothesize that CRP concentrations peak at these two points. We also posit that CRP will impact endometrial thickness and other reproductive variables because inflammatory processes are associated with endometrial pathologies. Serum samples every three days were collected from a sample of healthy, premenopausal Canadian women (n = 50) during one interovulatory period (thus measuring a luteal phase and subsequent follicular phase); daily endometrial thickness ultrasounds were also obtained.

We found support for this hypothesis as CRP significantly peaked at menses and ovulation in a sample of Canadian women. We also found that CRP is associated with ovarian hormones, gonadotropins, and endometrial thickness but was only associated with BMI at certain points in the menstrual cycle. CRP was also positively associated with endometrial thickness at some points in the cycle. These results suggest that CRP can reflect reproductive states in the human female, and that inflammatory processes are important mediators between ecology and reproductive function. This study was funded by the University of Illinois Campus Research Board.

Setting the record straight: Improving the quality of early museum records.

MARGARET CLEGG and HEATHER BONNEY. Department of Palaeontology, Natural History Museum, London.

The records held by museums on their human remains collections are relied on for information for research and repatriation claims. However, most documentation is often well over 100 years old when the quality of information in such records was not to modern standards. Not only is the information variable but over time errors may have crept into the records as they are transferred to the lasts medium. A current project at the Natural History Museum, London is bringing together all the information about each set of human remains in the collection and updating the records to modern standards. This project is still at an early stage. However, even the relatively small number of records examined has shown that there is a wide variability in both the information captured and its accuracy. One of the major sources of error is transcription; either from the original documentation or as the original handwritten records have been copied. 'Travellers' tales' which become associated with the records have been identified as another source of error and misinformation. This paper will discuss whether it is possible to identify which records are likely to be problematic and how to deal with the errors when they are found. The implications, particularly in overseas repatriations, need to be considered to ensure that only remains affiliated to the claimant community are considered as part of a repatriation claim.

Variation in tooth wear patterns amongst the Chumash of the Santa Barbara Channel area.

ANNA CLEMENT, SIMON HILLSON and IGNACIO DE LA TORRE. Institute of Archaeology, University College London.

The rich archaeological, ethnographic and anthropological record of the Chumash people from the Santa Barbara Channel area allows a detailed comparison of their tooth wear patterns to be made. This complex group of hunter-gatherers occupied the region from approximately 13,000 B.P. with major changes in subsistence strategies, population densities, habitat and social structures occurring over time. Their skeletal record was large enough to make comparisons between groups dated to the early, middle and later periods. In addition variation between island, coastal mainland and inland mainland groups was assessed. Permanent tooth wear was measured from digital photographs of the occlusal surface of the maxillary and mandibular teeth using image analysis software and a graphics tablet. The area of the occlusal surface and the area of exposed dentine were both measured, and a dentine proportion calculated by dividing the area of dentine by the area of occlusal surface. Wear patterns were compared independent of age, which was achieved by dividing the dentine proportions of each tooth by that of the first molar. Differences in wear rates were also highlighted. The results showed that the pattern of tooth wear varied over time and between island, coastal mainland and inland mainland populations. Differences between males and females were also identified. This variation was interpreted in terms of cultural as well as dietary changes. This study was funded by the Leverhulme Trust, grant number F/07134CA.

Paleoenvironmental reconstruction of the Old World monkey locality; Wadi Moghra, early Miocene, Egypt.

MARK CLEMENTZ¹, ELLEN MILLER², AHMED EL-BARKOOKY³, MOHAMED HAMDAN³, MOHAMED ADBEL GAWAD³ and SAFIA MOHAMED ALI HASSAN³. ¹Department of Geology and Geophysics, University of Wyoming, ²Department of Anthropology, Wake Forest University, ³Geology Department, Cairo University.

Wadi Moghra, Egypt, is a fossil locality preserving an array of extinct mammals (ca. 27 species), including remains of *Prohylobates tandyi* (Victoriapithecidae; Cercopithecoidea), the most morphologically primitive Old World monkey known. Information about the paleoenvironment(s) occupied by *P. tandyi* -- and other victoriapithecids -- is virtually non-existent, mostly owing to the fragmentary nature of collections, but also because species in Victoriapithecidae span wide geographic (ca. 4500 km) and temporal ranges (ca. 20-12.5 Ma). The one exception to this is work on the cercopithecoid *Victoriapithecus macinnesi* (ca. 15 Ma, Kenya), which indicates that the species was a terrestrial forager, likely utilizing widely

dispersed resources in riparian woodland, and seasonally wet, wooded grassland. However, whether the adaptations of *V. macinnesi* are broadly representative of victoriapithecids as a whole, including earlier and more primitive victoriapithecids such as *P. tandyi*, remains unknown.

Stable isotope compositions of tooth enamel from fossil species can serve as proxies for diet (carbon isotopes: ^{13}C) and habitat preferences (oxygen isotopes: ^{18}O), which in turn can be used for paleoenvironmental reconstruction. Here, we have sampled a diverse assemblage of proboscideans and large ungulates, including multiple species of anthracothere, other artiodactyls (e.g. suids, giraffoids), and perissodactyls to reconstruct the early Miocene environment of Wadi Moghra. Preliminary isotope results appear to indicate a relatively humid, tropical environment of woodlands and coastal forests. These findings are compared with previous isotope results from older, northern Egypt localities (Fayum, early Oligocene), to interpret how changing environmental conditions may have favored victoriapithecid diversification. Funding provided by the National Science Foundation (0808283), Leakey Foundation, and Wake Forest University.

The endocrine profile of a geriatric female chimpanzee (*Pan troglodytes*) 72 years of age suggests that menopause in the species is deferred in tandem with somatic aging.

C.T. CLOUTIER^{1,3}, D.C. BROADFIELD¹ and A.R. HALLORAN^{1,2,3}. ¹Florida Atlantic University, Department of Anthropology, ²The Maderas Rainforest Conservancy, ³The Elgin Center for Conservation and Behavioral Research.

Cloutier et al. 2009 demonstrated that a sixty-four year old female chimpanzee (*Pan troglodytes*) housed at a semi-free ranging facility in Florida was documented to give birth in 2001. In light of the exceptionally delayed reproductive senescence exhibited by this particular female, endocrinological analyses meant to determine the state of her current reproductive viability were conducted in 2008. Urine was collected from the study subject for a period of

88 days spaced within an interim of roughly 6 months and the specimens were sent to the Hominoid Reproductive Ecology Laboratory in New Mexico for assessment. Additionally, data was collected from three control females in order to provide a basis of comparison against the hormonal markers present in the geriatric study animal. Preliminary results show that, while the geriatric female does not presently appear to be cycling—her ovarian steroid hormonal levels parallel those of a pregnant or lactating female in the wild—the luteinizing hormone [LH] levels present are not necessarily indicative of a fully menopausal female, as they remain relatively low. As the chimpanzee in question was seventy-two years of age at the time of data collection, the results of this study provide critical insight into the reproductive capacity of *Pan troglodytes*.

Prognathism and the ontogeny of canine sexual dimorphism in *Macaca mulatta*.

SAMUEL N COBB and HESTER BAVERSTOCK. Functional Morphology and Evolution Unit, Hull York Medical School, University of Hull, UK.

Cercopithecines demonstrate considerable sexual dimorphism in both the facial skeleton and canine height. The maxilla houses the permanent canines during development, eruption and occlusion, and so as the canine increases in height during ontogeny maxilla height is expected to increase to house the developing canine. While the spatial demands of the developing canine are not expected to be great in younger males and females, as the male canine continues to lengthen, the maxilla is expected to increase in height. This study tests whether the male maxilla accommodates increased canine length via ontogenetic scaling of the maxilla in males and females, or a divergent pattern of scaling. The study therefore determines whether the coincidence of both increased prognathism and canine height are a predictable consequence of ontogenetic scaling in males and females. Measurements were taken from lateral cephalograms of longitudinal growth series of five male and five female individuals of *M. mulatta*. The length of the male canine occupies the entire maxillary height up to and during eruption, whereas the female canine only does so early in development. The height and length of the male and female maxilla are ontogenetically scaled, with increased facial length in males being as expected for a female extended along the ontogenetic trajectory to the maxillary length of an adult male. Increased facial prognathism in males is therefore a scaling consequence of the maxillary height associated with housing a long canine. These findings also indicate that dental development is constrained by the space available during development. This work was funded by the Royal Society and HYMS.

Pilot study for the analysis of stress and kinship in wild bonobos (*Pan paniscus*), Lomako Forest, Democratic Republic of Congo.

AMY K. COBDEN¹, MICHEL WALLER² and FRANCES J. WHITE³. ¹ Department of Anthropology, Emory University, ² Department of Anthropology, University of Oregon.

Dynamics of bonobo (*Pan paniscus*) social behavior differ from those of common chimpanzee (*Pan troglodytes*) social behavior in critical ways, particularly with respect to inter- and intra-sexual relationships. Of note, observations of life-long bonding between mothers and sons and strong alliances between female bonobos have raised significant questions regarding the relationship between kinship and the benefits of social living: does the presence of kin necessarily mean social support or measurable physical or psychosocial benefits?

To address this question, we collected weekly fecal and urinary samples from the Ndele bonobo community, as well as one week's

samples from the Iyema bonobo community in Lomako Forest during July and August of 2009. We combined the use of previously tested methods for the extraction of fecal and urinary glucocorticoids, as well as urinary C-Peptide of Insulin with new methods for fecal genetic analysis including polymorphism identification and genotyping using restriction site associated DNA (RAD) markers. Using this combination of methods, we examined whether or not metabolic and psychosocial stress levels across individuals were correlated to a) the number of related individuals and/or b) the overall relatedness within a feeding or nesting party. Our data and results are meaningful as they inform the direction of future questions regarding bonobo stress and social structure, as well as how they contribute to the development of new methods for the collection and analysis of genetic fecal samples from an endangered and hard-to-access species. This study was funded by The Leakey Foundation, Oberlin College, and the Institute of Critical International Studies (ICIS) at Emory University.

Conspecificity of South African robust australopithecines.

ZACHARY COFRAN¹ and J. FRANCIS THACKERAY². ¹Department of Anthropology, University of Michigan, ² Institute for Human Evolution, University of the Witwatersrand.

While most researchers regard the robust australopithecines from the South African sites of Kromdraai and Swartkrans as the same species, others argue that the two are distinct species based on dental differences. This study uses two morphometric techniques designed to address taxonomic issues when fossil samples are incomplete and fragmentary. South African robust australopithecine craniodontal data are analyzed to determine whether the hypothesis that the *Paranthropus robustus* holotype from Kromdraai (TM 1517) represents the same species as fossils from the site of Swartkrans (*P. crassidens*) can be rejected. Results indicate that the TM 1517 cranium is well within the range of variation displayed by the Swartkrans fossils, and that intraspecific variation within Swartkrans alone is large. In fact, the two most similar specimens in the combined sample are TM 1517 from Kromdraai and SKW 11 from Swartkrans Member 1. Isolated teeth that have been used to argue for two species of South African robust australopithecines may rather be attributable to early *Homo* at Kromdraai. This research was funded by grants from the University of Michigan Department of Anthropology and from the Rackham Graduate School (Z. C.), and from the French Embassy in South Africa, the National Research Foundation (South Africa) and the Andrew Mellon foundation (J.F.T.).

Trabecular bone volume fraction may reflect dietary adaptations: An analysis of the mandibular condyles of non-human primates.

SUSAN COINER-COLLIER and ROBERT S. SCOTT. Department of Anthropology, Rutgers, The State University of New Jersey.

Australopithecus anamensis, *Australopithecus afarensis*, and *Paranthropus boisei* display thick-enameled, large, flat post-canine teeth and increasingly robust skulls and jaws. This morphology has been interpreted as an adaptive trend from diets dominated by soft fruits to hard-brittle foods. However, studies of the microwear of these early hominins show neither the high incidence of pitting nor complex textures linked with hard-brittle foods. Rather, similar microwear between *Australopithecus afarensis* and *Gorilla gorilla beringei* potentially suggests tough food consumption. Thus, there may be a contradiction between apparent dietary adaptations and more direct (i.e., microwear) evidence.

Repetitive chewing of tough foods producing repeated and considerable masticatory loads and condylar reaction forces may lead to remodeling of the trabecular bone of the mandibular condyles. As this trabecular bone grows in response to loads generated by tough foods and/or repetitive chewing, trabecular bone volume fraction (BV/TV) may increase. Literature on several non-human species and modern humans shows lower BV/TV in modern humans—a possible consequence of diets of processed foods. Here, we report trabecular BV/TV generated from HRXCT slices of a small pilot sample of non-human primate mandibular condyles. *Pan troglodytes* has BV/TV of 43%—considerably higher than the 15–20% BV/TV reported in the literature for modern humans. *Ateles*, *Cebus*, and *Alouatta* evince an increasing trend in BV/TV from 34% to 48%. These preliminary data suggest that BV/TV may provide an epigenetic signal helping to resolve conflicts between apparent dietary adaptations of early hominins and dietary inferences based on their dental microwear.

Spatial ranks, depth functions, and scale curves as tools for testing the single-species hypothesis.

THEODORE M. COLE III¹ and DEBORAH L. CUNNINGHAM². ¹Department of Basic Medical Science, University of Missouri-Kansas City, ²Department of Clinical Science and Medical Education, Florida Atlantic University.

Paleoanthropologists often face the problem of testing the single-species hypothesis for a commingled assemblage of hominin fossils. Univariate approaches have numerous limitations, while most multivariate methods are infeasible with missing data. To address this problem, we present new methods for assessing relative multivariate variation in small, commingled hominin assemblages.

Our model of multivariate variation describes all of the possible shape (or size and shape) variation present in a commingled sample. Because assumptions of parametric multivariate statistics are violated (no missing data, normality, and independence of observations), we develop new descriptors that extend notions of nonparametric quantiles. We compute spatial

ranks for all possible ‘composite’ individuals that can be assembled from the fossils, and we then simulate commingled ‘assemblages’ for the extant reference taxa, computing their ranks in the same space. The spatial ranks order the observations from the center outward and are then used as the basis for spatial depth functions. We use the depth functions to construct multivariate ‘quantiles’ analogous to the probability density regions of multivariate normal distributions.

To test the single-species hypothesis, we use the multivariate quantiles to plot scale curves, which provide one-dimensional comparisons of the sizes and shapes of extant and fossil distributions. If the null hypothesis of a single species is rejected, further exploratory methods (such as data brushing or projection pursuit) may be used to identify individuals possibly belonging to taxa other than the one represented by the majority of specimens. The taxonomic identity of these outliers may then be investigated further.

Orbit and skull size in catemeral owl monkeys of the Argentinean Chaco.

MARK N. COLEMAN. Midwestern University.

A catemeral population of owl monkeys (*Aotus azarae*) in the Argentinean Chaco presents opportunities to investigate possible adaptations for diurnal activity in an otherwise nocturnal genus. We examined whether there have been changes in the bony architecture of the orbit and overall skull size that could be associated with the change in activity pattern. Using dried specimens of known age and sex (n=10), we measured the length, width and depth of the orbit, we calculated the area of the orbital rim and overall orbital volume and we characterized skull size using 27 additional cranial measurements. We compared these specimens to a sample of 300 individuals representing 9 different owl monkey species.

The catemeral population had orbital dimensions that were not significantly different from those of other *Aotus azarae* specimens, except for the relative depth of the orbit (catemeral vs. others; 0.73 vs. 0.76 mm, p=0.006). Although the size of the orbits in the catemeral population was not markedly reduced, 7 of the 27 cranial measurements showed significant differences. The Argentinean skulls had larger measurements for cranial height (32.5 vs. 30.7 mm, p=0.002), nasal aperture width (8.2 vs. 7.8 mm, p=0.046), and distance between zygomatic arches (41.9 vs. 40.0 mm, p=0.001) and tympanic rings (31.3 vs. 29.0 mm, p<0.001). These results suggest that there has not been strong selective pressure to reduce the bony orbit in this relatively recent catemeral population, although other factors may be acting to increase certain aspects of overall skull size.

3D automated quantification of asymmetries on fossil endocasts.

BENOÎT COMBÈS^{1, 2, 3}, JOSÉ BRAGA⁴, FRANCIS THACKERAY⁵ and SYLVAIN PRIMA^{1,2,3}. ¹INSERM, U746, F-35042 Rennes, France, ²INRIA, VisAGEs Project-Team, F-35042 Rennes, France, ³University of Rennes I,

CNRS, UMR 6074, IRISA, F-35042, France,
⁴Lab. of Anthropobiology AMIS, University
 Paul Sabatier, Toulouse, ⁵Institute for Human
 Evolution, University of the Witwatersrand.

Over the last 15 years computed tomography (CT) has become a common way to obtain high resolution three-dimensional images of cranial endocast of hominids. Among the different features that can be seen on such endocasts, of key interest are their shape asymmetries. In particular, protrusions of the frontal and occipital lobes, as well as differences in their width, have been typically observed in modern humans' brains. These have been often hypothesized to be linked to functional specialization, and especially language and handedness. The imprints of these protrusions on the inner surface of the skull are called the petalia. There is a lack of automated, reproducible and objective methods to quantify these protrusions and to assess (for instance) whether they are present in species other than *Homo sapiens*.

We propose a new method for the automated quantification of 3D endocranial shape asymmetries. We mathematically define the symmetry plane of the endocast as the 3D plane which best superposes the "right" and "left" sides of the endocranial surface. Then, we compute a 3D pointwise deformation field between the two sides of the endocast, allowing to match homologous points, and to assess their relative spatial position. The analysis of this 3D deformation field allows quantifying the shape asymmetries everywhere on the endocast. We illustrate our method on the endocast of Sts 5 (Mrs. Ples, *Australopithecus africanus*) whose very high resolution CT scan has been segmented using ITK-SNAP. The results suggest an opposite shape asymmetry in the fronto-temporal and occipital regions. This research supported by the French Institute for Research in Computer Science and Control (INRIA). Grant: 3D-MORPHINE (Collaborative Research Initiative).

Analysis of Qafzeh 27 - A New Adult Fossil from Qafzeh, Israel.

SILVANA CONDEMI¹, ALON BARASH² and BERNARD VANDERMEERSCH³. ¹ UMR 6578, Faculté de Médecine, Université de la Méditerranée, Marseille, France, ²Department of Anatomy & Anthropology, Sackler School of Medicine, Tel Aviv University, Israel, ³UMR 5199, Laboratoire d'Anthropologie des Populations du Passé, Université de Bordeaux, Talence, France.

The excavation of the Qafzeh cave, in the lower Galilee of Israel began in the 1934 by René Neuville with the discovery of 5 Mousterian individuals. From 1965 until 1979, Bernard Vandermeersch continued the excavation unearthing 21 more individuals, most of which are in a remarkable state of preservation, all attributed to *Homo sapiens*, and dating to around 100Kya. The aim of this paper is to present an unpublished individual from Qafzeh (Q27) that was unearthed in the early 1990s. This individual is represented by skull and a

mandible. The cranial elements are heavily deformed and crushed in such a way that the skull has completely lost its volume in the lateral aspect. As a result, all the facial bones are found on the left side, while the cranial base is mostly absent. The mandible, although crushed, is complete and all mandibular as well as the maxillary teeth are present and complete. From preserved cranial feature, it seems that the skull was of a young adult, probably a male, with all teeth fully erupted, without dental abrasion except for the incisors. CT scan study reveals two well preserved bony labyrinth. In this paper, we present a preliminary study based principally on the teeth and the bony labyrinth, with comparison to other specimens from Qafzeh, as well as other middle Pleistocene fossils. According to our results this fossil corresponds closely to other specimens from this population.

Intraspecific variation in primate pedal phalangeal curvature.

KIMBERLY A. CONGDON. Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine.

Considerable attention has been devoted to understanding phalangeal curvature in primates. It is generally accepted that pedal phalangeal curvature is related to climbing and grasping behavior, with greater curvature indicative of increased climbing. Although the relationship between curvature and climbing is considered applicable to hands and feet, surprisingly little is known about the functional morphology of pedal phalangeal curvature. Here, digital points were collected from adult 3rd and 5th digit proximal pedal phalanges in *Gorilla gorilla* (n=29), *Pan troglodytes* (n=30) and *Pongo pygmaeus* (n=25). An ontogenetic sample of *Pan troglodytes* (n=40) was used to evaluate the postnatal link between variation in phalangeal curvature and grasping behaviors. Angles of curvature were calculated using SAS and compared via ANOVA ($p<0.05$). Using behavioral studies to predict an interspecific gradient of variation in pedal phalangeal curvature, *Pongo* is found to be significantly more curved than *Pan* and *Gorilla*. Contrary to predictions, *Pan* is not significantly more curved than *Gorilla*. Furthermore, despite well-documented ontogenetic decreases in climbing frequency among wild chimpanzees, the degree of phalangeal curvature does not differ significantly between juvenile and adult chimpanzees. The interspecific findings suggest that the functional correlation between pedal phalangeal curvature and locomotor behavior is not as strong as that for manual phalanges, or that taxa with intermediate frequencies of grasping behaviors need not possess intermediate levels of pedal phalangeal curvature. Moreover, the lack of postnatal decreases in pedal curvature among chimpanzees brings into question current notions regarding the degree of phalangeal plasticity vis-à-vis ontogenetic variation in locomotor behavior. This study was funded in part by the Weiland Fund of Hunter College CUNY

Extracting ecological information from the mechanical properties and structure of primate teeth.

PAUL J. CONSTANTINO¹, JAMES J.-W. LEE², DYLAN J. MORRIS², ADAM HARTSTONE-ROSE³, TANYA M. SMITH⁴, BRIAN R. LAWN² and PETER W. LUCAS¹.

¹Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ²National Institute of Standards and Technology,

³Department of Biology, Pennsylvania State University, Altoona, ⁴Department of Human Evolutionary Biology, Harvard University.

A model has recently been proposed that uses fracture mechanics theory to explain how teeth are adapted to diet (Lucas et al., 2008). In this model, the mechanical properties of enamel are indicated as key variables in determining the critical loads for enamel fracture. However, virtually nothing is known of the mechanical properties of enamel in primates, apart from humans. We used nanoindentation to test the hardness (H) and elastic modulus (E) of teeth from a broad sample of primate taxa including strepsirrhines, platyrhines, Old World monkeys, and apes. While there are minor differences in the magnitude and distribution pattern of these properties among the taxa sampled, it is likely that these are due to different states of preservation (i.e., levels of dryness) rather than meaningful interspecific variation. Regardless, the degree of difference (approximately 15%) does not significantly affect the model. This broad consistency in primate enamel properties indicates that it is unlikely that variation in these properties contributes significantly to differences in dental-dietary adaptation (although these findings do not necessarily extend to non-primate taxa). Focus should instead be paid to other variables which have been shown to be critically important such as enamel thickness and the radius of curvature of tooth cusps. Research funded by NSF grant # 0851351 as well as GWU's Research Enhancement Fund and Selective Excellence Fund.

Isotopic evidence for the geographic origins and diet of the 36,000 year-old Hofmeyr skull.

SANDI R. COPELAND^{1,2}, MICHAEL P. RICHARDS¹, JULIA A. LEE-THORP³, JOHANN NEVELING⁴, VAUGHAN GRIMES^{1,5} and FREDERICK E. GRINE⁶.

¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology,

Leipzig, Germany, ²Department of Anthropology, University of Colorado at Boulder,

³Division of Archaeological, Geographical and Environmental Sciences, University of Bradford, UK, ⁴Council for Geosciences, Pretoria, South Africa,

⁵Department of Archaeology, Memorial University, ⁶Department of Anatomical Sciences and Department of Anthropology, Stony Brook University.

The 36,000 year old Hofmeyr skull from South Africa is the only adult human fossil known

from this time period of late Pleistocene sub-Saharan Africa. There are no faunal or archaeological materials associated directly with the skull and the outcrop from which it derived is no longer accessible. Nonetheless, isotopic evidence from the tooth enamel itself can still provide some context. We measured strontium isotopes to provide clues regarding the geographic origins of the individual, and we measured carbon isotopes to get some indication of the diet. We established the biologically available strontium isotope ratios for several geological members around the Hofmeyr site using plants, and found that they differ between members. The strontium isotopes in the Hofmeyr individual are consistent with one of the geological members that outcrops within a kilometer of the fossil locality, thus the individual may have been native to the area where he died. The carbon isotopes are slightly enriched, indicating that the individual consumed a dominantly C₃ diet with very modest amounts of C₄ (grass-derived) or marine foods. This study was funded by the Max Planck Society.

The peopling of Early and Late Holocene: The dental morphological evidence.

ALFREDO COPPA^{1,2}, FRANCESCA CANDILIO¹, MICHAELA LUCCI¹, RITA VARGIU¹ and ANDREA CUCINA³. ¹Department of Human and Animal Biology, University of Rome "Sapienza"; ²Musée de l'Homme/National Museum of Natural History, Paris, France. ³Facultad de Ciencias Antropológicas, Universidad Autónoma de Yucatán.

Previous studies on dental morphology tried to assess the phenetic relationships among Holocene human populations on a worldwide scale. They used to gather the human samples within single units only on a geographical base. In the present study we also divided the samples chronologically into Early (from Neolithic to the 5th century AD) and Late Holocene (6th century AD until present). Dental morphology was analyzed using the ASUDAS standards. Twenty-three Early and 33 Late Holocene groups were obtained by gathering 1263 samples (667 Early and 596 Late). Mean Measure of Divergence, Multidimensional Scaling and Maximum Likelihood have been used, which produced results that are consistent with one another, authenticate previously established migratory patterns and confirm the utility of dental morphology in the analysis of population affinities. (i) the populations tend to gather into four major groups, and follow a previously documented pattern of Sinodonts, Sudadonts, Western Eurasian and African populations; (ii) The Early Holocene Aleut-Eskimo group show affinity with the northern Asia populations, while the Late Holocene ones gather with the Ameridian samples, which supports the hypothesis of Siberian groups peopling the Americas; (iii) Ainu and Jomon show affinities, which corroborates the hypothesis that the former descended from the latter, while no affinities are encountered with the modern Japanese; (iv) the Sudanese gather with the Mediterranean groups during the Early

period, and with the Sub-Saharan in the Late period, which supports the notion of migratory waves from the south; (v) the North African groups always gather with the Mediterranean ones. This study was funded by "Progetti di Ateneo" Università di Roma "Sapienza".

The modern human mandible prior to M1 emergence: A closer look incorporating muscle insertions and the deciduous tooth arrangement.

MICHAEL COQUERELLE^{1,2}, STEFANO BENAZZI¹, FRED L. BOOKSTEIN¹, JOSE BRAGA², STANISLAV KATINA¹, DEMETRIOS J. HALAZONETIS³ and GERHARD W. WEBER¹. ¹Department of Anthropology, University of Vienna, ²Centre d'Anthropobiologie et Imagerie Anatomique FRE 2960 CNRS, Université de Toulouse III, ³School of Dentistry, University of Athens.

This study investigates the allometric shape changes of 49 human mandibles from birth to the complete emergence of the deciduous dentition incorporating the positions of the tongue, the genio-hyoid (GH) and digastric (Ds) muscle insertions. Dense CT-derived mandibular surface and tooth meshes were processed by geometric morphometric methods to produce a growth trajectory of the human mandible rendered as thin-plate spline deformations of a typical surface including the tooth germs.

Prior to the emergence of the second deciduous molar (dm2), the reshaping of the symphysis is accompanied by a reorientation of the developing anterior teeth and a forward and downward shift of the muscle insertions relative to the mandible centroid. From birth the chin flattens anteriorly and lateral protuberances appear when the triangle formed by GH and the two Ds change from equilateral to isosceles. When dm2 reaches occlusion, the ramus rotates toward the corpus, the gonial region becomes less prominent, and the GH and Ds displace outwards while the mental region projects forward.

Because they are anatomically- and temporally-related, we interpret the muscle insertion displacements as a result of the lowering of the hyo-laryngeal structures. This event is also coordinated with the reorientation of the anterior teeth. The combination of both the ramus rotation, possibly functionally related to the backward rotation of the face, and the descent of the hyo-laryngeal structures would expand the lower border outwards to provide space for the supra-hyoid and tongue muscles, and contributes to the projection of the mental region. Supported by the European Project "EVAN" MRTN-CT-2005-019564.

The effects of terrain on cross-sectional geometric properties of the femur and tibia in two Puebloan populations from the Middle Rio Grande region.

ROBIN M. CORDERO, VITALE S. SPARACELLO and OSBJORN M. PEARSON. Department of Anthropology, University of New Mexico.

This paper addresses the effects of terrain on two populations of agriculturalists from the Albuquerque Basin and the Jemez River Valley of the Jemez Mountains, New Mexico. The two populations were almost certainly closely related genetically and both lived during the Rio Grande Classic Period (AD 1325 – 1600). Populations within the Albuquerque Basin primarily cultivated along the Rio Grande floodplain and its major tributaries, ranging in altitude 1,584 m to 1,676 m. Populations of the Jemez River Valley cultivated the mountain river valleys ranging between 1,676 m to 2,133 m flanked by mesa tops averaging 2,400 m. It is likely that the terrain around Jemez imposed greater mechanical demand on limb bones, which should be manifested as greater J adjusted for size and ratios of I_{max/min} in the femur and tibia.

To test this relationship between terrain and cross-sectional geometry, we collected external contours of the femoral and tibial midshaft of skeletons of agriculturalists from the Albuquerque basin ($n = 20$ females, 20 males) and Jemez ($n = 20$ females, 20 males), and applied regression formulae that reliably estimate cross-sectional properties from external contours. J was standardized for body size by dividing by the product of body mass (estimated from femoral head size) and bone length. Preliminary results support the association between rugged terrain and stronger lower limb bones with flattened shafts.

Discovering developmental signals in phylogenetic dental data - from micro- to macro-evolutionary variability.

IAN CORFE¹, ERIK SEIFFERT², DOUG BOYER³, LAURA SÄILÄ^{1,4} and JUKKA JERNVALL^{1,3}. ¹Institute of Biotechnology, University of Helsinki, ²Department of Anatomical Sciences, Stony Brook University, ³IDEA, Department of Ecology and Evolution, Stony Brook University, ⁴Department of Geology, University of Helsinki.

Empirical results from developmental biology can help investigate dental characters used for phylogenetic and evolutionary analyses. We examined the order of cusp appearance and cusp mineralization in mutant and wild-type mice using fluorescent reporter genes and 3D nano-CT to determine whether the two were linked. Results confirm this - the first appearing and first mineralizing cusps of the lower molar are the protoconid and metaconid. Features located lower in the crown appear later; those at the anterior and posterior extremities of the tooth appeared and mineralized latest and are also the first to be lost and gained under experimental manipulation of ectodysplasin (*Eda*) levels. We then examined a recent comprehensive data matrix of fossil and extant primate relationships from a developmental perspective. Empirical development and population level variation studies show that features which appear chronologically later during development tend to be more variable intra-specifically. To determine whether these patterns also hold at the macro-evolutionary level, we examined a) the frequency of polymorphisms scored in the

data and b)the number of character states of features in different regions of the tooth crown, as measures of variability.

Our results show statistically significantly higher polymorphism and average character state numbers in late developing tooth features. We conclude that a developmental perspective is useful for uncovering patterns in character states across taxa. Conversely, in addition to containing hierarchical phylogenetic information, phylogenetic data may inform on development, an underlying mechanism of evolutionary change.

Variation in trabecular microarchitecture within the thoracic vertebral body of extant hominoids.

MEGHAN M. COTTER¹, BRENDAN J. GOODWINE², SCOTT W. SIMPSON¹ and CHRISTOPHER J. HERNANDEZ². ¹Department of Anatomy, ²Department of Biomedical Engineering, ³Department of Mechanical and Aerospace Engineering, Case Western Reserve University.

Humans are unique among the hominoids in being susceptible to osteoporosis-related spontaneous vertebral fractures. Because severe bone loss has been observed in wild apes, differences in bone volume alone are an incomplete explanation for differences in vertebral fracture incidence among hominoids. Trabecular bone carries more than half of the loads applied to vertebral bodies, making its structure key in determining vertebral bone strength. We examined trabecular microarchitecture within the T8 vertebral bodies of young adult humans, chimpanzees, gorillas, orangutans and gibbons ($n=6$ each, mixed sex) using 46 micrometer resolution micro-computed tomography images. The images were divided into anatomically defined subregions to determine intra-specimen variation in degree of anisotropy, trabecular bone volume, and variability of trabecular bone distribution. Degree of anisotropy of ventral subregions was significantly greater than dorsal subregions of the vertebral body ($p<0.05$) in all species indicating that they have trabecular bone adaptations to resist anterior and lateral flexion of the spine. All species displayed trends toward higher bone volume near the endplates and lower bone volume at the center of the vertebral body, but only *Pongo* and *Pan* demonstrated a significant difference ($p<0.05$). Lastly, variance in trabecular bone distribution within each vertebral body was not significantly different among the species. These results indicate that during young adulthood there are only minor differences in these vertebral microarchitecture parameters between humans and other hominoids, suggesting that differences in vertebral fracture susceptibility may be a result of differences in patterns of bone loss or trabecular bone interaction with the vertebral shell.

Primate diversity, conservation, and behavioral ecology at Ta Kou Nature Reserve, Binh Thuan Province, Vietnam.

HERBERT COVERT^{1,2}, HOANG MINH DUC², LUU HONG TRUONG² and TRAN VAN BANG². ¹Department of Anthropology, University of Colorado at Boulder, ²Center for Biodiversity and Development, Institute of Tropical Biology, Ho Chi Minh City, Vietnam.

Until recently south-eastern Vietnam was covered by forest, however, use of defoliates during the Vietnam War and rapid post-war development has caused significant deforestation and loss of biodiversity. Ta Kou Nature Reserve preserves one of the largest remaining coastal forests in this area of Vietnam including an 11,866ha core-zone dominated by the 697m high and 1,104ha large Ta Kou Mountain and is critical for biodiversity conservation. A surrounding buffer-zone includes human modified ecosystems dominated by sandy soils going through desertification. Our biodiversity surveys within the nature reserve have confirmed the presence of six primate species including two endangered leaf monkeys, three macaques, and a loris. The presence of *Trachypithecus marginata* (the Annamese silvered langur) and *Pygathrix nigripes* (the black-shanked douc) is of particular interest representing a southeastern most range extension for both species. Within Ta Kou, Annamese silvered langurs and black-shank doucs are restricted to the mountain; the three macaques are found in most areas of the reserve and often seen close to adjacent agricultural areas. The pygmy loris has been observed both on the mountain and surrounding forests. We have identified three primary threats to the primates in the reserve: trapping, disturbance by tourists, and potential disease transmission from uncontrolled release of animals. We are also studying niche-partitioning by the sympatric colobines to test hypotheses about ecological differences between members of *Pygathrix* and *Trachypithecus*. Interesting initial results include *Pygathrix* utilizing more frequent suspensory positional behaviors and spending more time foraging in the periphery of the canopy than *Trachypithecus*. This project was funded by Wenner Gren Foundation, IRC Grant #90, MacArthur Foundation, Grant# 09-92488-000-GSS, IUCN Netherlands/Ecosystems Grants Programme, Grant # 600174, SeaWorld and Busch Garden Conservation Fund, and Fulbright Foundation.

Genetic structure of Mennonite General Conference, Halderman and Old Colony populations: Molecular perspective.

MICHAEL H. CRAWFORD¹, PHILLIP E. MELTON², MJ MOSHER¹, ROHINA RUBICZ² and MARK ZLOJUTRO². ¹Laboratory of Biological Anthropology, University of Kansas, ²Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio.

A study was initiated in 1979 on the genetic structure and biological aging of Mennonite communities of Kansas and Nebraska. Initial analyses based on blood group and protein markers of General Conference Mennonites of Kansas and Nebraska yielded disagreement

between the reconstructed history of the congregations and their genetic affinities. Congregations that underwent fission during the early 1900s differed significantly from each other and were suggestive of the action of the founder effect. Additional samples were collected from six communities including Old Order Mennonites, who had emigrated from Cuatemoc, Mexico, and two additional Halderman congregations (Lone Tree and Garden View) that had split off the original community, Meridian. Mitochondrial DNA was extracted from 117 individuals representing six of the congregations and characterized for ten major European RFLP haplogroups. HVSI sequences were generated using an ABI 370 capillary system sequencer. Eight (H,I,J,K,T,U, pre-V and X) of the ten most common western European haplogroups were observed. SAMOVA analyses, with k number of groups equaling from 2 to 6, provided the most parsimonious $k=4$ ($F_{CT} = 0.07$, $p\text{-value}=0.02$). The four groups were: 1) Goessel/Henderson; 2) Meridian/Garden View; 3) Lone Tree; 4) Old Order. Goessel and Henderson constituted a single congregation in the Ukraine until 1860 and split into two communities on relocation to Kansas and Nebraska. Garden View and Lone Tree split from Meridian during the 1970s. MDS plots (stress value = 0.02) reflect the ethnohistory of these populations more accurately than either phylogenetic trees or R-matrix analyses based on classical genetic markers. This study was funded by grants from: NIH AAG01646 and Kansas Attorney General Settlement Fund KAN 30471.

How many species of South African *Australopithecus*: A morphometric analysis of the maxillary premolars and molars.

RAFLINE CRAWFORD. Department of Anatomy and Pathology, Des Moines University College of Osteopathic Medicine.

Suggestions of high levels of variation in size and morphology in *Australopithecus africanus* have resulted in debate over whether the current hypodigm should include another hominin species. Debate also continues over the number of species represented within the Makapansgat and Sterkfontein australopithecine samples or whether these sites sample different species entirely. Furthermore, diverse claims have been made regarding the phylogenetic relationships of *A. africanus* and South African australopithecines in general. In this study, I present analyses of maxillary premolar and molar shape variation in order to assess which australopithecine sample is more closely morphologically aligned with the Makapansgat hominins and to examine patterning of variation in South African australopithecine premolars and molars.

Dental landmark coordinates were digitized in TpsDig2 (Rohlf, 2006) from occlusal photographs of the maxillary premolars and molars for South African hominins from Kromdraai, Swartkrans, Sterkfontein, Taung, and Makapansgat. Landmarks recorded include cusp tips for unworn specimens and overall outlines of the premolars and molars for both worn and unworn specimens. These data were

imported into Morphologika (O'Higgins and Jones, 2004) where generalized Procrustes analysis and principal components analysis (PCA) were executed. Comparisons of overall shape of the maxillary premolars and molars and cusp locations for unworn specimens were made. Analyses were repeated with data available for worn specimens, excluding cusp tips, in order to increase sample sizes. Results of these analyses indicate a complex patterning of morphological variation across South African australopithecines that does not align well with Pliocene site boundaries and several current taxonomic attributions. This study was funded in part by The Paleontological Society, Geological Society of America, Evolving Earth Foundation, Lambda Alpha, Sigma Xi, and Washington University.

Cytokine polymorphisms in human populations: Testing the pathogen hypothesis.

FABIAN CRESPO^{1,2}, RAFAEL FERNANDEZ-BOTRAN², MANUEL CASANOVA² and CHRISTOPHER TILLQUIST¹
¹Department of Anthropology, ²Department of Psychiatry and Behavioral Sciences,
³Department of Pathology and Laboratory Medicine. University of Louisville.

Recent surveys of the geographical distribution of important human pathogens document ecologically based gradients and regional specificity. While humans certainly would have carried their share of pathogens during the peopling of different regions of the world, the emergence of agriculture and concomitant population increase precipitated and sustained transmission of human-specific and zoonotic pathogens. Human populations living in different ecological environments may therefore have been subject to different pathogen experiences, leading to differential selection of important components of the immune system. Cytokines are key regulatory molecules that play central roles in inflammatory and immune responses, including those against infectious pathogens. Thus, *do cytokine polymorphisms reflect past population health histories in different human populations?* In our worldwide survey of key inflammatory and anti-inflammatory cytokines and their major alleles, distributions of specific alleles appear to be non-random and exhibit regional variation. In higher resolution regional surveys, some alleles show clinal variation; reflecting either a process of serial colonization or selection. If natural selection was playing (and still plays) an active role in shaping the cytokine genetic make-up for different populations, which selective factor should be taken into consideration? We suggest a pathogen hypothesis to partly explain regional differences in cytokine allele frequencies. Specifically, regionally significant pathogens may have shaped different adaptive complexes of interactive cytokine alleles. In the current analyses, we explore the construction and distribution of adaptive complexes of cytokine alleles and how they vary with the presence of different kinds of pathogens.

The Late Stone Age human remains from Ishango (Democratic Republic of Congo). Contribution to the study of the African Late Pleistocene modern human diversity.

ISABELLE CREVECOEUR^{1,2}, PATRICK SEMAL², ELS CORNELISSEN³ and ALISON S. BROOKS⁴. ¹UMR 5199 - Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux 1, ²Laboratoire d'Anthropologie et de Préhistoire, Institut royal des Sciences naturelles de Belgique (IRSNB), ³Culturele Antropologie/Prehistorie en Archeologie, Koninklijk Museum voor Midden-Afrika (KMMA), ⁴Department of Anthropology, Georges Washington University.

The Ishango site (Democratic Republic of Congo) was excavated during two different campaigns, in the fifties by a Belgian team directed by the geologist J. de Heinzelin, and in the eighties by A. Brooks and collaborators. It led to the discovery of numerous human remains in two stratigraphic layers, representing a Late Pleistocene and a Neolithic occupations. The oldest one, the *Niveau Fossifère Principal (N.F.Pr.)*, has been dated to 20-25 Kyr and contains an exceptional archaeological material (engraved bones, hundred of barbed points, quartz microliths, thousand of faunal remains, etc.) which attests the existence of complex socio-cultural behaviours at that time in the region. However, the anthropological potential of the *N.F.Pr.* collection, one of the oldest sample of modern human population from Central Africa, has not yet been fully exploited. The early publications by Twiesselmann only focused on the most complete and mature human remains without taking the stratigraphic origin into account.

We present here a new inventory and comparative morphometric study of these Late Pleistocene human remains, notably by using medical and micro-Computer Tomography acquisitions. The Ishango remains exhibit morphometrical characteristics that lie on the edge of extant modern human diversity. The study of the inner ear structures show closer affinities with Middle Palaeolithic modern humans than with recent populations. The estimation of dental tissue proportions of a particularly voluminous molar also stand on the edge of recent variation. Together with a strong dimorphism, these new data question the use of recent populations as reference for modern human diversity. This study is funded by the program Prospective Research for Brussels (PRFB 2006/CN/JV/520) of the Institute for the encouragement of Scientific Research and Innovation of Brussels (ISRB) and by the Fulbright Research Scholarship (2009-2010).

Biometrics and locomotion in the Dassanech, a modern pastoral population from northern Kenya.

MELANIE D. CRISFIELD. Department of Anthropology, Rutgers University.

Although East Africa has been occupied by hominins since the divergence of the hominin and paninian lineages, little research has been conducted on modern unshod populations

inhabiting the East African Rift Valley. A single study was conducted on the Hadza of Tanzania (Musiba *et al.* 1997). This current study represents the first analysis of the biometrics and locomotor characteristics of an unshod Kenyan population. I focus on the Dassanech, a northern Kenyan pastoral population with inadequate nutrition from the East Turkana region.

The purpose of this study is to conduct a population-level analysis of a modern unshod group. I hypothesized that there would be a significant difference between the sexes for all variables measured. Biometric measurements were collected for 21 adult females and 19 adult males, including height, weight, functional leg length, stride length, and length and width of the right foot.

A significant difference ($p < 0.05$) was found between males and females for each set of measurements. Ongoing analyses are examining the relationship within each sex for height and stride length, height and foot length, and foot length and width. Intrasex comparisons will clarify the variability within and the characteristics of each sex. These results will then be compared to the results from Musiba *et al.* (1997) in order to examine population trends in East Africa.

Two fossil hominin footprint sites from the early Pleistocene have been found in the East Turkana region; this study is therefore an important contribution to understanding the evolution of bipedalism in East Africa. This study was generously funded by Bigel 2007, Waterman 2008 and CHES 2008

Juvenile food sharing among the Hadza hunter-gatherers of Tanzania.

ALYSSA N. CRITTENDEN¹, DAVID ZES², and FRANK W. MARLOWE³. ¹Center for Academic Research and Training in Anthropogeny (CARTA), University of California, San Diego, ²Center for Environmental Statistics, University of California, Los Angeles, ³Department of Anthropology, Florida State University.

Juvenile foragers among the Hadza hunter-gatherers of Tanzania collect various types of wild plant foods and hunt small sized prey animals. In addition to providing a substantial portion of their own daily energetic requirements, they routinely share food with other young foragers. Few quantitative data are available concerning the ways in which children distribute their own foraging yield. Here, we present preliminary data on sex and age differences in the amount and distribution of shared food. Food sharing occurs between related and unrelated individuals. There are no significant differences between the amount (kilocalories) of food that male and female foragers share, however female foragers are more likely to share with unrelated individuals (non-kin) than their male counterparts. In addition, adolescent foragers (10 – 17 years) are more likely than younger foragers (4 – 9 years) to share with related individuals. Among children, sharing may be involved in the social construction of relationships at a very early age. Over their lifetimes, Hadza children interact

with the same core group of individuals and social bonds are reinforced with the sharing of food. In addition to strengthening friendships, caloric investment helps to subsidize growth. In most natural fertility populations the rate of reproduction exceeds the amount of resources that parents can contribute to multiple offspring. Food sharing among juvenile foragers may be one mechanism that allows mothers to maintain the relatively short inter-birth intervals that characterize human reproduction. Support: National Science Foundation, Regents of the University of California San Diego, Friends of the International Center at the University of California San Diego, and Harvard University.

No need for violence: episodic memory and scramble competition can explain primate “war zones”.

MARGARET CROFOOT^{1,2}, DAMIEN CAILLAUD³, LILIANA SALVADOR⁴, SAMUEL SCARPINO³, DENIS BOYER⁵, SADIE RYAN⁶ and PETER WALSH⁷. ¹Smithsonian Tropical Research Institute, Panama, ²Division of Migration and Immunology, Max Planck Institute for Ornithology, Radolfzell, Germany, ³Section of Integrative Biology, University of Texas, Austin, ⁴Department of Ecology and Evolutionary Biology, Princeton University, ⁵Departamento de Sistemas Complejos, Instituto de Física, Universidad Nacional Autónoma de México, ⁶National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, ⁷Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany.

War zones—under-used areas where the ranges of neighboring social groups overlap—have been described in a number of species including ants, wolves, and humans. Lethal acts of territorial aggression have been observed in all of these species, and it has been argued that “war zones” are the result of avoidance of potentially dangerous shared areas. However, under-use of shared areas is not restricted to species that engage in lethal territorial aggression and seems to be a wide-spread pattern among primates. A number of alternate hypotheses can be invoked to explain why shared areas are under-used in species lacking lethal territorial aggression. Emerging evidence suggests that cognitive maps and episodic memory play important roles in primate foraging decisions; greater knowledge about the location and availability of resources located near the center of a range might increase their value relative to resources in rarely visited, peripheral areas, making foraging in these border areas unprofitable. Scramble competition may also lower the profitability of foraging in shared areas by decreasing resource availability and increasing uncertainty about the quantity and location of food resources. Here, we use a spatially explicit, agent-based foraging model to explore the contribution of contest competition, scramble competition and memory to the space-use patterns of white-faced capuchin (*Cebus capucinus*). We find a mosaic of evenly spaced home ranges with “war zones” emerges, even when our model does not include agonistic interactions between groups. Thus, this

memory-based model provides alternative economic explanations for home range behaviors that have previously been interpreted in terms of the avoidance of violent conflict.

New support for a human hand in the collapse of Madagascar's megafaunal community: Using ¹⁴C dates to track species persistence and population decline during the Holocene.

BROOKE E. CROWLEY¹, LAURIE R. GODFREY² and DAVID A. BURNET³. ¹Department of Ecology and Evolutionary Biology, UC Santa Cruz, ²Department of Anthropology, University of Massachusetts, Amherst, ³National Botanical Gardens, Kauai.

The vertebrate community of Madagascar is thought to be one of the most unique and diverse communities on Earth. However, faunal diversity today is substantially lower than that during the Pleistocene and Holocene, and it is clear that many of the extant species are threatened. Constraining the timing of the demise of these recently extinct species relative to natural and anthropogenically-driven environmental changes is an important step in understanding the continued existence of the surviving taxa. Here, we combine over 200 new radiocarbon dates with published ¹⁴C dates from extinct and extant subfossil vertebrates.

We analyze the data for patterns pre- and post-three major historical events: human arrival, established human settlements, and European arrival. These new data, which include the first radiocarbon ages for several extant lemur genera (e.g. *Eulemur*, *Lemur*, *Lepilemur*, and *Microcebus*), provide comprehensive evidence for prolonged locality occupation by extant and extinct species well before human arrival, with habitation of some localities extending back before the Last Glacial Maximum. Dated late occurrences for extinct species from all ecoregions postdate the period of human arrival and early settlement. Nevertheless, there is strong evidence for population declines in the extinct species roughly coincident to human arrival, and generally prior to the establishment of human settlements. Only *Megaladapis* and *Palaeopropithecus* have yielded remains that date close to European arrival. These findings provide an unprecedented amount of detail to Madagascar's recent chronology that will be valuable for future paleontological and conservation research. This research was funded by a collaborative grant Number UCOP/Labs 09-LR-07-115818-DOMN SC 20081267 between Lawrence Livermore and UC Santa Cruz.

A taphonomic study of human remains from Neolithic Orkney.

REBECCA CROZIER, Department of Archaeology and Palaeoecology, Queen's University Belfast.

Orkney is well known for its rich funerary archaeology. Neolithic chambered cairns, located throughout the archipelago, have yielded an enormous wealth of human skeletal material. However, this material frequently consists of

highly fragmented, disarticulated and disorganized bone, rather than discrete skeletons. The dominant interpretation of this evidence is that it represents a funerary rite of excarnation. However, there has been little work undertaken to specifically support or refute this hypothesis. The aim of this research was therefore to address this issue using a taphonomic approach. Specifically, the ‘Zoneation Method’ developed for human remains by Knüsel and Outram (2004). The focal site for investigation was Quanterness (Renfrew 1979) on Mainland which comprises 12,600 human bone fragments. Other sites were also examined for comparison and to provide a more comprehensive view. These sites were Pierowall, Westray; Ibsbister, South Ronaldsay; and Point of Cott, Westray. The results of this analysis indicate new evidence for trauma and deliberate modification of the human remains. The presence of features such as charring, impact notches, cut marks and differential preservation, indicates that the funerary process can no longer be adequately understood by the single rite of excarnation. Ultimately, this project challenges the current and widely accepted interpretation of funerary remains from Neolithic Orkney. This can only lead to a greater understanding of the reasons the tombs themselves were constructed, and therefore an insight into the way people incorporated death into their daily lives. Grant Support: Part funded by the 75th Anniversary prize, Queen's University Belfast.

Non-dietary abrasives and the evolution of hominin megadonty.

REBECCA CUDDAHEE¹, RICHARD MADDEN¹, STEVEN CHURCHILL¹ and RENE BOBE². ¹Department of Evolutionary Anthropology, Duke University, ²Department of Anthropology, University of Georgia.

Hypotheses concerning morphological differences in the dentitions of hominin genera usually invoke dietary differences. Recent work on living herbivores suggests that non-dietary abrasives from ingested exogenous grit play an important role in excess tooth wear and thereby constitute a potential selective agent in the evolution of tooth morphology. We suggest that to prolong the functional longevity of teeth subject to excess tooth wear, hominins responded in several ways, including the evolution of megadonty.

We hypothesize that if non-dietary mineral grit selects for structural properties of teeth to better resist abrasion, and if megadonty is the primary means by which hominins resist tooth wear, then the marine record of the changing intensity of soil erosion should correlate with a change in the rate of the evolution of megadonty.

From the literature, we collected hominin M₃ tooth size (n=41) and eolian dust data from the Arabian sea floor. Using time series analysis, we compare plots of M₃ area with eolian dust by constructing smoothing spline fits at various lambda values. We find temporal coincidence between accelerations of evolutionary rates in australopith M₃ “megadonty” and peaks in the export of eolian dust to the Arabian Sea floor. Our results indicate that non-dietary abrasives

may have played a significant role as a directional selective agent in the development of megadonty. To the extent that *Homo* shared environments with *Paranthropus*, the lack of the development of megadonty in *Homo* may be the result of a behaviorally-mediated decrease in the ingestion of non-dietary abrasives.

Diet and the parallel evolution of increased salivary amylase expression in primates.

ANDREW J. CUNNINGHAM^{1,2}, ASTRI ZULFA³, ERIN R. VOGEL², JESSICA M. ROTHMAN⁴, NANCY LOU CONKLIN-BRITTAIN⁵, KENNETH E. GLANDER⁶, SERGE A. WICH⁷, GEORGE H. PERRY⁸ and NATHANIEL J. DOMINY⁹. ¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Department of Biology, Universitas Nasional Jakarta, ⁴Department of Anthropology, Hunter College, ⁵Department of Human Evolutionary Biology, Harvard University, ⁶Department of Evolutionary Biology, Duke University, ⁷Great Ape Trust of Iowa, ⁸Department of Human Genetics, University of Chicago, ⁹Department of Anthropology, University of California Santa Cruz.

Starch is a semicrystalline carbohydrate in plants. It is vital to modern humans, contributing up to 70% of dietary energy. Such a reliance on starch is expected to favor digestive adaptations, particularly the expression of amylase, which is the sole enzyme responsible for starch hydrolysis. Recently, the number of copies of the salivary amylase gene (AMY1) has been shown to correlate with protein expression levels and to vary among humans as a function of traditional starch intake. Additionally, humans tend to have more AMY1 copies ($n = 4-6$ on average) than chimpanzees or gorillas ($n = 2$). This result corresponds well with inferred levels of starch intake, thus implying a human-specific adaptation, yet scarcely any empirical data exist on the amylase expression of great apes or the starch content of their diets. Here we present the first quantitative analysis of dietary starch and salivary amylase expression among great apes. To contextualize these results, we also measured the salivary amylase expression of *Alouatta palliata*, *Macaca fascicularis*, and *M. mulatta*. Among apes, we found a relative increase in AMY1 copy number in *Pongo pygmaeus*. This finding not only agreed well with high levels of protein expression, but also high levels of dietary starch. Such a result suggests independent adaptations to starchy diets among orangutans and humans. Among monkeys, we found negligible levels of salivary amylase in *Alouatta*, but immense levels in *Macaca*, which has two AMY1 copies. Thus alternate genetic mechanisms have driven the parallel evolution of salivary amylase expression among primates. This study was funded by the National Science Foundation (REU), grant number 0643122, and the David and Lucile Packard Foundation.

Ecological and reproductive influences on *Varecia variegata* ranging and feeding

behavior in Ranomafana National Park, Madagascar.

ELENA CUNNINGHAM and LYLE SCHOFIELD. Department of Basic Science, New York University College of Dentistry.

Varecia is a highly frugivorous lemur that lives in seasonal environments. As females give birth to litters and have high reproductive costs, male care of infants is an important component of *Varecia*'s reproductive strategy. We examined the daily feeding times and path lengths of two *Varecia variegata* males and two females who were observed between April and December 2008 in Ranomafana National Park, Madagascar. Based on Vasey's study of *Varecia rubra* (1997, 2005) we predicted that (1) *Varecia variegata* would conserve energy during the austral winter and that (2) male and females would have similar daily path lengths and feeding times due to cooperative infant care, but that (3) females would spend more time feeding due to higher reproductive costs. The results indicate that from April through September, male and female feeding and ranging followed similar patterns, and females tended to spend more time feeding. Increases and decreases in feeding time tended to mirror changes in daily path length. From October (when females gave birth) through December, male and female ranging patterns diverged. Although feeding times dropped precipitously for both sexes, males greatly increased their daily path length in October, while females travelled shorter distances. Rather than travelling for food, males may have been contributing to the care of the young by defending their territory. Female daily path length sharply increased the following month, while males travelled less. The diverging ranging patterns that followed the birth of the infants appear to reflect different care taking roles for males and females. The study was funded by the National Geographic Committee for Research and Exploration, grant number 8398-08, a Dean's Faculty Research Award from the New York University College of Dentistry, and the Data Service Studio of NYU.

What is dental ecology?

FRANK P. CUOZZO¹ and MICHELLE L. SAUTHER². ¹Department of Anthropology, University of North Dakota, ²Department of Anthropology, University of Colorado-Boulder.

For many years, teeth have been used as indicators of ecology and behavior in living and fossil humans and other primates. Early work focused on the link between dental morphology and diet and/or behavior, with more recent years emphasizing patterns of dental micro- and macro-wear, and microstructure, to understand primate ecology. Our collaborative, long-term study of the population of ring-tailed lemurs (*Lemur catta*) at the Beza Mahafaly has revealed an unusual pattern of frequent tooth loss (> 25% of the population), primarily the result of consuming a fallback food for which these primates are not dentally adapted, thus exhibiting evolutionary disequilibrium. Our ability to interpret these data was only possible

by combining our areas of expertise (dental anatomy [FC] and primate ecology [MS]). By integrating theoretical, methodological, and applied aspects of both areas of research, we developed the term "dental ecology" – defined here as the broad study of how teeth respond to the environment. This includes 1) identifying patterns of dental pathology, such as abscessed teeth, tooth loss, dental damage, and tooth use-wear, as these reflect feeding ecology, behavior, and habitat variation, 2) assessing ways in which dental development can reflect environmental change and/or stress, and 3) how dental structure, specifically enamel properties, but also macro-morphology, are adapted to, and reflect, feeding ecology. This new "dental ecology" perspective builds on earlier work by many workers, but expands on this work by integrating anatomy and ecology in a new way, to interpret living and fossil humans, nonhuman primates, and other mammals. Funding – University of North Dakota, ND EPSCoR, University of Colorado, the St. Louis Zoo (FRC 06-01), Primate Conservation Inc., the International Society of Primatologists, the American Society of Primatologists, The National Geographic Society

Sexual dimorphism in health status at prehistoric Point Hope, Alaska.

GRETCHEN DABBS. Department of Anthropology, University of Kentucky.

Previously, sexual dimorphism in individual health traits has been demonstrated in groups spanning geography and time. This project expands these laudable beginnings by examining differences in overall health status between the sexes in two groups of prehistoric native Alaskans thought to practice strict sexual division of labor. Using the protocol outlined in *The Backbone of History*, this paper addresses the health consequence of dramatically different daily occupational tasks within two samples of Native Eskimos from Point Hope, Alaska (Ipiutak 60 individuals; Tigara 233 individuals). Examination of the data shows that while individual health traits varied between sexes neither sex was at an overall disadvantage due to occupational duties. In fact, comparison of the Mark I Health Index score for males and females of both groups shows virtually no difference in overall health status between the sexes. However, both the Ipiutak and Tigara show between sex variation in how the health index score was achieved. The available skeletal data suggests females at Point Hope were experiencing higher levels of chronic stress, as is indicated by higher levels of cribra orbitalia, DJD in some areas, and stature estimates similar to males. On the other hand, males at Point Hope suffered higher levels of acute stress, represented by higher frequencies of hypoplasias, more major fractures of the limbs, more weapon wounds, and higher levels of systemic infection. It is clear neither sex was healthier than the other, but the avenues by which each sex arrived at their overall health followed dramatically different trajectories. This study was funded in part by a Collections Study Grant from the American Museum of Natural History.

Masticatory effort and dietary hardness in sooty mangabeys (*Cercocebus atys*) from Tai Forest, Ivory Coast.

DAVID J. DAEGLING¹, W. SCOTT McGRAW², ANNA E. VICK³, ANDREW J. RAPOFF⁴, ANDERSON BITTY⁵ and RICHARD PAACHO⁶. ^{1,3}Department of Anthropology, University of Florida, ²Department of Anthropology, Ohio State University, ⁴Department of Mechanical Engineering, Union College, ⁵University of Cocody, Ivory Coast, ⁶Tai Monkey Project, Tai National Forest, Ivory Coast.

Hard-object feeding in primates has received considerable attention from morphologists interested in the evolution and biomechanics of the skull. Durophagy is widely assumed to require elevated masticatory forces that are functionally linked to variation in craniofacial morphology. What is largely unknown from wild primate populations is how reliance on durophagy influences ingestive and masticatory behaviors, particularly the use of specific teeth and the number of chewing cycles per day, respectively.

Food hardness data were collected using handheld durometers in the Tai Forest, Ivory Coast for preferred items in the diet of a habituated group of sooty mangabeys (*Cercocebus atys*) in 2008-2009. Hardness of mangabey foods was related to observations on frequency of use of the incisors, canines and postcanine teeth during ingestion. In addition, the number of masticatory cycles per ingestive event was related to food hardness values.

Tai mangabeys routinely use their incisors to process hard objects, including their most preferred fruits --*Saccoglottis gabonensis* and *Coula edulis*. Breakdown of these fruits prior to mastication also requires high-intensity postcanine crushing. For the hardest items in the diet (Shore A Hardness > 75), incision counts covary strongly with masticatory cycle counts per ingestive event ($r^2 = 0.98$). Variance in incision and masticatory cycle counts is highest with respect to harder foods. Field measures of hardness do not covary strongly with masticatory cycles per feeding event. Food hardness is more clearly related to ingestive work involving the incisors -- and for the most preferred fruits, the postcanine teeth -- prior to mastication. Supported by National Science Foundation grants BCS-922429, -60017683, -0921770, -0922414.

Tooth use and loss at San Pedro de Atacama: The impact of Tiwanaku influence in northern Chile, AD 400-900.

PEDRO DA-GLORIA¹, MARK HUBBE², WALTER NEVES³, MARIA ANTONIETTA COSTA². ¹Department of Anthropology, The Ohio State University, ²Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica del Norte, Chile, ³Departamento de Genética e Biología Evolutiva, Universidade de São Paulo.

During the period of AD 400-900, Tiwanaku had a profound cultural and social impact on

various populations, including San Pedro de Atacama. During the peak of that influence, there was a more elaborated material culture, increase in social complexity, and improving health (e.g., increase in stature, decline in dental caries prevalence). In this study, we test the hypothesis raised by Neves and Costa that improving health was linked to dietary change. To test this hypothesis, we analyzed tooth wear in San Pedro de Atacama before, during, and after Tiwanaku influence. Using the Molnar scale, we scored 1754 teeth from 147 individual of three cemeteries: Solcor-3, Coyo-3, and Quitor-6, dating between AD 250-1240. The analysis revealed little change in the posterior dentition wear. On the other hand, we found significant changes in the anterior dentition wear. Considering that prevalence of tooth loss in San Pedro de Atacama ranges from 39-67% in females and 27-36% in males, we also investigated the influence of this factor on tooth wear. The analysis revealed a significant positive correlation between posterior tooth loss and anterior wear ($p<0.05$, males $r=0.61$, females $r=0.53$). As antemortem tooth loss has a multifactorial etiology in San Pedro de Atacama, we were unable to answer properly the hypothesis raised by Neves and Costa. These results suggest that research on populations with high tooth loss should consider carefully the influence of tooth loss on the pattern of dental macrowear. This study was funded by Fondo Nacional de Desarrollo Científico y Tecnológico (11070091) granted to WN and MAC, Conselho Nacional de Desenvolvimento Científico e Tecnológico productivity scholarship (301126-04-6) granted to WN, and Fundação de Amparo à Pesquisa do Estado de São Paulo (2004/04054-9) granted to PG.

Effects of distance from Africa on within-population phenotypic diversity in modern human dermatoglyphic finger ridge counts.

E. SUSANNE DALY¹, STEPHEN OUSLEY¹, and RICHARD JANTZ². ¹Department of Applied Forensic Sciences, Mercyhurst College, ²Department of Anthropology, University of Tennessee.

The past few years have seen a rise in the use of models for understanding the relationships of within-population variation to geographic distance. Recent genetic studies demonstrate a decrease in genetic differentiation with an increase in geographic distance to sub-Saharan Africa. The greatest intra-regional genetic diversity has been seen in Subsaharan Africans and lower in more distant regions. Analyses of craniometric and dental traits have provided similar results (Betti et al. 2008, Hanihara 2008, Manica et al. 2007, von Cramon-Taubadel and Lycett 2008). These results have been used to support the recent African origin model. Dermatoglyphic ridge counts are considered selectively neutral and provide an independent comparison with these results. This study employs R-Matrix analysis (Relethford and Blangero 1990) to test the fit of dermatoglyphic finger ridge counts to the African origin model. Samples were limited to males with a sample size of at least 50 from 81 populations representing 10 major geographic regions.

Simple regression analysis was used to analyze the relationship between intra-group variation and geographic distance. We found no significant correlation for within-group variation and distance from Africa. In addition, North and South America, not Subsaharan African, showed the most diversity. These results contradict results from genetic and craniometric traits and do not support the recent African origin model. Differences in these results are discussed in terms of trait selection, sample selection, sample size, and methodology.

Subtrochanteric dimensions of the femur: Where, oh where, to measure?

SHAMSI DANESHVARI. Department of Anthropology, University of New Mexico.

In Martin and Saller's Lehrbuch der Anthropologie(1957) subtrochanteric dimensions of the femur are measured two to five centimeters below the lesser trochanter. In most studies, researchers do not specify where within this range the measurement is taken. This study seeks to answer whether measurements within the range defined by Martin and Saller, as well as outside it, are statistically different.

Females and males (n=40) from the Documented Collection at the Maxwell Museum were studied. Medio-lateral and anterior-posterior measurements were taken on the right femur at half centimeter increments from zero to seven centimeters below the lesser trochanter. Repeated measures ANOVA was utilized to test if a significant difference exists between the values at each location for each individual and sex. The results indicate that there is an effect from where the measurements are taken, as the no effect hypothesis was rejected ($p=0.0155$ and 0.0127 for M-L and A-P respectively). Furthermore, the within individual effects were significant ($p<0.001$), indicating that there are differences in the measurements taken within each individual.

In conclusion, there is a significant difference in measurements of the femur below the lesser trochanter from zero to seven centimeters, including the defined range of two to five centimeters. In order to compare databases and individuals within a database, including the Robusticity Index, a specific point within the defined range must be utilized. Therefore, until a specific point is agreed upon, researchers should consistently report the specific distance from the lesser trochanter the measurement is taken to reduce error.

Fecal glucocorticoids and social contact among female rhesus macaques on Cayo Santiago.

JENNIFER DANZY¹, VERONICA GUTIERREZ², PATRICIA WHITTEN³, and BENJAMIN CAMPBELL¹. ¹Department of Anthropology, University of Wisconsin at Milwaukee, ²Department of Sociology-Anthropology, New Mexico State University, ³Department of Anthropology, Emory University.

Previous studies of stress hormones and reproduction in chimpanzees suggest that

mating may be stressful for females due to male coercion. However, there has been little exploration of the relation between mating and female stress in primates. In rhesus macaques, increased male mortality during the mating season indicates high levels of male-male competition, potentially making interactions with aggressive males stressful for females. We conducted a three month observational study of female mating behavior on Cayo Santiago in 2006. Here we examine the relationships between mating behavior and fecal glucocorticoids (fGC) from ten multiparous females; weekly fecal samples and associated behavioral measures for each individual were averaged across the mating season. We used Pearson's correlation tests to examine the potential relationships between fGC levels and female behavior.

Average fGC levels were negatively related to the average rate of female initiated approaches to males ($n=9$; $r=-.77$; $p=.02$) and to the amount of grooming that a female directed to other females ($n=10$; $r=-.63$; $p=.05$). Average fGC levels were unrelated to the number of approaches to other adult females.

These results suggest that during the mating season females with higher fGC levels initiate less social contact with others, especially with males. Our results also suggest that this is not a result of conspecifics avoiding affiliative contact with females with high fGC levels. Additional data from both the non-mating and mating seasons are needed to determine the potential relationship between female fGC levels and social contact behavior among rhesus macaques. Cayo Santiago is supported by Grant Number CM-5-P40RR003640-13 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH).

A comparative study of the analysis of osteological remains: Computed tomography versus physical examination.

CAITLIN DAR DENNE. Department of Anthropology, University of Utah.

This study is an experiment designed to compare the effectiveness of two skeletal trauma analysis techniques- Computed Tomography (CT) scanning and direct physical examination. CT scans create an unbiased record of an osteological specimen's existence and condition for research should anything happen to the remains. Prior to this study however, no extensive research had been carried out on the practicality of osteological analysis through CT scanning. I have worked with the NSF funded Open Research Scan Archive at the University of Pennsylvania; an expanding archive of osteological and mummified CT scans. Through this work, I hypothesized that CT scanning and physical examination would yield statistically similar osteological analysis and interpretations. Moreover, if assessed together, the two techniques would provide a more complete picture of the trauma associated with the specimen than either could alone.

As my test sample, I utilized six sub-adult pigs which had been traumatized in a perimortem context by a third party, buried, and excavated.

After excavation they were analyzed using CT scans and direct physical examination. The findings were compared through Chi-Squared analysis. The statistics showed that for "type" and "timing" both techniques provided similar results. The two techniques were then combined and compared to the actual record of trauma for each specimen. On average 68% of inflicted trauma was identifiable. This research is a pilot for more extensive studies on the application and assessment of radiographic technology in osteology. Continual assessment of the reliability and efficiency of analytical techniques will help move the field forward.

An assessment of health and activity of the nineteenth-century Junkin-Yost Cemetery from the Village of Indian Hill, Ohio.

MARGARET L. DAVID. Department of Anthropology, San Diego State University.

Little research has been done on non-indigenous, historical European American populations within the United States in bioarchaeology. The analysis of three human skeletons (30-40 year old male, 24-27 year old female, and a 2 year old subadult) recovered during a preservation effort of the undocumented Junkin-Yost Cemetery in the Village of Indian Hill, Ohio, provides new data on health and physiological stress for a 19th-century small sample of Euro-American farmers. Historical land deeds suggest these burials date roughly from 1824-1850, and are confirmed by the remains of one marble headstone dated at death to 1848. Both adults exhibit numerous dental pathologies, including caries, abscesses, calculus, and antemortem tooth loss, typical of the poor dental health and hygiene experienced by populations whose diets are high in carbohydrates. Skeletal changes associated with moderate physical activity are present on the adult male. The upper body exhibits osteoarthritis and enthesopathies, the lower thoracic vertebrae express a number of Schmorl's nodes, and the lateral shaft of the right tibia shows evidence of periostitis. The female exhibits thickening of the cranial vault consistent with healed porotic hyperostosis, and also possesses enamel hypoplasias on the mandibular canines; both suggest a biologically stressful childhood for this individual. This sample adds to the growing amount of data on health and activity in early America that are often lacking in the historical written record, and may help lead to a better understanding of the hardships of life in 19th-century southwestern Ohio.

HLA DQ and onchocerciasis in Ecuador: Interactions between genetic and environment in an endemic infection.

FLAVIO DE ANGELIS, ALESSIA GARZOLI and GIAN FRANCO DE STEFANO. Department of Biology, University of Rome "Tor Vergata".

As a consequence of long exposure to infectious diseases, natural selection has gradually modified the human genome, especially at level of the human leukocyte antigen (HLA)

complex. The aim of this study is to explore the HLA DQ variability in two populations living in the same Ecuadorian rain forest environment and subjected to the same environmental stress, mainly *O. volvulus*. Two HLA class II loci (HLA DQB1 and HLA DQA1) of 200 unrelated individuals from three Ecuadorian populations (Chaci and Tsachilas Indians and African Ecuadoreans) have been analyzed. HLA high resolution typing was performed by three different protocols: Sequence Specific Oligonucleotides hybridizations (SSO), Sequence Specific Primer amplification (SSP) and direct Sequencing (Sequence Based Typing, SBT).

Among the African Ecuadoreans a significant correlation exists between HLA-DQB1*0301 and protection against the infection of *O. volvulus*. These results confirm those previously reported for two African populations. A different putative protective allele exists among the Chaci: HLA DQB1*0402. A potential protective allele at HLA-DQA1 was not observed in either of the two populations but two different alleles seem to be responsible of the different disease clinical display in these populations: HLA DQA1*0102 in African Ecuadoreans and HLA DQA1*0301 in Chaci. These results are compared with a neighbor population, the Tsachilas, which are not currently affected by onchocerciasis, to compare the HLA allelic pool. Tsachilas allelic distribution appears of course closer to Chaci Indians but shows an unexpected high frequency of allele HLA DQA1*0501, related to protection against onchocerciasis in African populations. This study was funded by MIUR, COFIN 2006

Extensions for the NamUs databases: Geocoding and spatial search tools for forensic anthropologists.

ROCCO de GREGORY¹, BRUCE A. RALSTON², LING YIN² and NICHOLAS P. HERRMANN¹. ¹Department of Anthropology and Middle Eastern Cultures, Mississippi State University, ²Department of Geography, University of Tennessee.

In 2007, the unidentified decedents database of the National Missing and Unidentified Persons System (NamUs - www.namus.gov) was launched by the Office of Justice Program's National Institute of Justice (NIJ) as a resource for law enforcement officer, medical examiners, concerned family members and forensic anthropologists. By providing an interface for missing persons and unidentified decedents, NamUs provides a centralized database for matching cases from across the United States. Our research has focused on the development of geocoding tools for NamUs data entry and the integration of an internet-based GIS application that allows users to search the two databases based on spatial and attribute queries. The geocoding tools consist of interactive and batch geocoding using available online geocoding services. The internet-based search application entails an ArcServer geoprocessing application that allows users to simultaneously define a search area and a set of attribute queries. Examples of the geocoding tool and search

application will be highlighted. The mapping application allows forensic anthropologists and other stakeholders to examine unidentified decedent and missing person cases in a spatial format as compared to the currently available state and county level searches. The benefits of the geocoding and internet-based search application for NamUs users and administrators will be discussed through the use of several case examples. This study was funded by National Institute of Justice, Award Number 2008-IJ-CX-K406.

Hominoid visual brain structure volumes and the position of the lunate sulcus.

ALEXANDRA A. DE SOUSA¹, CHET C. SHERWOOD¹, HARTMUT MOHLBERG², KATRIN AMUNTS^{2,3}, AXEL SCHLEICHER⁴, CAROL E. MACLEOD⁵, PATRICK R. HOF⁶, HEIKO FRAHM⁴ and KARL ZILLES^{2,4}. ¹Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ²Institute of Neuroscience and Medicine, INM-1, INM-2, Research Center Jülich, ³Department of Psychiatry and Psychotherapy, Rheinisch-Westfälische Technische Hochschule, RWTH Aachen University, ⁴C. and O. Vogt Institute of Brain Research, Heinrich Heine University, Düsseldorf, ⁵Anthropology Department, Langara College, Vancouver, ⁶Department of Neuroscience, Mount Sinai School of Medicine.

It has been argued that changes in the relative sizes of visual system structures which predate an increase in brain size provide evidence of brain reorganization in the human lineage. However, reorganization may have been evident in australopiths, as indicated by the position of the lunate sulcus, which marks the anterior limit of the primary visual cortex. Yet data about the volume and anatomical limits of visual brain structures in the extant taxa phylogenetically closest to humans – the apes – remain scarce, thus complicating tests of hypotheses about evolutionary changes. Here, we analyze new volumetric data for the primary visual cortex and the lateral geniculate nucleus to determine whether or not the human brain departs from allometrically-expected patterns of brain organization. Primary visual cortex volumes were compared to lunate sulcus position in apes to investigate whether inferences about brain reorganization made from fossil hominin endocasts are reliable in this context. In contrast to previous studies, in which all species were relatively poorly sampled, the current study attempted to evaluate the degree of intraspecific variability by including numerous hominoid individuals, particularly of *Pan troglodytes* and *Homo sapiens*. In addition, we present and compare volumetric data from three new hominoid species – *Pan paniscus*, *Pongo pygmaeus*, and *Sympalangus syndactylus*, as well as a *Macaca fascicularis*. These new data demonstrate that hominoid visual brain structure volumes vary more than previously appreciated. In addition humans show relatively reduced primary visual cortex and lateral geniculate nucleus volumes as compared to allometric predictions from other hominoids. These results suggest that the position of the lunate sulcus on

fossil endocasts may provide evidence of hominin brain organization. This study was funded by the National Science Foundation (9987590, 01-113) and the James S. McDonnell Foundation (2002078).

Variability of GST Omega class gene polymorphisms in Cayapa and Colorados Amerindians of Ecuador.

GIAN FRANCO DE STEFANO, SARA PIACENTINI, RENATO POLIMANTI and MARIA FUCIARELLI. Department of Biology, University of Rome "Tor Vergata".

The Glutathione S-Transferases (GSTs) are a superfamily of proteins with a wide range of enzymatic and catalytic activities. In the 2000 year, a new GST isoenzyme was identified. This isoenzyme has novel structural and functional characteristics and represents a new GST class termed Omega (GSTO). In humans, GSTO include two expressed genes, GSTO1 and GSTO2, located on the chromosome 10q24.3. Several polymorphisms have been identified in the coding region of GSTO genes. Among these, GSTO1*A140D (rs4925), GSTO1*E155del (rs56204475), GSTO1*E208K (rs11509438) and GSTO2*N142D (rs156697) have been identified in a number of populations, but their worldwide distribution is still far to be completed.

The aim of this study is to present inedited data on the characterization GSTO gene polymorphisms in Colorados (Xachilas) and Cayapa (Chachi) Amerindians of Ecuador and in a sample of the Italian population in order to contribute the knowledge on the geographic and ethnic distribution of these polymorphisms. All groups were analyzed for the four polymorphisms of the GSTO genes: Detection of GSTO1*A140D and GSTO2*N142D alleles was performed by PCR-RFLP analysis, while GSTO1*E155del and GSTO1*E208K alleles were detected using the Confronting Two-Pair Primers (CTPP) analysis and allele specific PCR respectively. The results confirm what has been inferred from other genetic data about the high degree of heterogeneity among the Ecuadorian Amerindians, even within the same linguistic branch. The comparison between the present data and the results still now reported for other populations strengthen the hypothesis about the great heterogeneity of GSTO gene polymorphisms among humans. This study was funded by COFIN 2006, 2006053308 allocated to G.F. De Stefano.

Who's in and who's out? Re-evaluating the proposed congeneric status of *Afropithecus turkanensis* and *Morotopithecus bishopi*.

ANDREW S. DEANE¹, MARIAM C. NARGOLWALLA², DAVID R. BEGUN² and EMMA J. SMITH³. ¹Department of Anatomy and Neurobiology, University of Kentucky; ²Department of Anthropology, University of Toronto; ³PPD Inc.

Afropithecus turkanensis is a large-bodied early Miocene catarrhine from East Africa. Although there is little agreement on the phylogenetic status

of most early Miocene fossil catarrhines, there is general consensus that *Afropithecus* is derived relative to *Proconsul*. *Afropithecus* is distinguished from *Proconsul* by craniofacial and dental traits, many of which are shared with extant pitheciines and are functionally related to a sclerocarp foraging. It has recently been suggested that *Morotopithecus bishopi* and *Afropithecus* are congeneric based on their analysis of relative P³ and M³ dimensions. This contradicts previous analyses which favour a generic distinction based on the temporal separation of *Morotopithecus* and *Afropithecus* (~2.5–4.5 myr) and their interpretation of numerous craniofacial and dental dissimilarities. This study uses a three-part morphometric approach to craniofacial and dental anatomy to re-evaluate the congeneric status of *Afropithecus* and *Morotopithecus* (i.e. craniofacial linear dimensions, molar cusp proportions, incisor and canine crown curvature). Incisor curvature closely corresponds to dietary function and was used here to identify anterior dental specializations associated with the sclerocarp foraging feeding adaptation characteristic of *Afropithecus* and extant pitheciines. *Morotopithecus* lacks these anterior dental specializations, and is distinguished from *Afropithecus* by facial and molar morphometrics, suggesting that these taxa are sufficiently different to warrant generic distinction. An understanding of the age and hypodigm for *Afropithecus* is critical to interpretations of early hominoid biogeography and great ape origins, as it has been suggested that *Afropithecus* may be broadly ancestral to the earliest apes (*Griphopithecus*, *Kenyapithecus*) from Europe.

Assessing fertility and fecundity in slave groups of the Caribbean from mtDNA sequence variation.

MICHAEL DEASON¹, VINCENT MACAULAY² and YANNIS PITSLADIS¹. ¹Integrative and Systems Biology, University of Glasgow, ²Department of Statistics, University of Glasgow.

The African Diaspora in the Caribbean represents the largest forced relocation in history. While previous works have focused on historic ethnography and modern day molecular demography, few have combined the two. Despite the arrival of roughly 747,500 individuals to Jamaica over 152 years, the final slave population at the cessation of slavery was only 324,000. Slaves were initially acquired from the most westerly point in Sub-Saharan Africa and then progressively along the coast until roughly the Congo Delta. The aim of this study is to assess the matrilineal makeup of modern day Jamaica and compare it to the matrilineal makeup of cited source populations in western Africa in order to glean reproductive success during the era of slavery.

Using the first hyper variable region in the mitochondrial genome, 401 Jamaicans were compared to individuals from source populations found in the published literature. Source populations were then divided into West, West-Central, and South Africa. An analysis of molecular variance was then conducted between these groups to assess variation found within

and between groups. Results show Jamaica with a greater affinity to West-Central Africa, followed by West and then South. This not only mirrors the historical record as those arriving from West-Central were the most recent, but also highlights the life history constraints present as a result of intensive labor, patriarchal labor assignment, and poor nutrition. Low rates of fertility and fecundity may account for the discrepancy in regional origin. This study was funded by internal funds from University of Glasgow.

Explaining patterns of human genetic variation using coalescent-based models of human origins.

MICHAEL DEGIORGIO¹, MATTIAS JAKOBSSON², JAMES H DEGNAN³ and NOAH A ROSENBERG^{1,4,5}. ¹Center for Computational Medicine and Bioinformatics, University of Michigan, ²Department of Evolutionary Biology, Evolutionary Biology Centre, Uppsala University, Norbyvägen 18D, Uppsala, Sweden, ³Department of Mathematics and Statistics, University of Canterbury, New Zealand, ⁴Department of Human Genetics, University of Michigan, ⁵Life Sciences Institute, University of Michigan.

Studies of worldwide human variation have discovered three trends in summary statistics as a function of increasing geographic distance from East Africa: a decrease in heterozygosity, an increase in linkage disequilibrium (LD), and a decrease in the slope of the ancestral allele frequency spectrum. To explain these trends, we develop a coalescent-based serial founder model of human origins, in which populations migrate outward from Africa through a process where each of a series of populations is formed from a subset of the previous population in the outward expansion. Our model both recovers the observed decline in heterozygosity with increasing distance from Africa and produces the patterns observed in LD and the ancestral allele frequency spectrum. Although migration between neighboring populations and limited admixture between modern and archaic humans can be accommodated in the model while continuing to explain the three trends, a competing model in which a wave of outward modern human migration expands into a series of preexisting archaic populations produces nearly opposite patterns to those observed in the data. The results support a primary influence on variation patterns of a cumulative effect of genetic drift as humans colonized the world, and they highlight the utility of coalescent-based evolutionary models in providing explanations for observed patterns of human genetic variation.

Does mean osteon size decrease with increasing age in the second metacarpal?

BRIDGET DENNY¹, MARGARET A. STREETER¹, RICHARD LAZENBY² and MICHELLE S.M. DRAPEAU³. ¹Department of Anthropology, Boise State University, ²Anthropology Program, University of Northern British Columbia, ³ Department of Anthropology, University of Montreal.

Previous studies on bones such as ribs, femurs and tibias have shown that mean osteon size decreases with age in adults. The purpose of this analysis is to determine if this trend also applies to the second metacarpal. We evaluated 24 right second metacarpal cross sections from a mid-nineteenth century European cemetery located in Belleville, Ontario. In this preliminary study the point count method (at 200X) was used to determine mean osteon size for fifty osteons each from the right second metacarpals of males (n=18) and females (n=6) that ranged in age from 19 to 77 years (mean = 46 years). Results of our regression analysis when males and females are combined shows no correlation ($r=.009$) between age and mean osteon size. When males and females are considered separately, females show a positive correlation ($r=.66$), while in males there is a much weaker positive correlation ($r=.3$). This could be the result of differences in remodeling between males and females, the small sample size, or the discrepancy in sample size between the sexes. Analysis of a larger sample size, including more equal numbers of males and females, could clarify these results. This research was funded by the Fonds québécois de recherche sur la société et la culture (2008-NP-108312 to MSMD) and by the Natural Science and Engineering Research Council of Canada (Grant 183660-03; RL).

Monitoring nutritional stress with urinary $\delta^{15}\text{N}$ and C/N ratios in captive bonobos.

TOBIAS DESCHNER¹, BENJAMIN T. FULLER¹, VIKTORIA OELZE¹, SYLVIA ORTMANN², MIKEL P. RICHARDS¹ and GOTTFRIED HOHMANN¹. ¹Max Plank Institute for Evolutionary Anthropology, Leipzig, Germany, ²Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany.

In recent years methodological improvements have allowed for more precise estimates of wild primate nutritional intake. However, estimates of energy balance have remained relatively imprecise due to difficulties in exactly determining the energy expenditure of these animals. In the absence of a reliable intake-expenditure calculation, a method is needed that directly links changes in energy status to physiological changes that can be detected via markers in body excretions such as urine or feces. One promising marker is the $\delta^{15}\text{N}$ and the C/N ratio. Here we present the results of a food restriction experiment carried out in a group of captive bonobos (N=7). We measured changes in energy availability and body weight and determined $\delta^{15}\text{N}$ and C/N ratios in 280 urine samples by stable isotope ratio mass spectrometry analysis. During food restriction, urinary $\delta^{15}\text{N}$ increased and C/N ratios decreased as did individual body weight. Increased energy availability was associated with an increase in body weight and simultaneous decrease in urinary $\delta^{15}\text{N}$ and an increase in C/N ratios. Our results indicate that urinary $\delta^{15}\text{N}$ as well as the C/N ratio are suitable to monitor moderate longitudinal changes in food availability and body weight. We therefore conclude that the measurement of urinary $\delta^{15}\text{N}$ and C/N ratio in

urine of wild apes could be a promising method to identify variation in individual energy status. This study was funded by the Max Planck Society.

Mobility evidence during the Bell Beaker period in Western Switzerland through strontium isotope study.

JOCELYNE DESIDERI¹, DOUGLAS PRICE², JAMES BURTON², PAUL FULLAGAR³ and MARIE BESSE¹. ¹Department of Anthropology and Ecology, University of Geneva, ²Department of Anthropology, University of Wisconsin, ³Department of Geological Sciences, University of North Carolina.

The Bell Beaker culture initially refers to a pottery style largely widespread during the third millennium BC. Its particularly large geographic distribution has provoked different interpretations: diffusion of a culture by population movement, long-distance exchange of prestige goods, and absence of a real Bell Beaker population with only the diffusion of its cultural components.

In Switzerland, the Bell Beaker period would have developed following influences varying from both the Mediterranean region and Central Europe. Our previous research on dental morphology (nonmetrics) clearly shows a variability of the end of the Neolithic populations (Final Neolithic and Bell Beaker periods) which probably reveals mobility or external population contribution in Western Switzerland.

In order to validate and quantify this external population contribution during the Bell Beaker period in this region, enamel of 23 Bell Beaker individuals from the necropolis of the Petit-Chasseur (Sion, Valais, Switzerland) have been analyzed for strontium isotope ratio ($^{87}\text{Sr}/^{86}\text{Sr}$). Results of strontium isotope ratio are concordant with dental morphology results supporting mobility during the Bell Beaker period in Western Switzerland. Moreover, these results reveal some interesting points about the Bell Beaker individuals who have changed their "geological" residence during their lifetimes. This study was funded by the Swiss National Foundation (FNS), grant number IZKOZ3-123828/1 and the Boninchi Foundation (Geneva, Switzerland).

A case of valgus ankle in an early Pleistocene hominin.

JEREMY M. DESILVA¹ and AMANDA PAPAKYRIKOS². ¹Department of Anthropology, Boston University, ²Cushing Academy, Ashburnham, MA.

A skeletal correlate of bipedality is a perpendicularly oriented tibia relative to the plane of the ankle joint, positioning the foot directly under the center of mass. Non-human primates, in contrast, possess a tibial shaft that tilts laterally away from the plane of the ankle joint (valgus ankle), which positions the foot in inversion and is adaptive for arboreal climbing. KNM-ER 2596 is a small distal tibia from the 1.9 mya site of Koobi Fora, Kenya. Though it possesses many of the morphologies

functionally linked to bipedality, such as an expanded metaphysis and a mediolaterally reduced anterior aspect of the talar surface, it also possesses a valgus tilt to the ankle. We test the competing hypotheses that the KNM-ER 2596 tibia is from a cercopithecoid, a non-human hominoid, or a pathological hominin. A survey of the orthopaedic literature and a comparative study of modern human (n=77), fossil hominin (n=13), non-human primate (n=171), and fossil cercopithecoid (n=12) tibiae support the hypothesis that KNM-ER 2596 is from a hominin. Untreated breaks of the lower third portion of the fibula can result in a valgus tilt to the distal tibia and occasionally other peculiar morphologies found in the KNM-ER 2596 tibia such as a superoinferiorly atrophied medial malleolus. The morphology of this tibia is incompatible with hypotheses that it is from a cercopithecoid or a hominoid, and instead, we suggest that KNM-ER 2596 belonged to a hominin that may have suffered a fracture of the lower left fibula as a juvenile.

Correlation between first molar occlusal and approximal wear.

CHRISTINA A. DETER and PATRICK MAHONEY. School of Anthropology and Conservation, University of Kent.

Studies of human dentition routinely include measurements of occlusal (chewing surface) and approximal (mesial/distal surfaces) wear with insights gained into diet, and behavior. Yet, few consider the relationship between the two types of dental wear. This study investigates the correlation between occlusal and approximal wear in an archaeological sample of modern humans.

Right maxillary first molars were selected from a late Archaic North American hunter-gatherer site, (3385 ± 365) (n=169) and a late Anasazi early Zuni agricultural site (~1300 AD) (n=89). The approximal facet was measured at the widest breadth using needle tipped digital calipers. Digital images were taken of the occlusal surface and wear was recorded as the percentage of dentine exposed to the total occlusal surface, as described by Deter, 2009. A quadratic model was used to explore the relationship between the two variables.

Results for both groups show that the early stages of occlusal and approximal wear increase at a similar rate. In the middle and later stages of tooth wear (greater than 50% occlusal wear), there was a strong negative correlation between occlusal and approximal wear: as the occlusal wear increased, the approximal wear decreased. This pattern continued into the final stages of tooth wear. Implications for methodology are discussed.

Why does starvation make bones fat?

MAUREEN J. DEVLIN¹, ALISON M. CLOUTIER¹, ILKA PINZ², CLIFFORD J. ROSEN², MARY L. BOUXSEIN¹. ¹Beth Israel Deaconess Medical Center, Harvard Medical School, ²Maine Medical Center Research Institute.

Human bone loss (e.g. due to osteoporosis or anorexia) is associated with increased bone marrow fat. It is unclear whether these adipocytes (fat cells) exacerbate bone resorption, have a protective function, or simply fill empty endocortical space. However, the fact that marrow fat increases in anorexia suggests a possible role in human skeletal adaptations to starvation.

Here we test the effect of caloric restriction (CR) on bone formation and marrow fat in mice. The hypothesis is that CR will increase marrow adipogenesis and decrease bone formation, as seen in humans. Male C57Bl/6J mice (N=4-8/group) were fed normal (N) or 30% CR diet from 3-6 or 3-12 wks of age. At endpoints, we measured bone formation and marrow adiposity via dynamic histology, and also used magnetic resonance imaging and spectroscopy to quantify bone marrow fat content.

By MR spectroscopy, CR induced a 148% increase in distal femoral marrow fat in CR vs. N at 6 wks of age (62.02 vs. 24.97 A.U./10000, N=2-4/grp). Dynamic histology confirmed a dramatic increase in marrow adiposity in CR vs. N, +200% at 6 wks, and +794% at 12 wks (p<0.05 for both), and demonstrated that CR decreased bone formation by 75-85% vs. N, with 60-70% fewer osteoblasts and 70-100% more osteoclasts (p<0.05 for all).

These data demonstrate that CR increases marrow fat and decreases skeletal acquisition, and thus can serve as a model for skeletal effects of human starvation. Future studies will investigate the role of marrow fat in skeletal recovery from caloric restriction. This study was funded by NIH R01 AR049265 (MLB).

The relationship between oral health and general health: associations between periodontitis and non-oral skeletal pathologies.

SHARON N. DEWITTE. Department of Anthropology, University at Albany.

Numerous studies within modern populations have shown associations between oral disease and other diseases, such as cardiovascular disease, certain types of cancer, and pulmonary infections. Recently, the author addressed the question of how oral health was associated with general health in past populations by examining the relationship between periodontitis and dental caries and the risk of mortality in a skeletal sample from medieval England. The results of that study suggest that these oral pathologies were associated with elevated risks of mortality (DeWitte, n.d.); however, no attempt was made to determine which particular diseases or causes of death periodontitis or dental caries were associated with in the population. The current study builds upon this previous research by examining whether periodontitis and cribra orbitalia are associated with periodontitis within a medieval cemetery from London. Cribra orbitalia is often interpreted as an indicator of childhood anemia, whereas periodontitis is part of an inflammatory response to trauma or infection that can occur at any age. A sample of 238 individuals from the St. Mary Graces cemetery (c. 1350-1538 AD) in London was used for this study. The results indicate that periodontitis is

significantly associated with periodontitis but not cribra orbitalia in this sample. The association between periodontitis and periodontitis might indicate that periodontitis initiated inflammatory responses elsewhere in the body or perhaps both pathologies reflect an underlying hyperinflammatory trait. This study provides important new information about the skeletal indicators of frailty that are commonly used by investigators interested in health patterns within past populations. Funding for the research was provided by the University at Albany Center for Social and Demographic Analysis and the University at Albany Faculty Research Awards Program.

Sagittal suture mechanics in apeloid vs. non-apeloid *Cebus* during hard-object feeding.

JASON DHABLIWALA¹, CRAIG BYRON¹, CALLUM ROSS², DAVID REED² and QIAN WANG³. ¹Department of Biology, Mercer University, ²Department of Organismal Biology and Anatomy, University of Chicago, ³Basic Medical Sciences, Mercer University School of Medicine.

Cranial sutures are ligamentous connective tissues found between individual intramembranous bones of the skull and face. Previous work demonstrates a functional relationship between dietary material properties and sagittal suture morphology in *Cebus* primates. The apeloid capuchins consistently show sagittal sutures with enhanced interdigitating complexity which is notable because they also are known to uniquely exploit mechanically demanding diets. In this study, three *Cebus* primates are used (1 apeloid and 2 non-apeloid) to measure and record mechanical strains from the sagittal suture while simultaneously recording EMG data from temporalis, masseter, and digastric muscles. These experimental subjects were fed foods of varying material hardness which were differentially processed by subjects. Namely, apeloids exhibited the capacity for generating highly forceful bites while non-apeloids preferred easier to process foods. The performance of the sagittal suture across these varying diets is compared with particular emphasis on three homologous recording sites, Anterior at point bregma, Posterior at point lambda, and Middle midway between bregma and lambda. The null hypothesis that the strain regime within the sagittal suture is tensional is not fully supported. *In vivo* results here support the notion that larger strains are experienced during forceful biting but this is not continuous throughout sagittal suture tissue. Thus, specific muscle function during chewing is important for assessing the mechanical strain regime in sagittal sutures and thus may influence their morphology.

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The ethnoprimateology of Limón, Costa Rica: A survey in conservation.

ILEANA I. DIAZ. Department of Anthropology, University of Central Florida.

Species diversity is currently being threatened by the occurrence of multiple pressures including loss of forest habitat and human predation for food and commercial gain. In the province of Limón, Costa Rica forest clearing for banana and pineapple plantations destroys the forest and impacts species diversity. In July and August, 2009, 120 adults in three villages: Cariari, Primavera, and Portica were surveyed about primate conservation knowledge, attitudes, beliefs and behaviors. This study used an interview schedule to explore three major questions 1. Is there a consensus on attitudes and beliefs among villagers regarding primates and forest conservation? 2. Do these perceptions of nonhuman primates vary in relationship to respondent age, sex, education, profession and village? 3. To what extent does knowledge about primates vary in relationship to respondent age, sex, education, profession and village? Results indicate villagers share conservation views: 115/120 agreed primate conservation is 'very important'. Positive attitudes toward primates were statistically significantly ($p \leq .05$) correlated with male sex, younger age (under 35 years), increasing education (primary school 81% or higher 88%) and occupation (farmers 82% and vendors 94%). Knowledge was influenced by profession ($\chi^2=15.7$, $p=0.047$). Farmers were more knowledgeable and more concerned with conservation issues compared to other villagers. The results of this study suggest education is necessary to further conservation efforts especially regarding changing agricultural patterns.

The use of strontium isotopes to examine residential mobility in the semi-arid north of Chile: A preliminary study.

ELIZABETH A. DIGANGI. International Criminal Investigative Training Assistance Program, Bogotá, Colombia.

The semi-arid north region of Chile is bounded by the Andes Mountains to the east and the Pacific Ocean to the west. Archaeologically, human settlements were evident in this area from at least 12,000 years ago. The final culture prior to European contact were the Diaguita (A.D. 1000-1536); and while much work has focused on their subsistence strategy and health for example, little is understood about their population movement. Complicating the picture is the length of population history in this region and the hypothesis based on cultural diffusion of ceramics that the Inca empire expanded into this region of Chile within the last 100 years before European contact. The purpose of this study was to test the hypothesis that strontium isotope analysis could be a useful tool to examine population movement amongst the Diaguita and preceding cultures. Molar tooth enamel from seven prehistoric individuals and three camelids dating to the Diaguita and Archaic cultures were prepared and analyzed. The results indicate that the data consist of biogenic strontium. In addition, the data from this preliminary sample falls within the range of strontium values reported by Knudson and Torres-Rouff (2009) for San Pedro de Atacama, located 800 miles north of the semi-arid north region. This study is

important because the semi-arid north of Chile is poorly understood bioarchaeologically, especially when compared to the emerging picture from Andean Peru and Northern Chile. Strontium isotope analysis can therefore be used here to investigate a variety of questions, including population movement.

Duet type description and matching in the Bolivian gray titi monkey, *Callicebus donacophilus*.

KIMBERLY A. DINGESS. Department of Anthropology, State University of New York, Oneonta, Department of Anthropology, Indiana University, Bloomington.

A conspicuous feature of titi monkey (*Callicebus* spp.) behavior is the presence of loud song duets performed by mated pairs. Here two distinct duet-types from a wild population of *Callicebus donacophilus* are described. Type 1 duets comprise 4 categories of harmonic syllables, while type 2 duets are characterized by a sequence of syllables comprising a high frequency chevron element and 1-2 harmonic notes with low fundamental frequency. Type 2 syllables have a significantly shorter duration and higher frequency of maximum amplitude than type 1.

Playback experiments were used to determine whether type 1 and type 2 duets are functionally distinct. Six groups (mated pair and resident offspring) received 1 of each duet type and their vocal and behavioral responses were recorded. Subjects responded more aggressively to type 1 trials as measured by matching (choosing to respond to a neighbor's song with the same song form), length of vocal response, and approaches to the speaker. Type 2 playbacks elicited fewer vocal responses (only 5/12 trials) but still a relatively high proportion of type 2 duets. In all trials (type 1 and type 2 combined) with a vocal response, the initial response type matched that of the playback. While the precise function of the duet types remains unclear, they likely serve as a form of graded signal. The observed matching of duet-types is a behavior traditionally believed to be unique to avian species. This is the first description of such matching in a primate species. This study was funded by the American Society of Mammalogists, International Primatological Society, and Sigma Xi.

The sequence of dental emergence in the Malayan colugo (*Galeopterus variegatus*) and its bearing on a potential synapomorphy of Euprimates.

WENDY DIRKS¹, ROBERT L. ANEMONE², K. CHRISTOPHER BEARD³ and PAUL TAFFOREAU⁴. ¹School of Dental Sciences, Newcastle University, ²Department of Anthropology, Western Michigan University, ³Carnegie Museum of Natural History, Pittsburgh, ⁴European Synchrotron Radiation Facility, Grenoble.

Phylogenetic relationships within the Euarchonta remain contentious. Some analyses place Scandentia as the sister group to Primates, some group Scandentia and Dermoptera in a

clade, and recent molecular evidence places Dermoptera as the sister group to Primates (corroborating the monophyly of Primatomorpha). Here we examine the sequence of dental emergence in the Malayan colugo, *Galeopterus variegatus*, and compare it to published data on plesiadipiforms, tree shrews, and both extant and fossil primates. Twelve juvenile colugo specimens with developing dentitions from the collections of the Natural History Museum, London, were examined. The stage of emergence of each tooth was scored as a fraction of erupted crown height, from the appearance of the cusp tip above the alveolus to occlusion. Published specimens of *Plesiadapis* and Eocene notharctids were re-examined, along with specimens of the pen-tailed tree shrew, *Ptilocercus lowii*. The sequence of emergence in the maxilla of *Galeopterus variegatus* is $(dp^4 = dp^3 = M^1)-di^2-(di^3=dc^1=M^3)-M^2-C^1-I^2-P^3-d^4-I^3$ and in the mandible it is $di_1-di_2-(dp_3=dp_4=M_1)-(dc_1=M_2=di_3)-I_1-(I_2=P_3=P_4)-C_1-I_3$. In those Eocene primates for which information is available, as well as tarsiids, lorisids, galagids, most lemuroids, and some platyrhines, P4 precedes P3 in emergence, while in plesiadipiforms, P3 precedes P4 or emergence is simultaneous. In *Galeopterus*, premolar emergence appears to be almost simultaneous, but in one specimen, P3 was in occlusion, while P4 had not yet reached the occlusal plane. In tree shrews, P4 precedes P3 in *Tupaia glis*, but in the more primitive *Ptilocercus*, P3 precedes P4. The emergence of P4 before P3 may be a synapomorphy of Euprimates.

Rectal flexion is homoplastic amongst great apes.

TODD R. DISOTELL and CHRISTINA M. BERGEY. Center for the Study of Human Origins, Dept. of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

Recently, the hypothesis that humans are more closely related to orangutans than any other living primate has been resurrected. An analysis of morphological and physiological characters including rectal flexion, receding hairlines, sparse chest hair, the ability to smile with the lips closed as well as the ability to grow a beard and a mustache simultaneously led proponents of this theory to the conclusion that the orangutan is more closely related to humans than are chimpanzees. From these conclusions they suggest serious flaws in most molecular analyses carried out to date.

However, extensive analyses of alignments of the complete human, chimpanzee, orangutan, and macaque genomes, along with a draft of the gorilla genome suggest otherwise. Phylogenetic analyses of all 22 autosomes and the X chromosome unequivocally infer a human-chimpanzee relationship regardless of the technique used. Furthermore, an analysis of thousands of *Alu* insertions, nearly homoplasy-free molecular characters, yields the same result for each chromosome.

Large-scale analyses of complete genomes therefore reveal that numerous morphologically and physiologically similar characters are either

homoplastic or have been misinterpreted. The hypothesis that orangutans - and not chimpanzees - are most closely related to humans clearly fails to be verified.

Estimation of a person's height based on fragments of long limb bones and foot length in a Central European population.

MILUSE DOBISIKOVA¹, JARMILA ZOCOVA², JOSEF URBAN³, MICHAL BERAN⁴ and PETR VELEMINSKY¹. ¹The National Museum, Prague, Department of Anthropology, ² Science Faculty, Charles' University, Prague, ³ 1st Faculty of Medicine, Charles' University, Prague, ⁴ 2nd Faculty of Medicine, Charles' University, Prague

The forensic anthropologist is often faced with only fragments of human bodies or bones. The aim of this research was to estimate a person's height on the basis of the humerus and femur and their fragments as well as on the basis of foot length. This research was conducted in individuals of the Czech population from the 20th century.

We used autopsy material from the Institute of Forensic Medicine in Prague, representing a sample of 107 male and 53 female femurs and humeri. This represents the first sample of femurs and humeri collected randomly from a Central European population with known demographic data. Regression equations for the calculation of the height from maximum bone length as well as other dimensions and their combinations, for both men and women as well as regardless of sex, were proposed after taking 17 measurements on the femur and 14 measurements on the humerus.

the second autopsy sample consisting of 482 male and 234 female bodies to estimate a person's height from the length of the non-stressed foot. At the same time, we measured the length of the non-stressed foot and t. hat of the foot fully stressed in the upright standing position in 50 living men and 50 living women. Using the determined factor, it was possible to convert the length of the non-stressed foot to the length of the stressed foot. The proposed regression equations can be applied in both forensic practice as well as the anthropology of past populations. This study was supported by research project of the Czech Ministry of Culture VZ PM MK00002327201.

Face to face with the social brain: Correlated evolution of neocortical structure and facial expression in anthropoids.

SETH D. DOBSON. Department of Anthropology, Dartmouth College.

The neocortex evolved in correlation with both group size and various aspects of the visual system in anthropoid primates. This pattern may be due to selection for processing visual-based social signals, such as facial expressions. The purpose of this study is to examine the relationship between neocortical structure and facial expression using facial nucleus volume (cranial nerve VII) as a proxy for facial motor control.

Data on brain component volumes were gathered from the literature for 24 species (11 platyrhines and 13 catarrhines). Multiple regression analyses were carried out for three different dependent variables: total neocortex, non-striate cortex, and striate cortex (VI). Rest of the brain (ROB) and facial nucleus were used as predictor variables. Separate regressions were performed for anthropoids, platyrhines, and catarrhines. Generalized least squares was used to generate phylogenetically-informed standard errors and regression coefficients. Statistical significance was assessed using 95% confidence intervals (CI).

Facial nucleus volume was a significant predictor of the size of the neocortex in catarrhines (CI = 0.08/0.48), and the size of VI in anthropoids (CI = 0.01/0.71) and catarrhines (CI = 0.32/0.98). ROB was a significant predictor variable in all cases but one: VI vs. ROB in catarrhines (CI = -0.18/0.40). These results suggest that the correlation between facial nucleus volume and neocortex volume in catarrhines is due primarily to the relationship between the facial nucleus and primary visual cortex. Thus, facial expression may have been an important selective pressure on the catarrhine visual system, but not the neocortex as a whole.

Social dimensions of local cranial variation in the ancestral Pueblos of the Ridges Basin.

MICHELE TOOMAY DOUGLAS¹ and ANN L.W. STODDER². ¹Department of Anthropology, University of Hawai'i Mānoa, ²SWCA Environmental Consultants, Inc. Phoenix.

The Animas La Plata Archaeological Program resulted in recovery of 279 individuals from 22 early Pueblo I sites in southwestern Colorado. Analysis of the cranial data addressed questions about the degree of genetic relatedness of people in several villages and site clusters around the Ridges Basin where different architectural and material culture traditions were evident. We also addressed the biological identity of 33 individuals represented in a large assemblage of processed human remains deposited in a pithouse at one site, Sacred Ridge (5LP0245). Biodistance studies of these several small assemblages reveal different degrees of biological affinity among the geographically clustered village groups, and the distinctiveness of the people in the fragmentary assemblage compared to those in normative burials at the same site and at other sites in the Ridges Basin.

Metric data was obtained for 35 crania recovered during the Animas La Plata project; nonmetric data was obtained from 102 individuals. This sample size discrepancy is not unusual; the vagaries of preservation and cranial modification typically minimize the potential contribution of craniometrics in this region. Cranial and infracranial nonmetric traits, many of which can be recorded in fragmentary remains, are underutilized here. These data are simply not collected or are unreported for many projects, or the trait lists are prohibitively small and inconsistent. The relevance (and irrelevance) of specific traits is addressed, and data recording and analysis protocols for nonmetric data, particularly as related to small samples are suggested.

Renewed work in the Mursi formation.

MICHELLE S.M. DRAPEAU¹ and RENÉ BOBE². ¹Department of Anthropology, Université de Montréal, ²Department of Anthropology, University of Georgia.

The Mursi Formation, from the Lower Omo Valley, was explored in the late 1960s and early 1970s by Kenyan, American and French teams. However, attention by these different teams was given primarily to other formations in the area that were more prolific or more easily accessible. As a consequence, only a very limited fraction of the formation, the 'Yellow Sands', was ever surveyed at the southern limits of the sediments. In 2009, a new team (formerly co-directed by the late Elizabeth Harmon) revisited the area in order to establish the possible access routes to the sediments and to survey other parts of the Mursi Formation.

The sedimentary sequence of the Mursi Formation is believed to be slightly older than 4 Ma, the period when the genus *Australopithecus* appeared in the fossil record. Despite the importance of that period, few documented localities are known. In those few sites, environmental reconstructions vary from open to forested, but it is not resolved whether early hominins occupied all or only a segment of these environments. Investigation of the Mursi Formation will contribute to expand our knowledge of that important time period.

The 2009 field season identified one new locality in the northern part of the Mursi Formation that included Elephantidae, Suidae (*Nyanzachoerus*), Bovidae (*Aepyceros*), Hippopotamidae, Crocodilia (including *Euthecodon*), Testudines, small and big fish, and fossil wood. The small sample size does not allow for accurate habitat reconstruction, but the large fish remains imply the presence of a large body of water in the area.

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Sexual dimorphism in auricular medial projection and post-auricular sulcus morphology.

JESSICA L. DREW¹ and DANIEL J. WESCHOTT². ¹Department of Anthropology, Florida Atlantic University, ²Department of Biological Sciences, Florida International University.

Auricular surface elevation and post-auricular sulcus are osteological indicators for determining sex that are presented in numerous standard skeletal biology reference books. However, no known study has examined the accuracy of the auricular surface elevation for estimating sex in adults, and only one small study has tested the post-auricular sulcus. In this study, the validity of using these characteristics as indicators of sex in adult skeletal remains was tested three ways: 1) overall success rate of the method, 2) probability of correctly sexing an individual using only the auricular surface morphology, and 3) testing the repeatability of the method. The ilia of 150 adults of known sex

were examined and the auricular surface was scored as completely elevated, partially elevated, or not elevated. In addition the presence or absence of a post-auricular sulcus was scored. Complete elevation is rare, but it only occurred in females in our sample. Partial elevation and the presence of a wide post-auricular sulcus was common (>80%) among females. The post-auricular sulcus is uncommon in males, and when present is usually narrow and shallow. The results suggest that when present, a medially projecting auricular surface and a post-auricular sulcus are reliable indicators that the individual is female. However, if the traits are absent, they provide little valuable evidence about sex.

Secular change of the pelvis in the United States: 1842-1981.

KATHRYN DRISCOLL. Department of Anthropology, University of Tennessee.

The human pelvic girdle is surrounded by debate and discussion. While the structure of the modern human pelvis likely resulted from a compromise between locomotion and parturition, its form is also susceptible to continued alteration due to maternal health, early childhood nutrition, individual health, activity patterns, and genetics during its growth. Additionally, technological advances may alter the size and shape of the birth canal. These variations in form were the focus of this research.

The pelvic girdles of individuals born in the United States between 1842 and 1981 were examined in this study. Skeletons from the Hamann-Todd Osteological Collection, the Robert J. Terry Anatomical Skeletal Collection, and the William M. Bass Donated Collection were utilized. Five birth cohorts made up of equal numbers of male and female, black and white individuals were digitized, and 3D coordinates were collected.

Analyses of the AP and transverse diameters of the inlet, outlet, and midplane of the birth canal indicate significant differences between the birth cohorts. Each cohort exhibited significant differences in the AP diameter of the inlet while only the black females exhibited significant change in the transverse diameter of the inlet—this illustrates that a shape shift is occurring within the human pelvis. Shape changes were also noted in the outlet; these changes were further explored using 3D morphometric software. Deciphering these changes in the pelvic form is essential to understanding the secular change that is occurring in skeletal growth and development of the pelvic girdle.

A structural analysis of feeding in *Archaeolemur* and *Hadropithecus* using finite element analysis.

ELIZABETH R. DUMONT¹, LAURIE R. GODFREY² and TIMOTHY M. RYAN³
¹Department of Biology, University of Massachusetts-Amherst, ²Department of Anthropology, University of Massachusetts-Amherst, ³Department of Anthropology, Pennsylvania State University.

The trophic adaptations of the “monkey lemurs,” *Archaeolemur* and *Hadropithecus*, have been the subject of considerable research since Cliff Jolly likened *Hadropithecus* to *Theropithecus*, positing specializations for small object feeding, specifically the seeds and leaves of grasses. Recent research focusing on enamel microstructure, microwear, and stable isotopes has suggested that *Archaeolemur* may have processed large, hard objects (such as nuts) that would have required wide gapes and large bite force for cracking, while *Hadropithecus* used its molars to grind small but gritty objects (such as the corms of grasses). We used 3D finite element models of the skulls of *Hadropithecus stenognathus* and *Archaeolemur* sp. cf. *edwardsi* to evaluate their performance under loading regimes that mimicked unilateral biting with P4 and M2 at maximum gape, thus testing the plausibility of the above hypothesis. We compared absolute gape, the efficiency with which muscle force is transferred to bite force, von Mises stress (a predictor of failure), and the energy expended by muscles as they deform the skull. *Archaeolemur* had an absolutely wider gape than *Hadropithecus* at both tooth positions. The mechanical efficiency of the two species was equal during P4 biting, but *Hadropithecus* was substantially more efficient during M2 biting. *Hadropithecus* exhibited slightly more stress under both loading regimes but consistently expended less energy on deformation. These results support the hypotheses that *Hadropithecus* processed absolutely smaller food items than *Archaeolemur* and had a mechanical advantage during molar biting. In contrast, given equal stress states, *Archaeolemur* could have produced relatively higher bite forces. This study was funded by NSF DBI-0743460 to ERD.

Longitudinal evaluation of spinal osteoarthritis in *Macaca mulatta* supports a cross-sectional approach.

ANDREA E DUNCAN¹, RICKI J COLMAN², and PATRICIA A KRAMER¹. ¹Department of Anthropology, University of Washington, ²Wisconsin National Primate Research Center, University of Wisconsin Madison.

Spinal osteoarthritis in humans is widespread but little understood. Macaques exhibit a naturally-occurring form of spinal arthritis similar in its radiographic manifestation to that of humans. Because only cross-sectional analyses have been completed in either species, we wondered whether or not longitudinal data would indicate similar patterns.

The prevalence and progression of spinal OA were assessed radiographically in 68 *Macaca mulatta* (41 males, 27 females) housed at the Wisconsin National Primate Research Center. Multiple radiographs were obtained over a 20-year span (animals aged 11 to 32 years at time of imaging). Osteophytosis (OST) and disk space narrowing (DSN) were determined from lateral spinal radiographs using an Atlas method. Average OST and DSN were computed for the thoracolumbar spine (T8-L7). Age and body mass were covariates in multiple regression analyses.

Previous cross-sectional analyses of *M. nemestrina* found that age and body mass significantly predicted ($p < 0.001$) OST and DSN: 61% of the variability in OST was explained by age (coeff=0.08) and body mass (coeff= 0.06) while 57% of variability in DSN was explained by age (coeff=0.07) and body mass (coeff= 0.11). Our longitudinal analyses found that 57% of the variability in OST was explained by age (coeff=0.09) and body mass (coeff= 0.07) and 39% of variability in DSN was explained by age (coeff=0.06) and body mass (coeff= 0.05).

This study represents the first long-term longitudinal assessment of OA in primates and finds that the relationship among the covariates in the cross-sectional and longitudinal approaches are similar. This work was supported by NIH grants P01 AG-11915 and P51 RR000167. This research was conducted in part at the WNPNC which received support from Research Facilities Improvement Program grant numbers RR15459-01 and RR020141-01.

Biological distance among victims of ritual violence from a Postclassic Maya temple.

WILLIAM DUNCAN. Department of Sociology and Anthropology, East Tennessee State University.

Excavations at the site of Ixilú in Guatemala recovered a series of skulls arranged in rows and pairs from a small temple (Structure 2023). Six skulls were placed in pairs on the east-west midline of the building. Fifteen skulls were placed in two rows in the center of the building. All of the skulls faced east. The discovery raised a number of questions, including is this mortuary patterning (being placed in the skull rows versus pairs) reflected in biological distance between the individuals in the respective treatments? If there is a significant difference between the individuals receiving different mortuary treatments then that would suggest the selection criteria for the respective mortuary treatments were based, at least in part, on kinship. To address this question, traits from the Arizona State University dental trait system as well as rare traits described by Alt and colleagues were assessed for the skulls. A principal components analysis was completed on the traits and the component scores were saved. Interindividual euclidean distances were calculated on the basis of the component scores and were partitioned to create within and between group ranges of distances for the skull rows and pairs. There were no significant differences found between the skull rows and pairs. However three of the individuals exhibited a rare dental trait, supernumerary teeth. Resampling the likelihood of three individuals exhibiting this trait indicates that this is a nonrandom occurrence, and is attributable to the three individuals being related. This study was funded by NSF-BCS #0125311.

Leaping adaptations in the hindlimb of middle Eocene omomyid primates from the Uinta Formation, Utah and Mission Valley Formation, California.

AAPA ABSTRACTS

RACHEL H. DUNN. Center for Functional Anatomy and Evolution, Johns Hopkins University Medical School.

Most omomyids are relatively small bodied, but beginning in the middle Eocene, during the Bridgerian North American Land Mammal Age (NALMA), some begin to grow larger. The largest omomyids occur in the late middle Eocene during the Uintan NALMA and belong to the genera *Macrotarsius* and *Ourayia*, both of which had an estimated body mass above one kilogram. The postcrania of small omomyids are relatively well known, and are generally thought to show active arboreal quadrupedal and leaping adaptations. New postcranial specimens from the larger Uintan omomyids, *Ourayia* (two species), *Chipetaia lamporea*, and *Mytonius hopsoni* have recently been recovered from the Uinta Formation, Utah and from the Mission Valley Formation, California. These specimens provide additional information concerning the locomotor behavior of large, late surviving omomyid primates in North America.

The new specimens include distal tibiae and partial calcanei of *Chipetaia*; distal femora, distal tibiae, cuboids, and partial calcanei of *Ourayia uintensis*; complete calcaneus of *Ourayia* sp.; and a partial calcaneus and astragalus of *Mytonius*. Metric analysis of these elements using regressions and ratios indicates that *Ourayia* and *Chipetaia* show greater development of some traits associated with leaping behavior than do many older, smaller omomyids from North America. The elements of *Mytonius*, although fragmentary, lack some leaping features that are well-developed in *Ourayia* and *Chipetaia*, suggesting that *Mytonius* relied more on arboreal quadrupedalism. This project was funded in part by Sigma Xi and Washington University in St. Louis.

New catarrhine fossils from the early Miocene of Rusinga and Mfangano Islands, Kenya.

HOLLY M. DUNSWORTII¹, WILLIAM E.H. HARCOURT-SMITH², KIERAN P. MCNULTY³ and DANIEL J. PEPPE⁴. ¹Department of Anthropology, Northeastern Illinois University, ²Dept. of Anthropology, Lehman College-CUNY & Department of Vertebrate Paleontology, American Museum of Natural History, ³Department of Anthropology, University of Minnesota, ⁴Department of Geology, Baylor University.

Intensive paleontological and geological research was renewed on Rusinga and Mfangano Islands in 2006. Three subsequent surveys and three full expeditions have resulted in the discovery of 51 new primate specimens. These new specimens are attributed to *Dendropithecus macinnesi* (isolated teeth; associated distal humerus, proximal ulna and proximal radius), *Limnopithecus legetet* (partial mandible), *Nyanzapithecus vancouveringorum* (isolated teeth), Primates (femoral head; proximal ulna; navicular; astragalus; isolated phalanges; distal tibia; proximal ulna; proximal radius; cuboid; cuneiform; two maxillae; isolated teeth), *Proconsul heseloni* (cuneiform;

isolated metatarsals; phalanx; femoral heads; mandibular condyle; isolated teeth), and *Proconsul nyanzae* (isolated teeth; associated teeth; partial mandible) and are presented within the context of early Miocene catarrhine inter- and intra-specific diversity and evolution. A core aspect of our current work on the islands is placing these primate fossils within a broader geological and paleoecological context. With respect to the specimens presented here, fossils from the site of Nyamsingula on Rusinga Island include the first *P. heseloni* to be collected from the Kulu Formation, which is younger than the ca. 18.0 Ma Hiwegi Formation but older than the overlying Kiangata Agglomerate-Lunene Lava series, dated to ca. 15 Ma. According to our latest stratigraphic interpretation, the Kulu fauna is contemporaneous with faunas from West Turkana, and may be closer in age to the fossil-bearing layers from Maboko than those from the Hiwegi Formation on Rusinga. We hypothesize that the significant differences between these regional primate communities reflect paleobiogeographic and/or paleoecological differences. This research was made possible with grants from The Leakey Foundation and the National Science Foundation (0852609 and 0852515) and by funding from NYCEP, University of Minnesota, Baylor University, and Northeastern Illinois University.

Multivariate assessment of the fossilized frontal bone from Aitape, New Guinea.

ARTHUR C. DURBAND and JODY A. CREEL. Department of Sociology, Anthropology, and Social Work; Texas Tech University.

The Aitape skull was discovered in 1929 during petroleum prospecting in the Sepik region of northern New Guinea. The specimen consists of a nearly complete frontal bone with some attached parietal bone and an additional associated cranial fragment. While this specimen was originally thought to be of Pleistocene age, later radiocarbon dates from the site suggest an age of approximately 5000 years B.P. for this individual. Despite being somewhat younger than initially suspected, the Aitape frontal remains a potentially valuable source of information about early inhabitants of Sahul. It has received very little attention relative to similarly aged specimens from Australia, even though it is arguably just as informative in many respects. Only two projects have investigated Aitape to any significant degree in the 80 years since its discovery, and neither of those projects used multivariate statistics.

In this project the Aitape frontal is compared to 13 late Pleistocene/early Holocene Australian crania as well as 126 modern New Guinea crania collected from the Sepik coast region. These crania are compared using principle components analysis and canonical variates analysis, the latter of which is examined for statistical significance through the use of random expectation statistics (after Jantz & Owsley, 2001). The results show that Aitape shares strong shape characteristics with both ancient Australians as well as the modern New Guinean populations. Evolutionary trends in

frontal bone shape in the region are highlighted by this work. Financial support for this project was provided by the Franklin Research Grant Program of the American Philosophical Society.

Measuring the inter-species variability of endocast growth using shape regression and spatiotemporal registration.

STANLEY DURRLEMAN^{1,2}, XAVIER PENNEC¹, ALAIN TROUVÉ², NICHOLAS AYACHE² and JOSÉ BRAGA³. ¹Asclepios team-project, INRIA Sophia Antipolis-Méditerranée, France, ²Centre de Mathématiques et Leurs Applications, ENS-Cachan, France, ³FRE 2960 CNRS, Université Paul Sabatier, Toulouse, France.

Large database of anatomical surfaces offer the way for an automatic and quantitative analysis of the morphology of population and species. In this study, we used fossil endocasts segmented from CT images of chimpanzees and bonobos, as the closest extant relatives of modern humans. Given the dental age of every observation, our purpose is to analyze not only the morphological variations between species at a given age, but also the difference in terms of the growth of the endocasts.

For this study, we applied advanced morphometric tools introduced recently by the authors in Computational Anatomy. Contrary to standard morphometric techniques, we analyze the global shape of the endocast without relying on specific landmarks. Surfaces are modeled as currents, which enables surface comparison in absence of point correspondences between surfaces. Large deformations are used to capture anatomical variations.

First, we performed a shape regression (shape vs. dental age), which infers a 'typical' continuous evolution from the endocasts of the same species. Then, given two growth scenarios, we used spatiotemporal registration to analyze the differences between both scenarios in terms of morphological changes (at a given age) and change of the growth speed (once the morphological changes have been discounted). Eventually, this study shows the potential of new methodological tools to give a visual description of the inter-species variability and to support it with quantitative measures. Possible applications are a better determination of the age of a new endocast and a better understanding of the main shape differences between species.

Ontogeny of positional behavior in captive silvered langurs (*Trachypithecus cristatus*).

AMY L. EAKINS and W. SCOTT McGRAW. Department of Anthropology, Ohio State University.

An increasing number of primate positional studies have focused on ontogenetic development. As primates age and body size increases, the manner in which animals navigate their environment responds to shifting biomechanical, nutritional, socio-behavioral and reproductive factors. In this study, we examine positional behavior in a colony of captive colobines, hypothesizing that locomotor and

postural diversity will increase with age due to changing physiological and ecological processes.

We examined age effects on positional behavior in silvered langurs (*Trachypithecus cristatus*) housed at the Columbus Zoo. Data were collected from January – August 2009 using instantaneous focal animal sampling on a breeding group containing four adults, two juveniles, and one infant. During each scan we recorded the focal animal's identity, maintenance activity, substrate, and postural (19 categories) or locomotor (12 categories) behavior. Chi-square tests were performed on the data set of 4504 scans.

Contrary to expectations, our analyses show that positional diversity decreased with age. Younger individuals displayed a greater range of behaviors while demonstrating elevated frequencies of climbing ($p = 0.0065$) and leaping ($p = 0.0004$). Use of hindlimb postures also show an age effect with propped-foot sitting becoming increasingly common in older individuals. Behaviors not associated directly with age may be explained by interacting factors, including age, sex, and reproductive state. We conclude that in this captive group of silvered langurs, diversity of positional behaviors and frequencies of specific locomotor activities covary with age, but that captive environments may be responsible for results at odds with those obtained from free-ranging populations. Supported by Ohio State University Social and Behavioral Sciences Undergraduate Research Grant.

Variations on a theme: Cold adaptations across the New World.

K LINDSAY EAVES-JOHNSON. Department of Anthropology, University of Iowa.

Ecogeographic patterning in body size related to Bergmann's Rule (1847) correlates latitude with body mass in humans and other endotherms. The present study evaluates the hypothesis that cold-adapted populations from high and low latitudes, as well as from high-altitude express similar patterning in morphological shape following Bergmann's Rule. To test the influence of cold-adaption on morphological form, data was collected from the 4th and 8th ribs using measures modified from Franciscus and Churchill (2002) in addition to standard osteometric variables such as bi-iliac breadth and humeral/femoral length and joint area. The mixed-sex North and South American sample comprises Pt. Hope Alaskan Iñupiat ($n = 20$), Tierra del Fuegans ($n = 9$), Southern Patagonian Aónikenk ($n = 7$) and high-altitude Atacameños ($n = 21$). The Iñupiat, Tierra del Fuegan and Aónikenk samples agree well with expected ecogeographic patterns for their particular regions of long term habitation. All three groups are similar in having wide bi-iliac breadths and relatively deep tuberculoventral chords and obtuse posterior costal angles, indicative of a wide trunk. Major variations exist in limb length and relation to predicted body mass based on joint surfaces. The Aónikenk, historically renowned for their height, as well as the Tierra del Fuegans, appear to converge on a pattern closer to gigantothermy, not seen in the Iñupiat

or Atacameños samples. The Atacameños appear to exhibit a unique pattern complicating altitude and climate. Results are presented in the context of human adaptation to climate through both biological and cultural means. This study was funded by the National Science Foundation, DDIG grant award: 0752723, and generous support from the UI Stanley Foundation.

Abnormal is the new normal: In some paleoanthropological, but not biomedical, research.

ROBERT B. ECKHARDT¹, ALEX WELLER¹, KAITLYN M. MCGRATH¹ and MACIEJ HENNEBERG².

¹Laboratory for the Comparative Study of Morphology, Mechanics and Molecules, Department of Kinesiology, The Pennsylvania State University, University Park, ²Biological Anthropology and Comparative Anatomy Research Unit, The University of Adelaide.

We consistently have presented data (e.g. Jacob, et al., 2006) supporting the hypothesis that LB1 from Liang Bua Cave, Flores, manifests pervasive abnormalities, in the craniofacial skeleton, dentition and postcrania, indicating serious developmental disorder. Supporters of the notion that LB1 is the type specimen of a new human species present conflicting statements. Descriptively, Brown, et al. (2004) characterized the LB1 cranium as "long and low," while Falk, et al. (2009) termed it "extremely brachycephalic" (our original measurements on LB1 show a cephalic index approximating 0.80, objectively neither). Brown, et al. (2004) noted the LB1 cranium is "free of substantial distortion" and "it is not possible to locate most of the standard craniometric landmarks with great precision," yet Baab and McNulty (2009) say their "series of 35 homologous landmarks on an LB1 cranial cast provided the basic data for morphometric analysis" showing LB1 is "fairly asymmetrical" and "readily explained by the taphonomic processes to which all fossils are subject." Our superquadric modeling (Sommer, et al., 2006), here of other excavated Flores crania, counter this global taphonomic dictum. Although Falk, et al. (2009) held that "its degree of left-right asymmetry is within the ranges observed for normal humans," Kaifu, et al. (2009) confirm our findings (e.g. to within 1° of our palatal rotation measurement) that "LB1 exhibits antemortem craniofacial deformities." Diagnosis of positional deformational plagioccephaly misleadingly understates LB1's abnormality. Like microcephaly, another developmental sign sometimes accompanying it (Nassogne, et al., 2000), plagioccephaly can arise from dozens of genetic and non-genetic causes.

New approaches to the use of dental morphology in forensic contexts.

HEATHER J.H. EDGAR¹ and STEPHEN D. OUSLEY². ¹Maxwell Museum of Anthropology, Department of Anthropology, University of New Mexico, ²Department of Applied Forensic Sciences, Mercyhurst College.

Estimating ancestry is a central challenge in forensic anthropology. Most attempts to systematize the estimation of ancestry have centered on cranial metric and non-metric observations. To date, forensic anthropologists have considered only a small subset of the available dental traits, and have generally analyzed them in a non-statistical framework. This underutilization is surprising given that dental morphology has been shown to provide excellent data for examining variation within and between human populations. This quality should also make dental characteristics useful for estimating population affinities of single individuals.

To address these issues, dental morphological data were collected from samples of several contemporary U.S. populations, including African, European, New Mexico Hispanic, South Florida Hispanic, and New Mexican Native Americans ($n=600$). Using the characteristics that varied the most among these samples, discriminant functions were developed for use in estimating ancestry. The functions were then applied to a validation sample that included individuals from each group represented ($n=50$). Overall accuracy was 55%, with correct assignment for each group ranging from 42% to 100%. While imperfect, the results are far from random. This investigation shows the potential for the use of dental morphology in forensic contexts, especially when a multi-trait, statistical, regional, and populational approach is employed.

Growth change of calcaneal internal structure in Japanese macaques: correlations with locomotor development.

NAOKO EGI¹, NAOMICHI OGIHARA² and WATARU YANO³. ¹Primate Research Institute, Kyoto University, ²Department of Mechanical Engineering, Keio University, ³Department of Zoology, Kyoto University.

Internal structures of limb bones have been suggested to correlate with mechanical requirements. Recent studies revealed that trabecular bone ontogeny occur in relation to locomotor development in humans. This study examined ontogenetic changes of calcaneal internal structure in a cross-sectional sample of 52 Japanese macaques (*Macaca fuscata*) to clarify formation of trabecular and cortical bone structures relative to locomotor developments in a non-human primate. Structures were examined using micro CT scanner images with 0.020 – 0.050 mm voxel sizes, and structural parameters (degree of anisotropy, number, thickness, and bone volume fraction of trabeculae, and cortical thickness) were measured at the posterior talar articulation and at the tubercle.

Trabeculae in the macaque calcanei become elongated during the last quarter of the fetal period. Around six-months-old, when the juvenile macaques start to walk, the degree of anisotropy and number of trabeculae at the tubercle reach the adult condition. Trabecular thickness continues to increase by 15-months-old, when the juvenile macaques begin to walk for long distances. Cortical bones appear around two-years-old and increase the thickness until the subadult period. The timing of establishment

of the trabecular alignment in the macaque sample supported the correlation of trabecular bone ontogeny with locomotor development. On the other hand, the elongation of the trabeculae starts earlier in macaques, suggesting an interspecific difference from humans, and the changes on volume of trabeculae and cortices occur later in the ontogeny, suggesting that these structural changes may be influenced by the body size and/or muscle size than by locomotor development. This study was funded by Japan Society for the Promotion of Science (JSPS) Grant-in-Aid for Scientific Research (B) 19370101.

Cortisol reactivity of female brown capuchins: Effects of troop size in a risky, low-energy environment.

ERIN EHMKE and SUE BOINSKI. Department of Anthropology, University of Florida.

Group size mediates the dynamic influence of predation risk, resource availability and other extrinsic factors on the fitness of social females. But does group size predict the intrinsic reactivity of females to extrinsic conditions? Do females living within groups of unequal size exhibit similar stress responses to social and ecological variation? In this study of brown capuchins (*Cebus apella*) at Raleighvallen (RV), Suriname, we test group-level hypotheses regarding relationships between the size of two study troops ($n_1=27$, $n_2=9$), mean female cortisol levels, predation and seasonality. Regardless of troop size, perceived predation risk, as measured by alarm call rates, appears to be a primary stressor to female *C. apella* in RV. Females in the large group, however, exhibited more stress (higher cortisol levels) than females in the smaller group, especially in response to perceived predation risk. Neither seasonal food availability nor dominance interactions covaried with female stress, although cortisol data suggest that large-group females incurred more stress when food availability becomes unpredictable. Only in the large group did aerial alarm rates positively correlate with female cortisol levels, even in the absence of a predator. This suggests that risk from aerial predators is both strong and unpredictable enough to warrant a long-term stress response, with possible deleterious consequences for the health of large-group females. In sum, our data indicate that in RV's risky, low-energy environment, female brown capuchins in larger troops may be susceptible to greater stress from predation and unpredictable food than those in small groups. This study was funded in part by the U.S. National Science Foundation, grant numbers SBR-9722840, BCS-0078967, and BCS-0352316 awarded to S.B., and NIH grant RR000167.

The influence of artificial cranial deformation on human temporal bone shape.

YASMINE EL GABBANI. Department of Anthropology, New York University New York Consortium in Evolutionary Primatology (NYCEP).

Recent research on hominid crania indicates that the shape of the temporal bone preserves a strong phylogenetic signal. Consequently, several studies have advanced using patterns of temporal bone shape variation to reconstruct relationships among recent human populations, as well as great apes and fossil hominin taxa. This study examined the effect of developmental pressures on reconstructing relationships among populations based on the shape of this cranial region. Patterns of temporal bone shape variation both within and among archaeological Native American groups that practiced various methods of artificial cranial deformation were quantified using 3D geometric morphometrics. Three hypotheses were addressed: (1) cranial deformation has no influence on temporal bone shape; (2) effects of cranial deformation on temporal bone shape are independent of the deformation type; (3) cranial deformation is unlikely to influence reconstructions of population relationships. Results indicate that cranial deformation does have a measurable effect on temporal bone shape. However, some aspects of temporal bone shape are likely to maintain a phylogenetic signal regardless of deformation status. Implications for using artificially deformed crania in reconstructions of population history incorporating this cranial region are discussed.

Behavioral differences between Neandertals and Upper Paleolithic modern humans: Dietary evidence through occlusal dental microwear texture analysis.

SIREEN EL ZAATARI^{1,2} and JEAN-JACQUES HUBLIN¹. ¹Max Planck Institute for Evolutionary Anthropology, ²The Wiener Laboratory, Athens.

Using microwear texture analysis, the most recent development in the field of dental microwear, occlusal molar microwear signatures of the majority of Middle and Upper Paleolithic adult individuals recovered from the numerous Western Eurasian sites were studied. Through analyzing effects of time, geographical location, climate (vegetation cover), and technology on the diets of these groups, this study explores how Neandertals were able to adapt to and survive the severely changing Ice Age environments and why they disappeared around the time of advent of modern humans in Europe. The results of this study show that the Neandertals microwear signatures are closely correlated with temporal/geographic variation in vegetation cover, thus they were environmentally driven. Clear dietary distinctions were visible between individuals from cold-steppe versus forested environments. For the Upper Paleolithic humans, the results show a pattern of correlation between their diet and their associated technological context, but not with vegetation cover as is the case for the Neandertals. The microwear signatures clearly distinguish specimens of Aurignacian and Gravettian contexts from those of Magdalenian contexts. Compared to the Neandertals, the microwear patterns show that the diets of the Aurignacian and Gravettian specimens were more varied whereas those of the Magdalenian specimens were different.

The implications of these finds on differences in subsistence strategies between Neandertals and modern humans, added reliance of modern humans on technological advancement for food acquisition, and the possible role of competition over food resources in Neandertals disappearance at the time of advent of modern humans will be discussed. Funded by the Max Planck Society, the National Science Foundation and the Leakey Foundation.

Molecular arms races between hosts and pathogens in primate evolution.

NELS C. ELDE and HARMIT S. MALIK. Howard Hughes Medical Institute, Division of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle.

Distinguishing self from non-self is a fundamental biological challenge. Many pathogens exploit the challenge of self-discrimination by employing mimicry to subvert key cellular processes including the cell cycle, apoptosis, and cytoskeletal dynamics. Other mimics interfere with immunity. Poxviruses encode K3L, a mimic of eIF2 α , which is the substrate of Protein Kinase R (PKR), an important component of innate immunity in vertebrates. The PKR-K3L interaction exemplifies the conundrum imposed by viral mimicry. To be effective, PKR must recognize a conserved substrate (eIF2 α) while avoiding rapidly evolving substrate mimics like K3L. Using the PKR-K3L system and a combination of phylogenetic and functional analyses, we uncover evolutionary strategies by which host proteins can overcome mimicry. We find that PKR has evolved under dramatic episodes of positive selection in primates, where rates of non-synonymous nucleic acid substitutions (dN) outpace silent substitutions (dS). Positive selection can be a hallmark of molecular 'arms races' where advantageous substitutions are repeatedly fixed at host-pathogen interfaces. Indeed, we find that the ability of PKR to evade K3L from vaccinia virus is partly due to positive selection at sites most intimately involved in eIF2 α recognition. We also find that adaptive changes on distinct surfaces of PKR produce variants with combinations of substitutions that increase the odds of defeating mimicry. Our study demonstrates how host proteins can compete in molecular arms races against mimics, revealing remarkable evolutionary flexibility at protein interaction interfaces challenged by mimicry. This study was funded by an HHMI Early Career Scientist, Searle Scholar, and Burroughs Wellcome Investigator Awards to H.S.M., and an Ellison Medical Foundation Fellowship of the Life Sciences Research Foundation to N.C.E.

Variation in human body proportions during ontogeny.

COURTNEY D. ELEAZER¹, LIBBY W. COWGILL² and BENJAMIN M. AUERBACH¹. ¹Department of Anthropology, University of Tennessee, Knoxville, ²Department of Anthropology, University of Central Florida.

Human variation in body proportions has been shown to reflect an evolutionary response to climate and mean average temperature, with body mass increasing and limb length decreasing with latitude. It remains unclear whether or not these proportions are maintained during allometric growth in ontogeny. Due to a higher surface area to mass ratio and deficiency in brown adipose tissue and subcutaneous fat, subadults must rely on "dry" heat dissipation rather than evaporative cooling to maintain a neutral body temperature and are therefore more susceptible to heat stress than adults. Given this selective pressure and relatively higher mortality rates, subadults are expected to retain appropriate proportions during growth. This study tests this prediction via analyses of subadult anthropometric data from Eveleth & Tanner's (1976) *Worldwide Variation in Human Growth* and other more recent studies, as well as limb proportion measurements in six different skeletal samples.

The results of this analysis indicate that correlations between latitude and anthropometric variables are just as high, if not higher, during growth as in adulthood. Correlations between height, weight, sitting height, bi-iliac breadth, and leg length are moderate to high, with leg length showing the lowest correlation coefficients and bi-iliac breadth the highest. In addition, variation in brachial and crural indices generally conforms to what would be expected based on adult limb proportions, with greater variation in the upper limb. The results of this study suggest that although body proportions are shifting during development, the relationship between climate and relative surface area is maintained.

Inter- and intra-population variation in aggression by adult male chimpanzees.

MELISSA EMERY THOMPSON¹, MARTIN MULLER¹, NICHOLAS NEWTON-FISHER², IAN GILBY³, SONYA KAHLENBERG⁴, ZARIN MACHANDA⁴, KLAUS ZUBERBÜHLER⁵ and RICHARD WRANGHAM³. ¹Department of Anthropology, University of New Mexico, ²School of Anthropology & Conservation, University of Kent, ³Department of Human Evolutionary Biology, Harvard University, ⁴Department of Biology, Bates College, ⁵School of Psychology, University of St. Andrews

Chimpanzee males have been noted for frequent and sometimes severe displays of aggression. However, little comparative data have been available to assess the extent and causes of variability in aggression over time or across populations. Here, we apply identical analytical procedures to examine longitudinal data on male aggression by East African chimpanzees (*Pan troglodytes schweinfurthii*) at Kanyawara, Kibale National Park (N = 13 years) and at Sonso, Budongo Forest Reserve (N = 6 years), both in Uganda. These communities are geographically-proximate, demographically-similar, and have been monitored using comparable data collection techniques. Both all-occurrences sampling of aggression and targeted aggression focal sampling indicated

that adult males in the Kanyawara community engaged in significantly more frequent and severe aggression to both males and females than did those in the Sonso community. At both sites, dominance rank positively influenced the expression of aggression, but age interacted with rank to produce higher rates of aggression by young, dominant males towards adult females. Dominance hierarchy stability, operational sex ratio, and the availability of receptive females influenced variability in male-male aggression over time but did not predict male-female aggression. We conclude that proximate contextual factors influenced male investment in risky aggressive behavior against other males, and that differences in the availability of fertile females can at least partially explain the heightened male-male aggression at Kanyawara. However, the intensity of aggression towards females could not be predicted by proximate demographic factors, and our data suggest that longer-term processes including cultural and individual variation may have an influence. This study was supported by grants for long-term research to the Kibale Chimpanzee Project from the National Science Foundation (SBR-9729123 and SBR-9807448) and to the Budongo Forest Project from the Royal Zoological Society of Scotland.

Do loud calls reflect energy status in male simakobu monkeys (*Simias concolor*)?

WENDY M. ERB¹, THOMAS ZIEGLER² and KURT HAMMERSCHMIDT³. ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Reproductive Biology Lab, German Primate Center, Göttingen, ³Cognitive Ethology Lab, German Primate Center, Göttingen

In many primate species, males produce loud calls, which may convey information about the signaler's current competitive ability if such calls are more costly to produce for individuals in poor condition or with low energy reserves. Since energetic constraints are suggested to be more severe in folivores, these effects might be stronger and thus easier to assess in folivorous species. We studied call variation in wild, male simakobu monkeys (*Simias concolor*), a folivorous Asian colobine living in small one-male groups. We combined behavioral observations and ecological measures with acoustic analysis to determine the influence of energy status on male loud calls. Data were collected for habituated (N=4) and unhabituated (N=7) adult males in the Peleponian forest (Siberut, Indonesia). Using data from full-day follows (N=215 days) and acoustic analysis of 186 loud calls (recorded between June 2005–December 2008), we calculated calling rate, call duration, syllable number, and intersyllable duration to assess the energetic costs of calls in relation to physical (temperature, rainfall), ecological (phenology) and behavioral (feeding, ranging) measures of energy availability. Our analysis revealed that males produced shorter calls with fewer elements when measures of energy reserves were lower, supporting the hypothesis that calls may be used to assess the current physical condition of competing males.

Calling rates, however, could not be explained by energetic measurements, suggesting that other factors may be relevant. Future analyses will explore the influence of receptive females, infants, and food resources on the production of calls as part of male reproductive strategies in this species. Supported by the Margot Marsh Biodiversity Fund, Primate Conservation, Inc. American Society of Primatologists Small Conservation Grant, and National Science Foundation DDIG (BCS-0752504).

Varying morphology and fitness criteria in a computer simulation of bipedal running.

TOM EREZ¹, WILLIAM D. SMART¹ and HERMAN D. PONTZER². ¹Department of Computer Science, ²Department of Anthropology, Washington University in St. Louis.

The computational study of human gaits is a growing area of research, and dynamical simulations are a promising tool that is still under-utilized. In this work we investigate features of optimality in human running gaits using computer simulation. We use methods of optimal control to generate stable gaits from first principles in a dynamical model of a human-like biped, modeling the ground-foot interaction as a hybrid system, representing the existence or absence of a contact as a discrete variable. Since we can change the structure of the cost function, our model is a useful platform to study hypotheses about different performance features (e.g. rewarding for speed vs. rewarding for efficiency) and the resulting optimal gait at each case. Our results also allow us to uncover quantitative relationships between morphological variables (e.g. leg length) and resulting changes in the shape and cost of the optimal gait. We examine these results in light of proposed links between anatomy and endurance running in the hominin lineage. This study was funded by the Washington University School of Arts and Sciences, and NSF award BCS 0924609.

Evidence of perimortem trauma in free-ranging mountain gorillas (*Gorilla beringei beringei*) from Volcanoes National Park, Rwanda.

AMANDINE B. ERIKSON¹, STEPHEN P. NAWROCKI¹, SHANNON C. McFARLIN², TIMOTHY G. BROMAGE³, KATIE FAWCETT⁴, MICHAEL R. CRANFIELD⁵ and ANTOINE MUDAKIKWA⁶. ¹Archaeology and Forensics Laboratory, University of Indianapolis, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Hard Tissue Research Unit, Department of Biomaterials and Biomimetics, New York University College of Dentistry, ⁴Karisoke Research Center, Dian Fossey Gorilla Fund International, ⁵Mountain Gorilla Veterinary Project, ⁶Tourism and Conservation, Rwanda Development Board.

Analyses of trauma and pathology in skeletal collections derived from wild great apes can provide unique insight and improve our understanding of mortality in living populations.

Here we focus on perimortem trauma associated with a modern skeletal sample of Virunga mountain gorillas. The most common cause of death reported previously for mountain gorillas is trauma, resulting from conspecific aggression (most notably infanticide) or poaching-related incidents. Individuals also succumb to respiratory disease, another common source of fatality. The application of a forensic perspective can aid in clarifying the circumstances of death from analyses of skeletal remains, when records are incomplete or cause of death unknown.

We examined evidence of perimortem trauma in a skeletal collection comprised of 78 mountain gorillas (43 adults; 35 infants/juveniles) from Rwanda. Availability of associated veterinary and life history records for many individuals in this collection provides a unique opportunity to clarify the manner in which circumstances surrounding death leave their mark on the skeleton. Analysis of 66 crania and 57 postcrania revealed that blunt force trauma was most common, and regularly found on infants, corresponding with known incidents of conspecific aggression. Trauma associated with infanticide was preferentially distributed in the cranial vault, ribs, and pelvis. Sharp force trauma, inflicted by bladed instruments, was documented on four individuals. No clear skeletal evidence of gunshot wounds exists. Overall, a wide range of perimortem trauma is documented within this assemblage, providing many possible avenues of comparison with similar primate populations and skeletal collections from other parts of the world. This resource is funded by the National Geographic Society, Leakey Foundation, and National Science Foundation (BCS 0852866).

Mechanical loading and remodelling: Comparing porosity in two Lake Baikal hunter-gatherer populations with differing patterns of mobility using micro-CT.

KATHLEEN FACCIA¹ and HELEN BUIE².
¹Department of Archaeology, University of Calgary, ²Department of Mechanical Engineering, University of Calgary.

The Cis-Baikal region of Siberia is rich in prehistoric hunter-gatherer remains, once inhabited by two temporally and bioculturally distinct mid-Holocene groups (ca. 9000 to 3000 ybp). Biomechanical research focusing on the femoral midshaft (Lieverse et al. 2007, Stock *in press*) indicates greater femoral loading in the earlier Kitoi [versus later Isakovo-Serovo-Glazkovo (ISG)], and in Kitoi males versus females. Other studies have provided varied results regarding the influence of biomechanical factors on bone remodelling in archaeological populations (Burr et al. 1990, Pfeiffer et al. 2006). This study investigates the potential for detecting activity-induced microstructural changes in Lake Baikal hunter-gatherer femora. Midshaft femoral samples were collected from adult individuals where age-at-death and sex could be determined, and who lacked skeletal evidence of disease or injury at death. Using micro-CT, cortical samples were scanned, producing 6µm isotropic 3D images. Images were inverted, and characteristics of the canal

networks were analyzed (canal number, connectivity, diameter, thickness, separation, surface to volume ratio, overall porosity and degree of anisotropy). Samples were stratified by temporal period (Kitoi, n=9; ISG, n=55), age (young, middle, old adult), and sex. A modified single-classification ANOVA ($\alpha=0.05$) detected no canal pattern differences between age- and sex-matched Kitoi and ISG individuals. Likewise, no differences were found between age-matched Kitoi males and females (ANOVA and Kruskal-Wallace $\alpha=0.05$). These results suggest that other variables (e.g., diet, genetic factors) overrode biomechanical influences on canal parameters, or that gross morphological shape differences were highly effective at stabilizing the mechanical environment and, consequently, remodelling activity.

This study was funded by a Major Collaborative Research Grant from the Social Sciences and Humanities Research Council (Grant # 412-2005-1004), the Northern Scientific Training Program (University of Calgary), and the Department of Archaeology (University of Calgary).

Juvenile primates: Development from a life history perspective.

LYNN A. FAIRBANKS. Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles.

The extended period of immaturity is one of the most interesting features of the primate order, and one that differentiates primates from other mammals. Yet, most early studies of juvenile development in primates took delayed development for granted. They focused on 'how' early social environments influenced development, but not on 'why' it developed that way. Evolutionary biological models of life history tradeoffs that were used to understand variation across species were rarely applied to nonhuman primate studies. Juvenile Primates, originally published in 1993, brought together a group of primatologists to partially address this void and to create a volume that focused on the juvenile period from a broad, functional, comparative and evolutionary perspective. This approach recognized that extended development is a costly strategy, and that the benefits of slow development must outweigh the risk of mortality before reproduction. The contributors to this symposium follow and expand on that tradition by presenting an array of papers designed to understand juvenile primate development as a set of functional adaptations within a social, ecological and life-history context.

Does the amount of bone dictate the trabecular bone structure in strepsirrhine lumbar vertebrae?

ROBERTO FAJARDO¹, JEREMY DE SILVA² and LAURA MACLATCHY³. ¹Department of Orthopaedics, University of Texas Health Science Center, San Antonio, ²Department of Anthropology, Boston University, ³Department of Anthropology, University of Michigan.

There is considerable interest in determining how body weight, behavior and developmental and phylogenetic history are related to trabecular construction, and how trabecular parameters are correlated. For example, does amount of bone (BV/TV), predict how species construct trabecular lattices? To address this question, we acquired µCT image data from 29 last lumbar vertebral bodies of 8 strepsirrhines (n>2/spp) using a desktop system. Data were acquired with a 55 kV source and a range of cubic voxel dimensions (12 µm – 36 µm) depending on the size of bone. Volumes of interest spanned the entire body between the cranial and caudal growth plates. Results indicated that many structural variables are correlated significantly with BV/TV. The structural model index, an indicator of the extent to which trabeculae are rod-like or plate-like, decreased strongly with increased BV/TV ($r=-0.98$, $p<0.001$). Tb.N ($r=-0.80$, $p<0.05$) and Conn.D ($r=-0.88$, $p<0.001$) were inversely correlated with BV/TV as well. In contrast, the DA did not correlate with BV/TV, suggesting that bone mass and its organization are independent in this region of the strepsirrhine spine. We further investigated this issue by assessing the relationship between the DA and SMI, Tb.Th, and Tb.N., in order to determine whether the type of trabecular shape (SMI), its thickness, or number, impacted the organization of the trabecular lattice. In each case, no significant relationship was found, further showing that trabecular organization in the vertebral body is independent of bone mass related quantities. The DA likely reflects other influences, such as loading environment.

Endocast of Taung (*Australopithecus africanus*) compared to that of LB1 (*Homo floresiensis*)—more than just a coincidence?

DEAN FALK. Department of Anthropology, Florida State University.

Unpublished papers that included detailed illustrations of Taung's sulcal pattern from the University of Witwatersrand Archives reveal that Raymond Arthur Dart described and illustrated sixteen sulci on the Taung endocast, in contrast to just two sulcal identifications published in his 1925 announcement of *Australopithecus africanus*. In his unpublished analysis, Dart concluded that Taung's brain was advanced in three cortical association areas that were located in parieto-occipital, caudal temporal, and rostral prefrontal regions. The shapes and sulcal patterns in these three regions indicated to Dart that *Australopithecus* was closer to *Pithecanthropus* than to living apes. He also concluded that australopithecine brains had evolved in a global rather than mosaic manner. Although a few of Dart's sulcal identifications (including that for the lunate sulcus) are questionable, his claim that the Taung endocast reproduced a shape that was advanced toward a human condition in its prefrontal cortex and caudally-protruded occipital lobe is persuasive. Dart's unpublished illustrations and analysis of Taung's endocast had not yet come to light in 2005 when Falk *et al.* published their initial description of the virtual endocast from LB1 ("Hobbit," *Homo*

floresiensis). LB1's endocast reproduces derived shape features in the same three cortical association regions that Dart had identified on the Taung endocast, which led Falk *et al.* to conclude (as Dart had for Taung) that the morphology of Hobbit's cerebral cortex resulted from global cortical reorganization. This paper compares the two endocasts and discusses the possible evolutionary significance of their similarities and differences.

The role of tuberculosis in sex-specific mortality, Massachusetts 1850–1910.

NICOLE FALK SMITH and ALAN C. SWEDLUND. Department of Anthropology, University of Massachusetts, Amherst.

Between 1850 and 1910 tuberculosis (TB) was the leading cause of death in the U.S., and the industrialized world, generally. Using a bioanthropological approach, we investigate a series of 14,810 individual deaths from a cluster of towns and one small city in Massachusetts. In this paper we focus on the epidemiology and social etiology of differences by sex and by age. In the so-called modern mortality regime females have higher survivorship at all ages compared to males. Historically this was not always the case.

We were able to confirm a pattern of excess female mortality over males, most apparent at reproductive age, and explained largely by TB deaths. This sex difference has been previously noted in the literature for other geographic regions. However, what has been missing and is contributed here is a more detailed inspection of competing causes of death, and the patterns reflected in male age specific death rates. Our analysis also identified an age-sex mortality crossover effect—in which the previously higher rates of female deaths dropped below those for males at around age 45. After we demonstrate the major patterns graphically, we conclude by discussing the implications for health, productivity and reproductivity in this historical population. As TB regains attention as a world-wide health threat, the biocultural lessons from the past have relevance for today.

Preliminary analyses of five skulls from wet-burial bundles recovered from Sitio La Regla (P30 Rg), Costa Rica.

MONICA FARALDO. Levehulme Centre for Human Evolutionary Studies, University of Cambridge, and the Department of Anthropology, University of Miami.

Important clues to understanding how and when humans entered the Americas may be gathered from the skeletons and burial practices of prehistoric groups in the New World. I examined osteological material at the Museo Nacional de Costa Rica which were recovered secondary, wetland burials from the Sitio La Regla site, dated to ~2,500 ya. These materials are unique for their early age and internment style. I gathered craniometric data for 5 adult skulls using 29 variables in FORDISC 3 and CRANID. These data were used to test hypotheses about affinities with other extinct and extant human groups. The manner of burial

was similar to the Windover site in Florida, dated to ~7,500 ya. The sample comprised 3 males and 2 females. Group affinity analyses yielded mixed results. Classic Native American traits were found in three of the skulls (2 male/1 female). These traits include: cranial vaults are short and broad at the base, lower face, moderate nasal aperture, and complex cranial sutures. Analyses also showed that 2 individuals (1 male /1 female) exhibited European traits: limited prognathism, narrow nasal aperture, smaller zygomatics, and simple cranial sutures. These initial data suggest that the humans who entered the New World may not all exhibit traits traditionally associated with extant Native Americans of Asian origin in the New World. Future analyses of the postcranial and material culture remains should enhance and shed more light on the origins of these ancient inhabitants of Costa Rica and how they came to live there. This work was supported in part by Museo Nacional de Costa Rica Departamento de Antropología e Historia and the Department of Anthropology, University of Miami.

Patterns and sources of mortality among geladas (*Theropithecus gelada*) at Guassa, Ethiopia.

PETER J. FASHING¹, NGA NGUYEN¹, JEFFREY T. KERBY², LAURA M. LEE¹, NIINA O. NURMI³ and VIVEK V. VENKATARAMAN⁴. ¹Department of Anthropology, California State University Fullerton, ²Department of Biology, Penn State University, ³Guassa Gelada Research Project, ⁴Department of Anthropology, State University of New York – Stony Brook.

Mortality patterns provide critical insights into primate life histories and population trends, yet data on the factors that contribute to variation in mortality trends in wild primates are limited. We present the results of a 31-month study of the patterns and sources of mortality among members of a ~220-member band of wild geladas inhabiting an unusually ecologically-intact alpine grassland at Guassa, Ethiopia. The habitat at Guassa is dominated by tall grasses, experiences long periods of inclement weather, and contains a full complement of potential gelada predators. Among the adults (n=58) in 10 intensively-monitored one-male units, 38% of males and 29% of females died during the study. Parasitic infections were associated with elevated rates of mortality among male, but not female, geladas. Ethiopian wolves (*Canis simensis*) posed little threat to geladas and were often documented nearby (≤ 5 m from geladas), while domestic dogs (*Canis familiaris*) from distant farms cooperatively hunted geladas on multiple occasions, killing at least three geladas. Additional evidence suggests spotted hyenas (*Crocuta crocuta*) also prey on geladas at Guassa. Infant (n=25) survivorship values to 12 and 18 months were 68% and 65%, respectively. Three infant deaths occurred in the aftermath of takeovers of their units and were directly observed or inferred to have resulted from infanticide. Overall, adult and infant rates of mortality among geladas at Guassa appear to be higher than for geladas in the Simien

Mountains. Our results offer insight into the factors that contribute to variation in mortality among geladas inhabiting a relatively intact ecosystem. This study was funded by Margot Marsh Biodiversity Foundation, Pittsburgh Zoo, Cleveland Metroparks Zoo, and Primate Conservation Inc.

Three-Dimensional Microtomographic Analysis of Sexual Dimorphism in Human Molar-Crown Tissues.

ROBIN N.M. FEENEY^{1,2}, ANTHONY J. OLEJNICZAK^{1,3} and JEAN-JACQUES HUBLIN¹. ¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ²Department of Anthropology, The Ohio State University, ³National Centre for Human Evolutionary Research (CENIEH).

Anthropologists frequently assess the sex of an individual from dental remains by using external tooth dimensions. While males have larger teeth than females on average in many species, it is unknown whether this size difference is also manifest in the thickness and three-dimensional distribution of enamel and dentine. In this study, microtomographic imaging was employed to assess sexual dimorphism in crown-tissue components in human molars. Although few measurements were statistically significant between sexes, males and females do differ in enamel thickness and in crown composition. Males exhibit greater average crown volume, dentine volume, enamel-dentine junction surface area, and enamel volume. Males are also characterized by thicker maxillary molar enamel and thinner mandibular molar enamel than females. In contrast, females evince a greater proportion of enamel in their crowns and relatively (size-scaled) thicker enamel compared to males, likely owing to their relatively reduced volume of dentine. These sex differences parallel those documented between modern humans and Neandertals, wherein modern humans have smaller molars but absolutely and relatively thicker enamel than Neandertals, which is a function of their similar enamel volume deposited over a smaller dentine core. Variability between sexes, and the potential for this variation to bias measurements deriving from samples where one sex is overrepresented, should be considered in future studies of enamel thickness and crown composition, particularly when isolated fossil teeth and teeth of unknown sex are examined. Supported by the Max Planck Society, the EVAN Marie Curie Research Training Network (MRTN-CT-019564), and the Sigma Xi Grant-In-Aid of Research (The Scientific Research Society). AJO acknowledges the Spanish Ministry of Science and Innovation for their support.

Limb development and its relationship to locomotion in juvenile apes: *Pan* and *Gorilla*.

CONNIE D. FELLMANN. New York University, Department of Anthropology, Center for the Study of Human Origins, and New York Consortium in Evolutionary Primatology (NYCEP).

Patterns of locomotor development in *Pan* and *Gorilla* show that climbing frequencies peak between 6-23 months but remain high longer in *Pan*. While body size differences go far in explaining this developmental variation, the impact of biomechanics has yet to be addressed. Here, the high frequencies of climbing in juvenile apes are the hypothesized result of relatively high muscle mechanical advantage in the lower limb. In order to address this issue, I ask: 1) if juvenile apes have relatively high muscle mechanical advantage in their *quadriceps femoris* muscle facilitating climbing, despite smaller and weaker musculature, and 2) if anatomical mechanical advantage is similar, at similar sizes, following the pattern observed in locomotor development. Cross-sectional growth series of *Gorilla gorilla* (n=79) and *Pan troglodytes* (n=78) are used to assess hind limb and *quadriceps femoris* lever arm lengths. Functionally based segment lengths are used as proxies for muscle mechanical advantage. Growth trajectories are compared to determine when and how adult size is obtained within and across taxa using Kruskall-Wallis and Mann-Whitney U tests. Differences in allometric growth rates are assessed using bivariate RMA regressions. Results indicate: 1) young apes have relatively high mechanical advantage associated with the *quadriceps femoris* muscle, and 2) gorillas and chimpanzees follow the same ontogenetic trajectory, suggesting that at similar sizes, mechanical advantage is maintained. This integration of skeletal and locomotor data demonstrates the role that growth and development can play in the selection of adaptive juvenile locomotor behavior. This study was funded by NYU, NYCEP, and the NSF 0333415 (NYCEP IGERT).

Tracking ancient lentiviral infiltrations in the genome of Malagasy lemurs.

CEDRIC FESCHOTTE¹, CLEMENT GILBERT¹, DAVID G. MAXFIELD¹ and STEVEN M. GOODMAN². ¹Department of Biology, University of Texas, Arlington, TX, USA; ²Department of Zoology, Field Museum of Natural History.

Retroviruses are RNA viruses that are reverse transcribed into DNA and inserted into the host's genome. Though this process happens most frequently in somatic cells (e.g., immune cells for HIV), retroviruses can occasionally be integrated in the genome of the host's germ cells. Such viral insertions may thus be transmitted vertically from parent to offspring, leading to the formation of "endogenous retroviruses." A substantial fraction of mammalian genomes (about 8% in humans) corresponds to remnants of endogenous retroviruses integrated throughout evolution, providing a fossil record of past viral invasions and important clues on the history of modern retroviruses. In this study, we demonstrate that an endogenous retrovirus related to HIV and other lentiviruses was endogenized independently and quasi-simultaneously in two lineages of Malagasy lemurs around 4.2 million years ago. These are the first endogenous lentiviruses discovered in primates. Based on

sequences collected from different lemur species, we reconstructed an apparently intact and complete sequence for this ancestral prosimian lentivirus. Together these data provide evidence that lentiviruses have repeatedly infiltrated the germline of prosimian species and that primates have been exposed to lentiviruses for a much longer time than previously thought. Furthermore, our study indicates that lentiviruses may still be circulating in lemurs and that a systematic screening of Malagasy mammals could further our knowledge on the past and present diversity of lentiviruses. Finally, our study sets the stage for an unprecedented opportunity to reconstruct an ancestral primate lentivirus and thereby advance our knowledge of host-virus interactions. This study was funded by the National Institutes of Health, grant R01GM77582 to CF.

Agricultural subsistence and sex-differential effects to dental health at La Playa (BC 1600-200 AD).

MISTY FIELDS. Department of Anthropology, University of Nevada, Las Vegas.

Archaeological research indicates that in many early agricultural communities, women experienced more severe dental pathology than corresponding males. This study considers the long-term relationship between female oral health and the transition to agriculture by examining dental caries and tooth loss in a prehistoric skeletal sample.

The dentition of an Early Agricultural skeletal sample ($n=142$) from the site of La Playa in Sonora, Mexico was examined by age and sex for variation in dental pathology rates. Age categories were assigned to span pre-, peak-, and post-reproductive years: 15-24 as young adults ($n=15$), 25-34 as adults ($n=35$), 35-44 as mature adults ($n=48$) and 45-55 ($n=44$) as post-reproductive. Dental caries and antemortem tooth loss (AMTL) rates were analyzed to test the hypothesis that, in a population undergoing a subsistence shift to agriculture, females would exhibit higher pathology rates due to reproductive physiological effects to the oral microenvironment. Adult females and males were found to have similar caries rates. However, significant sex-differences in AMTL were identified ($p=.02$). Male-female comparisons across age groups show that La Playa women had substantial increases in tooth loss over the reproductive lifespan compared to age-matched men.

These findings, in light of clinical dental research on oral health and pregnancy, provide an important temporal component to understanding the evolutionary history and differential health impact of agriculture. Results suggest a dynamic process in the development of oral health trends as a function of the shift to agriculture and the burden of increased childbearing that females undertook during this transition. This study was funded through the University of Nevada, Las Vegas Graduate and Professional Student Association (GPSA), the James F. Adams GPSA Scholarship Fund, and the UNLV Department of Anthropology Patricia Rocchio Memorial Scholarship.

Evolution of human aging.

CALEB FINCH. Davis School of Gerontology and the College, University of Southern California.

Human have evolved lifespans that are 2-fold longer than the great apes. In wild chimpanzees and in traditional forager-farmers with limited access to modern medicine, most mortality is due to infections. Although we know little of the diseases of aging under pre-modern conditions, in captivity, chimpanzees present a lower incidence of cancer, ischemic heart disease, and neurodegeneration than current human populations. These major differences in pathology of aging suggest the evolutionary importance of genes that mediate infection, inflammation, and nutrition. The unique human apolipoprotein E alleles are proposed as a prototype of genes which influence blood lipids, arterial and Alzheimer disease, and brain development.

Niche separation between mouse lemurs (*Microcebus murinus*) and clutter foraging bats at Berenty Private Reserve, Madagascar.

KRISTA FISH and MICHELLE SAUTHER. Department of Anthropology, University of Colorado.

Primates share their habitats with a variety of animals. However, research into community ecology has seldom examined how primates coexist with other animals that utilize similar resources. Like mouse lemurs, bats from the families Vespertilionidae and Hipposideridae are clutter foragers that hunt insects within the forest canopy at night. Animals separate their niches in a shared habitat by utilizing different portions of that habitat, being active at different times, or consuming different resources. Whether gray mouse lemurs (*Microcebus murinus*) and clutter foraging bats separate their niches along the above parameters was investigated during a six-month study at the Berenty Private Reserve in Madagascar.

Dietary intake of bats was monitored through examinations of fecal samples. The timing and location of bat foraging were studied through mistnet captures and observations using nightvision binoculars and bat detectors. Mouse lemur diets and foraging behaviors were explored through continuous focal sampling of mouse lemurs.

Bats and mouse lemurs separate their niches by foraging in different locations within a shared habitat and by consuming similar resources but doing so during different seasons. Bats most frequently foraged between zero to three meters within the forest canopy while mouse lemurs most frequently foraged between three to seven meters in the canopy and emergent trees. During the season in which bats were most active, mouse lemurs foraged on fruit but shifted to insects when bats became less active. Understanding niche separation between these taxa that have co-existed since the Eocene has implications for the evolution of primate foraging strategies. This study was funded by a

University of Colorado Museum of Natural History grant, an American Society of Primatologists General Small Grant, a Sigma Xi Grants-in-Aid of Research, a William H. Burt Museum Fund grant and a University of Colorado Beverly Sears Graduate Student Grant.

Functional loading, facial remodelling and the formation of the maxillary sinus and maxillary fossa in *Macaca fascicularis* and *Cercopithecus torquatus*.

LAURA C FITTON¹, JUNFEN SHI², JIA LIU³, MICHAEL J FAGAN² and PAUL O'HIGGINS¹. ¹Functional Morphology and Evolution unit, Hull York Medical School, University of York, UK, ²Department of Engineering, University of Hull, UK, ³Department of Computer Science, University of Hull, UK.

Macques and mangabeys, two closely related taxa, provide an opportunity to investigate the relationship between functional loading, facial remodelling and the formation of the maxillary region. As juveniles, neither possesses a maxillary sinus however by adulthood macaques develop an internal sinus whereas mangabeys develop an external fossa. This study investigates how differences in cranial architecture between these taxa and subsequent bearing of stresses and strains might relate to maxillary sinus formation in *Macaca fascicularis* (macaques) but fossa formation in *Cercopithecus torquatus* (mangabeys).

Finite element models were produced for both species and several hypothetical models created in which the maxillary region was experimentally modified by e.g. filling in the maxillary sinus or fossa or creating a fossa instead of a sinus. The models were loaded according to the regimen predicted by multibody dynamic analysis for a series of biting scenarios and facial strains were computed. Using VoxFE, a custom made finite element analysis tool, the models were then adapted by either adding bone (voxels) to regions predicted to experience compressive strains or removing it from regions of low or tensile strain.

The results reveal that via such 'adaptive remodelling' hollow spaces are formed in the maxillary region. Further they underline the significance of applied loads and the spatial relationships between the dentition, maxilla, nasal cavity and orbits in governing how loads are transmitted through the face. The findings suggest that the loading regimen and the spatial relationships of facial structures may be critical cues in the development of the maxilla. This study was funded by the BBSRC grant numbers BBE0138051 and BBE014259, European Union Marie Curie Action 020601 (PALAEO), Leverhulme F/00224 and Marie Curie Research Training Network 19564 (EVAN).

Sex related differences in human ear ossicle dimensions.

STEFAN FLOHR, JASMIN LECKELT and UWE KIERDORF. Department of Biology, University of Hildesheim, Germany.

Determination of sex in subadult skeletal individuals is problematic because most bones reach their final dimensions not until early adulthood under the influence of sexual hormones. Ear ossicles are an exception in that at birth they have already attained their final size. Thus, potential differences in ear ossicle dimensions between sexes might allow sex determination in infants or children.

To study whether such differences actually exist we obtained measures and indices on 79 males and 80 incudes of 116 adult / subadult individuals of both sexes from an early medieval cemetery at Greding, Germany. Sex could be determined in 74 individuals (41 males, 33 females) using common diagnostic traits especially of the pelvis. Forty-two predominantly subadult individuals could not be sexed. Mean coefficients of variation from measurements by two observers ranged between 0.44 and 2.18%.

The data were analyzed for side differences, influence of age, and differences between sexes. No significant differences in ossicle dimensions between body sides or age groups were recorded. Significant sex differences were found only for one length measure and one index of the incus.

Using discriminant analysis 82% of the males but only 57% of the female individuals were correctly classified based on these variables. Our results demonstrate that certain incus dimensions differ significantly between sexes and may therefore be used as an additional trait in sex determination of skeletal individuals. This could prove especially helpful in subadult skeletons that are difficult to sex on the basis of other morphological criteria.

How diet affects gastrointestinal microbial communities: A study of two sympatric lemurs (*Lemur catta* and *Propithecus verreauxi*) in Beza Mahafaly special reserve, Madagascar.

ANDREW FOGLER¹, MICHAEL TEAGUE O'MARA² and NAYUTA YAMASHITA³.

¹Department of Biology, The University of Southern California, ²Department of Anthropology, Arizona State University,

³Department of Anthropology, The University of Southern California.

Many plants contain structural carbohydrates and toxic secondary compounds in their tissues to deter herbivores. Herbivores harbor symbiotic microbes that breakdown these dietary anti-herbivory compounds, reducing their negative impact or transforming them into a nutritive source. I studied the abundance and diversity of the bacterial community within the digestive system of two sympatric primates, the ring-tailed lemur (*Lemur catta*) and Verreaux's sifaka (*Propithecus verreauxi*), as a function of their different diets: omnivory and folivory respectively. I hypothesized that the community structure of the gastrointestinal (GI) bacteria in these two species would differ in their composition in direct correlation with the requirements to digest different plant anti-herbivory compounds (e.g., tannins and phenolics) in their diets.

I sampled the GI bacteria present in fecal samples from wild sympatric populations of *L. catta* and *P. verreauxi*, to control for habitat bacterial availability. A set of fifteen 16S rRNA-based probes indicated the diversity and abundance of major bacterial groups. Preliminary results indicate a large overlap in the diversity of bacterial groups present in *L. catta* and *P. verreauxi* feces. Differences were observed in the GI bacteria between the lemur species and with changing habitat from gallery forest to spiny forest. This study increases our knowledge of the digestive microbial community and its interaction with the host animal's diet. This study was funded by the Jane Goodall Institute at The University of Southern California and by Sigma Xi, The Scientific Research Society.

New evidence from the Early Bronze Age in Italy of surgical practice following skull trauma.

VINCENZO FORMICOLA¹, GINO FORNACIARI², DAVIDE CARAMELLA², SONIA CAMMELLINI¹ and MARIASILVIA SACCONI¹. ¹Dipartimento di Biologia, University of Pisa, ²Dipartimento di Oncologia, dei Trapianti e delle Nuove Terapie in Medicina, University of Pisa.

Forms of trephination carried out in order to remove part of the injured skull are not infrequent during the Bronze Age. The case presented here provides evidence of a less invasive technique applied in an adult individual found in a cave deposit (Garbu du Surdu, Finale Ligure, Italy) dated to the Early Bronze Age. The skull exhibits a left temporal bone fracture healed with loss of bony fragments. The squama appears slightly depressed and shows two main lines of fusion radiating from the lower part of the bone where three lacunae can be observed. On the parietal bone immediately above the area affected by trauma, the skull shows two regularly curved grooves. One, about 3 cm long, starts from the posterior border of the suture squamosa; the other, 9 cm long, runs above the first and reaches the coronal suture. Remodelling of compacta indicates that the two incisions were made during life. These observations suggest that this individual suffered a violent blunt trauma that broke the temporal bone. The trauma was not lethal but required surgical treatment and care. Above the injured area the skull was incised with a pointed tool in order to detach the soft tissues overlying the fracture, to remove isolated bone fragments and to keep the wound clean. The shorter incision was probably a first attempt, interrupted because it was too low. This case proves once more the therapeutic knowledge of these populations and emphasizes their ability to modulate surgical procedures according to specific needs.

Testing the "second australopithecine species hypothesis" for Sterkfontein Member 4, South Africa.

CINZIA FORNAI^{1,2,3}, RONALD J. CLARKE¹, JACOPO MOGGI-CECCHI², JASON

HEMINGWAY¹, FRIKKIE C. DE BEER⁴ and MABUTI J. RADEBE⁴.

¹School of Anatomical Sciences and Institute for Human Evolution, University of the Witwatersrand, ²Dipartimento di Biologia Evoluzionistica "Leo Pardi", Università degli Studi di Firenze, ³University of Vienna, ⁴Nuclear Energy Corporation of South Africa, Necsa

The issue of the high morphological variability observed within the *Australopithecus africanus* hypodigm has been variously explained by different authors. In particular, Ronald J. Clarke believes that Sterkfontein Member 4 and Makapansgat sites contain a further *Paranthropus*-like *Australopithecus* species other than *A. africanus*, which is represented by several fossils including Sts 71, StW 252, StW 505 and several isolated dental remains. However, there is not a general consensus on this issue as well as about the diagnostic features to be considered and the specimens that show a different morphology to *A. africanus*. Clarke identified the dental morphology as one of the distinctive feature between the two morphotypes, where in the second species the molars are low and bulbous with cusp tips orientated towards the crown centre. In order to highlight and evaluate these dental features, we applied geometric morphometrics to three-dimensional spatial configurations obtained from volume rendered virtual images generated through X-ray Computer Tomography. The sample consisted of 60 maxillary molars belonging to the genera *Australopithecus*, *Paranthropus* and *Homo* from the Plio-Pleistocene South African sites of Sterkfontein, Swartkrans, Kromdraai, Makapansgat, and Cooper's Cave. After assessing the repeatability of the procedure for landmark collection and the discriminant power of the methods proposed, we applied them for the main purposes of this research. The results obtained do support the hypothesis of the occurrence of two different australopithecine species in Sterkfontein Member 4 where the individuals considered as belonging to the second species form a separate cluster to those considered as *A. africanus*. This study was funded by: Nuclear Energy Corporation of South Africa, Necsa (Mobility) 2007, J.J.J. Smieszek bursary, 2007 and 2008, Palaeontological Scientific Trust - PAST, 2007 and 2008, Italian Government scholarship (Jan-Sep 2008), Postgraduate Merit Award, University of the Witwatersrand, 2008, Bradlow Scholarship, Faculty of Science, University of the Witwatersrand, 2009. Supported by National Science Foundation Physical Anthropology HOMINID program and European Union FP6 Marie Curie Actions MRTN-CT-2005-019564 "EVAN."

Influence of body size on jaw-gape related characteristics among marmosets.

ELLIOTT C. FORSYTHE and SUSAN M. FORD. Department of Anthropology, Southern Illinois University.

The use of the anterior dentition to elicit exudate flows, a behavior known as tree-gouging, has previously been shown to correspond to several

characteristics related to jaw-gape among the Callitrichidae. Several studies have shown that the gouging marmosets exhibit mandibular and basicranial adaptations that allow for relatively increased maximum jaw-gape in comparison to the non-gouging tamarins. However, few studies have investigated variability between marmoset genera in jaw-gape related characteristics, despite their extreme variability in size and exudate reliance. This study explores mandibular and basicranial characters linked to jaw-gape among marmoset taxa to determine if differently sized marmoset taxa differ in the expression of jaw-gape related characteristics. Metric data from a sample of marmoset crania were standardized with the biomechanical standardization technique using a bite-force proxy (mandible length) and the geometric mean. One-way Anova and Tukey's HSD were used to compare marmoset genera on the basis of several gape related characteristics of the basicranium and mandible. Results show that the smallest marmoset, *Cebuella pygmaea*, has the most exaggerated adaptations to gape: it has a significantly longer basicranium, a longer and lower mandibular condyle, and a lower coronoid process than the larger marmoset taxa. *Mico* and *Callithrix* exhibit less extreme expression of jaw-gape related characters. These results suggest that smallest marmosets have an increased ability to produce wide jaw-gapes when compared to larger gougers. Future studies of gouging biomechanics must take into account the marked variability between marmoset genera when interpreting proposed adaptations to gouging.

Investigation of dietary texture at the Carrier Mills Archaeological District, Illinois (10,000 B.P. to 950 B.P.) using microwear analysis

LAUREN A. FORSYTHE¹ and TRACY L. PROWSE². ¹Department of Anthropology, Southern Illinois University Carbondale, ²Department of Anthropology, McMaster University.

Dental microwear analysis was used to investigate dietary texture in a sample of Archaic (10,000-3,000 B.P.) and Woodland period (3,000-950 B.P.) Native American teeth from the Carrier Mills Archaeological District (Saline County, Illinois). Facet 9 was examined on thirty molar teeth using a scanning electron microscope at a resolution of 500x, and the number of pits and scratches were visually quantified. The four variables analyzed (number of pits, number of scratches, total number of features, and the pit-to-scratch ratio) were used to compare differences in dietary texture between the Archaic and Woodland periods, between males and females (both within and between time periods), and between individuals exhibiting skeletal evidence of treponemal disease and those who did not. The results indicate that there were no significant differences in dietary texture between the Archaic and Woodland periods and no significant differences between diseased and non-diseased individuals in the sample. Males and females, however, did exhibit differences in microwear features. Females had higher values than males for all four variables examined,

although only the number of pits and total number of features were significantly different ($p<0.05$). These results indicate that males and females consumed diets with different textures. Explanations for sex-based differences in dental health suggest that females consumed more plant-based foods than males, and that they tasted these foods regularly during processing. The results of this research are consistent with the hypothesis that females were exposed to soil-based grit and phytoliths in connection with sex-based patterns of food preparation and consumption.

Body size and maneuverability in human evolution.

ADAM D. FOSTER, HALLIE M. EDWARDS and DAVID A. RAICHLEN. School of Anthropology, University of Arizona.

The appearance of *Homo erectus* is characterized by an increase in body size compared to earlier hominins. Larger body size has many advantages, among them increased foraging ranges associated with more open habitats and a dietary shift that accompanied the evolution of *Homo erectus* (Antón et al. 2002). However, few studies have examined the question of why small body sizes persisted in hominins for nearly six million years prior to the emergence of the genus *Homo*. One possibility is that a small body size provided benefits to hominins living in more closed environments. We hypothesize that small body size improves maneuverability, a possible advantage in the more forested habitats occupied by small bodied hominins. In this study, we examined the impact of body size on maneuverability by timing human subjects sprinting along a 30 meter outdoor trackway. After a period of rest, subjects sprinted along a 30 meter tight slalom course with 45° turns. The degree of maneuverability was calculated as the percent difference in time between the straight sprint and the slalom sprint. High degrees of maneuverability are associated with a smaller difference in time between straight and slalom courses. We found that body mass is significantly positively correlated with percent difference in time between the two courses ($r^2=0.95$). These results suggest that smaller body sizes allow for greater turning performance and maneuverability. Therefore, it is possible that small body size was beneficial for early hominins in closed forested environments.

Drilling away the spirits: A worldwide study of trepanation.

L. FRAME. Department of Anthropology, East Carolina University.

Trepanation is a worldwide phenomenon that is most often studied on a case-by-case basis, with few comparisons cross-culturally or through time and with no agreement as to why it was practiced. Earlier theories have suggested ritualistic and magico-therapeutic purposes and have proposed a higher frequency of trepanations in adult males as a result of injuries sustained in warfare and gender-specific ritual

practices. A compilation of case reports and information on trepanation is therefore vital for bioarchaeological study of the procedure. This research catalogues and describes incidences of trepanation in the extant literature in order to present a worldwide comparison of the practice and ascertain reasons for its performance. Over fifty case reports of trepanned skulls from all time periods and geographic locations were examined. Age and sex were assessed for archaeological specimens, and sociocultural variables such as religion were noted for more recent cases. Basic statistical analysis produced a strong correlation between the practice of trepanation and the biological and sociocultural variables. More adult males were trepanned than females and children; about 85% of the skulls were male. The few trepanned children showed evidence of development disorders. The relative lack of pathology on female skulls possibly suggests trepanation occurred for religious reasons rather than for physical ones. More than half of the males had evidence of skull trauma, but there were also males without pathologies, suggesting that males were trepanned for ritualistic reasons as well.

Variation in anterior nasal spine prominence in extant human adults and subadults.

ROBERT G. FRANCISCUS^{1,2} and CHRISTINA L. NICHOLAS¹. ¹Department of Anthropology, ²Department of Orthodontics, University of Iowa, Iowa City.

The anterior nasal spine (ANS) is a derived trait in *Homo* in contrast to a markedly less developed or absent anterior nasal tubercle in extant and fossil apes and pre-*Homo* hominins. Nonetheless, intraspecific variation in human ANS prominence exists and is incompletely understood owing largely to a dearth of studies with sufficiently large sample sizes, geographic variation, and joint consideration of other facial traits. Moreover, beyond the work of Mooney and Siegel (1986) showing significant early (fetal) developmental ANS differences between Euro-American and African-American subadults, further understanding of ANS variation related to midfacial growth is also lacking. Are population differences in ANS prominence that are apparent in fetal ontogeny simply maintained through subsequent development? Or, do population differences intensify later in development because changes in ANS prominence are developmentally correlated with midfacial dimensions that accelerate in later growth spurts?

We evaluate these alternatives using discrete coding stages for ANS prominence in geographically diverse cranial samples of adults ($n=519$) and subadults (fetal $n=135$; birth-17 years $n=180$). The largest portions of our samples comprise arguably the greatest clinal axis of extant human ANS prominence diversity (i.e., NW Europe to sub-Saharan Africa). In our dataset, statistically significant populational differences in ANS prominence occur, unexpectedly, only after birth and not in fetal stages. Moreover, ANS prominence in our adult dataset is strongly positively associated with narrow nasal and midfacial width dimensions

and greater piriform aperture height and nasal bridge elevation dimensions, a constellation of populational differences that are less manifest in early developmental stages. This research was funded by NSF (SBR-9312567), the Leakey Foundation, and a UI Stanley Graduate Award for International Research.

The influence of sexual dimorphism on allometric interpretations in sister colobine species.

BRENDA C. FRAZIER. Department of Anthropology, Penn State University.

Clarifying the intersection of allometry and sexual dimorphism is important for making species distinctions in extinct forms. To better understand these phenomena in extant primates, a comparison of craniofacial shape and allometry was undertaken using 3D coordinate landmark data, endocranial volume estimates, and linear metrics collected from museum specimens of two species of odd-nosed colobines. Despite their close genetic affinities, *Nasalis larvatus* and *Simias concolor* differ in many aspects of their biology, including their endemic habitats, body size, and degree of sexual dimorphism. Recent work comparing craniofacial morphology between females of the two species has suggested that while their shapes are distinct, these shapes are affected in similar ways by intraspecific size differences. When males are included in the analyses, however, these seemingly parallel static allometries diverge. Although craniofacial shape is still correlated with cranial size in both species, the effects of size on shape within species are different. Here I report on the altered picture of intraspecific allometry in the *Nasalis-Simias* lineage when sexual dimorphism is considered. Beyond cranial allometry, our interpretations of brain-body relationships are also affected by the inclusion of the extremely dimorphic *Nasalis* males. This work was supported by an NSF Graduate Research Fellowship and Doctoral Dissertation Improvement Grant #0824583 and by internal grants from the College of Liberal Arts and the Department of Anthropology at Penn State.

3D semilandmark geometric morphometric quantification of modern human facial development.

SARAH E. FREIDLIN^{1,2,3}, PHILIPP GUNZ¹, KATERINA HARVATI^{4, 2, 3} and JEAN-JACQUES HUBLIN¹. ¹Max Planck Institute for Evolutionary Anthropology, ²Department of Anthropology, City University of New York Graduate School, ³New York Consortium in Evolutionary Primatology, ⁴Dept. Early Prehistory and Quaternary Ecology, Eberhard Karls University of Tübingen, Germany.

Facial morphology features prominently in taxonomic identification and phylogenetic reconstructions of the human fossil record; however, its use remains controversial, as their evolutionary significance is not well-understood. Improved knowledge of facial developmental variation and integration is necessary in order to assess the value of facial

morphology in defining species and in phylogenetic reconstructions.

This study uses geometric morphometric methods to quantify ontogenetic and adult facial variation, assess its patterns of co-variation, and use the insights gained to help interpret the evolution of human facial form in the Middle to Late Pleistocene. 430 facial landmarks and semilandmarks on curves and surfaces were digitized on surface and CT scans of 202 subadult and adult individuals from three diverse modern human groups: Europe, Africa and North America. The measurement protocol was designed to capture features such as browridge morphology, the canine fossa, and zygomatic orientation.

After Procrustes registration the shape variables were analyzed using principal components; ontogenetic trajectories were calculated by regressing shape on centroid size. Results show some population-specific features are already established at the time of birth. Postnatally population facial growth trajectories are not parallel, i.e. postnatal growth contributes to shape differences among adults. We present aspects of facial shape that are established early in ontogeny. We suggest that those might prove to be particularly useful in phylogenetic analyses as they are less likely to be affected by epigenetic factors. We discuss implications of these findings for modern human evolution and the interpretation of facial features in fossil *Homo*. This study was funded by the Marie Curie Actions grant MRTN-CT-2005-019564 "EVAN," the Max Planck Society, NSF 0851756, and the L.S.B. Leakey Foundation.

An affine-adjusted analysis of tibial shape in hominoids.

MELANIE A. FRELAT¹, STANISLAV KATINA^{1,2}, GERHARD W. WEBER¹ and FRED L. BOOKSTEIN^{1,3}. ¹Department of Anthropology, University of Vienna, ²Department of Applied Mathematics and Statistics, Comenius University, Slovakia, ³Department of Statistics, University of Washington.

Functional-anatomical studies of hominoid lower limb bones typically focus on the measurements that appear explicitly in biomechanical models. Here we show how the tools of geometric morphometrics can supply less theory-laden visualizations at large scale. After a standard Procrustes analysis of landmark-semilandmark configurations on a sample of 77 tibiae represented by their surface scans, we directly intervened in the affine subspace of shape space to impose equality between the moment of inertia along the long axis of the bone and the sum of the moments along the other two axes. In other words, we "sphericized" the originally axial forms in the average of lateral and frontal views. Relative warps (principal components) analysis of the altered forms now allow much clearer visualizations of its patterns of bending and twisting, and partial least-square analyses can assess the relationship between arboreal locomotion, centroid size and body mass, and tibial shape in a likewise isotropic fashion.

Nonhuman primates generally exhibit a number of familiar contrasts with the typical human tibial morphology. In scatters of the first two or three relative warps, *Gorilla* clearly clusters separately from *Pan* but overlaps with *Pongo*. The higher bending and greater torsion of the shaft in *Pan* account for most of this difference. Across species, variations in arboreal locomotion mode and body mass are highly correlated with the shape of the adult tibia. Further understanding of how the lower limb adapts to the loads arising during locomotion via these taxonomically contrasting bends and twists would better be investigated ontogenetically. This study was supported by the EU PF6 Marie Curie Actions grant (EVAN, Human Resource and Mobility Activity) MRTN-CT-2005-019564.

Femoral shaft waist distribution and its relationship to mobility levels and other size/shape measures in three temporally distinct populations.

LUKÁŠ FRIEGL¹, TRENTON W. HOLLIDAY¹ and VLADIMÍR SLÁDEK^{2,3}. ¹Department of Anthropology, Tulane University, ²Department of Anthropology and Human Genetics, Faculty of Science, Charles University in Prague, ³Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic.

Previously, we developed the concept of the femoral shaft waist (Friedl et al. 2009). We believe that such a measure has biomechanical importance since it reflects the place with the lowest adaptive strengthening of the shaft against overall bending and torsional stresses. Here, we explore its distribution in three temporally and behaviorally distinct samples to assess whether mobility levels influence its location. We also explore its relationship to other body size/shape measures for possible prediction. Prehistoric (n=45), historic (n=72), and recent human samples (n=53) were used. External A-P and M-L diameters were measured on femora from 65% to 35% BML in 1% steps. Polar moment of area (J) was estimated following Pearson et al. (2006) and location of minimum J was recorded. Results show that femoral shaft waist distribution is skewed distally in prehistoric and historic samples with the majority of observations between 65 and 60 %BML. This holds true for prehistoric males and females but only for historic males. Historic females and the recent human sample show a normal distribution ($P=0.33$, resp. $P=0.35$) around midshaft. This may suggest that with decreasing mobility over time, the femoral shaft waist shifts distally. RMA regression analyses revealed non-significant relationships between minimum J position and other size/shape measures. However, we did find a significant positive relationship between minimum J and minimum M-L diameter ($r=0.63$, 0.59, 0.68), suggesting that A-P diameter may change more easily according to behavior, while M-L diameter better reflects shaft structural properties.

Cranial bone thickness in artificially deformed skulls.

MARTIN FRIESS¹ and ROMAN HOSSEIN KHONSARI². ¹Département HNS & UMR 7206 du CNRS, Musée de l'Homme, ²Department of Craniofacial Development, King's College London.

Artificial cranial deformations have been observed in numerous populations around the world, and are often seen as social/cultural markers, thus yielding valuable insight into the behaviour of past populations. While many anthropological studies have focused on effects of intentional deformations on growth, e.g. changes of the face and base, or incidence of Wormian bones, few have investigated possible alterations of the thickness of the cranial vault. In order to address this question, we have sampled medical CT scans from several populations and developed a protocol for measuring cranial vault thickness in the frontal, occipital and the parietals. The sample consists of 56 male and female individuals, representing two major deformation types (antero-posterior and circumferential) and two geographic distinct areas (South America and Europe). We also included undeformed skulls from each population. Each skull was CT-scanned according to the same protocol, specifically developed for craniometric analyses. A series of measurement points along the frontal, parietal and occipital bones were defined, and measurements were taken (following the HMH protocol) in single slices, reconstructed perpendicular to the skull surface.

The results reveal a significant trend towards reduced cranial thickness among both deformation types, when compared to their undeformed counterparts. This reduction is mostly driven by thinning of the diploë, whereas inner and outer tables appear more stable. While further investigations are required, in particular to fully map the enormous individual variability encountered, our analyses show new insight into the biomechanics of normal and altered cranial growth, and may help identify deformed crania.

Preliminary report of new research on the Lake Manyara Beds, Arusha Region, Tanzania.

STEPHEN R. FROST¹, KATERINA HARVATI², CHARLES SAANANE³, LIANE GIEMSCH^{2,4}, FRIEDEMANN SCHRENK⁵, LEAH E. MORGAN⁶, PAUL R. RENNE^{7,8}, MAYA M. WILDGOOSE⁷ and HILDE SCHWARTZ⁹. ¹Dept. Anthropology, University of Oregon, ²Dept. Early Prehistory and Quaternary Ecology, Eberhard Karls University of Tübingen, Germany, ³Archaeology Unit, History Dept., Faculty of Arts and Sciences, University of Dar es Salaam, Tanzania, ⁴Institute of Pre-and Protohistory and Medieval Archaeology, Eberhard Karls University of Tübingen, Germany, ⁵Dept. of Vertebrate Paleobiology, Johann Wolfgang Goethe-University, Frankfurt, ⁶Faculty of Earth and Life Sciences, Vrije University, Amsterdam, ⁷Dept. Earth and Planetary Science, University of California, Berkeley, ⁸Berkeley Geochronology Center, Berkeley, ⁹Dept. Earth and Planetary Sciences, University of California, Santa Cruz.

The Lake Manyara beds are a series of Pleistocene lake margin sediments in the vicinity of Makuyuni Village in Northern Tanzania. The 30 m-thick section consists of a terrigenous upper member and lacustrine lower member that unconformably overlies volcanic basement in the Manyara Rift. These fossiliferous deposits were most recently explored by the Hominid Corridor Project in 1994-5. In July of 2008 an international team conducted a field season of geological, paleontological, and archeological research with the goals of extending previous paleontological work, identifying archeological localities preserving artifacts in situ, refining the stratigraphy of the region, and conducting geochronological analysis.

A significant result of the 2008 field season is that Ar/Ar analysis of single feldspar crystals from one of the underlying volcanic rocks and a pumice lapilli-rich tuff near the upper-lower member contact yielded preliminary age estimates of 6 Ma and 1 Ma respectively. Rich faunal material, consistent with the radiometric age of 1 Ma, was also recovered, including aff. *Theropithecus oswaldi*, *Eurygnathohippus* sp., *Equus* sp., Rhinocerotidae, *Elephas recki* aff. *ilireensis*, *Hippopotamus* aff. *gorgops*, *Metridiochoerus compactus*, ?*Phacochoerus* sp., *Kolpochoerus* sp., Alcelaphini, *Aepyceros*, Bovini, Hippotragini, Reduncini, Tragelaphini, and Giraffidae. Bovids, equids, and suids are the most abundant families (54%, 24% and 13% respectively of material identifiable to family). Alcelaphins are the most abundant bovid tribe; all other tribes are rare. Acheulean lithics were common as surface occurrences, but were only recovered in a stratigraphic context in one test excavation near the upper-lower member contact.

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Application of LC-IRMS to measure $\delta^{13}\text{C}$ values of single amino acids in archaeological bone collagen from north-central California.

B.T. FULLER^{1,2}, C.I. SMITH¹ and E.J. BARTLELINK³. ¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, ²Centre for Archaeological Sciences, Katholieke Universiteit Leuven, Leuven, Belgium, ³Department of Anthropology, California State University, Chico.

The isotopic analysis of $\delta^{13}\text{C}$ values from bulk bone collagen has played an important role in the identification of paleodiets in past populations from around the world. However, little research has been conducted at the single amino acid level for archaeological $\delta^{13}\text{C}$ values. The application of compound-specific stable isotope analysis has the potential to lead to more accurate measurements by the removal of contamination, as well as providing additional dietary information through separating a bulk $\delta^{13}\text{C}$ isotopic signal into its single amino acid $\delta^{13}\text{C}$ values. The recent development of Liquid Chromatography-Isotope Ratio Mass Spectrometry (LC-IRMS) now permits the

online isotope measurement of complex compounds such as amino acids and carbohydrates without the need for derivatization, resulting in simplified sample preparation and improved accuracy and reproducibility.

In this study, we apply a new chromatographic method to analyze stable carbon isotope ratios in 25 bone collagen hydrolysates from humans, animals, and fish using LC-IRMS. The bone collagen samples come from archaeological sites in the San Francisco Bay and Delta region of the lower Sacramento Valley, and have bulk protein $\delta^{13}\text{C}$ values that indicate various levels of marine protein consumption such as wild salmon. Analysis of the $\delta^{13}\text{C}$ single amino acid values show how they change at the molecular level in relation to the different bulk protein $\delta^{13}\text{C}$ values. Specific $\delta^{13}\text{C}$ amino acid markers will be identified and discussed in the context of detecting subtle shifts in marine protein consumption in pre-contact north-central California. Supported in part by a Wenner-Gren Foundation grant #7163 and NSF grant BCS-0424292.

The paleopathology of a French colonial cemetery on the Mississippi gulf coast.

J. LYNN FUNKHOUSER and MARIE DANFORTH, Department of Anthropology, University of Southern Mississippi.

This presentation examines the health experiences of early eighteenth century European immigrants to the Mississippi Gulf Coast. Most were low-status individuals forcibly expelled from France and brought to Biloxi to colonize Louisiana. Historical records report the immigration effort was poorly provisioned and that large numbers died from malnutrition and disease soon after arrival. The remains of thirty adults, presumably colonists from this period based on collagen dating and grave goods, have been recovered at the Moran site (22HR511). DNA analysis (n=8) suggests all are European. Most are males, and only one lived past age 40. Estimated mean height is 165.1cm for males (n=15) and 155.49cm for females (n=3), which is several centimeters shorter than contemporary European populations. Hypoplasias were found on thirteen of twenty individuals scored with nine showing multiple episodes. Most lesions were of moderate severity, and ages at formation ranged broadly between two and five. Porotic hyperostosis was seen in several individuals, but all cases were slight. Frequencies for caries and antemortem tooth loss are relatively low, and periosteal lesions suggestive of infectious disease are rare. Arthritis is uncommon, as would be expected given the young age at death for most. Trauma also is infrequent, but two crania do display possible healed blunt force trauma. The population as a whole fits the expected demographic profile of a colonial settlement. The health patterns revealed also accord with individuals who endured harsh childhoods and died from acute rather than chronic causes as they sought new lives in the New World.

Molar size variation related to age in Amboseli baboons (*Papio cynocephalus*)

JORDI GALBANY², LAIA DOTRAS¹, JEANNE ALTMANN³, ALEJANDRO PÉREZ-PÉREZ¹, SUSAN C. ALBERTS¹. ¹Department of Animal Biology, University of Barcelona (Spain), ²Department of Biology, Duke University, ³Department of Ecology and Evolutionary Biology, Princeton University.

Tooth size is a common variable used in primatological and anthropological studies. It can provide information about tooth development, phylogeny or ecological adaptation. Moreover, several studies have evaluated sexual dimorphism by using dental size in primates; dimorphism is particularly remarkable in the canines. But some researchers have pointed out that tooth size can be modified by the degree of interproximal tooth wear, i.e., wear between the teeth that generates attrition and wears away the rounded profile of the crown. Interproximal tooth wear is known to increase with age in humans, but has not been investigated before in natural populations of non-human primates. In the present study, we examined molar size from a single well-known aged population of wild baboons from Amboseli (Kenya), both males (n=41; from 7.4 to 20.45 years old) and females (n=54; from 5.53 to 26.64 years old). The results showed a significant reduction in the mesiodistal length of lower M1 in males and females, as a function of age. There was also a reduction in upper M1 length as a function of age, significant in females, and also a non-significant trend in reduction of length in the M2 for both sexes. These results demonstrate that molar size, especially M1, is directly related to age due to interproximal wearing caused by M2 and M3 compression loads. Researchers should take into account this phenomenon when measuring tooth length for odontometric purposes. This research was funded by the US National Science Foundation (BCS-0323553 and BCS-0323596) and the Spanish CGL2004-00775/BTE and CGL2007-60802 projects.

Ontogenetic patterning of the whole long bone: Patterns of metaphyseal and epiphyseal growth.

EVAN M GAROFALO. Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

Linear long bone growth has been demonstrated to be highly sensitive to environmental factors. Because of this relationship, variation in linear limb bone growth is used to examine growth and health among humans. In order to maintain the congruence of joint surfaces, epiphyseal growth is assumed to be less sensitive to environmental perturbations. However, ontogenetic patterns of metaphyses and epiphyses have generally been unexamined, and it is therefore unclear how variation among regions of long bones relate to each other throughout growth.

This study examines the growth trajectories of femoral and humeral length, metaphyseal and epiphyseal transverse dimensions, and cortical

and medullary areas. Based on previous studies, it is expected that although metaphyses and epiphyses will follow a trajectory similar to that of the long bones, the initial rate of growth exceeds that of long bones and supersedes estimated functional loading demands. This will vary among limb bones and regions within each. Measurements and cortical areas were obtained from Arikara juveniles (n=46, fetal to 18 years) and young adults (n=9).

Results indicate that the femoral and humeral metaphyses and epiphyses follow a growth trajectory similar to those of diaphyseal lengths. Yet, metaphyses and epiphyses attain dimensions close to adult sizes earlier than diaphyseal lengths. In addition, femoral rates are greater than the growth trajectories of humeral dimensions, most notably during the initial three years of life. The proximal and distal femoral dimensions also exceed estimated body mass to a greater degree than the humeral dimensions.

Getting in the groove: Indirect observations of the primate vomeronasal system using CT.

EVA GARRETT. Department of Anthropology, The Graduate Center of the City University of New York; New York Consortium in Evolutionary Primatology (NYCEP).

There is a long-standing hypothesis in physical anthropology that a sensory trade-off has occurred between olfaction and vision in primate evolution when anthropoids transitioned to a diurnal activity pattern and began using visual stimuli more prominently than pheromone detection (vomerolfaction). While this trade-off hypothesis seems supported by reduction in the vomeronasal system and enhancement of the visual system in some extant primates, it has not been properly tested using fossils. Garrett, Smith et al. (2009) identified histologically an osteological correlate of the vomeronasal system in the form of bilateral bony palatal grooves (PG) on the nasal floor, formed by the articulation with cartilage surrounding the vomeronasal organs. This study focuses on CT as a means of observing and quantifying the PG in a nondestructive manner.

CT scans of strepsirrhine (n=7), platyrhine (n=10) and hominoid (n=1) crania were visually inspected for presence of the PG, and linear measurements were estimated using ImageJ software. As expected, the PG was present in strepsirrhines and platyrhines possessing vomeronasal organs but absent in the hominoid. Comparisons of linear dimensions within and between taxa indicate effects of size, activity pattern and ontogeny on the PG. PG dimensions scale negatively with body size and are larger in nocturnal genera. In platyrhines, some genera may not fully form the PG until later juvenile stages. Results from this study support using CT to investigate the morphology of the vomeronasal system. Ultimately this method will be applied to fossils, shedding new light on the sensory trade-off hypothesis in primates.

The effects of health stressors on postcranial sexual dimorphism: A comparison of recent American populations.

HEATHER M. GARVIN¹, CHRISTOPHER W. RAINWATER^{2,3,4} and CHRISTOPHER B. RUFF¹. ¹Center for Functional Anatomy and Evolution, Johns Hopkins University, ²Department of Anthropology, Center for the Study of Human Origins, New York University, ³New York Consortium in Evolutionary Primatology, ⁴Office of Chief Medical Examiner, New York City

Sexually dimorphic skeletal traits are the result of an array of extrinsic and intrinsic factors which act on the sexes disproportionately and/or are translated differently by the sexes. In this study, a modern forensic human skeletal sample (Forensic Anthropology Data Bank) was compared to skeletons from a 19th century low socioeconomic population (Hamann-Todd Collection) in order to analyze the sex-specific response of postcrania to health stresses.

The Forensic Anthropology Data Bank represents a forensic sample of modern "healthy" individuals, compared to the Hamann-Todd collection which is biased towards individuals of low socioeconomic status (frequently indigent and malnourished). Stature, body mass, femoral length, humeral length, and femoral head diameter were analyzed. Based on the "cylindrical model" of the human body, a measure of trunk breadth was derived from femoral head diameters and femoral lengths. The following hypotheses were tested: (1) "healthy" males and females would have larger measurements in all skeletal traits, the largest difference being in stature and limb lengths; (2) trunk breadth measurements would remain constant, following ecogeographic expectations for two populations of similar climate; (3) if female buffering exists and males are skeletally more sensitive to environmental influences, the "healthy" population should show a greater degree of sexual dimorphism.

Results support all of the aforementioned hypotheses, except female buffering. The increase in femoral head diameter was not significant in either sex nor was male humeral length. Though this is contrary to the significant increase in stature and femoral length, it may reflect differential effects of health stressors.

Developmental integration of the cerebrum and cerebellum: Implications for human brain evolution.

IAN D. GEORGE¹, KIMBERLY K. POPE¹, AMANDA J. MOFFITT², LEI WANG^{3,4}, LYNN D. SELEMON^{4,5} and KRISTINA ALDRIDGE¹. ¹Department of Pathology & Anatomical Sciences, University of Missouri School of Medicine, ²Department of Psychological Sciences, University of Missouri-Columbia, ³Department of Psychiatry, Northwestern University School of Medicine, ⁴Department of Psychiatry, Washington University School of Medicine, ⁵Department of Neurobiology, Yale University School of Medicine.

The cerebellum, via its reciprocal connections with the cerebral cortex, plays an integral role in cognitive processes that are important to human evolution, including learning, attention, and

language. Interference with neurogenesis during temporally limited spans of fetal development can selectively diminish neuronal populations, and potentially affect connectivity. Here we examine the long-term effects of disrupting neurogenesis during early gestation on the cerebello-thalamo-cerebral circuit in the Rhesus macaque (*Macaca mulatta*). Magnetic resonance scans were collected at 0.5, 1, 3, and 5 years of age in Rhesus macaques exposed to x-irradiation during early gestation (X; N=5), at a time coinciding with thalamic neurogenesis (E30-41), and in sham-irradiated control animals (C; N=4). We compared cerebellar volume, and correlations between cerebellum and thalamus, and cerebellum and cerebrum at each of each time point.

Results show significant reduction of cerebellar volumes between X and C at each age group ($p<0.05$) as observed previously in volumes of the thalamus and cerebrum. Further, correlations between cerebellar volume and volume of the other two structures were reduced in X relative to C. These results suggest disruption of cerebellar development and its relationship with the cerebrum following altered neurogenesis. These findings may shed light on the parallel evolution of cerebellum and cerebrum observed in the fossil record, and suggests that changes in the development of this circuit may be important in the evolution of human cognitive functions. This study was funded by NIH grants MH071616 and T32MH117104 and the University of Missouri Life Sciences Fellowship.

Sixteen trepanations on eight skulls from Keushu (Ancash, Peru).

KARINA GERDAU-RADONIC¹ and ALEXANDER HERRERA². ¹Université Bordeaux I, LAPP - PACEA UMR 5199 (Bordeaux, France); IDARQ (Lima, Peru)

²Departamento de Antropología, Universidad de los Andes (Bogotá, Colombia).

Craniotomies are a vivid example of the surgical skills of ancient Andean populations. Trepanation studies from the Andes have revealed that multiple individuals were subjected to, and survived more than one trepanation, that techniques evolved through time and space, and that some interventions were due to trauma. This first case-study in the north-central Andes offers insights into trepanation during a precise period of time at one single location: Keushu (Ancash, Peru). Which techniques were employed? Which were the preferred trepanning loci? What were the reasons for the procedure? What was the survival rate? How do the data from Keushu compare to that of other studies? Eight neurocranials, excavated from two collective mortuary structures (AD 600-1470), present 16 trepanations. Three techniques were employed: scraping, linear cutting, and boring and cutting. The long-term survival rate is of 75% as 12 of the 16 trepanations showed evidence of long-term healing. One individual with two craniotomies presented no signs of healing, and another individual presented two trepanations with short-term healing. Moreover, two of the intervened crania showed clear evidence of

infectious disease and trauma. This study confirms observations made in other recent studies on over-all survival rates, preferred cranial loci for surgical interventions, and the broad distribution of the techniques employed. Additionally, it contextually anchors the spatio-temporal distribution of trepanation practices in the Ancash highlands. Finally, it is suggested that craniotomies were practiced as a form of treatment, both for injuries and illnesses.

Morphological systematics of the kipunji, *Rungwecebus kipunji*.

CHRISTOPHER C. GILBERT^{1,2}, WILLIAM T. STANLEY³, LINK E. OLSON^{4,5}, TIM R. DAVENPORT⁶ and ERIC J. SARGIS^{1,7}.

¹Department of Anthropology, Yale University,

²Yale Institute for Biospheric Studies, Yale University,

³Department of Zoology, Field Museum of Natural History,

⁴Department of Mammalogy, University of Alaska Museum of the North,

⁵Institute of Arctic Biology, University of Alaska Fairbanks,

⁶Wildlife Conservation Society, Tanzania Program,

⁷Division of Vertebrate Zoology, Peabody Museum of Natural History.

Since its initial discovery and description, the systematic position of the kipunji (*Rungwecebus kipunji*) has been a matter of debate. First placed in the mangabey genus *Lophocebus*, subsequent molecular studies have indicated that the kipunji is most closely related to baboons (*Papio*), resulting in the erection of a new genus, *Rungwecebus*. Notably, there have been no phylogenetic analyses of the kipunji based on morphology. The recovery of an M2 subadult male kipunji specimen, in addition to the M1 juvenile voucher specimen, has since allowed for further study. Here we present a cladistic analysis of *Rungwecebus* craniodental morphology, using quantitative and qualitative characters. We examined 76 M1 and M2 juvenile/subadult males representing all papionin genera, taking note of character states which hold steady throughout ontogeny. To control for ontogenetic changes, only those 60 characters expressing unchanged character states between juvenile and adult specimens were coded for *Rungwecebus* and entered into the larger, recently published, 151 character matrix of adult male morphology (Gilbert et al., 2009). To account for allometry among adult male characters, the narrow allometric coding method was applied. The resulting most parsimonious tree suggests that *Rungwecebus* is most similar to *Lophocebus*, a result congruent with the first morphological descriptions. However, due to the large amount of missing data for *Rungwecebus*, there is low bootstrap support for any relationships within the larger *Theropithecus/Papio/Lophocebus/Rungwecebus* grouping. Combining these results with previous molecular and phenetic studies, it is prudent to maintain *Rungwecebus* as a distinct genus, pending additional molecular and adult morphological data. This study was generously supported by the Wildlife Conservation Society and a Donnelley Fellowship from the Yale Institute for Biospheric Studies to CCG.

Asymmetries of the temporo-parietal cortical areas in common chimpanzee: functional correlates and comparison with human.

EMMANUEL P. GILISSEN¹ and WILLIAM D. HOPKINS². ¹Department of African Zoology, Royal Museum for Central Africa, Tervuren, Belgium, Université Libre de Bruxelles, Laboratory of Histology and Neuropathology, Brussels, Belgium, ²Agnes Scott College, Decatur, Georgia, Yerkes Regional Primate Research Center, Atlanta.

A left larger than right Planum Temporale (PT) is a neuroanatomical asymmetry common to both human and chimpanzee. PT lies on the superior temporal gyrus. A similar asymmetry was observed on the human Parietal Operculum (PO) (Habib et al., 1995). The convergence of PT and PO asymmetries is strongly associated with right-handedness in human. In this study, we assessed whether this combination of asymmetries also exists in common chimpanzee. Magnetic resonance scans were obtained in 83 captive common chimpanzees (55 females and 28 males, age range 6 to 50 years) housed at the Yerkes National Primate Research Center in Atlanta. Planum Temporale was quantified following procedures previously employed (Cantalupo et al., 2003; Hopkins, 2007) and parietal operculum was defined as the maximal linear distance between the end point of the sylvian fissure and the central sulcus (Habib et al., 1995). Two tasks with different motor demands were designed to simulate the termite fishing and anvil use behavior of wild chimpanzees. For both PT and PO, chimpanzees showed significant leftward asymmetries but a Pearson r failed to reveal any significant association between the measures ($r(80)=0.195$, $p>0.05$), as has been reported in human (Habib et al., 1995). Finally, handedness effect was identified only for tool use (termite fishing) ($F(1, 63) = 4.18$, $p < 0.05$). Right-handed chimpanzees had significantly lower PO and PT AQ scores than non-right-handed chimpanzees. Overall, this suggests that in spite of a comparable combination of structural asymmetries, handedness effects are not similar in human and chimpanzee. This study was funded by the European Commission, contract number 029023.

Chronology of the developing dentition in a juvenile gorilla.

HALSZKA GLOWACKA. Department of Anthropology, University of Toronto.

Models of growth derived from dental development in living primates are commonly used to infer aspects of life history in fossil apes and humans. Currently, only two gorilla dentitions have been examined for incremental patterns of growth, a sample size not large enough to represent the variation of a species. The aforementioned dentitions demonstrate considerable variation in crown initiation times and crown completion of the M1.

Here, data are presented on the chronology of dental development in one juvenile female gorilla of unknown provenance. Histological sections of maxillary and mandibular I1-M2

were examined using polarized light microscopy. Crown initiation times of all teeth, crown completion of M1, and age at death were assessed using short- and long-period lines in enamel. The age of death (4.8 years) was determined from a pattern of accentuated growth lines present in all teeth. Crown initiation dates are later than those previously reported for one gorilla, particularly in the anterior teeth, and are comparable to those reported for the second gorilla. Maxillary M1 crown formation time (3.3 years) is longer than those previously reported, while mandibular M1 crown formation time (2.9 years) differs from only one of the previously published gorillas. Cuspal enamel formation times are generally greater than published data. The results of this study contribute to a growing wealth of knowledge on dental development patterns in extant hominoids and have important implications for the use of small extant samples as proxies for reconstructions of development and life history in fossil primates. Research supported by the University of Toronto.

Partial skeleton of *Theropithecus brumpti* (Primates: Cercopithecidae) from the Chemeron Formation of the Tugen Hills, Kenya.

EMILY D. GOBLE¹, CHRISTOPHER C. GILBERT^{1,2}, JOHN D. KINGSTON³ and ANDREW HILL¹. ¹Department of Anthropology, Yale University, ²Yale Institute for Biospheric Studies, Yale University, ³Department of Anthropology, Emory University.

A complete skull and partial skeleton of an adult female *Theropithecus brumpti* (KNM-TH 46700) was discovered at Site #152 in the Chemeron Formation by the Baringo Paleontological Research Project (BPRP) in 2003. BPRP Site #152 is dated at 2.7-2.9 Ma. While the male *T. brumpti* morphotype is well documented from Ethiopia's Omo Shungura Formation as well as sites on the East and West sides of Kenya's Lake Turkana, the female *T. brumpti* morphotype is not well known. Our specimen represents some of the best-preserved associated cranial and postcranial female *T. brumpti* remains. Postcranial remains include elements of the axial skeleton and the lower limb. While aspects of the cranium and skeleton conform to those of specimens previously assigned to *T. brumpti*, other features, particularly on the femur and tibia, appear to differ from those previously described for this species. KNM-TH 46700 appears to be unique in the large degree of bowing observed on the femoral and tibial shafts. These differences may represent general variation within the *T. brumpti* population, variation between the sexes in *T. brumpti*, or the incorrect assignment of previous hindlimb specimens to *T. brumpti*. In total, and conforming to previous suggestions regarding the locomotor repertoire of *T. brumpti*, the observable morphological features of the hindlimb such as the low angle of the femoral neck and the large lesser trochanter suggest that KNM-TH 46700 was a terrestrial quadruped also capable of moving adeptly in the trees.

BPRP works in association with the National Museum of Kenya, and thanks the Government of Kenya for research permission and the Minister for Home Affairs and National Heritage for permission to excavate. This study was funded by a grant from the MacMillan Center for International and Area Studies, the John F. Enders Fellowship and the Bryan Patterson Memorial Grant to EDG, a Donnelley Fellowship from the Yale Institute for Biospheric Studies to CCG, Emory URC grant to JDK, NSF grants (currently BSC-071137 to AH, JDK and Alan Deino), and grants to AH from Clayton Stephenson, and the Schwartz Family Foundation.

A new look at an old problem: Assessing population structure in Mesolithic – C-Group Nubians using population genetics statistics for cranial discrete traits.

KANYA GODDE. Department of Anthropology, University of Tennessee.

Irish (2005), Irish and Turner (1990), and Turner and Markowitz (1990) hypothesized that a population replacement event occurred in Nubia after the Paleolithic. Examining this period of time (Paleolithic – C-Group) for population changes is complicated by a hiatus in the archaeological record between the A- and C-Group (Nielson 1970), indicating an abandonment of the area. In order to understand the population structure during this critical time in Nubian history, this study applies a population genetics approach to cranial discrete traits. Four samples were observed for 20 cranial nonmetric traits: a Mesolithic group from Wadi Halfa, an A- and C-Group from Wadi Halfa (data contributed by Dr. Nancy Lovell), and a C-Group from Sayala (Strouhal and Jungwirth 1980). The population genetics statistics derived from the data included an R matrix, Mahalanobis D² with a tetrachoric matrix, F_{st}, principal coordinates analysis (PCO), and a Relethford and Blangero (1990) residuals analysis modified for cranial discrete traits. The F_{st} among the four groups indicates a high amount of variation, which was supported by the modified Relethford-Blangero residuals; the residuals imply a high level of extraregional gene flow was maintained in Nubia during these time periods, across all groups. The plot from PCO depicts the two C-Groups clustering with the preceding Mesolithic and A-Group. The biological data here and elsewhere agree with the archaeological and mortuary evidence that there was population continuity (despite high levels of extraregional gene flow), during this time. Moreover, the returning population after the hiatus is biologically and culturally Nubian.

Dental complexity, topographic relief, and dietary reconstruction in subfossil lemurs.

LAURIE R. GODFREY¹, STEPHEN J. KING^{1,2}, KATHLEEN M. MULDOON^{3,4} and MARINA B. BLANCO¹. ¹Department of Anthropology, University of Massachusetts-Amherst, ²Department of Anthropology, Stony Brook University, ³Department of Anatomy,

Dartmouth Medical School, ⁴Department of Anthropology, Dartmouth College.

Whereas the notion that tooth shape reflects diet has long been appreciated by morphologists and paleontologists, it is only recently that advances in 3D dental topographic analysis have allowed investigators to develop sophisticated yet simple measures of crown shape. Alistair Evans and colleagues introduced a “homology-free” technique to measure the topographic “complexity” of molar crowns; this measure captured dietary similarities in mammals as different in tooth form as rodents and carnivores. More recently, Doug Boyer calculated a dental relief index (essentially, the relationship between 3D and 2D crown areas) that captured dietary differences across a wide variety of eutherians. According to these authors, dental “complexity” separates species consuming animals (low values) from mixed omnivores (intermediate values) and herbivores (high values). Topographic “relief” separates frugivores/graminivores (low values) from omnivores (intermediate values) and insectivores/folivores (high values). Because these measures distinguish diets along different spectra, there is no reason to assume that they should be correlated; however, together, they may provide more information regarding diet than each provides taken alone. Such analysis could advance paleontological inference.

Here we collected complexity and topographic relief data for second lower molars of individuals representing fifteen species of extinct lemurs, along with a known-diet comparative sample of extant lemurs. Individuals with pristine morphology were selected for these comparisons, so that the results would not be confounded by wear. As expected, the two measures are not correlated, but they do succeed in separating species in a manner that provides insights into both food processing and diet. This research was funded by NSF BCS-0721233 to P.C.Wright, L.R.Godfrey, and J. Jernvall and a fellowship from the John Simon Guggenheim Foundation (LRG).

Anthropological genomics in the era of affordable and high-throughput technologies.

OMER GOKCUMEN. Department of Pathology Brigham and Women's Hospital, Harvard Medical School.

The new genomic technologies, including next generation sequencing and array-based whole-genome approaches, introduced powerful and affordable ways to address the complex questions posed by anthropology. In addition, the technologies identified new forms of genomic variation, such as copy number variants (CNVs), (gains or losses in the genomic content), which have been shown to be widespread among healthy humans. Hence, I would like to outline some of the possibilities and pitfalls of utilizing these technologies in anthropological research.

First, I will describe our efforts to describe the whole genome of a Korean individual using next generation sequencing (27.8x coverage), targeted bacterial artificial chromosome sequencing and array comparative genomic

hybridization (aCGH). I will contrast the power of different methodologies in describing different classes of genomic variation and touch on the genomic impact of more than 3 million single nucleotide polymorphisms (SNPs), as well as thousands of structural variants, including CNVs. In the second part of this talk, I will describe methodologies and emerging trends in comparative studies of primate genomes. In particular, I will chart the steps that we took to design a species-specific array platform to study within species variation among rhesus-macaques. Using this platform, we have identified approximately 1,000 CNV regions among rhesus macaques and demonstrated that these CNV regions overlap with more than 300 genes, primarily related to neurogenesis and immunity. Such platforms will soon be affordable by the anthropology community to address fundamental questions about human evolution, bringing with it new methodological, theoretical and ethical challenges.

Variation in osteon circularity and its impact on estimating age at death.

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

Researchers have implemented many histomorphometric techniques to estimate age at death for human skeletal remains. Osteon circularity (On.Cr) is a factor potentially affecting these estimations. While previous studies have reported relations between osteon size and age, few studies have focused on the shape of secondary osteons. Additionally with age, the numbers of observable osteons and osteon fragments increase, and an asymptotic value for osteon population density (OPD) is eventually achieved. Bone cortex usually reaches asymptote by 60 years of age, but it can occur as early as age 50. Once asymptote is reached, histological methods can no longer produce age estimation techniques. The purpose of this study is to establish if circularity differs between age groups and whether observed osteon circularity is due to effects of increasing OPD per unit area and osteon size on the shape of osteons. To determine circularity, osteons were measured from thin cross-sections of femora and ribs of individuals under and over the age of 50 from a modern population cadaver collection. The observed results support the observations of Curey (1964) and Britz et al (2009) that osteon cross-sectional shape becomes more circular with age. With the increase in OPD per unit area with age, the probability of eccentric and larger osteons surviving to be measured decreases. The decrease seems to be continuous with age. This may be useful to help identify if a bone is at OPD asymptote or even help refine our ability to estimate age for older individuals.

Shape variation and morphological integration in the human dentition: Evolutionary and static approaches.

AIDA GÓMEZ-ROBLES¹, MARÍA MARTINÓN-TORRES¹, JOSÉ MARÍA

BERMÚDEZ DE CASTRO¹, ANTHONY J. OLEJNICZAK¹, LEYRE PRADO-SIMÓN¹ and JUAN LUIS ARSUAGA². ¹Centro Nacional de Investigación sobre la Evolución Humana (CENIEH). Burgos, Spain. ²Centro de Evolución y Comportamiento Humanos (UCM-ISCHI), Madrid, Spain.

The quantification of shape variation and morphological integration in the human dentition is typically approached using either metric data or observations of discrete characters. Modern geometric morphometric methods, however, provide a new source of information to explore morphological differences among species and patterns of covariation within the dentition. In the study presented here, teeth from all tooth positions in both the maxilla and mandible, and from most species of the genera *Australopithecus*, *Paranthropus* and *Homo* were employed in a landmark- and semilandmark-based geometric morphometric analysis of dental morphology. Results demonstrate the presence of significant differences in the occlusal morphology of nearly all tooth positions among all species, and these differences are larger when the phylogenetic distances between species is greater. Moreover, the results presented here demonstrate strong morphological correlations from an evolutionary point of view (pooling together different species of the human lineage), such that teeth from different positions within the jaw have evolved together as a single functional unit in the hominin lineage. Nonetheless, when analyzed from a static point of view (a single species sample of *H. sapiens* teeth), only some of these correlations are significant, showing stronger patterns of covariation within the classically described modules of the dentition than between these modules. These results underscore the potential explanatory power of combining traditional morphometric methods, geometric morphometrics, and genetic information to fully understand the evolution of the human dentition. This study was funded by the Spanish Ministry of Ciencia e Innovación (project DGI CGL2006-1352-C03, Juan de la Cierva research fellowship, and FPU grant), Fundación Atapuerca, Fundación Duques de Soria and Consejería de Cultura y Turismo of Junta de Castilla y León.

The combination of a small brain, large olfactory bulb and high visual acuity in the stem middle Miocene cercopithecoid *Victoriapithecus macinnesi*.

LAUREN GONZALES¹, BRENDA BENEFIT¹, FRED SPOOR², PETER MORRISON² and MONTE MCCROSSIN¹. ¹Department of Anthropology, New Mexico State University, ²Department of Cell and Developmental Biology, University College London.

The skull, KNM-MB 29100, of *Victoriapithecus macinnesi* from 15 mya Maboko formation preserves the only complete and minimally distorted eucatarrhine neurocranium known prior to 6 mya. Accurate measurement of cranial volume based on analysis of CT scans reveals that *V. macinnesi* has a much smaller brain than previously estimated (Benefit and McCrossin,

1997). Relative to a body weight of 4 kg, a minimum estimate for a large male, the brain volume of *V. macinnesi* falls within the range of extant strepsirrhines, at the lower end of platyrhines, and below that of extant catarrhines. Relative to brain volume and body weight, olfactory bulb size of *Victoriapithecus* is larger than expected for extant catarrhines, overlapping the lower end of the strepsirrhine range. As for the stem anthropoid *Parapithecus* and stem catarrhine *Aegyptopithecus*, optic foramen area plots within the range of extant cercopithecooids relative to body and brain size, indicating it had high visual acuity.

Since *Victoriapithecus* lagged behind extant cercopithecooids in the evolution of its brain and olfactory bulb size, but postdates the hominoid/cercopithecoide divergence, it appears that increased brain size and reduced olfactory bulb size occurred independently in Hominoidea and Cercopithecoidea, as it seems to have done in platyrhines and catarrhines (Bush et al., 2004). The *Victoriapithecus*, *Parapithecus* and *Aegyptopithecus* evidence suggests that it was only when brains became larger in independent crown anthropoid lineages, that a reduction in olfactory bulb size occurred, replacing an acute olfactory sense with increased frontal lobe matter and enhanced social intelligence in these higher primates.

Variation in the human hand: Growth, sexual dimorphism, and ancestry.

RICHARD A. GONZALEZ¹. ¹Department of Anthropology, St. Lawrence University.

The present study identifies metric trends associated with sex and group differences in the growth of the human hand. Data utilized for this study were collected by the Highway Safety Research Institute, University of Michigan (Snyder et al., 1977). Twelve common anthropometric measurements were analyzed utilizing a sample of 3,728 individuals ages 2–17.9 of African and European descent. The data were organized into eight age group categories, which represent the childhood period, the juvenile period, and the pubertal period. Multivariate statistics by means of a GLM MANOVA procedure and a Canonical Discriminant Function Analysis procedure revealed meaningful sex and group specific influences in hand growth and development. Six of the twelve selected variables provided statistically meaningful information for sex and ancestry. These variables are: hand length; thumb crotch-middle finger length; thumb diameter; middle finger length; maximum fist circumference; and maximum fist depth. Group and sex specific differences are evident in all stages of development. Similarly to other regions of the body, group and sex variation in the human hand results from differences in ontogenetic developmental pathways. In this study, size is the major source of variation. In both groups, females exhibit a much earlier culmination of hand growth than males. However, individuals of African descent exhibit a slightly longer period of hand development than individuals of European descent. Since developmental pathways in the hand are sex and group specific, it is imperative to treat males

and females, as well as different populations independent of one another.

A synthetic view of morphological and genetic diversity in the Americas.

ROLANDO GONZÁLEZ-JOSÉ¹, MARÍA C. BORTOLINI², FABRICIO R. SANTOS³ and SANDRO L. BONATTO⁴. ¹Centro Nacional Patagónico, CONICET, Argentina, ²Departamento de Genética, Universidade Federal do Rio Grande do Sul, Brazil, ³Departamento de Biologia Geral, Universidade Federal de Minas Gerais, Brazil, ⁴Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Brazil.

During the last decades, several studies based mainly on partial evidence such as skull morphology, archaeology, linguistics and molecular genetics have presented competing, apparently mutually exclusive, settlement hypotheses. In general terms, the main contradictory views are represented by the genetic-based “Single Wave” or “Out of Beringia” model and the cranial morphology-based “Two Components/Stocks” model. Here, we present a geometric morphometric analysis of 576 ancient and modern skulls suggesting that the classical “Paleoamerican” and “Mongoloid” craniofacial patterns should be viewed as extremes of a continuous morphological variation. We discuss our results in the light of recent advances aimed to detect the stochastic or non-stochastic (e.g. selective) origin of the observed morphological patterns. Our results suggest that recent contact among Asian and American circumarctic populations took place during the Holocene. These results along with data from other fields are synthesized in a model for the settlement of the New World that considers, in an integrative and parsimonious way, evidence coming from genetics and physical anthropology. This model takes into account a founder population occupying Beringia during the last glaciation characterized by high craniofacial diversity, founder mtDNA and Y-chromosome lineages, and some private autosomal alleles. After a Beringian population expansion, which could have occurred concomitant with their entry into America, more recent circumarctic gene flow would have enabled the dispersion of northeast Asian-derived characters and some particular genetic lineages from East Asia to America and vice versa.

A distal humerus of the strepsirrhine primate *Karanisia* from the late Eocene of Egypt.

KATHERINE E. GOODENBERGER¹, ERIK R. SEIFFERT² and ELWYN L. SIMONS³. ¹Interdepartmental Program in Anthropological Sciences, Stony Brook University, ²Department of Anatomical Sciences, Stony Brook University, ³Division of Fossil Primates, Duke Lemur Center.

Karanisia clarki is an enigmatic strepsirrhine primate from the earliest late Eocene (~37 Ma) Birket Qarun Locality 2 (BQ-2) in the Fayum Depression, Egypt. The genus was previously known solely from isolated teeth and

mandibular fragments, and on the basis of dental characters has been variously placed as a crown lorisid, a stem lorisiform, a stem lemuriform, and as a stem strepsirrhine. Excavation at BQ-2 in 2008 led to the recovery of a distal humerus that is attributable to *Karanisia* on the basis of size and relative abundance. *Karanisia* exhibits morphological features that are common in extant galagos and some clinging primates, including a broad and spherical capitulum that is separated from the trochlea by a deep gutter, a shallow coronoid fossa, and a medial epicondyle with no retroversion. *Karanisia* did not have a broad brachialis flange as in some vertically clinging and leaping ‘prosimians’, and lacks the slow-climbing adaptations that are seen in lorises; the specimen would be consistent with a combination of clinging and generalized arboreal quadupedalism. Multivariate morphometric analyses of multiple measurements from the distal humerus place *Karanisia* close to the Miocene stem galagid *Komba* and Malagasy lepilemurids, indriids, and lemurids, but far from extant lorises. The distal humeral morphology shared by *Karanisia*, *Komba*, and some lemurs is likely to be primitive within crown Strepsirrhini, whereas the morphologies observable in galagos and lorises represent divergent specializations from a more generalized common ancestor. This research was funded by NSF, The Leakey Foundation, and the Turkana Basin Institute.

Femoral, skeletal, and body mass size variation: Relationships and implications for sexual dimorphism studies.

ADAM D. GORDON. Department of Anthropology, University at Albany – State University of New York.

Inferences regarding social structure, competition, and mating system in extinct hominins are typically made on the basis of sexual dimorphism, where size variation of skeletal or dental elements in fossil samples is compared to variation found in extant primate taxa. However, previous work relating body size dimorphism to behavior in living primates has analyzed body mass, whereas analyses of body size dimorphism in fossil taxa rely on skeletal size variation. As several authors have pointed out, these two types of size variation are rarely equal.

This study analyzes the relationship between sexual dimorphism in body mass, femoral head size, and postcranial skeletal size (using a geometric mean of 16 postcranial measurements) for 10 anthropoid species including modern *Homo sapiens*. Notably, individual body mass and 16 measurements from the femur, tibia, humerus, and radius are available for all 417 adult, wild-shot specimens included in this analysis. For the nine non-human species, postcranial skeletal size dimorphism (PSSD) ratios differ from body mass dimorphism (BMD) ratios by 5.6% on average (range: -9.6% to +10.7%) and femoral head size dimorphism (FHSD) ratios differ from BMD ratios by 10.3% on average (range: -9.7% to +22.2%). In comparison, human PSSD ratios are 35.2% higher than human BMD ratios, and human FHSD ratios are 36.9% higher. These

results indicate that skeletal dimorphism in modern humans drastically overestimates body mass dimorphism, particularly relative to other primates, and suggest that the relationship between skeletal and mass dimorphism must be taken into account in analyses of fossil hominin size dimorphism.

Looking up: Human tibial trabecular bone microarchitecture and the development of the femoral bicondylar angle.

JAMES H. GOSMAN¹, DO-GYOON KIM² and RICHARD A. KETCHAM³. ¹Department of Anthropology, The Ohio State University, ²College of Dentistry, The Ohio State University, ³Department of Geological Sciences, University of Texas at Austin.

The objective of this research is to examine how human locomotor development contributes to changes in tibia trabecular microarchitecture from homogeneous, high density morphology to one highly spatially differentiated as associated with the development of the femoral bicondylar angle. The hypothesis tested predicts that the pattern of ontogenetic within-tibial variability in the relative bone volume fraction between the medial and lateral tibial condyles will occur in concert with age-related alterations in the femoral bicondylar angle. This is a companion study to previous research documenting the general pattern of ontogenetic change using High Resolution X-Ray Computed Tomographic scanning and three-dimensional quantitative analyses of archaeological juvenile human skeletal remains from SunWatch Village, an Ohio Valley maize-dependent agricultural village (AD 1200-1300). The individuals selected for this research are a subsample of the original 33 non-adult proximal tibiae, which had well-preserved ipsilateral femurs available for measurement of the femoral bicondylar angle. Spherical volumes of interest (VOIs) were identified from the reconstructed scan data in the center of each tibial condyle for resolution-corrected morphometric structural analysis including bone volume fraction (BV/TV), trabecular number, trabecular thickness, and the degree of anisotropy (DA). In addition, a ratio was developed describing the relative bone volume fractions comparing the lateral to the medial VOIs. The changing patterns of bone strain were studied by finite element modeling. The results of this work suggest that the femoral-tibial alignment changes associated with maturation of human gait and the development of the femoral bicondylar angle contribute to intra-tibial trabecular bone microarchitectural differentiation. Grant Sponsors: National Science Foundation Dissertation Improvement; Grant number: BCS-0650727 (JHG); National Science Foundation; Grant number: EAR-0646848, (RAK).

The effect of unstable substrates on the locomotion of capuchin monkeys.

ASHLEY D. GOSELIN-ILDARI. Inter-departmental Doctoral Program in Anthropological Sciences, Stony Brook University.

Primates are distinguished from other mammals in the frequent use of diagonal-sequence and compliant gaits. These unique traits have often been cited as enhancing stability in a terminal branch environment. Here I test the hypotheses that diagonal-sequence and compliant gaits afford greater stability by examining the effect of unstable substrates on the locomotion of capuchins. One subject was filmed during locomotion on a stationary substrate and on an unstable substrate. The unstable substrate was spring loaded using three compressive springs that deformed two inches under the weight of three kilograms. Standard kinematic variables were collected and data were analyzed using ANCOVAs with speed as the covariate. The majority of kinematic variables did not differ significantly between the stable and unstable substrates. Diagonality (the time between the touchdown of a fore foot and the touchdown of the hind foot on the same side) was significantly lower on the unstable substrate than on the stable substrate. Unilateral double limb support was significantly reduced on the unstable substrate than on the stable substrate, suggesting the subject preferred not to use unilateral limb support in the more unstable environment. The subject used more triple limb support on the unstable apparatus than on the stable apparatus however this difference was not significant. Currently, there is no support for an increased use of diagonal-sequence and compliant gaits on unstable substrates. Future work in this area will focus on creating more challenging experimental designs in order to test the results further.

Lemurs on the rocks: Preliminary study of ring-tailed lemur demography, habitat use, and feeding ecology in rocky outcrop habitat in south-central Madagascar.

LISA GOULD, ALEXANDRA CAMERON and DENISE GABRIEL. Department of Anthropology, University of Victoria.

The viability of a primate species occupying a forest fragment is dependent upon an array of habitat parameters including resource availability, edge characteristics, population densities, and utility of the surrounding matrix. In June and July 2009, we collected demographic, habitat use, and feeding data on ring-tailed lemur populations residing in two rocky outcrop mixed-forest fragments in south-central Madagascar – a 28 ha fragment located in the Tsaranoro Valley and a 22.5 ha fragment at Anja Special Reserve – to assess how fragmentation influences ring-tailed lemur population size, ranging behavior and feeding ecology in this unusual habitat. We found ~8 groups ranging in size from 5 to 15 individuals in the Tsaranoro fragment, and at least 11 groups of between 8 and 16 individuals at Anja, with group fusion at each site often resulting in much larger aggregations. Fission-fusion groupings have not previously been reported for this species. The large population size at the smaller Anja Reserve is likely related to permanent access to water. Ring-tailed lemurs at Tsaranoro spent more time (40%) terrestrial than in previously studied habitats, and lemurs at both sites used large boulders and cliffs

extensively. The primary food resources at both sites were the fruit and leaves of *Melia azadirach-* a marked contrast to this species' diet at other sites. This is the first study of *Lemur catta* in this region and habitat, and our results further illustrate *Lemur catta*'s remarkable ecological and behavioral plasticity, and persistence, in the face of shrinking habitat, and also spent a higher proportion of time feeding than those at Anja (35% versus 28%), but consumed a smaller number of different food items (26 versus 15). The primary food resources at both sites were the fruit and leaves of *Melia azadirach-* a marked contrast to this species' diet in other habitats. This is the first study of *Lemur catta* in this region and habitat, and our results further illustrate *Lemur catta*'s remarkable ecological and behavioral plasticity.

Divergent patterns of integration and reduced constraint in the human pelvis and the origins of bipedalism.

MARK GRABOWSKI. Department of Anthropology, University of Illinois at Urbana-Champaign.

Bipedal locomotion is generally accepted as being the first characteristic that separated hominins from our most recent common ancestor with the chimpanzee. When compared to all other extant apes, the human pelvis reveals a fundamental reorganization of bony morphology comprised of multiple trait-level changes, many of which are associated with this novel locomotor behavior. In addition to shape and size changes, establishing how the pattern of phenotypic integration — associations between traits — within the pelvis has evolved is essential to explaining this evolutionary transition as integration patterns may facilitate or constrain morphological change. This analysis reveals that the human hip bone is less integrated than that of all other apes, and many traits thought to be important in the shift to bipedalism are individually less integrated and less constrained when compared either to other pelvic traits in humans, or the same traits in all other apes. In addition, the human pelvis exhibits a pattern of integration that is distinct from all other apes not only in the levels of integration but also in the evolutionary response to selective forces this pattern could produce. These results suggest that natural selection for bipedalism likely broke down earlier hominid integration patterns and realigned patterns of variation (i.e. reintegrated traits) in response to the shape of the adaptive landscape. These findings are the first indicator that changes in integration patterns played a significant role in the evolution of bipedalism.

Chuvash origins: Evidence from mtDNA Markers.

ORION M. GRAF¹, JOHN MITCHELL², STEPHEN WILCOX³, GREGORY LIVSHITS⁴, MICHAEL H. CRAWFORD¹.

¹Department of Anthropology, Lab of Biological Anthropology, University of Kansas,

²Dept of Genetics, School of Molecular Sciences, La Trobe University, Melbourne.

³Australian Genome Research Facility Ltd, The Walter and Eliza Hall Institute of Medical

Research, Parkville, Australia, ⁴Department of Anatomy, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel.

A sample of 96 unrelated individuals from Chuvashia, Russia was sequenced for hypervariable region-I (HVR-I) of the mtDNA molecule. The Chuvash speak a Turkic language that is not mutually intelligible to other extant Turkish groups, and their genetics are distinct from Turkic-speaking Altaic groups. Some scholars have suggested that they are remnants of the Golden Horde, while others have advocated that they are the products of admixture between Turkic and Finno-Ugric speakers who came into contact during the 13th century. Earlier genetic research using autosomal DNA markers suggested a Finno-Ugric origin for the Chuvash. This study examines non-recombinant DNA markers to better elucidate their origins.

The majority of individuals in this sample exhibit haplogroups H (31%), U (22%), and K (11%), all representative of western and northern Europeans, but absent in Altaic or Mongolian populations. Multidimensional scaling (MDS) was used to examine distances between the Chuvash and 8 reference populations compiled from the literature. Mismatch analysis showed a unimodal distribution. Along with neutrality tests (Tajima's *D* (-1.43365) $p < 0.05$, Fu's *F_s* (-25.50518) $p < 0.001$), the mismatch distribution is suggestive of an expanding population. These tests suggest that the Chuvash are not related to the Altai and Mongolia along their maternal line but supports the "Elite" hypothesis that their language was imposed by a conquering group-leaving Chuvash mtDNA largely of Eurasian origin with a small amount of Central Asian gene flow. Their maternal markers appear to most closely resemble Finno-Ugric speakers rather than fellow Turkic speakers.

Structural and material compliance in the alveolar process of colobine mandibles.

MICHAEL GRANATOSKY¹, DAVID J. DAEGLING¹, W. SCOTT McGRAW² and ANDREW J. RAPOFF³. ¹Department of Anthropology, University of Florida, ²Department of Anthropology, Ohio State University, ³Department of Mechanical Engineering, Union College.

Modeling stress and strain in the facial skeleton requires an understanding of the material properties of bone and its structural composition. Most comparative models implicitly assume all bone is structurally and materially identical throughout the face. The bone of the alveolar process may be more prone to stress concentrations than bone elsewhere owing to material effects, such as areas of concentrated load transmission due to complex alveolar geometries and interfacial effects due to material inhomogeneity. These observations suggest that greater compliance of alveolar bone is biomechanically advantageous for mitigating stress concentrations. Existing data, however, conflict over the relative compliance of alveolar bone in the primate mandible.

Using microindentation and micro-computed tomography, we sampled serial transverse sections of rehydrated mandibular bone in six adult specimens of *Colobus polykomos* and *Procolobus badius* from Tai Forest, Ivory Coast to investigate whether alveolar and basal bone differ in stiffness and volume fraction, respectively. Vickers hardness values were converted to elastic modulus via established regression.

Based on > 100 indentations per specimen, we found that the elastic modulus of alveolar bone is significantly less than basal bone. In addition, in terms of bone volume fraction (exclusive of alveoli) we find evidence of greater porosity in alveolar bone. These findings suggest that the greater compliance of alveolar bone is achieved by both structural and material means. The reduced stiffness and increased porosity of alveolar bone likely prevents development of large local stress concentrations, and contributes to optimizing strength relative to mass in the mandible at large. Supported by National Science Foundation grants BCS-922429, -60017683, -0921770, -0922414.

Interpersonal conflict in America during the early 20th century: A bioarchaeological study of cranial trauma in the Hamann-Todd collection.

KATY D. GRANT and JACQUELINE T. ENG. Department of Anthropology, Western Michigan University.

Research was conducted at the Cleveland Museum of Natural History using the Hamann-Todd Osteological Collection to investigate patterns of interpersonal violence in America during the early 20th century. Because Cleveland, Ohio experienced a huge influx in both population and industry during the late 19th- and early 20th centuries, it was hypothesized that this unpredictable social instability would have resulted in a high rate of interpersonal aggression. Furthermore, because there was an out-migration of African Americans from the southern states to the northern states into large cities, including Cleveland, during a time of severe inequality, it was hypothesized that traumatic lesions would be more prevalent in those of African descent.

The sample from CMNH consisted of 145 adult crania, including 74 individuals of African descent (39 males and 35 females) and 71 individuals of European descent (40 males and 31 females). All crania were examined macroscopically and with the use of a hand lens. The total frequency of any traumatic lesions found per total crania observed was 23.4% (34/145). When testing for race, the results were not statistically significant ($p=0.979$). Although males generally exhibit more fractures than females in most studies, the results of this study did not find sex differences to be statistically significant ($p=0.561$). Although the location of fractures, facial versus cranial, was statistically significant ($p=0.000$), the location of fractures was not found to be significant when race and sex were considered. We discuss the implications of the results and compare them to other studies of conflict.

New estimates of stature and body mass for KNM-WT 15000.

RONDA R. GRAVES¹, ROBERT C. McCARTHY², AMY C. LUPO², DANIEL J. WESCOTT^{1,2,3}, DEBORAH L. CUNNINGHAM⁴. ¹Interdepartmental Doctoral Program in Anthropological Sciences (IDPAS), Stony Brook University, ²Department of Anthropology, Florida Atlantic University, ³Department of Biological Sciences, Florida International University, ⁴Department of Clinical Science and Medical Education, Florida Atlantic University.

Just how strapping was KNM-WT 15000? Previous estimates suggest that Nariokotome Boy would have attained an adult stature of 185 cm (~6'1") and body mass of 68 kg (~150 lbs). These adult estimates were based on modern human models that incorporated a long, extended period of growth and a fully-developed adolescent growth spurt. However, recent fossil discoveries, improved research methods, and new insights into human and non-human primate ontogeny suggest that KNM-WT 15000 matured faster than a modern human, calling into question previous estimates of adult size. To reassess adult stature and body mass in KNM-WT 15000, we modified chimpanzee and modern human growth curves to create a number of hypothetical *H. erectus* velocity curves. We calculated the amount of growth remaining at death using these curves, and increased juvenile stature and body mass estimates accordingly. The curves that most accurately match the series of events in KNM-WT 15000's life history produced estimates both shorter (163 cm, ~5'4") and smaller (56 kg, ~123 lbs) than previously calculated. Bootstrap analyses confirm that our new estimates reduce the range of variation in *H. erectus*, so that Nariokotome Boy may have been strapping as a youth, but his estimated adult size falls in line with other *H. erectus* specimens. The implications of these new estimates for interpretations of encephalization, physiology, growth and development, behavior and sexual dimorphism in *H. erectus* change our understanding of the transition from australopiths to later *Homo*.

Integrating social science and anthropological genetics: Race, human variation, and health.

CLARENCE C. GRAVLEE¹ and CONNIE J. MULLIGAN^{1,2}. ¹Department of Anthropology, University of Florida, ²Genetics Institute, University of Florida.

There is long-standing debate about the relative importance of genetic versus sociocultural factors in explaining racial inequalities in health. In recent years, the debate has taken a new turn, as researchers are now able to type millions of single nucleotide polymorphisms (SNPs) and to estimate genetic ancestry using ancestry informative markers (AIMs). Studies that take advantage of these advances, however, rarely incorporate data on the environmental components of complex disease.

Anthropologists are uniquely positioned to address this gap. Here we integrate ethnographic, epidemiologic, and genetic data on the social and cultural context of hypertension among people of African ancestry in Puerto Rico and the mainland United States. Among Puerto Ricans, African genetic ancestry appears to be associated with blood pressure ($p=0.037$). This association disappears, however, once we account for socioeconomic status (SES) and how Puerto Ricans are perceived by others in terms of *color*. The interaction between SES and *color* is significantly associated with systolic blood pressure ($p=0.003$).

These findings are consistent with the hypothesis that the association between African ancestry and blood pressure reflects increased exposure to social stressors related to institutional and interpersonal racism, rather than to functional genetic differences. We report new ethnographic data from the southern United States to establish the plausibility of this hypothesis among African Americans in the mainland United States.

Our results suggest that the integration of methods and theory from the social sciences can help to answer questions in anthropological genetics that cannot be solved by technological advances alone. This study was funded by the National Science Foundation (BCS 0078793, BCS 0724032, BCS 0820687) and by the American Heart Association, Florida and Puerto Rico Affiliate (0010082B).

A cross-cultural perspective on human-pet dynamics.

PETER B. GRAY and SHARON M. YOUNG. Department of Anthropology, University of Nevada, Las Vegas.

Due in part to declining human fertility, geographic mobility, and growing consumerism, pets increasingly serve the function as emotional surrogates of children, with tremendous resources poured into their care. However, this function of pets may be quite different from the more typical human-pet dynamics characterizing a wider array of societies until recently. To help fill a gap in scholarship on pets, we sought to better characterize human-pet dynamics in a standardized cross-cultural sample. Using the electronic Human Relations Area 60 society Probability Sample (eHRAF), we coded for various features of human-pet dynamics. Preliminary analyses indicate that dogs are the most commonly kept pets, with other pets including cats, birds, primates, and turtles. We also present data on pet socioecological functions (e.g., hunting, protection, playthings for children), living arrangements, diet, and both positive (e.g., grooming, verbal communication, perceptions) and negative (e.g., killing, physical abuse, verbal abuse) facets of human-pet interactions. As one example of a positive human-pet interaction, in five societies humans are described breastfeeding pets such as dogs and nonhuman primates. These data illustrate both similarities and differences cross-culturally in human-pet dynamics as well as many stark contrasts with how pets such as dogs in the U.S.

are treated today in contrast to patterns from this wider sample.

Mouse shoulder morphological development responds to locomotor differences in climbing and running.

DAVID J. GREEN^{1,2,3}, BRIAN G. RICHMOND^{2,3,4} and SARA L. MIRAN³. ¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, ³Department of Anthropology, The George Washington University; ⁴Human Origins Program, National Museum of Natural History, Smithsonian Institution.

Bone growth, morphology, and remodeling are related to variation in loading regimes, but questions remain about how loading influences bone development. Primate shoulder morphology has been closely linked with species-level differences in locomotion, yet the functional importance of primitive shoulder characteristics in early hominin fossils remains unclear. To more directly examine the relationship between behavior and morphology, we examined the epigenetic influence of locomotor differences on the scapula and its intrinsic musculature in wild-type mice 1) in control cages, 2) given full access to activity wheels, and 3) housed in 100cm-tall "climbing" wire mesh tower cages with water sources positioned at the top. Two groups (one four- and one seven-week-old group at the start of the 11-week experiment) were distributed among the three experimental groups, each containing 15 individuals.

We found that wheel-running mice protracted their forelimbs more cranially relative to the shoulder joint than climbing mice at touchdown, however, the climbers retracted their forelimbs significantly farther behind the shoulder prior to liftoff. The climbers had significantly narrower supraspinous fossae than the runners, resulting in significantly smaller ratios of relative supraspinous and infraspinous breadths. These differences correspond with observed disparities in forelimb movement about the shoulder joint during climbing and running and support the hypothesis that locomotor differences can bring about significant changes in shoulder morphology during growth. These results suggest that certain aspects of primate shoulder morphology are especially informative about locomotor behavior during growth, and have implications for functional inferences about fossil hominin shoulder morphology. Support for this research was provided by the National Science Foundation IGERT Program (99875690), an NSF Doctoral Dissertation Improvement Grant (BCS-0824552), and a Wenner-Gren Foundation Dissertation Fieldwork Grant.

The daily grind: Osteoarthritis and activity patterns associated with grain preparation in Early Bronze Age Jordan.

LESLEY GREGORICKA and JAIME ULLINGER. Department of Anthropology, The Ohio State University.

Osteophytosis and osteoarthritis of thoracic vertebrae, osteoarthritis of the upper limb, and the presence of kneeling facets on metatarsals were examined to reconstruct activity patterns at Early Bronze Age Bab edh-Dhra', Jordan. Specifically, we test the hypothesis that agricultural intensification from EBIA (3150-3050 BCE) to EBII-III (2900-2300 BCE) led to more demanding workloads involving grain processing. This was tested by evaluating degenerative changes in areas commonly impacted as a result of repetitive grinding activities: the spine, shoulder, elbow, and foot. Osteoarthritis (marginal lipping) appeared relatively static across the EBA in the glenoid fossa at 20% (n=69) for EBIA and 23% for EBII-III (n=185), the radial head from 10% (n=51) to 5% (n=103), and the olecranon process of the ulna from 23% (n=61) to 33% (n=90), with no difference between time periods. However, significant differences in frequency in the left humeral head from 20% (n=25) to 4% (n=46) and the distal humerus from 22% (n=49) to 0% (n=40) suggest increased physical stress in EBIA (Fisher's $p=0.029$ and $p=0.002$, respectively). Moreover, metatarsal kneeling facets experience a significant decrease from EBIA (22%, n=252) to EBII-III (7%, n=432) (χ^2 $p<0.0001$). While vertebral osteophytosis displayed a marked increase of 18%, articular facet osteoarthritis remained unchanged, suggesting little change in spine mobility.

The evidence suggests that grinding activities affected more EBIA people; conversely, in EBII-III, the increasingly urban environment required new tasks, perhaps encouraging family groups to more equally share the burden of grinding grain and thus placing less stress on certain individuals. This research was supported by a Smithsonian Institution Pre-doctoral Fellowship, a Sigma Xi Grant-in-Aid of Research, and the NSF-REU (SES 0649088) Summer Research in Biocultural Anthropology at Notre Dame program.

Using GIS interpolation to analyze the relationship between topographic features and bearded saki monkey travel patterns in Brownsberg Nature Park, Suriname.

TREMAINE GREGORY¹, MARILYN NORCONK¹ and AMANDA MULLETT².

¹Department of Anthropology, Kent State University, ²Department of Geography, Kent State University.

Bearded saki monkeys (*Chiropotes sagulatus*) are among the most mobile arboreal primates for their size (2.77kg). Large group size (40+ individuals) and a specialization for seed predation are likely to be the driving factors for such high mobility. During a 13-month study in Brownsberg Nature Park (BNP), Suriname, TG found that the sakis travel up to 4km per day, at rates as fast as 330m per 10-minute sample period, with a daily net elevation change of up to 925m. The sakis also used the "berg's" steep slopes at higher frequencies than the top of the plateau, most likely due to a preference for the slope's assemblage of large feeding and travel trees. We explored bearded saki travel strategies

that may maximize efficiency while navigating steep slopes, assuming that energy expenditure differs depending on how a ridge is navigated. Using GPS points gathered at 10-minute intervals, we used the spatial analyst toolset from ESRI's (Environmental Systems Research Institute) ArcMap 9.3 to interpolate the density distribution of sites used by bearded sakis during the study period. We identified three possible strategies that may maximize the use of terrain during travel: 1) descending ridges by using the path of least slope, 2) crossing from one ridge to the next by staying at the same elevation, and 3) using familiar travel paths. GIS interpolation may improve our understanding of how arboreal animals use topographic features to maximize travel efficiency, while also helping observers make predictions during follow periods about where animals will go. This study was funded in part by the Graduate Student Senate, Kent State University.

Shape analysis of the hominoid clavicle.

THOMAS M. GREINER. Department of Health Professions, University of Wisconsin – La Crosse.

The clavicle can be found within the vertebrate bauplan, yet is rudimentary or missing among most mammals. Only volant and arboreal mammalian groups possess a well developed example of this bone. As such, the clavicle can be viewed as one of the defining characteristics of the primate order. This project explores the morphological variation that is seen in the ape and human clavicle.

Clavicles of over 300 apes and humans from the Hamann-Todd collection housed in the Cleveland Museum of Natural History were examined using the techniques of 2D geometric morphometrics. Each clavicle was evaluated from a cranial/superior perspective. Shape differences were captured as XY coordinates for 12 anatomical landmarks and 16 sliding landmarks located along the ventral and dorsal edges. These data were explored using generalized Procrustes analysis, and related methods, as provided by the TPS program series.

Statistical comparisons show that significant differences ($P < 0.05$) for clavicle shape occur among all combinations of genus and side. Hylobatids appear to have a slightly longer right clavicle, and humans show right/left differences in the shape of the costoclavicular ligament insertion scar. The familiar S-curve of the clavicle is found only in *Homo* and *Pan*. *Gorilla* demonstrates a single sharp curve near the conoid tubercle. Hylobatids show a single, gentler, convex curvature. The shape differences found among these groups cannot be easily explained by body size allometry or by locomotor/positional behavior.

Life and death in the land of Coosa: Oral health in a Late Mississippian village.

MARK C. GRIFFIN. Department of Anthropology, San Francisco State University.

The David Davis Farm site (40HA301) was a Late Mississippian village which was occupied for a fifty-year period around AD 1550. The cultural association for this site has been identified as Mississippian Dallas. Middle and Late Mississippian Dallas culture in southeastern Tennessee has been documented at approximately 65 settlements in the Tennessee River region. The David Davis Farm site is unique among these sites because of its relatively short duration of occupation and because it is one of the likely stopping points for the De Soto entrada of 1539–1543. Research for sites from this period contributes to our understanding of the impact of European exploration on Native American populations. In order to examine frequencies of carious lesions, each tooth was examined with 3.5x dental loupes and stainless steel dental probes. All anterior teeth were examined with 3.5x dental loupes for the presence of linear enamel defects. Each tooth position was also examined macroscopically for the presence of alveolar defects. Defects were recorded by location and size. Examination of the dental remains in this sample shows a number of important features: (1) the frequency of carious lesions is remarkably low for a southeast US population of this time period, (2) the frequency of periodontal disease is also relatively low, and (3) the frequency of enamel hypoplasias while low for the entire dentition is quite high for certain key teeth. The results indicate a relatively healthy population that was likely consuming a diet lower in carbohydrates than other populations from the area.

Comparative forefoot trabecular bone architecture in extant hominids.

NICOLE L.GRIFFIN¹, RICHARD A. KETCHAM², KRISTIAAN D'AOÛT^{3,4}, ANDREI POSTNOV⁵, NORA DE CLERCK⁵, TIM M. RYAN⁶ and BRIAN G. RICHMOND^{7,8}. ¹Department of Evolutionary Anthropology, Duke University, ²Department of Geological Sciences, University of Texas at Austin, ³Department of Biology, University of Antwerp, Belgium, ⁴Centre for Research and Conservation, Royal Zoological Society of Antwerp, Belgium ⁵Department of Biomedical Sciences, University of Antwerp, ⁶Department of Anthropology, Pennsylvania State University, ⁷Center for the Advanced Study of Hominid Paleobiology, The George Washington University, ⁸Human Origins Program, Smithsonian Institution.

Although all extant hominoids are capable of walking bipedally, it is well accepted that modern humans dorsiflex their metatarsophalangeal joints to form a stiff propulsive lever during the terminal stance phase. The appearance of a metatarsal-fulcrimating foot in the hominin fossil record has been difficult to identify, partially because researchers disagree over the use of the external skeletal morphology to differentiate forefoot functional differences in extant great apes and humans. In this study, we approach this problem by quantifying internal bone architecture to look for patterns in trabecular bone that reflect the different loading pattern in these joints in

humans and great apes. High-resolution x-ray computed tomography data were collected for first and second metatarsal heads of *Homo sapiens* (n=26), *Pan paniscus* (n=17), *Pan troglodytes* (n=19), *Gorilla gorilla* (n=16), and *Pongo pygmaeus* (n=20). Trabecular bone fabric structure was analyzed in three regions of each metatarsal head. While bone volume fraction did not significantly differentiate human and ape trabecular structure based on functional differences, human metatarsal heads generally show more anisotropic trabecular architectures, especially in the dorsal regions compared to the corresponding areas of the great ape metatarsal heads (Mann Whitney *U* test p-values < 0.05). Therefore, the differences in anisotropy between humans and great apes support the hypothesis that trabecular architecture in the dorsal regions of the human metatarsals are indicative of a forefoot habitually used for propulsion during gait. This study provides a potential route for predicting forefoot function and gait in fossil hominins from metatarsal head trabecular architecture. This project has been funded by the L.S.B. Leakey Foundation, NSF IGERT 9987590, Sigma Xi Grant-in-Aid of Research, Lewis Cotlow Research Fund, GWU Selective Excellence Initiative and NSF IGERT 9987590.

Endocranial anatomy of a new *Homo erectus* specimen from Sangiran (Java, Indonesia).

DOMINIQUE GRIMAUD-HERVÉ¹, ANTOINE BALZEAU¹, HARRY WIDIANTO², TONY DJUBANTONO³, FLORENT DETROIT¹, ANNE-MARIE SEMAH^{1,4} and FRANCOIS SEMAH¹. ¹Muséum national d'histoire naturelle, Département de Préhistoire, UMR 7194, France, ²Balai Arkeologi, Jakarta, ³Centre Archéologique, Jakarta, ⁴IRD, Bondy, France.

A fossil hominin remain has been fortuitously discovered in June 2005 out of stratigraphical context in Java, Indonesia. This unpublished specimen probably comes from the Grenzbank formation (≈ 1 Ma) of the Sangiran Dome (East Java) and consists of a left posterior part of a cranial vault, including large elements of the parietal, temporal and occipital bones. The fossil is very well preserved exocranially but is filled with hardened sediment recovered by a calcite layer. The matrix filling precludes one from viewing the endocranial cavity and the internal features of the specimen. Internal morphological features (such as thickness distribution and structural bone composition, semi-circular canals, pneumatization of the temporal bone, endocast) have been virtually reconstructed in 3D and studied using imaging methodologies. The virtual endocast in particular has been obtained by identification of the boundary between the fossil and the filling sediment or the air by manual segmentation on CT scan data in order to obtain an accurate 3D model. We have used rapid-prototyping techniques to obtain physical replications of both the skull and the endocast without the matrix filling. The anatomical data for this unpublished *Homo erectus* are compared with those available for other Indonesian hominins and the particularities of this specimen are discussed.

Testing the scaling relationship of tooth size and jaw size in three hominin species: Are hominins “good” primates?

PASHLEE M. GRIMMETT, ALEKSANDRA OLDAK, LYNN E. COPES and WILLIAM H. KIMBEL. Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University.

Recently, Plavcan and Daegling (2006) investigated the relationship between tooth size and jaw size in anthropoid primates. They found limited support for the hypothesis that jaw size directly covaries with tooth size either intra- or interspecifically, and no support for the hypothesis that mandibular robusticity covaries with tooth size. We tested the same relationships in *Australopithecus afarensis*, *Paranthropus boisei* and *Homo sapiens* to determine if the trends reported by Plavcan and Daegling occur in hominins with strikingly divergent masticatory adaptations. We included all *A. afarensis* and *P. boisei* specimens with mandibles still containing dentition, and 20 prehistoric anatomically modern *Homo sapiens* from Nubia, Egypt (10 males, 10 females). Most intraspecific analyses were either insignificant ($p>0.05$) or had a very low r^2 . Contrary to our expectations, many measures of molar size were not correlated with mandibular size in *P. boisei*; furthermore, canine size and mandible size were not correlated in *A. afarensis*, although a larger sample size is necessary before firm conclusions are reached. Canine dimorphism, but not mandibular size dimorphism, was present in the modern *Homo sapiens* sample; in most of the non-human primate analyses reported by Plavcan and Daegling, both types of sexual dimorphism were present. Interspecifically, many dental metrics correlated strongly with linear measures of mandibular height and width and shape ratios describing mandibular robusticity. This resembles the pattern reported by Plavcan and Daegling, indicating that even the remarkable masticatory adaptations seen in some hominin species do not significantly alter the “typical” scaling pattern present in other primates.

How tooth wear informs the paleoecology of extinct hominins.

FREDERICK E. GRINE¹, PETER S. UNGAR² and MARK F. TEAFORD³. ¹Departments of Anthropology and Anatomical Sciences, Stony Brook University, ²Department of Anthropology, University of Arkansas, Fayetteville, ³Center for Functional Anatomy & Evolution, Johns Hopkins University School of Medicine.

Over thirty years of research on extant mammals has provided clear evidence that patterns of microscopic use-wear on teeth provide information pertaining to diet. Quantitative studies of microwear features and of microwear surface textures have demonstrated that, in general, frugivorous species can be differentiated from folivorous taxa, and a strong association between the consumption of hard dietary items (e.g., nuts

and seeds) and wear fabric complexity. Of course, food items are not the only agents that can produce microwear; there is ample evidence for the importance of exogenous grit in its formation. Microwear fabrics may also be variably “turned-over” following an ecologically mediated shift in diet. As such, microwear provides some indication of an individual’s dietary habits in the days (perhaps weeks to months) prior to sampling – the so-called “Last Supper Effect.”

Molar microwear in “*Australopithecus anamensis*” and *Praeanthropus afaensis* is remarkably homogenous between specimens across time and paleoecological context, and is most similar to that of *Paranthropus boisei* among extinct hominins studied thus far. Although these species have been argued to show craniodental evidence for an adaptive shift to diets dominated by hard, brittle foods, none of the fossils exhibit microwear expected of a hard-object feeder. On the other hand, microwear suggests an increased component of such foods in the diet of *Paranthropus robustus* compared with *Australopithecus africanus* and especially *P. afaensis*. Tooth wear provides intriguing clues about the paleoecology of these Plio-Pleistocene hominins, and the possible selective milieu underlying the evolution of their craniodental attributes.

Discriminant analyses of *Tarsius* cranial morphological variation.

NANDA GROW, SHARON GURSKY-DOYEN and MICHAEL ALVARD. Department of Anthropology, Texas A&M University.

The extent of tarsier (Genus: *Tarsius*) species diversity is still being explored. The goal of this study is to investigate the range of variation between Sulawesian tarsier populations by determining to what extent they are distinct from one another compared to variation across all species. Our data sources include tarsier cranial and dental morphometrics from AMNH and USNM specimens collected from sites in Sulawesi (*Tarsius dianae*, *T. pelengensis*, *T. pumilus*), Borneo (*T. bancanus*) and the Philippines (*T. syrichta*). Data also include cranial measurements of field specimens from Morowali Nature Reserve in Central Sulawesi, Indonesia (putatively *T. dianae*) and Tangkoko Nature Reserve in North Sulawesi, Indonesia (*T. spectrum*). A discriminant analysis reveals significant differences between the Philippine, Bornean and Sulawesian samples, as well as between Sulawesian species. The morphology of the tarsier species in Central and Northern Sulawesi are significantly different from each other as well as from the other tarsier species. The Sulawesian samples differ from each other in both shape and size; the tarsiers of Central Sulawesi are larger. These results verify previously established taxonomic groups.

Linear enamel hypoplasia as an indicator of physiological stress in great apes: reviewing the evidence in light of species differences in enamel growth.

DEBBIE GUATELLI-STEINBERG¹, REBECCA FERRELL² and JENNIFER

SPENCE¹. ¹Department of Anthropology, The Ohio State University, ²Department of Anthropology, Smithsonian Institution.

Recent work indicates that in great apes, the prevalence of linear enamel hypoplasia (LEH), a dental indicator of physiological stress, is associated with diet and habitat. For example, gorillas (especially *G. beringei*) usually exhibit the lowest frequencies of LEH and are the most folivorous of the great apes. However, to begin to understand the ecological signal LEHs may provide, it is necessary to assess how enamel growth variables affect LEH expression. We suggest that the angles that striae of Retzius make with the enamel surface affect LEH depth and perceptibility and that longer enamel formation times afford greater opportunity for LEH formation. Accordingly, we hypothesized that relative to other great apes, gorillas should have the most acute angles of striae of Retzius and shallowest defect depths. We also hypothesized that male canines, which take longer to form than female canines, should exhibit greater defect numbers in all the great apes. As predicted, we found that striae of Retzius made more acute angles with the enamel surface in the anterior teeth of gorillas than in those of chimpanzees and orangutans. Defect depths on *Gorilla* teeth were also generally shallower than they were on teeth of *Pongo* (but not so different from *Pan*). Finally, greater numbers of defects in males relative to females were found on the canines of *Pongo* and *Gorilla*, the most sexually dimorphic of great apes. These results suggest that patterns of LEH expression in great apes should be analyzed with respect to both ecology and enamel growth variables. Supported by NSF Grant BCS-0607520.

Survey and recensus of the longtailed macaques (*Macaca fascicularis*) of Mauritius.

LISA M. GUIDI and ROBERT W. SUSSMAN. Department of Anthropology, Washington University in St. Louis.

In terms of distribution, behavioral flexibility and environmental adaptability, few nonhuman primate species are as successful as the longtailed macaques (*Macaca fascicularis*). Because longtailed macaques share many characteristics with humans, they can provide us with a potentially excellent model for human evolution. In order to better understand the adaptability of macaques, detailed studies need to be conducted in both native and in introduced habitats thereby providing a better indication of which behavioral and environmental characteristics are flexible and which are phylogenetically constrained. Mauritius offers an opportunity to study macaques in the latter environment. In recent years however, Mauritian macaques have undergone intense rates of capture for the biomedical industry – a development which has had a drastic effect on the feral population. A survey and recensus was undertaken in the summer of 2009 to assess the current situation with the macaques and to seek out potential research sites. Census estimates indicate that the macaque population has been greatly reduced from approximately 40,000 in

the mid 1980's to about 8,000. However, there are still potential research sites on the island. Given the need for additional ecological and behavioral data on the longtailed macaques, our assessment is that the island of Mauritius remains an ideal location for research of this species despite the decrease in the feral population, providing that much needed governmental and/or private regulation of the remaining population is taken.

Locomotor versatility in wild ateline primates.

DENISE M. GUILLOT. Department of Anthropology, University of Michigan.

Positional studies quantifying the frequency of locomotor behaviors have demonstrated differences in primate locomotor profiles, but primates may also differ in the versatility of their response to environmental challenges. Here, locomotor versatility is defined as a locomotor response pattern involving rapid and frequent transitions between modes that are quite biomechanically distinct. Central to the idea of versatility, is that it may contribute to the capacity for a flexible locomotor response and influence the extent to which an individual can adjust to micro-habitat heterogeneity. This study examines locomotor versatility through a comparative analysis of *Alouatta seniculus*, *Lagothrix poeppigii*, and *Ateles belzebuth* and specifically examines whether these closely related atelines vary in their capacity for locomotor versatility. Independent bouts of behavior were derived from raw video of wild subjects. Video bouts were viewed frame-by-frame and the following data were collected: general activity (travel, feeding or resting) and the total number of unique, non-repeating locomotor modes divided by total locomotor bout time. *Ateles* integrated a greater variety of distinct modes into their locomotor repertoire per unit time compared to either *Alouatta* or *Lagothrix* suggesting that *Ateles* locomotor response pattern is relatively more versatile. Locomotor versatility may contribute to travel efficiency by shortening path length. In addition, it may reflect an adaptive response to the need to manage the mechanical challenges of large body size in a complex and instable arboreal environment. This research is supported by a NSF Dissertation Improvement Award (BCS-0452886) and Boston University.

Three-dimensional paleopathological study on chronic osteomyelitic lesions.

GASPARD GUIPERT and BERTRAND MAFART. Antenne de l'Institut de Paléontologie Humaine, UMR 7194, Europôle Méditerranéen de l'Arbois, Aix en Provence, France.

3-D medical imaging methods have by now become a widely used tool in the field of Paleoanthropology. However, little use has been made of these methods so far in Paleopathological studies. It was proposed here to apply CT-scan 3-D reconstruction methods to detecting and modeling the internal structure of

these infectious bone lesions in a historical population. Two skeletons from the historical burial site at Notre-Dame-du-Bourg in Digne, France, showed fistular orifices characteristic of osteomyelitis: one right male tibia (13th-15th century) and one left female femur (16th-17th century). Osteoscopic and 3D imaging paleopathological studies were performed on these lesions.

CT scanographic images were obtained using a helical medical scanner with 1.25 mm slices, a reconstitution interval of 0.625 mm and a rotation time of 0.7 rev/s. The matrix consisted of 512x512 pixels, the SFOV was 25 cm and the resulting pixel size was 0.48 mm. 3-D reconstructions of the infectious intraosseous cavities were obtained by postprocessing the CT data with the Mimics 9.0 software program (Materialise ®). The slice-by-slice studies made it possible to analyze the relationships between the infectious cavities, the normal medullar cavity and the diaphyseal bone. The morphology of the 3-D reconstructed cavity was compared with current medical data and the etiological diagnoses were discussed.

Based on these cases, the authors present a three-dimensional morphological method for analyzing chronic osteomyelitic lesions in the

Intraspecific variation in spectral tarsiers.

SHARON GURSKY. Department of Anthropology, Texas A&M University.

Historically, a species' social system was perceived to be a fixed attribute and deviations were usually treated as aberrant or maladaptive. Over the last few decades, sociocologists have started to recognize that variation in social systems is normal and adaptive. This poster explores how ecological variation affects the mating system of a nocturnal primate, the spectral tarsier, *Tarsius spectrum*. Several studies of the spectral tarsier have illustrated variation in this species' mating system. Although most groups exhibit a monogamous mating system, a small proportion of the population consistently exhibits a polygynous mating system.

This study was conducted at Tangkoko Nature Reserve in Sulawesi, Indonesia during 2007. Group size was highly variable, ranging from two individuals to as many as eight individuals per sleeping site. Although most groups were comprised of a single adult male and a single adult female, approximately 19% of the groups contained two adult females. Three of the five groups with two adult females contained two young infants. As might be expected, polygynous groups were statistically larger than were monogamous groups. The mean group size of monogamous groups was 2.9 whereas the mean group size of polygynous groups was 6.0. Monogamous groups were statistically more likely to use non-*Ficus caulocarpa* trees than were the polygynous groups. Polygynous groups consistently used more sleeping sites, larger diameter sleeping trees, and taller sleeping trees than did monogamous groups. Although this study found that ecological variation is an important determinant of mating system within spectral tarsiers, phylogenetic

factors may also constrain the potential for polygamy. This study was funded by CI-Primate Action Fund, Primate Conservation Inc. and Texas A&M University.

Functional morphology of the hand in *Theropithecus*.

EMILY H. GUTHRIE and STEPHEN R. FROST. Department of Anthropology, University of Oregon.

To better understand manual morphology in *Theropithecus*, we analyzed a sample of cercopithecid metacarpals and phalanges, including seven measurements on each metacarpal and phalanx from 25 species, including terrestrial and arboreal colobines and cercopithecines. The significant patterns of variation were 1) robusticity (length/proximal breadth) of both metacarpals and phalanges and 2) length of the first digit relative to the lateral ones.

Theropithecus is extreme in both ways. Theropiths, including fossil *T. oswaldi* and *T. brumpti*, show the most robust hand elements. Among cercopithecids hand bone robusticity is associated with terrestriality. *Theropithecus*, including *T. brumpti*, also has a proportionally long thumb compared to all other cercopithecids. Our results show the thumb is long compared to all medial rays, augmenting previous research demonstrating the high opposability index (thumb-length x 100/ index-ray length) in *Theropithecus*.

This combination of features in the hand is striking. We think relatively robust hand bones are an adaption to locomotion in *Theropithecus*. Another possibility is cold habitats (Allen's Rule), which may explain *Macaca thibetana* which is also robust even compared to other terrestrial taxa. However, *Theropithecus* fossils are not known from such climates and terrestrial locomotion is more likely. We think the proportionally long thumb is an adaption for manual foraging as often described in this genus.

The fossil *Theropithecus brumpti* is often described as the arboreal theropith. However, based on manual robusticity, *T. brumpti* was as terrestrial as *T. gelada* and *T. oswaldi*. Additionally, *T. brumpti* had the same adaptation for manual foraging described by previous researchers. This study was funded by the Geological Society of America (EG), the Paleontological Society (EG) and the University of Oregon (SF).

The effects of sex and ancestry on pubic symphysis morphology.

ERIN GUTHRIE. Department of Anthropology, Binghamton University.

The purpose of this study is to test the Suchey-Brooks method against a large sample containing males and females of both African and European descent to determine whether separate male and female statistics are necessary, and whether ancestry should be considered in the construction of predictive statistics. The study sample consists of data compiled from multiple sources, and consists of

878 individuals (470 females, 408 males). Summary statistics were calculated for males and females by phase score, and t-tests run to compare male and female means for each phase. Analysis of covariance was used to determine whether (and to what degree) variations in ancestry and sex affected variation in pubic phase. Inaccuracy and bias statistics were calculated for each subgroup by phase and for the combined sample. Finally, the percentage of individuals falling within the published 95% prediction intervals of each phase was calculated.

Results of the ANCOVA tests indicate that neither sex nor ancestry contributes significantly to variation in pubic phase score. Inaccuracy and bias statistics support previous studies' conclusions that the pubic symphysis aging method is more reliable for younger individuals than older. Overall, the Suchey-Brooks method correctly classifies 83% of individuals. This study suggests that separate male and female statistics and the 1989 "race modification" of the Suchey-Brooks method for African males are unnecessary. A single system with broader 95% prediction intervals, applicable to all individuals regardless of ancestry or sex, is a more accurate utilization of the information we obtain from the pubic symphysis.

Anatomical placement of the human eyeball in the orbit – new metric data and guidelines proposal for facial identification.

PIERRE GUYOMARC'H, HÉLÈNE COQUEUGNIOT, BRUNO DUTAILLY and CHRISTINE COUTURE. UMR 5199 PACEA, Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux 1, France.

Forensic facial reconstruction/approximation and superimposition techniques are ultimately used to help the identification of unknown deceased and facial recognition largely depends on the accuracy of the reconstructed eyes region. Recent publications reconsidered traditional guidelines that appeared to erroneously place the eyeball in the orbit. We present here a metric study which goal is the elaboration of regression formulae enabling a more precise eyeball positioning.

Hundreds of faces (CT scans) have been collected in French hospitals. A subsample ($n = 140$) of known age and sex adult scanners has been randomly selected, with a homogeneous biologic repartition (sex ratio 1:1, 18-95 years). Landmarks were recorded using the Half-Maximum Height protocol and plans constructed from the Frankfort horizontal plan, allowing reproducible measurements.

Inter- and intra-observer errors were calculated, distances between landmarks were extracted and the normality of the distributions was checked. Sex and age influences on the eyeball position are statistically low.

The more superiorly and laterally positioning of the eyeball in the orbit is confirmed. Since good correlations were found in the distances between the most anterior point of the eyeball and the orbital rims, linear regressions allowed the creation of prediction formulae. Eyeball position in the mediolateral and in the superoinferior plans is best evaluated respectively by the

orbital width and height. Eyeball diameters and protrusion are also discussed using multiple regressions.

This metric data, based on a large sample, can be used both for manual or computer-assisted facial approximation in two or three dimensions, and superimposition techniques.

A contribution of health status and mortuary practices in the Colonial and Republican Quito. A case of study from the San Francisco Church excavations.

ANGELICA GUZMAN^{1,2}, PAOLA LEON² and ALFREDO SANTAMARIA². Department of Anthropology, Universidad de los Andes Bogotá, Colombia; ² Fondo de Salvamento del Patrimonio Cultural FONSAL, Research Division, Quito, Ecuador.

Restoration and excavations of the San Francisco Church in Quito, Ecuador, carried on during 2008 and 2009, left uncovered a cemetery that according to the archeological record and historic sources, was used since the 16th century until the middle of the 19th century. The macroscopic analysis of the human remains showed evidence about the health status of the Colonial and Republican Quito, as well as information of the cultural syncretism between pre-Columbian interments and Catholic burial practices. It was recovered a burial associated to Inca ceramics; also primary and secondary burials in coffins and drawers, and commingled human remains. Osteobiographies along with the spatial and contextual analysis of the burials established a particular relationship between sex and age variables, socio-economic status and their allocation in the church.

The human skeletal remains (MNI=258), among unborn children, infants, youth and adults indicate high levels of mortality during early childhood. Macroscopic examinations of pathological conditions such as high frequencies of periostitis, criba orbitalia, generalized hyperostosis, one possible case of tuberculosis and three possible cases of treponemal infections support historical records about Ecuadorian epidemics.

This research greatly contributes to complement the knowledge about the impact in the Americas' health conditions, mortality patterns and diseases after the Old World contact. Furthermore, it enhances the understanding of the church as an instrument of the colonial rule through its capacity to reinforce economic, racial, and gendered relations by the regulation of the mortuary practices. This study was funded by Fondo de Salvamento del Patrimonio Cultural FONSAL, Quito, Ecuador

Recreational drug use as potential protection against pathogens: Smokers among Central African foragers have fewer worms than non-smokers.

EDWARD H. HAGEN¹, CASEY ROULETTE¹, BARRY S. HEWLETT¹, ROGER J. SULLIVAN² and REMI LAGANIER³.

¹Department of Anthropology, Washington State University, ²Department of Anthropology, California State University Sacramento, ³Institut Pasteur de Bangui, Central African Republic.

Current neurobiological theory of recreational drug use is based on the observation that all addictive drugs induce changes in activity of dopaminergic circuitry, interfering with reward processing, thus enhancing drug seeking and consumption. Current theory of drug origins, in contrast, views almost all major drugs of abuse, including nicotine, cocaine and opiates, as plant neurotoxins that evolved to punish and deter herbivores. According to this latter view, plants should not have evolved compounds that reward or reinforce plant consumption. Mammals, in turn, should not have evolved reinforcement mechanisms easily triggered by toxic substances. Situated in an ecological context, drug reward is a paradox.

We report results of a study among Aka foragers of the Central African Republic that tested one potential resolution of the paradox, namely that humans, like other animals, might have evolved to counter-exploit plant neurotoxins. The Aka have high levels of helminth infection yet little access to Western anti-worm medicines, and so might be motivated (consciously or unconsciously) to increase consumption of certain readily available substances. The plant defensive chemical nicotine, in particular, is an effective antihelminthic. Tobacco is widely used at the study site.

We recruited 40 adult Aka men and women into a cross-sectional study of smoking behavior vs. levels of intestinal helminths. Each participant was interviewed about tobacco use and provided saliva and stool samples to assess exposure to nicotine and levels of intestinal helminths, respectively. As predicted, the mean level of intestinal helminths among smokers was significantly lower than among non-smokers. This study was funded by the Washington State University Alcohol and Drug Abuse Research Program.

Therapeutic outcomes of medicinal plant applications in three cultural groups.

ROBERT A. HALBERSTEIN. Dept. of Anthropology, University of Miami.

Medicinal plant products have been administered for a wide range of health problems cross-culturally since prehistoric times, and toxic side-effects have also been recorded. The safety and effectiveness of several herbal medications were evaluated with original data collected in Caribbean (N=286), Caribbean-American (N=290), and American (N=111) populations and a survey of 91 medicinal plant shops ("botanicas") in Miami, FL.

84% of the Caribbean respondents age 21-84 and 65% of Caribbean-American subjects age 21-85 reported regular usage of botanical medicines for disorders ranging from flatulence and dandruff to cancer and AIDS, and the medicaments were cited as particularly effective in the management of chronic conditions such as diabetes, hypertension, arthritis, insomnia, asthma and depression. Phytochemical assays of botanical specimens obtained from the *botanicas* indicate the presence of curative bioactive pharmaceutical constituents as claimed, and preparation procedures serve to

enhance phytochemical bioavailability while simultaneously reducing or neutralizing potential toxicity. A double-blind experiment on homeopathic Bach® Flower Essences involving a sample of Americans age 18-49 and weighing 87-251 pounds revealed statistically significant differences between treatment and placebo-control groups with respect to the outcomes of standardized stress tests. The Bach combination formula Rescue® Remedy was more effective than placebos in reducing high levels of anxiety that were measured and quantified. Gender, age, and body weight were not correlated with test results.

Forelimb morphology and locomotor profile of *Protopithecus* and *Caipora*.

LAUREN HALENDAR. City University of New York, New York Consortium in Evolutionary Primatology.

The locomotor profile of the giant subfossil platyrhines, *Protopithecus* and *Caipora*, was originally reconstructed, based mostly on limb proportions, as suspensory in the mode of the extant genera *Ateles* and *Brachyteles*, with some climbing included for the alouattine *Protopithecus*. It was later suggested that the two taxa could have been largely terrestrial based on their large body size, paleoenvironmental reconstructions, and the biomechanics of brachiation. No detailed description of the fossil morphology was used to draw this conclusion, nor does this information exist in the literature, despite the fact that these genera are represented by nearly complete skeletons, a rare treat for paleoanthropologists. Filling this gap begins here, with a description of the forelimb. Neither of the fossils exhibits any of the classic features of terrestrial catarrhines, such as a retroflexed medial epicondyle, a posteriorly directed olecranon process, or short straight phalanges, but they could have used the ground facultatively as many extant atelines, even *Ateles*, occasionally do. Unlike *Ateles*, however, neither fossil has a reduced thumb, an adaptation to extreme suspensory behavior. There are differences between the two genera, especially in the width of the distal humerus and the shape of the olecranon fossa and proximal ulna, that suggest previous work lumping them together into a single locomotor category is an oversimplification of their positional behavior; *Protopithecus* is comparable to *Alouatta* while *Caipora* is more comparable to *Ateles*. However, their much larger size suggests mixed arboreal substrate use perhaps resembling a chimpanzee or gorilla.

Bone as a biomarker of mercury exposure in prehistoric arctic human populations: Initial method validation using animal models

CARRIN M. HALFFMAN. Department of Anthropology, University of Alaska Fairbanks.

Marine mammals are dietary staples among many indigenous peoples of the Arctic, but these foods sometimes contain high levels of mercury, a toxic heavy metal that can cause

nerve and brain damage. Because mercury can be released into the environment by both industrial and natural processes, prehistoric marine mammal consumers may have been exposed to this toxicant, but little is known about preindustrial mercury levels. This research examined the potential for using the mercury concentration of archaeological bone as a biomarker of mercury exposure. For a biomarker to be valid, it must correspond with the extent of exposure. Correspondence with exposure was examined by comparing bone mercury concentration to controlled exposure level in laboratory rats, and to the stable nitrogen isotope ratio ($\delta^{15}\text{N}$) (a proxy measure of exposure) in prehistoric seals from Thule-period archaeological sites in Alaska. Results show that bone mercury is strongly related to exposure. These promising results suggest that, with further validation on human subjects, bone mercury may provide a reliable archive of mercury exposure in preindustrial archaeological populations. This research was funded in part by the University of Alaska Fairbanks Center for Global Change and Arctic System Research Student Award funded by the Cooperative Institute for Arctic Research through cooperative agreement NA17RJ1224 with the National Oceanic and Atmospheric Administration

Hierarchical clustering of the vocal analyses of alarm calls reveals precise number of callers in a group of wild white-faced capuchin monkeys (*Cebus capucinus*).

ANDREW R. HALLORAN and C.T. CLOUTIER. Maderas Rainforest Conservancy, Florida Atlantic University, Department of Anthropology, Elgin Center for Conservation and Behavioral Research.

Spectral analysis of the alarm calls of capuchin monkeys show enough individual variation to statistically determine the precise number of callers. Vocal samples ($n>1200$) were taken from a group of wild and unhabituated white-face capuchin monkeys on Ometepe island, Nicaragua. The samples, consisting only of alarm calls directed at the observer, were identified by the individual monkeys producing them. The samples were then converted to spectrums and analyzed for duration, percent of onset abruptness, and the first through third spectral peak frequencies. The data in these results were then standardized to euclidean distance and clustered to 10 euclidean units using Ward's minimum variance of hierarchical cluster analysis. The results revealed the same number of clusters as individual callers. Further review revealed that each recorded vocalization was correctly assigned to the correct cluster at a rate greater than chance. Such results indicate that hierarchical clustering of vocal analyses may be a reliable method in grid or transect sampling to determine an accurate census.

Does day range impact long bone morphology? What we know from observations of baboon femora and humeri.

KELLI M. HAMM. Department of Anthropology, University at Albany.

Neanderthals and early anatomically modern humans (EAMHs) exhibit differences in femoral morphology compared to recent humans, including a larger degree of anteroposterior curvature and thicker diaphyseal cortices. It has been demonstrated that bone tissue adapts to applied external forces (such as changes in magnitude, frequency, and rate of force) with resulting changes in bone architecture. This study explores the association of femoral morphology and locomotion in Neanderthals, EAMHs, and recent humans by examining differences in femoral and humeral longitudinal curvature and cross-sectional area of a group of terrestrial quadrupedal primates as they relate to ranging behavior.

Four subspecies of baboons (*Theropithecus gelada*, *Papio hamadryas anubis*, *Papio h. cynocephalus*, and *Papio h. ursinus*) were examined, as they are phylogenetically closely related and yet differ in distance traveled per day (day range, DR). Femora and humeri of baboons were scanned with a 3D scanner, then imported into 3D modeling software where measurements of curvature and transverse cross-sectional area were obtained through manipulation of bone models. Analyses of covariance ($\alpha = 0.05$) were then performed on logged data to explore DR's power of predictability of curvature and cross-sectional area.

When body size variation is reduced, results indicate that humeral curvature ($p=0.004$) and cross-sectional area ($p=0.116$) in baboons are reasonably well predicted by ranging behavior, although statistical power was limited by small sample sizes. This suggests that ranging behavior may be important in understanding morphological differences in long bones of fossil hominins.

Novel 3D analysis of the proximal femur and hip joint function in living and fossil anthropoids.

ANDREW S. HAMMOND¹, J.M. PLAVCAN² and C.V. WARD¹. ¹Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine, ²Department of Anthropology, University of Arkansas.

Miocene and Plio-Pleistocene fossil catarrhines are hypothesized to display a range of locomotor adaptations, yet none converges completely on extant apes despite some overlap in body size. Many taxa are known from the proximal femur, which directly reflects hip function. Although some work has been done, certain aspects of femoral and hip morphology (functional axes and curved surfaces) have proved difficult to quantify.

This study employs novel 3D methods to quantify shape variation of the proximal femur and acetabulum in a large sample of extant anthropoids, allowing us to test hypotheses of locomotor adaptation in fossil catarrhines. Continuous laser scan data were analyzed using PolyWorks (Innovmetric, Inc.). This software enabled us to establish and compare functional axes, joint centers, and articular size, shape and distribution.

Our results demonstrate that abduction capacity of the femur is affected by trochanteric height, neck shaft angle and bone segment lengths, as well as head and fovea position, although these features are found in different combinations among taxa. Furthermore, although femoral head and lunate surface areas as a whole scale allometrically, species vary in size, shape and position of the femoral head, with terrestrial monkeys having less articular surface area posteroinferiorly relative to the fovea, and significantly more femoral articular area extending laterally from the spherical head surface onto the neck, reflecting an emphasis on flexed and adducted hip postures. Fossil apes and monkeys exhibit a suite of morphologies that reflect differential patterns of hip joint function, providing important insights into catarrhine evolution.

Geographic structure of dental variation and the peopling of East/Southeast Asia and Pacific.

TSUNEHICO HANIHARA¹ and HAJIME ISHIDA². ¹Department of Anatomy, Kitasato University School of Medicine, ²Department of Anatomy, University of the Ryukyus, Sagamihara.

In the last decade, a near consensus has emerged in supporting single African origin of modern humans in east Africa. However, the pattern of dispersal and global diversity, as well as colonization history of modern human populations are far from obvious and focus of heated debate. In the present study, equilibrium models of isolation by distance were applied to metric and nonmetric dental datasets for 10 major geographic samples from around the world. Linear and nonlinear regression analysis show that phenotypic similarity between populations decreases as the geographic distance increases. This indicates that geographic distance is one of the significant and primary determinants of not only genetic but also phenotypic variation between human population groups. The difference of morphological diversity within and between regional populations confirms, moreover, the primary role of sub-Saharan Africa in the evolution of our species. The variation of East/Southeast Asians is relatively large, suggesting a complex population history such as possible earlier divergence and multiple migrations from outside sources. On the other hand, the pattern of dental variation and affinities among major geographic populations indicate extreme isolation and subsequent retaining of upper Palaeolithic features in Australians and to a lesser extent Melanesians. The present findings suggest that the global pattern of dental variation is more or less similar to that expected under a neutral model of genetic drift balanced by gene flow.

Biomechanics of climbing in 4 species of prosimian, with special reference to lorises.

JANDY B. HANNA¹, SCOTT EVERETT¹ and DANIEL SCHMITT². ¹West Virginia School of Osteopathic Medicine, ²Duke University.

Apes, atelines, and lorises, have anatomical traits that may adapt them to a more arboreal lifestyle involving frequent climbing. Apes and atelines exhibit low FL/HL vertical peak force ratios during horizontal locomotion and ascent. Lorises, however, exhibit the opposite ratio during horizontal locomotion, which may be related to their slow, cryptic locomotion and congruent fore- and hindlimb morphology. No data are available on loris force ratios during climbing. Thus, the goal of this study is to test the hypothesis that loris vertical peak force ratios will shift toward higher hindlimb than forelimb peak forces during climbing, similar to other primates.

Four species of prosimian (*Loris tardigradus*, 0.173kg-0.197kg; *Cheirogaleus medius*, 0.212-0.233kg; *Nycticebus pygmaeus*, 0.393-0.634kg; *Eulemur mongoz*, 1.34-1.54kg) at the Duke Lemur Center climbed a vertically-oriented instrumented rigid-wooden pole. Vertical peak forces were determined for at least 10 fore- and hindlimb steps for all individuals (2-3 per species); speed was determined from videorecordings.

Results show that, as expected, lemurs experience significantly more force on their hindlimbs than forelimbs during climbing ($p < 0.05$). Lorises show the opposite pattern ($p < 0.05$). In general, lemurs climb faster than lorises, but this speed difference is not significant. At overlapping speeds, the force distribution for each group is maintained. These results are unexpected considering that lorises climb often and may be expected to show a force ratio more similar to apes and atelines. These data show that lorises climb in a manner atypical of most other primates and highlights the complicated relationship between behavior, anatomy, and performance in primates. This study was funded by NSF, BCS-0749314.

Placing bipedalism within a phylogenetic framework: Preliminary results.

WILLIAM HARCOURT-SMITH. American Museum of Natural History.

Bipedalism arguably defines the hominin clade. The anatomical features that relate to this unusual form of locomotion are routinely used to place Late Miocene hominoid skeletal remains within the hominini. It is a paradox then, that hominin systematics exclusively relies on cranio-dental characters to construct cladograms, phylogenies and evolutionary scenarios. This occurs due to the fact that type specimens are nearly always exclusively craniodental, and that there is sometimes poor association between types and postcranial remains from the same stratigraphic horizon. However, enough hominin taxa do in fact exist with reasonably well associated postcranial remains to warrant investigation into the feasibility of using postcranial characters (whether continuous or discrete) in hominin phylogeny reconstruction.

A first step in this direction would be to investigate the relationships between living hominoid taxa using postcranial data. In this preliminary report, the 3D landmark coordinate data from five different tarsal bones (medial cuneiform, navicular, talus, calcaneus and

cuboid) were used as a test case. The data were subjected to Procrustes superimposition and analysed using PCA. These data were then subjected to several tree building algorithms, including rooted and unrooted maximum likelihood and neighbor joining. Results show that these postcranial data, especially for the analyses using multiple bones, match the consensus phylogeny for extant hominoids as determined from molecular data. These results are discussed within the context of future proposed work on fossil hominin postcranial remains.

Biological affinities and the construction of cultural identity within the proposed Coosa Chiefdom.

MICHAELYN S. HARLE. University of Tennessee.

This study investigates biological relationship sixteenth-century, late Mississippian communities in eastern Tennessee and adjacent northern Georgia. The primary goal is to examine regional interactions between these communities and their constructions of social identity and sociopolitical dynamics vis à vis their biological affinities. Questions regarding regional interactions between these groups have been a stimulus for archaeological debate. These interactions may have played a crucial role in the construction of separate cultural identities. What is not clear is to what extent differences in cultural identity reflect or are related to differences in biological relationships. The skeletal samples used in this study represent six Late Mississippian archaeological sites assigned to three archaeological phases: the Dallas Phase, Fains Island, Cox, and David Davis sites; the Mouse Creek Phase, Ledford Island site; and the Barnett Phase, King and Little Egypt sites. These sites are often suggested to be part of the Coosa chiefdom described by sixteenth-century Spanish accounts. Forty-three dental and cranial nonmetric traits were recorded for 963 individuals. Mahalanobis D² was used in order to calculate biological distance.

Comparisons between biological distance and geographical distances suggest that the samples used in this analysis do not conform to the expected isolation-by-distance model. Furthermore, East Tennessee groups appear distinct from their North Georgia neighbors suggesting little biological interaction between these groups. The results of the biological distance analysis conforms to differences in material culture and mortuary ritual between these groups suggesting that biological interactions played a crucial role in the construction of cultural identity.

The proximal femur of early hominins: The pattern and significance of interspecific shape variation.

ELIZABETH H. HARMON¹ and J. MICHAEL PLAVCAN². ¹Department of Anthropology, CUNY, ²Department of Anthropology, University of Arkansas.

Though an understanding of morphological variation in hominin limb elements is critical to understanding and testing hypotheses of functional variation in locomotion, multivariate studies quantifying postcranial variation are relatively uncommon. Here we assess size and shape variation in a series of attributed and unattributed proximal femurs from *Australopithecus*, *Paranthropus*, and *Homo* using traditional linear data and landmark analysis.

Data were gathered for 21 hominin specimens and 311 specimens of extant *Pongo*, *Gorilla*, *Pan* and *Homo*, representing all extant subspecies where appropriate. Six linear dimensions and seventeen landmarks were taken for each proximal femur. Linear dimensions were transformed to dimensions shape ratios following the procedure of Darroch and Mossman (1985). Landmark data were subject to generalized procrustes analysis. For both data sets, subsets of linear dimensions and landmark data were analyzed. Bootstrap analyses of results from PCA and discriminant function analysis were used to compare variation between fossil and extant taxa.

Results largely corroborate the distinctiveness of form in different extant taxa and fossil samples. *Australopithecus afarensis* and *A. africanus* cluster with *Gorilla* and *Pan*, while those attributed to *Homo* tends to cluster with extant *Homo*. However, even though individual fossil samples form distinct clusters in many analyses, within-sample variation tends to be low compared to extant species, but the total variation among fossil hominins as a group is subsumed within that of extant *Gorilla*. The overall results, while suggestive of taxonomic differences in form, dictate caution in inferring the nature of functional variation among these samples.

Treponemal disease in baboons: The evolution and transmission of non-human primate strains.

KRISTIN HARPER¹, SASCHA KNAUF^{2,3}, ROBERT FYUMAGWA⁴, RICHARD HOARE⁴, FABIAN LEENDERTZ³ and GEORGE ARMELAGOS⁵. ¹Robert Wood Johnson Health & Society Scholars Program, Columbia University, ²Clinic for Obstetrics, Gynecology and Andrology of Large and Small Animals, Justus-Liebig-University, Giessen, Germany, ³Junior Research Group "Emerging Zoonoses", Robert Koch Institute, Berlin, ⁴Tanzania Wildlife Research Institute, Arusha, Tanzania, ⁵Dept of Anthropology, Emory University.

The bacterium *Treponema pallidum* causes syphilis in humans, as well as the non-sexually transmitted, childhood diseases yaws and bejel. It has been known for some time that Old World non-human primates, including gorillas, chimpanzees, baboons, and patas monkeys, are also infected with *T. pallidum* in the wild. Several decades ago, researchers examined the prevalence and clinical signs of treponemal disease in wild West African baboons and isolated a single strain: until now, the only one available for analysis. This strain causes a yaws-like infection in humans and could not be

differentiated genetically from yaws-causing strains in recent studies. These findings bolster earlier observations consistent with treponemal disease in baboons being mild and non-sexually transmitted. Beyond this, however, little is known about treponemal infection in wild, non-human primates.

Here, we extend the study of treponemal disease to non-human primates in East Africa, where infection had previously reported to be rare or absent. We present the results of a comprehensive study of an epidemic in Tanzanian baboons. Clinical signs of the disease, its mode of spread, and the genetic relationship between East African baboon strains, West African baboon strains, and human strains were investigated. We demonstrate that the previously described strains circulating in West Africa are distinct from those present today in Tanzania, indicating that strains infecting baboons are more diverse than previously suspected. *T. pallidum* evolution and transmission mode within baboons will be discussed, as well as the relationship between strains found in human and non-human primates.

This study received support from dissertation improvement grants from the National Science Foundation (grant no. 0622399) and the Wenner-Gren Foundation, a pre-doctoral fellowship from the Howard Hughes Medical Institute, the Robert Wood Johnson Foundation Health & Society Scholars program, the German Academic Exchange Program (grant no. D/06/43974), the Christian Vogel Fond 2006, WAZA (project no. 07002), and the Messerli Foundation of Switzerland.

Correspondence between crown and cervical dental measurements from Late Bronze Age Greece.

NATHAN KAYNE HARPER. Department of Anthropology, University of Nevada, Las Vegas.

With the introduction of standardized dental cervical metric methods and equipment, researchers have hoped to expand sample sizes beyond standard crown measurements while explaining similar genetic and environmental components. Correlations between these dimensions are little understood and have been studied on a limited number of populations. The study of crown and cervical dimensions is extended to a sample of 131 individuals from Late Helladic Greece (Athenian Agora, Corinth and Ayia Triadha). Mesiodistal and buccolingual crown and cervical dimensions were recorded for the left side polar teeth in both the upper and lower arcades. Results indicate buccolingual crown vs. cervical dimensions are significantly correlated with mesiodistal dimensions less so. Correlations within measurements are not significantly different. Principal components analysis describes a similar level of variation (Eigenvalues, Crown PC1 7.609, PC2 2.802; Cervical PC1 7.953, PC2 3.120) and percent of variation (Crown PC1 47.55%, PC2 17.51%; Cervical PC1 49.703%, PC2 19.487%) between dimensions. Positive loadings in the first PC for both crown and cervical dimensions indicate

that size is a significant factor in describing variation. These analyses of crown and cervical measures suggest that cervical data can be used to describe similar relationships to those given by crown dimensions. The results correspond with previous research from both medieval England (Hillson et al. 2002) and Archaic Florida (Stojanowski 2006) and suggest that relationships between crown and cervical dimensions are broadly geographically and temporally stable. This research was supported by the J. Lawrence Angel Fellowship in Human Skeletal Studies.

Craniofacial variation and its relationship to diet in sympatric species of colobine monkeys.

JENNIFER M. HARRINGTON and JOYCE E. SIRIANNI. Department of Anthropology, University at Buffalo.

Colobine monkeys exhibit considerable craniofacial variation among species in general and between sympatric species of the same genus. The dietary differences within and between genera is also considerable (Curtin, 1977; Koyabu and Endo, 2009). *Presbytis*, *melalophus* and *Presbytis obscurus* are sympatric species inhabiting southeast Asia, while *Colobus guerza* and *Colobus badius* are African sympatric species. The purpose of this study is to investigate the relationship between craniofacial morphology and dietary adaptations in sympatric species of *Presbytis* and *Colobus*. Do species with similar diets but belonging to different genera exhibit similar morphological patterns?

Occlusal patterns and craniometric data were collected from dry skulls and radiographs of 50 male colobine monkeys: *Presbytis melalophus* (9); *Presbytis obscurus* (9); *Colobus badius* (9), and *Colobus guereza* (23).

While the posterior dentitions were observed to be in normal occlusion, a protrusion of mandibular incisors in front of the maxillary incisors known as 'underbite' was observed more frequently in *P. melalophus* (100%) than in *P. obscurus* (16%) and more frequently in *C. badius* (59%) than in *C. guereza* (18%). Species with a higher incidence of the underbite trait have broader, shorter faces with a major proportion of the shortening being seen in the length of the maxilla. They have more obtuse facial angles (Nasion-Prosthion-Posterior Nasal Spine) and more acute cranial base angles which tend to bring the maxillary dentition under the neurocranium.

A comparison of the diets of the sympatric species belonging to *Presbytis* and *Colobus* favors a conclusion that species with similar diets exhibit similar craniofacial morphology.

Pelvic variability and sexual dimorphism in Prehistoric Rapanui.

AMBER HARRISON¹ and NATIAN K. HARPER². ¹Statistical Research Inc., ²Department of Anthropology, University of Nevada, Las Vegas.

Population specific sexual dimorphism and pelvic variability in Prehistoric Rapanui are

tested using standardized measurements on an archaeological sample. Six pelvic measurements were taken on a sample ($n=46$) of individuals housed at the Padre Sebastian Englert Museum in Rapa Nui, Chile. Males and females were first evaluated using univariate statistics to determine differential size differences, and then a stepwise discriminant function procedure was applied to determine the reliability of these measurements for determining sex. Comparisons were made between the Rapanui sample and the Terry Collection samples of North American blacks ($n=80$) and whites ($n=80$) to test for population differences in size and shape. Rapanui males, were correctly classified at 93.3%, and 93.8% of females were correctly classified. Comparisons indicate that there are statistically significant size differences between Rapanui and the Terry Collection samples. Whites were found to be significantly larger in all dimensions, followed by blacks, then the Rapanui. The Rapanui showed a significantly smaller, yet highly dimorphic pelvic morphology. This investigation indicates that the method can be used to measure sex differences with high accuracy in the Rapanui sample. Additionally, this research demonstrates that population variability needs to be considered when applying traditional methods of sex determination using the os coxa. Future research utilizing this isolated skeletal sample and other geographically diverse samples may further our understanding of pelvic variability within and between populations.

The walking wounded: Mapping nonlethal violence on living Africans to provide insight for bioarchaeological interpretation.

RYAN P. HARROD, PIERRE LIÉNARD and DEBRA L. MARTIN. Department of Anthropology, University of Nevada, Las Vegas.

Although finding evidence of healed trauma on archaeological populations is fairly straight forward, the interpretation of the evidence is not. A questionnaire and body-mapping project was initiated and designed to indicate the patterning of healed wounds in Turkana communities (Kenya). Endemic patterns of aggression resulting from raiding and wife beating among pastoralists are well documented. The study documents cases of healed trauma resulting from all types of injuries sustained by individuals. The primary causes of those injuries have been determined through interview data. The findings indicate that 68.8% of the males and 85.7% of females reported trauma from accident or subsistence-related activities (e.g., falls, animal inflicted trauma, and plant interactions). For aggression-related trauma, 21.4% of the women suffered injury to the body and 64.3% sustained head injuries. For men, 43.8% suffered trauma to the body and 68.8% to the head. Injury recidivism was analyzed to understand the life history of reoccurring injury. Men (81.3%) suffered abuse as children, and 76.9% continued suffering from injuries as adults. These data confirmed our hypotheses about injury recidivism and raiding societies. About half (57%) of all women reported abuse as children, and of those, 87.5% report having

suffered injury as adults. These data demonstrate a number of cautionary points for bioarchaeologists including (1) the over-interpretation of trauma as aggression-related (2) the under-reporting of injury recidivism, and (3) the need for a more nuanced approach to understanding sex differences in patterns of trauma.

Comparing macroscopic, microscopic, and metric methods of assessing enamel hypoplasia: An alternative approach using a metric assessment of perikymata spacing.

BRENNNA HASSETT¹, SIMON HILLSON¹ and DANIEL ANTOINE². ¹Institute of Archaeology, University College London, ²The British Museum, London.

The macroscopic observation of enamel hypoplasia is standard practice in the bioarchaeological assessment of 'health', yet there remains no firm consensus on the patterns of hypoplastic defects of enamel caused by different enviro-social factors (e.g. weaning, subsistence transition, epidemic disease). It is suggested that failure to identify a coherent pattern in terms of peak age of, sexual dimorphism in, or effects of socio-economic status on defect occurrence results from the failure of macroscopic methods to detect a proportion of enamel growth disruption events. Taking a small sample of 18 sub-adults from the post-medieval London assemblage from the Lower Churchyard of St. Bride's Church, Fleet Street, the macroscopic observation of linear-form hypoplastic defects is compared to a microscopic assessment of defect presence. An established standard macroscopic method and one using a revised method of estimating defect timing are compared with visual observation at 10x magnification. These three methods are then compared to a metric approach established to remove the subjective element in visual defect identification and replace it with a more objective method based on metric assessment of deviation from the normal distribution of distances between successive perikymata, while controlling for the natural variation in perikymata spacing which occurs across the dentition. Differences were found in the number, location, and timing of observed defects using each method, and macroscopic methods were seen to 'miss' a considerable proportion of defects. This has implications for the use of standard techniques for assessing childhood growth disruptions in bioarchaeology. This study was funded through the generous support of the Wenner-Gren Foundation, Grant no. 7718.

Activity-related changes in the geometry of the proximal femur: A study of two Near Eastern samples.

KEVIN G. HATALA^{1,2}, STEVEN E. CHURCHILL³, JAIME ULLINGER⁴ and SUSAN GUISE SHERIDAN⁵. ¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Department of Evolutionary Anthropology, Duke University,

⁴Department of Anthropology, The Ohio State University, ⁵Department of Anthropology, University of Notre Dame.

Cross-sectional geometry of the proximal femur is compared in two Near Eastern human skeletal samples to examine the relationship between bone geometry and probable activity patterns. One sample consisted of 42 fragmentary and commingled femora from the Early Bronze Age (2950-2300 BC) site of Bab edh-Dhra' (Jordan). The other was made up of 57 fragmentary and commingled femora from the Byzantine (5th – 7th century AD) monastery of St. Stephen's in Jerusalem. Archaeological and historical evidence indicates distinct differences in the daily activities of the two groups represented by the skeletal samples. The Jordanian sample was part of a fairly mobile agricultural society, while the monastic sample was more sedentary and had a unique workload consisting of hundreds of genuflections each day. Femora were physically sectioned at the subtrochanteric region, cross-sectional views were photographed, and the images were analyzed using a computer program. The results clearly corresponded with aspects of the probable activity patterns in each sample. The Bab edh-Dhra' sample showed geometric ratios that reflected more ovoid cross-sectional shapes, indicating a higher level of mobility. The St. Stephen's sample showed significantly greater bending rigidities in all directions, a response consistent with habitual exposure to multi-directional forces arising from genuflection. The similarity between these results and the archaeological and historical evidence for activity strengthens the argument that cross-sectional geometry can be an accurate indicator of activity patterns in bioarchaeological studies. The results also support the idea that this method can even be applied in samples of fragmentary and commingled skeletal remains. This study was funded by the National Science Foundation Research Experiences for Undergraduates (SES 0649088).

The diversity of recent positive selection in human populations.

JOHN HAWKS. Department of Anthropology, University of Wisconsin-Madison.

Genome-wide scans have identified hundreds of candidate loci for positive natural selection in human populations during the last 30,000 years. Candidates have been identified in dense single nucleotide polymorphism (SNP) samples in only a handful of populations, limiting our understanding of their origin and dispersal, and reducing the power of statistical tests. Here, I extend tests of selection to the Phase 3 HapMap samples of people with ancestry in Gujarat, India; Kinyawa and Webuye, Kenya; and Tuscany, Italy. The results are compared to earlier samples representing Northern Europe; Ibadan, Nigeria; Tokyo, Japan and Beijing, China, as well as the more limited SNP number taken from the broader geographic sample of the Human Genome Diversity Project. Candidate loci include those that strongly reject the hypothesis of genetic drift under a model of Holocene and earlier population growth; the

results show these to be strongly biased toward genic regions. Some loci have a strongly regional geographic distribution (high Fst) but others present an unexpected combination of very recent, very widespread, and relatively rare. These examples do not match the predictions of a "wave of advance" model of selection, and suggest that occasional long-distance migration or interaction epistases been important factors in our recent evolution. Stochastic processes underlying selection, including mutation, gene-gene interactions, and rare dispersal, may have been chief determinants of the present pattern of human diversity.

Determinants of skeletal age deviation in South African children.

NICOLA HAWLEY^{1,2}, EMILY ROUSHAM¹, SHANE NORRIS², JOHN PETTIFOR² and NOËL CAMERON^{1,2}. ¹Health and Lifespan Research Centre, Loughborough University, United Kingdom, ²Department of Paediatrics, University of the Witwatersrand, South Africa.

Although recent research has linked decreased bone mass and increased risk of fracture in childhood with delayed skeletal maturity relative to chronological age, knowledge of factors determining skeletal age deviation (SAD) is limited. The current study explores biological and environmental factors associated with SAD in the South African Birth to Twenty longitudinal birth cohort study.

Skeletal age was examined in 368 children (n=194 male) aged 9/10 years using the Tanner and Whitehouse (TW3) method. Key indicators of growth (i.e. height, weight, and growth velocities), body composition, and socio-economic status (SES) were assessed during infancy and childhood.

Multivariate regression analysis identified two independent predictors of SAD in both males and females. Being stunted at two years was associated with greater delay in skeletal maturity at 9/10 years. Having greater lean mass at 9/10 years was associated with less delay. Further gender specific factors were identified; greater weight at two years in males and being pubertal at 9/10 years in females were associated with less delay in skeletal maturity. Measures of SES were independent predictors of SAD in males only, but became non-significant when included with measures of current stature and body composition. The results of this study suggest that increased weight in infancy and greater lean mass in late childhood are determinants of the degree of difference between skeletal maturity and chronological age.

The Genetics of the Alaskan North Slope (GeANS) Project reveals a higher than expected frequency of mtDNA haplogroup D among Alaskan Inupiat populations.

M GEOFFREY HAYES^{1,2} and MARGARITA RZHETSKAYA¹. Departments of ¹Medicine and ²Anthropology, Northwestern University, Chicago, IL.

The nature of the Thule expansion from north Alaska to the Eastern Canadian arctic appears to have been a very rapid migration, taking perhaps only 100-200 years for Alaskan Thule populations to reach their eastern terminus. This migration is associated with a clear signal of near population replacement; the migrating Thule replacing, and perhaps interbreeding with, late Paleo-Eskimo populations – the Dorset. The Inupiaq speaking populations across northern North America are virtually monomorphic for mitochondrial haplogroup A (the remainder are D [<3%]), and this reduced genetic variability is not unexpected in small, isolated populations, such as the prehistoric Thule are likely to have been. Very little is known genetically of the North Alaskan Inupiat population, the local descendant of the most-likely source population for the subsequent Thule/Inuit inhabitants of the Eastern North American Arctic. Our recent investigations of mtDNA haplogroup frequencies of individuals residing in communities across the North Slope reveal a higher frequency of haplogroup D (14/109, or 13%; the remainder are A) than anticipated suggesting they are a reasonable source population for the D (as well as A) present in the contemporary Eastern Arctic populations. Herein, we present our preliminary investigations into the mtDNA and Y-chromosome haplotype frequencies of Inupiat populations from the Alaskan North Slope, and discuss the placement of this population in the geographical and temporal context of North American Arctic Prehistory. This study was funded by the National Science Foundation, grant number OPP- 0732857.

Grasping primate development: ontogeny of intrinsic hand and foot proportions in white-fronted capuchin monkeys (*Cebus albifrons*).

AMBER N. HEARD-BOOTH¹ and JESSE W. YOUNG². ¹Department of Anthropology, University of Texas at Austin, ²Department of Anatomy and Neurobiology, Northeastern Ohio Universities College of Medicine.

The present study examines the ontogenetic changes of intrinsic hand and foot proportions in white-fronted capuchin monkeys (*Cebus albifrons*). Previous studies of primate limb growth have shown that young primates often have relatively large hands and feet for their body size. This feature is thought to afford enhanced grasping ability for clinging to their caregiver's fur as well as facilitate locomotion on relatively large (i.e., "adult-sized") substrates. If directional selection for improved grasping ability is responsible for the scaling trends observed in young primates, then one might expect intrinsic hand and foot proportions to also change throughout growth.

We measured manual and pedal metapodials and non-distal phalanges in a mixed-longitudinal radiographic sample of 23 *C. albifrons* individuals (15 male and 8 female; combined age range: 0-4.4 years). Raw bone lengths were 1) converted into phalangeal indices (PI: non-distal phalangeal length ÷ metapodial length) to test for age-related changes in intrinsic proportions and 2) regressed against body mass to test for allometric growth

of individual elements. Spearman correlations and LOESS regressions showed that manual and pedal PIs generally decrease with body mass and age, respectively. Linear mixed-effect regressions of log bone lengths on log body masses revealed that metapodial lengths generally scaled allometrically faster than phalangeal lengths, accounting for the observed declines in PIs over development. The data from this study are consistent with the hypothesis that primates are under selection for increased grasping ability early in life.

Were the Bronze Age inhabitants of Tepe Hissar biological participants in an inter-regional exchange network across the Iranian Plateau? A dental morphometric investigation.

BRIAN E. HEMPHILL. Dept. of Sociology and Anthropology, California State University, Bakersfield.

Tepe Hissar represents one of the best known Bronze Age sites in Iran. Located 150 kilometers northeast of Tehran, it has been suggested from archaeological evidence that the inhabitants of this site were involved in trade relationships with urban populations of the Bactrian-Margiana Archaeological Complex of south Central Asia and, to a lesser degree, with urban populations of the Harappan Civilization within the Indus Valley of Pakistan. This research seeks to test whether such trade across the Iranian Plateau was accompanied by gene flow. This investigation is based on measurement of maximum mesiodistal lengths and buccolingual breadths of all permanent teeth, except third molars, and assessment of dental morphology variations scored in accordance with the Arizona State University Dental Morphology System in a sample of 214 individuals recovered from Tepe Hissar for which sex could be determined. These data were contrasted with 20 samples of prehistoric and living individuals from Central Asia, Pakistan, and peninsular India. Patterns of intersample differences were examined with neighbor-joining cluster analysis and multidimensional scaling.

Results obtained from odontometric and dental morphology analyses are virtually identical. In both cases, the inhabitants of Tepe Hissar exhibit closer affinities to Central Asians, especially the inhabitants of Altyn depe, than to prehistoric and living inhabitants of the Indus Valley and peninsular India. Hence, it appears that while trade between Tepe Hissar and southern Central Asia did result in significant gene flow, this was not the case between Tepe Hissar and populations of the Indus Valley and beyond.

Handedness and enthesis size: A relationship?

CHARLOTTE HENDERSON. Department of Archaeology, Durham University, UK.

Occupation defines who we are, because it defines our role and position in society. Consequently, activity-patterns have been widely studied in archaeological contexts and

one of the most commonly used methods is the study of entheses. Entheses have two forms: fibrous and fibrocartilaginous. The former are poorly demarcated on skeletal remains. Fibrocartilaginous entheses, in contrast, are well demarcated because of the two layers of fibrocartilage mediating between soft and hard tissue. The aim was to study differences in size of fibrocartilaginous entheses in the upper limb, between the left and right sides in skeletons of known occupation and known age. The hypothesis was that right side entheses would be largest, because the majority of the population are right handed. The majority of the skeletons were from St. Bride's Church, but two further London collections were used to increase sample size: Chelsea Old Church, and St. Benet Sherehog (n=48). All skeletons were male. Measurements were made of eight entheses in the upper limb in two perpendicularly bisecting directions. Measurements of nearby bony structures, such as the vertical head diameter for the supraspinatus insertion, were also taken. The presence of enthesal remodelling was also recorded. Results indicated that there was very little difference in size between left and right sides, even when the data had been standardized by bone size. The hypothesis was rejected. Many methods have been used to record entheses for activity studies, but until enthesal remodeling is understood, they should be applied to archaeological samples with caution.

Confirmation of secular increase in spina bifida occulta among Swiss birth cohorts.

MACIEJ HENNEBERG¹, YU CHAO LEE², LUCIAN BOGDAN SOLOMON², FRANK JACOBUS RÜHLI³, REGULA SCHIESS³, LENA ÖHRSTRÖM³, THOMAS SULLIVAN⁴ and HATEM ALKADHI⁵. ¹Biological Anthropology and Comparative Anatomy Research Unit, The University of Adelaide, Australia, ²Department of Orthopaedics and Trauma, Royal Adelaide Hospital, North Terrace, Australia, and Discipline of Orthopaedics and Trauma and Discipline of Anatomical Sciences, The University of Adelaide, Australia, ³Institute of Anatomy, University of Zürich, ⁴Discipline of Public Health, The University of Adelaide, Australia, ⁵Institute of Diagnostic Radiology, University Hospital Zurich.

Previous studies on the prevalence of spina bifida occulta have indicated a secular increase in its frequency and possible population differences in the prevalence of the condition. Rise in spina bifida occulta and its associated pathologies may have impact on the health of the population. We studied the frequencies of closed and open sacral canals at each sacral level in two birth cohorts in Switzerland.

Transverse CT scans and multiplanar reconstruction images of sacra of 95 males and 96 females born in 1940-1950 and 99 males and 94 females born in 1970-1980 in Switzerland were reviewed. All participants were patients who underwent routine clinical abdominal CT examinations. Images taken for symptoms related to spina bifida and pelvic ring injury were excluded. Frequencies of non-closure at each level were compared between the two birth

cohorts and the sexes using logistic GEE regression models incorporating interaction effects.

We found that individuals born later have significantly more open sacral arches when compared to those born 30-40 years earlier at all sacral levels (OR = 0.50, p < 0.01). When results were compared to previously published data on Australian cohorts, the trend was the same, but Swiss in both cohorts were less likely to have an open section than Australians at all locations apart from S2.

This study confirmed a secular trend in opening of sacral canal among two different generations in Switzerland and demonstrated a population difference in the prevalence of spina bifida occulta.

Fluctuating asymmetry and developmental stress in three Imperial Roman cemeteries.

SAMANTHA M. HENS¹ and VALERIE B. DELEON². ¹Department of Anthropology, California State University Sacramento, ²Center for Functional Anatomy and Evolution, Johns Hopkins University.

Fluctuating asymmetry (FA) is commonly used as a biological indicator of individual and population health, environmental stress and developmental stability. This study examines FA in the craniofacial skeletons of individuals representing three Imperial Roman populations: Velia, Isola Sacra and Castel Malnôme, which vary in their exposure to nutritional and systemic stress, due in part to differing underlying economic conditions. Previous studies indicate that while the individuals buried at Velia and Isola Sacra were from coastal port populations, their diets were significantly different. The individuals from Castel Malnôme represent an inland population from the area of Rome involved in heavy labor associated with salt production. Data were recorded from 34 three-dimensional landmark coordinates on the crania of 65 individuals and analyzed using Euclidean Distance Matrix Analysis (EDMA), a geometric morphometric approach. Landmark coordinates were digitized in two separate trials and averaged to minimize error.

Results indicate that crania from Velia display greater amounts of FA than those from Isola Sacra, suggesting that individuals buried at Isola Sacra suffered less nutritional/systemic stress than those buried at the more southern port of Velia. Interestingly, the individuals buried at the Isola Sacra site exhibit greater FA than those from nearby Castel Malnôme. Overall, levels of FA were low for all three populations. These results support the idea that varying levels of nutritional/systemic stress affect the development of the cranium and this asymmetric variation may be identified as evidence of this stress. This study was funded in part by a grant from Research and Sponsored Projects, University Enterprises, Inc. at the California State University Sacramento.

The association between several serum biomarkers and cardiovascular disease status in captive western lowland gorillas (*G. gorilla gorilla*).

ERIC HENTHORN¹, PAM DENNIS², HAYLEY MURPHEY WESTON³, ILANA KUTINSKY⁴, WILLIAM DEVLIN⁴ and MARY ANN RAGHANTI^{1,2,5}. ¹Department of Anthropology, Kent State University, ²Cleveland MetroParks Zoo, Cleveland, ³Zoo Atlanta, Atlanta, ⁴Michigan Heart Group, Troy, ⁵Department of Anthropology and School of Biomedical Sciences, Kent State University.

Captive western lowland gorilla (*G. gorilla gorilla*) mortality due to cardiovascular disease has been reported to be as high as 41% in adult males during a 10 year period. Postmortem diagnoses include aortic dissection and fibrosing cardiomyopathy. We suspected that cardiac disease in captive gorillas is associated with metabolic syndrome, including dyslipidemia, insulin resistance, and increased inflammation. To address this question, serum was analyzed for several biomarkers from captive gorillas (31 males, 17 females) from AZA institutions. Cardiac disease status was identified from echocardiographs (n = 21 cardiac disease, n = 27 normal). Only one female presented with cardiac disease. An analysis of males showed serum leptin to be greater in individuals with heart disease $t(29) = -2.37$, $p = 0.03$. To further evaluate this, a multiple linear regression was conducted regressing various biomarkers on leptin. The model that explained the greatest proportion of variance for males with heart disease, $R^2 = 0.610$, $F(5, 18) = 3.78$, $p = 0.03$, revealed that significant predictors included insulin, $b = 0.467$, $t(17) = 2.39$, $p = 0.02$, and cholesterol $b = -0.480$, $t(17) = -2.307$, $p = 0.04$. In humans high concentrations of leptin, insulin, and cholesterol are associated with metabolic syndrome and cardiovascular disease. It appears that these risk factors are also associated with heart disease in male gorillas at zoos. This work was supported by the Institutes of Museum and Library Services (MA 06-08-0349-08)

Stature and activity-related osteological changes in Late Neolithic populations from Qinhai and Hebei Provinces, China.

MAURICIO HERNANDEZ¹ and HONG ZHU².

¹Department of Anthropology, CUNY Hunter College, ²Research Center for Chinese Frontier Archaeology, Jilin University.

It is generally agreed that human populations experienced marked health changes worldwide during the subsistence switch to agriculture. The goal of this research is to assess the impact that subsistence changes and associated activity patterns on the health of Northern Chinese populations. The study incorporates archaeological site reports, along with postcranial data from four contemporaneous populations from the Xindian culture in Qinhai Province and one population from the site of Jiangjialiang in Hebei Province, China. The data was compared to historic East Asian collections housed at the AMNH, New York City and the NMNH, Washington, D.C. in order to discern differences in bone structure and stature.

Average male and female stature was calculated for each site and degrees of bilateral asymmetry for both sexes were determined by percentage

directional asymmetries (%DA) and percentage absolute asymmetries (%AA). The results suggest moderately higher levels of bilateral asymmetry in males from Neolithic populations. Lastly, we note that these populations experienced increased incidence of lower limb periostitis, lumbosacral transitional vertebrae and complete spina bifida of varying degrees. Such conditions suggest high frequencies of heavy lifting and generalized infections, probably exacerbated by improper nutrition. Our findings indicate moderate to severe osteological changes occurring at the regional level within these Late Neolithic populations. These changes come as a result of a shift in subsistence activities and increasing socioeconomic complexity. This study was funded by the Lynn-Marie and Walter Wieland Fund for Field Anthropology, awarded to undergraduate and graduate students at CUNY Hunter College, NY.

Does the behavior of blind night monkeys (*Aotus*) differ from conspecifics with normal vision?

JAMES P. HERRERA¹, BREHAN C. FURFEY² and LINDA TAYLOR³. ¹Inter-departmental Doctoral Program in Anthropological Sciences, SUNY Stony Brook, NY, ²Evergreen State College, WA, ³Department of Anthropology, University of Miami.

Night monkeys (*Aotus*), like tarsiers, are secondarily nocturnal. The DuMond Conservancy (Miami, FL) houses night monkeys, some of which are blind due to biomedical research performed elsewhere. Because visual acuity in primates is posited to have coevolved with arboreality, we hypothesized that there would be detectable differences in the behavior of blind individuals compared to sighted conspecifics. We scored the frequency of six behaviors (scent mark, vocalize, socialize, locomote, feed, inactive) for focal animals during 101 fifteen minute-long sessions (median = 4/individual). The study included six blind and 18 sighted monkeys housed outdoors in social groups. Observations were randomized and scores did not differ between samples (Friedman test, $p > 0.05$), eliminating moonlight as a systematic source of variability. The proportion of scores in each behavior did not differ between blind and sighted individuals, except that scent marking was significantly more frequent in blind monkeys (mean = 0.047, $sd = 0.015$) than in sighted monkeys (mean = 0.011, $sd = 0.009$; $U = 23.5$; $p < 0.05$). Our results indicate that blind individuals are still active and engaged in social life but may compensate for lost visual input with increased reliance on olfaction. Because crypsis is important to their life style, increasing the frequency of calling may not be a viable alternative. Comparison of data under contrasting light conditions (full moon cf. no moon) may shed more insight into the means by which individuals respond to life in the trees without normal vision.

Dental wear and antemortem tooth loss among three Archaic Florida hunter-gatherer skeletal samples: Gautier (8BR193),

Bay West (8CR200), and Windover (8BR246).

CHRISTEN HERRICK¹, HEATHER WALSH-HANEY¹ and KATY SHEPHERD¹. ¹Division of Justice Studies, Florida Gulf Coast University.

Age, sex, diet, and the paramasticatory behaviors associated with social rank affect the prevalence of antemortem tooth loss and the extent of dental wear observed within hunter-gatherer populations. The destruction of occlusal surfaces progress through the following destructive changes: polishing, blunting, dentin exposure, dentin coalescence, and pulp chamber exposure. Additionally, dental wear hastens antemortem tooth loss and may lead to localized and/or systemic infections. We add to existing dental wear and antemortem tooth loss research through our investigation of oral health in Florida Archaic skeletal samples from Gautier (8BR193, $n=839$), Bay West (8CR200, $n=303$), and Windover (8BR246, $n=1236$). In addition, our research helps to provide information concerning the overall health status of early Floridian hunter-gatherers.

We scored the incidences of antemortem tooth loss and the degree of dental wear in each skeletal sample as observed macroscopically through a 5x hand lens. The Gautier sample evidenced the greatest degree dental wear and antemortem tooth loss ($n=14$ individuals; 87.5%) while the Windover sample had the least ($t=9.082$; $p=0.000$). The Bay West sample was similar in frequency and degree to Gautier; although, the findings were statistically different ($t=2.853$; $p=0.004$). Dietary differences between these samples may be related to the differences in dental wear and attrition frequency.

Isotopic evaluation of modern human remains from the University of Tennessee William M. Bass Donated Collection.

NICHOLAS P. HERRMANN¹, ZHENG-HUA LI² and MIRIAM SOTO³. ¹Department of Anthropology and Middle Eastern Cultures, Mississippi State University, ²Department of Earth and Planetary Sciences, University of Tennessee, ³Department of Anthropology, University of Tennessee.

Documenting variation in isotopic signatures of modern human populations has become a key area of investigation for forensic anthropologists. The present study builds on recent advances in isotopic research by examining the variation in the William M. Bass Donated Collection housed at the Forensic Anthropology Center (FAC) at the University of Tennessee. Results of the initial year of research are reported with work focusing on extraction protocol improvements and sample assessment. Donations at the FAC have been processed through the Anthropological Research Facility and represent a proxy for modern surface and buried forensic cases. Osseous, hair, and dental samples were selected from 66 donations with detailed residential histories. Multiple constituents including bone collagen, bioapatite (phosphate and carbonate), and hair keratin are prepared from bone, teeth and hair for isotopic

analysis by using refined protocols after Ambrose (1990, 1993), Balasse et al (2002) and Stephan (2002). The protocols are enhanced by shortening the cycle of each sample preparation period by applying the ultrasonic water bath to the extraction process, application of full-strength NaOCl for bone and tooth apatite preparation, and developing a doping method to improve d18O analytical precision of tooth phosphate on TC/EA. Resulting isotopic profiles are then compared to the residential histories of the sampled donations. Finally, an internet-based forensic isotopic database has been developed for the submission of isotopic profiles from known individuals with residential histories. The database will be demonstrated and available for review.

The premature closure of the sagittal suture and its consequences on the human skull shape: New findings and hypothesis.

YANN HEUZE¹, SIMEON A. BOYADJIEV² and JOAN T. RICHTSMEIER¹. ¹Department of Anthropology, The Pennsylvania State University, ²Section of Genetics, Department of Pediatrics, School of Medicine, University of California Davis.

Nonsyndromic sagittal craniostenosis (NSC) is an isolated developmental anomaly corresponding to the premature closure of the sagittal suture. So far, little is known about the genetic basis of NSC and this anomaly is thought as a homogeneous phenotypic group of unknown etiology presenting with dolichocephaly. Our goal was to investigate skull shape variation in a sample of infants with NSC. 3D coordinates for a set of 33 landmarks and 189 semilandmarks were measured on preoperative head CT exams of 43 infants with NSC (35 boys and 8 girls) aged from 0.9 to 9 months. The final location of the semilandmarks was obtained using a bending energy minimization algorithm and shape coordinates were estimated using Procrustes superimposition. Patency of the anterior and posterior aspects of the sagittal suture (SS) was recorded as totally or partially fused.

Shape coordinates were analyzed using principal component analysis. No obvious separation of the data was observed according to sex or 3-month age groups. However, the first principal component (PC1) allowed the separation of individuals according to SS patency. PC1 negative scores corresponding to an anteriorly closed and posteriorly fused SS were associated with a larger temporal width and a relatively high position of lambda. PC1 positive scores corresponding to an anteriorly fused and posteriorly closed SS were associated with a posteriorly narrower skull, a relatively low lambda and an anteriorly projected frontal. These observations are interpreted in terms of growth trajectories affected by the timing of sagittal suture closure and dynamics of the growing brain. This study was funded in part by DE016886, CDCSR01000350 and R01 DE018500.

Reassessing Neanderthal locomotor efficiency on a non-plain terrain.

RYAN HIGGINS. Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

Long limbs are often predicted to improve locomotor efficiency by reducing the angular displacement of the stepping leg while increasing stride length. It has been suggested that early in the evolution of the genus *Homo*, long lower limbs facilitated changes in ecology such as allowing larger home ranges in open environments. In contrast, *Homo neanderthalensis* exhibits a secondarily truncated limb morphology, possibly the result of selection to minimize relative surface area in cold climates. Most studies on human locomotor efficiency focus on efficiency in open, flat environments and conclude that the short-limbed Neanderthals were less efficient locomotors than modern humans. Since archaeological evidence suggests that Neanderthals never took advantage of the Great Eurasian plain and had an ecology consistent with strict cave dwelling, this investigation compares Neanderthal and modern human locomotor efficiency on sloped terrains. A trigonometric model was developed that determines the angle of the stepping leg when given the step length, lower limb segment lengths, and the degree of the slope. Neanderthal and modern human expectations were contrasted and then compared to analogous situations occurring in the family Bovidae. Results suggest that 1) for any given stride length, long distal limb segments increase the angular displacement of the stepping leg when hiking up sloped terrains; 2) Neanderthals can be more efficient locomotors on sloped terrains than longer-limbed modern humans due to their low crural indices; and 3) shortened distal limb segments appear to be important for bovids that inhabit sloped terrains regardless of climate.

Intersegmental coordination during quadrupedal walking in Japanese macaques (*Macaca fuscata*).

YASUO HIGURASHI, EISHI HIRASAKI and HIROO KUMAKURA. Graduate School of Human Sciences, Osaka University.

Animals must coordinate the motion of their body segments in order to move from one place to another. Recent experimental studies applying principal component analysis (PCA) to kinematics have advanced our knowledge of intersegmental coordination in motor behavior. During human walking, the motion of three segments in the lower limb, *i.e.*, the thigh, leg, and foot, can be captured by a smaller number of principal components (PCs). This "low dimensionality" might simplify the potentially complex process of locomotor control. So far, PCA has been used mostly in studies of human movements. Here, we applied PCA to quadrupedal walking in Japanese macaques (*Macaca fuscata*) to address two issues: (1) the number of PCs needed to capture limb motion sufficiently, and (2) the differences in intersegmental coordination between the hind- and forelimbs. Two Japanese macaques were motivated to walk on a flat runway and other substrates at their preferred speed. We measured

elevation angles (with respect to the vertical axis) for six limb segments: the thigh, leg, foot, upper arm, forearm, and hand. We performed PCA on elevation angles for the hind- and forelimbs separately. The variance accounted for by the first two PCs was >98% for the hindlimb and ~96% for the forelimb for walking on the runway. Stick figures reconstructed from the first two PCs show that the segment motion can be captured sufficiently by a smaller number of PCs for the hindlimb, but not for the forelimb. These results suggest different control strategies for the hind- and forelimbs. This study was funded by Grant-in-Aid for JSPS Fellows, grant number 915.

Patterns of morphological integration in the newborn brain.

CHERYL A. HILL¹, JORDAN R. AUSTIN¹, JOAN T. RICHTSMEIER², YINGLI WANG³, ETHYLIN W. JABS³ and KRISTINA ALDRIDGE¹. ¹Department of Pathology and Anatomical Sciences, University of Missouri-Columbia School of Medicine, ²Department of Anthropology, Pennsylvania State University, ³Department of Genetics and Genomic Sciences, Mount Sinai School of Medicine.

Different regions of brain develop and evolve in concert, resulting in integration of neural structures. Patterns of morphological integration (MI) are thought to change during the lifespan, resulting at least in part from the influences of genetic and environmental factors. The purpose of this study is to determine morphological integration patterns of the brain in newborn (P0) wild-type mice to establish baseline information concerning the integration of the brain at birth. Analysis of mice on an inbred genetic background allows examination of MI patterns while eliminating potential effects of divergent genetic backgrounds on these patterns.

The study sample includes 22 mice sacrificed at P0, bred on the C57BL/6 inbred background. Three-dimensional landmark coordinate data were collected from micro-magnetic resonance images of the murine brain. Twenty landmarks collected from internal and external structures were analyzed for patterns of integration using MIBoot, a nonparametric method for analyzing integration patterns. Results suggest that distances spanning from the midline internal structures to surface landmarks are highly integrated at P0 mice. However, linear distances that include bilateral internal structures, such as caudate nuclei, demonstrate lower integration with other portions of the brain. By understanding the developmental precursors for neural integration in mouse models, we can begin to discern the developmental bases for differences in neural integration in anthropological samples. This project was supported by NIH grant: NIDCR R01 DE018500.

Growth and development in the children's skeletons and dentitions from the Neolithic site of Catalhoyuk in Turkey.

SIMON HILLSON¹ and BASAK BOZ². ¹Institute of Archaeology, University College London, UK, ²Trakya University, Edirne, Turkey.

Since 1996, excavations at Catalhoyuk have produced at least 300 human skeletons. Two thirds of these are of children. This large assemblage can be used to address questions about the social organisation of the houses on the site which contain the burials. Current interpretations stress divisions between more "important" houses (larger, more elaborate, or with more burials, or longer lasting) and the ordinary houses. In this project we use development of bones and teeth to test the hypothesis that children buried in "important" houses lived under more favourable conditions of diet and hygiene and achieved developmental stages at a younger age than those buried in other houses.

Measurements of developing bones or teeth were available for 139 individuals from the collection, divided into two groups: "important" houses and normal houses. Measurements of the basilar occipital are particularly useful for studying the rapid growth of young children, but the two groups of children showed very similar patterns of development for this bone. In addition, for all age groups, long bone development was compared with dental development, which is thought to be less affected by environmental factors than skeletal growth. There were, however, similarly few differences between the groups. Thus, we have not so far been able to demonstrate any differences in developmental schedule and conclude either that the social differences were not large enough to affect children's growth, or that burial in one or the other group of houses did not reflect large social differences.

Life and health among the enslaved of Ingleside Plantation, Davidson County, Tennessee.

SHANNON CHAPPELL HODGE¹. ¹Department of Sociology and Anthropology, Middle Tennessee State University.

Data were collected from a skeletal population of enslaved African Americans from the Ingleside site, an antebellum plantation near Nashville, Tennessee. Remains were evaluated for presence of nutritional or metabolic stress, infectious disease, non-specific infection, trauma, degenerative diseases, skeletal robusticity, enthesopathic lesions, and dental disease, particularly focusing on the comorbidity of these conditions. Methods involved gross examination, tabulation of observed pathology, and analysis using conventional statistical tests for parametric and non-parametric data.

Ingleside Plantation was owned by William Jefferson Donelson, nephew of U.S. President Andrew Jackson. Ingleside was contiguous with Jackson's Hermitage, and records suggest slaves of both plantations worked together and were well-provisioned. Existing bioarchaeological literature on slavery and local archival records suggested the Ingleside slaves would have been well-nourished but exhibit work stress and

premature degenerative conditions consistent with enslavement.

Contrary to expectations, analyses demonstrate that the Ingleside's slaves suffered high infant and childhood mortality and frequent nutritional and metabolic insult. The population also suffered expected types of work stress, but to an unexpected degree of severity. This research contributes new information to the revisionist debate surrounding power relationships between slave and master, and the status of slaves in the antebellum economy. In particular, these results lend scientific weight to first-person slave narrative documenting neglect and overwork at the hands of many slaveholders, and belie apologists' claims that slaves' status as valued property would have ensured adequate nutrition for childbearing women and spared men, women, and even children from the deleterious effects of excessive manual labor. This study was funded by the Faculty Research and Creative Activities Committee, Middle Tennessee State University.

Inferred geographic origin of a population range expansion using GIS and multi-locus genomic data: The origin of modern humans as a test case.

JASON A HODGSON^{1,3} and MARY BLAIR^{2,3}.
¹Center for the Study of Human Origins, Dept. of Anthropology, New York University,
²Ecology, Evolution and Environmental Biology, Columbia University, ³The New York Consortium in Evolutionary Primatology.

Humans and many other species are characterized by a recent origin followed by range expansion into virgin territory. Here we present a method for inferring the geographic origin of a species characterized by range expansion using multi-locus genetic data and Geographic Information System (GIS) models. Population genetic models suggest that the serial founder effect associated with a population range expansion results in a loss of genetic diversity with increasing distance from the geographic origin of the expansion. We utilize the negative correlation between geographic distance and genetic diversity to infer the origin of the range expansion. We calculate average heterozygosity for sample populations across the landscape using multi-locus genetic data. We then calculate the geographic distance from multiple points sampled systematically across the landscape to all of the sample populations. We use a least-cost model implemented in ArcGIS 9.3.1. This can consider landscape features such as bodies of water, deserts or mountains with different costs to movement, more realistically describing potential dispersal routes. We then calculate the correlation coefficient (r) and the coefficient of determination (r^2) between geographic distance and heterozygosity for all sampled points. The geographic origin of expansion is inferred to be the point with negative r and maximum r^2 . We have automated the process using Python and Perl.

We demonstrate this method with a human data set consisting of 181 worldwide populations (121 African, 60 non-African) and 848 genomic microsatellite loci.

A GIS-based approach to documenting carnivore and hominin damage to bones.

JENNIFER A. HODGSON^{1,2}, THOMAS W. PLUMMER^{1,2,3}, JAMES S. OLIVER⁴, REBECCA BOSE⁵. ¹Department of Anthropology, City University of New York (CUNY) Graduate Center, ²New York Consortium in Evolutionary Primatology (NYCEP), ³Department of Anthropology, Queens College, CUNY, ⁴Anthropology and Information Technology, Illinois State Museum, ⁵Wolf Conservation Center, South Salem, NY.

Experimental studies of modern carnivore tooth marking patterns and human butchery patterns are integral to understanding the nature of carnivore and hominin involvement in archaeological bone assemblages. However, experimental data-sets for carnivore- and hominin-induced modifications are limited. Further, methods for analysis of these modifications on archaeological bone assemblages are not well standardized. Here we present an expanded set of large canid bone damage data collected from feeding experiments conducted with Mexican Gray Wolves (*Canis lupus baileyi*) and Red Wolves (*Canis rufus*). We also present cut mark data collected from butchery experiments on goat limbs using stone tools. We use the image-analysis GIS approach described by Marean et al. (2001) to document both tooth mark and cut mark distribution. Further, we introduce the use of the ArcGIS Spatial Analyst tools to identify bone modification hot spots and to determine whether clusters are significant. Our results suggest that with a large enough sample, the GIS Spatial Analyst can be a useful tool for analyzing the distribution of bone modifications and for making comparisons between experimental and fossil assemblages which will aid in identifying the size of carnivores modifying assemblages and potentially their access sequence. Finally the use of this rigorous methodology is a step toward increasing standardization in methods of taphonomic analysis.

Constrained development of language processing: Ontogenetic organization of the developing petrosal conditions the early human speech pattern.

LISA A. HOGAN. Department of Anthropology, University of New Mexico, Albuquerque.

Developmental events in the temporal bones shifts the pattern of a given speech sound's acoustic profile through the time children are mapping linguistic sound systems; both individual speech sounds and their relationships to another in the map change as children's hearing approaches adult sensitivities. Learning effects form a hierarchy of perception based on auditory frequencies differentially accessible through development (ontogeny).

To model the acoustic effects caused by developing temporal bones, adult data collected from native speakers of Diné and English were modified to reflect the form of children's hearing sensitivities at different ages based on

the patterns established in the psychoacoustic literature. Vowels and vowel maps were compared for points of similarity in the way information in vowels is filtered due to the constraint imposed by immaturity of temporal bones at different developmental stages.

Results show that the generalized pattern expected is observed. Early formant peak pattern becomes successively modified in a constrained pattern reflecting maturational process.

There is an interesting and as yet unexplained artifact in the observed gradual progression to full adult hearing which may be the effect of the foramen of Huschke acting as a data filter in the time sequence correlated with bipedal walking. If this hypothesis is correct it will have significance for models suggesting a cascade of developmental timing effects stage throughout early language development. Given that immature temporal bones reflect brain expansion and rotational birth in hominids, these results contribute to the discussion of the biological underpinnings of the evolution of language.

Adaptations to tree-gouging in the anterior masticatory apparatus of marmosets (*Callithrix*).

RUSSELL HOGG^{1,2}, MATTHEW J. RAVOSA¹, CHRISTOPHER J. VINYARD³ and TIMOTHY M. RYAN⁴. ¹Department of Pathology & Anatomical Sciences, University of Missouri School of Medicine, ²Department of Anthropology, CUNY & NYCEP, ³Department of Anatomy and Neurobiology, NEUCOM, ⁴Department of Anthropology, Pennsylvania State University.

Although all genera of Callitrichinae engage in exudative to some degree, marmosets (*Callithrix*, *Cebuella*) take advantage of exudates to the greatest extent. To facilitate exudate feeding, marmosets use their anterior teeth to gouge holes in bark and actively stimulate gum flow. As such, their anterior mandibular teeth possess specialized adaptations such as thickened labial enamel. Marmosets also show masticatory features that facilitate increased gape, but do not appear to generate relatively large bite forces during gouging. However, even without increased bite force the anterior teeth of gougers likely experience different loading patterns compared to non-gouging platyrhines. Specifically, one might expect that the anterior teeth and symphysis of marmosets are adapted to accommodate relatively high stresses linked to dissipating forces from yield-resistant and tough tree barks. This study uses histological data from thin-sectioned teeth, microCT data of jaws and teeth, and macroscale tests of simulated symphyseal loads to compare the micro- and macro-architecture of the anterior masticatory apparatus in *Callithrix* and *Saguinus* (as well as the outgroup *Saimiri*). *Callithrix* differs from the other genera in that its canine enamel possesses a much higher degree of decussation, and its anterior tooth roots are larger relative to alveolar bone volume. However, simulated jaw loading suggests a reduced ability to withstand external forces in the marmoset symphysis. The

contrast between increased load-resistance ability in the anterior dentition versus relatively reduced symphyseal strength suggests both a potentially complex loading environment during gouging and a mosaic pattern of dentofacial adaptations to this derived biting behavior. This study was funded by NSF Doctoral Dissertation Improvement Grant 0622479 and NSF grants: BCS-0924592, BCS-0412153, BCS-0094666, BCS-990847.

Body proportions of the Jebel Sahaba sample.

TRENTON W. HOLLIDAY¹. ¹Department of Anthropology, Tulane University.

The Epipaleolithic site of Jebel Sahaba (Sudan) was discovered in 1962, ca. 1 km from the east bank of the Nile, and ca. 3 km north of Wadi Halfa (the site is now submerged beneath Lake Nasser/Nubia). From 1962-1966, a total of 58 intentionally-buried skeletons were uncovered at the site. Diagnostic microliths suggestive of the Qadan industry as well as the site's geology suggest an age of 14 – 12 ka for these burials. In this study, the body proportions of the Jebel Sahaba hominins are compared to those of a large ($N = \text{ca. } 1100$) sample of recent human skeletons from Europe, Africa, and the north circumpolar region, as well as to terminal Pleistocene "Iberomaurusian" skeletons from the northwestern African sites of Afalou (Algeria) and Taforalt (Morocco), and Natufian skeletons from the southern Levantine sites of El Wad and Kebara.

Univariate analyses distinguish Jebel Sahaba from European and circumpolar samples, but do not tend to segregate them from North or Sub-Saharan African samples. In contrast, multivariate analyses (PCA, PCO with minimum spanning tree, NJ and UPGMA cluster analyses) indicate that the body shape of the Jebel Sahaba hominins is closest to that of recent Sub-Saharan Africans, and different from that of either the Natufians or the northwest African "Iberomaurusian" samples. Importantly, these results corroborate those of Irish (2000), who, using non-metric dental and osseous oral traits, found that Jebel Sahaba was most similar to recent Sub-Saharan Africans, and morphologically distinct from their contemporaries in other parts of North Africa. This study was funded in part by NSF (grant number SBR-9321339).

The Hobbit Brain: Some questions about its 'derived' features.

RALPH HOLLOWAY¹, JANET MONGE² and TOM SCHOENEMANN³. ¹Dept. Anthropology, Columbia University, ²Dept. Anthropology, University of Pennsylvania, ³Dept. Anthropology, Indiana University.

One of the major problems with paleoneurological interpretations is that these are based on extremely small samples. Irrespective of whether the "Hobbit" is indeed a new species, or an unmatched form of pathology, claims regarding derived or primitive characteristics require testing against larger samples of anthropoid endocasts. The endocast

collection collected by Holloway is roughly 200, including some 40+ *Pan paniscus*, 30+ *Pan troglodytes*, 40+ *Gorilla*, 25+ *Pongo*, and roughly 100 Hylobatids.

These endocasts have been recently CT scanned, and form a good basis for examining the seven character states that Falk et al (JHE) have suggested are derived features on the endocasts of LB1. *Pan paniscus* in particular shows a set of features including a squared prefrontal profile, cerebral cortex caudal to the cerebellar lobes, pronounced prefrontal poles (gyri recti), and protuberant Broca cap regions. Additionally, two microcephalic endocasts do show cerebral lobes overlapping and caudal to the cerebellar lobes, suggesting that if the microcephalic sample were increased, morphometric analyses might show more overlapping between microcephalics and LB1. We are NOT suggesting here that LB1 is therefore a microcephalic, but simply that overlapping cerebral lobes is an ambiguous feature that does not help clarify LB1's status as a valid taxon. Because the proposed derived features of LB1 can be found in ape endocasts, they cannot be regarded as diagnostic. Expanded comparative analysis will be required to determine whether there truly are any derived features of LB1, or whether it exhibits any pathologies.

Contrasting growth patterns in strength of the human mandible and long bones.

MEGAN HOLMES, EVAN GAROFALO and CHRISTOPHER RUFF. Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

Previous authors have demonstrated divergent developmental patterns in cranial and postcranial skeletal elements. These differences have been attributed to separate driving forces of distinct regions related to varying functional demands. However, comparison of differential growth patterns in bone strength properties has received little attention. This study aims to quantify and compare ontogenetic trends of cross-sectional structural properties between two skeletal regions with different functional demands – the mandibular body and femoral and humeral diaphyses. Using bi-planar radiographs, strength properties were determined for the mandible, humerus and femur from 47 individuals within the Sully (Arikara) archaeological sample. Ages, determined from dental eruption, tooth development, and epiphyseal closure, ranged from infancy to adulthood. Both sagittal bending rigidity (I_x) and strength (Z_x) were calculated for each skeletal element. To assess developmental relationships between crania and postcrania, variables were subjected to loess regression, percent adult attainment and growth velocity analyses.

Results of this study revealed divergent growth trajectories of strength properties between the mandible and postcrania. Specifically, mandibular strength achieves near-adult values by early adolescence, whereas postcrania continue to grow in strength into adulthood. Furthermore, developmental patterns of mandibular strength properties are highly

related to molar emergence. In contrast, growth of femoral dimensions in particular is closely related to increase in body mass. Earlier development of strength properties in the mandible appears to be needed for a fully functioning masticatory apparatus, while postcranial growth is delayed until sufficient energy can be allocated to its development.

Do impact forces associated with horseback riding result in stronger femora?

BRIGITTE HOLT¹, NICOLA RADI², GIOVANNA BELCASTRO³ and ALESSANDRO CANCI⁴. ¹Department of Anthropology, University of Massachusetts, ²Department of Biology, University of Pisa, ³University of Bologna, Department of Evolutionary and Experimental Biology, ⁴Department of History and Cultural Resources, University of Udine.

Archaeological evidence suggests horse riding originated during the Bronze Age and that early riders did not use stirrups, a method that places the rider frequently in front or behind the horse's center of mass, requiring high adductor and rotator muscular effort to maintain balance. Bronze Age human femora often exhibit musculoskeletal stress markers associated with these muscle forces around the hip joint and proximal epiphysis. The high muscle forces should result in medio-lateral expansion of the proximal femur.

We tested the hypothesis that muscular forces engendered by riding lead to remodeling of the proximal femur. We analyzed femoral cross-sectional properties of 15 adult males from the Bronze Age site of Olmo di Nogara (Italy), all exhibiting markers associated with riding, and a comparative sample of non-riders from the Mesolithic. Olmo femora should exhibit mediolaterally reinforced proximal cross-sections, reflecting hip muscle forces. Cross-sectional dimensions were obtained from CT scans and a combination of bi-planar radiographs and molds for the Olmo and Mesolithic samples, respectively. Contrary to expectations, the Olmo femora have lower cross-sectional rigidity than the Mesolithic femora, and did not differ in ML dimensions. These results suggest that the strains involved in riding are not high enough to trigger remodeling, confirming results from one study of muscle strength and bone mineral density (BMD) in adolescent riders that found that, while riders had stronger thigh muscles than non-riders, they did not differ in femur BMD, suggesting that the strains associated with riding do not result in stronger bones. This study was funded by NSF grant # 0642710.

Heterogeneity of maternal diet in a stable isotope weaning study.

SARAH HOLT¹, HENRY SCHWARCZ², CHARLES FITZGERALD³ and ANNE KEENLEYSIDE⁴. ¹Department of Anthropology, the Ohio State University ²School of Geology and Earth Sciences, McMaster University ³Department of Anthropology, McMaster University ⁴Department of Anthropology, Trent University.

A common assumption in stable isotope weaning studies is homogeneity of the maternal diet and transitional food offered to the infant throughout the weaning process. This research utilizes dental serial sampling on the remains of 11 subadults from the ancient Greek site of Apollonia Pontica in Bulgaria to address the homogeneity of diet in lactating mothers and the variation in weaning foods consumed by infants through the stable isotopic analysis of carbon and nitrogen. To see the effects of change in the maternal diet, $\delta^{13}\text{C}$ vs. $\delta^{15}\text{N}$ values are plotted for individual subadult teeth (dm1, dm2 and M1) for which at least three sections were sampled. Where the diet of a lactating mother remains constant, weaning onto a single transitional diet will produce a linear relationship with a slope of 3:1 and a strong correlation between $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$. In the Apollonia sample only one individual tooth shows a slope approaching 3:1, and five individuals show very strong correlations between $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ($r \geq 0.85$). For these particular individuals it is probable that the weaning diet remained consistent throughout the transitional food period, and the scatter is derived from variation in the maternal diet during this period. Individuals who show an extremely low correlation and variation in slope in all teeth sampled may have consumed a variety of weaning foods, and the diet of their mothers may also have been varied.

Color centers induced in dental enamel during synchrotron microcomputed tomography: Phase I assessment.

CAROLINE F. HORTON¹, GARY D. RICHARDS^{1,2}, TIM D. WHITE¹, ALASTAIR MACDOWELL³, REBECCA S. JABBOUR^{1,4} and JAMES NASIATKA³. ¹Human Evolution Research Center, University of California, Berkeley, ²Dept. of Physiological Sciences, A. A. Dugoni School of Dentistry, University of the Pacific, ³Advanced Light Source, Lawrence Berkeley National Laboratory, ⁴Dept. of Biology, Saint Mary's College of California.

The applicability of synchrotron micro-CT (SR-mCT) for studies of tooth development and morphology has been demonstrated by researchers using the European Synchrotron Radiation Facility (ESRF). They have also documented temporary darkening in scanned enamel. This color-center effect is considered minor, only occurring during submicron scanning with long scan times. Prior to SR-mCT imaging of rare teeth, we tested the extent and duration of SR-mCT-induced color changes in modern and fossil enamel.

Our sample comprises modern and fossilized/perminalized teeth from hyaenas, cervids, and humans ($n=21$). The Advanced Light Source, Lawrence Berkeley National Laboratory, SR-mCT provided an ESRF-comparable critical energy of 10.5KeV. Enamel was exposed to increasing levels of beam energy (20, 30, and 40KeV) at one of three different positions for an equivalent duration (~8-9 minutes). Only three teeth were rotated, and these were exposed at only one position to 40KeV for one hour.

We induced color centers (light-gray) in enamel within minutes of exposure; longer exposure intensified graying. All specimens banded in a pattern consistent in intensity and location with area and duration of exposure. Generally, color centers resolved within days, although banding was observable in fossil hyaena enamel for >1 year. Increasing exposure time and area produced similar results but generally longer recovery times. In this study, color centers always occurred, while their intensity and recovery depended on sample, exposure time, and x-ray energy. We conclude that SR-mCT-induced color centers are significant, occur within minutes of exposure, are not limited to submicron scans, and may last for extended periods.

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Twin studies of dental crown morphology: Genetic, epigenetic and environmental determinants.

TOBY HUGHES¹, JEREMY VO¹, SUZANNA MIHALIDIS¹ and GRANT TOWNSEND¹. ¹School of Dentistry, University of Adelaide, South Australia.

Dental development reflects environmental and epigenetic modulation of gene expression through time. Examination of phenotypic expression in genetically identical and fraternal twins provides a powerful means to estimate genetic, epigenetic and environmental contributions to observed variation.

Our aim was to determine the relative contribution of the genotype to expression of cusps 5, 6 and 7, as well as groove patterning, in primary and permanent mandibular molars (dm2, M1 and M2). Phenotypes were recorded using dental models from a sample of Australian twins, collected during an ongoing study of dento-facial development. Turner ASU plaques were used for scoring. The sample comprised 128 twin pairs (60 monozygous, 68 dizygous) with at least partial data for dm2, M1 and M2. This abstract presents data from the right quadrant, dichotomized for presence/absence of cusps, and scored as 'X', 'Y' or '+' for groove pattern. Structural equation modeling was conducted using Mx.

No variation was observed for cusp 5 on dm2 (complete presence). A model containing additive genetic effects and unique environment effects was appropriate for: groove pattern (dm2, M1); cusp 5 (M1); cusp 6 (dm2); cusp 7 (dm2, M1, M2). Heritability estimates ranged from 77%-99%. A model incorporating only environmental variation was appropriate for groove pattern (M2) and cusp 6 (M1). There was evidence of a shared (twin) environment effect on cusp 5 (M2) and cusp 6 (M2).

According to Butler's field model, the most mesial tooth within each 'field' shows most stability in size and morphology. It has been

proposed that dm2 should be considered as part of the permanent molar series, based upon ontogeny and phylogeny. This is supported by our data – dm2 was the only tooth for which all four phenotypes were influenced principally by the genotype. Our findings should be interpreted cautiously as sample sizes were underpowered to resolve the applied models (especially for M2). More data are being collected to develop a multivariate genetic model of molar cuspation and patterning. This study was funded by the National Health and Medical Research Council and the Australian Dental Research Foundation.

The heritability of baboon limb bone morphometry.

BRANNON I. HULSEY¹, GRACIELA S. CABANA¹ and LORENA M. HAVILL².

¹Department of Anthropology, University of Tennessee, ²Department of Genetics, Southwest Foundation for Biomedical Research.

The purpose of this study is to gain insight into the degree of genetic control of limb bone morphometry in primates by estimating the heritability (h^2), that part of the variation that is due to the additive effects of genes, of humeral and femoral measurements in baboons. The degree to which various limb bone dimensions, including proportions, are relatively influenced by genetics and environment is a topic of considerable interest in anthropology. Studies of secular change, climatic adaptation, taxonomic designation, and ancestral population affinity assume some genetic control over variation in limb structure and proportions, but few have attempted to quantify the magnitude of the genetic influence. Here we test the hypothesis that there is significant, detectable genetic influence on intra-specific variation in limb bone morphometry.

We measured lengths and breadths of the entire bone, diaphysis, and articular surfaces of the skeletonized right humerus (164 females, 74 males) and left femur (113 females, 68 males) of pedigreed baboons. We used a variance decomposition approach implemented in SOLAR to assess age, sex, and genetic effects. In general, age and sex effects account for 60% to 75% of the variation in these measurements. Statistically significant residual h^2 estimates range from 0.28 (breadth of the medial condyle) to 0.89 (medio-lateral diameter at 75% length) for the femur and from 0.22 (trochlear breadth) to 0.85 (medio-lateral diameter at 40% length) for the humerus. These results have important implications regarding the influence of genes on limb bone morphometry in general and on limb bone proportions.

Genes and language in the Americas.

KEITH HUNLEY. Department of Anthropology, University of New Mexico

Given that the peopling of the Americas was recent on an evolutionary time scale, and there is good Native American biological and cultural data, it is surprising that we know so little about the prehistory of the Americas. Did the initial colonization proceed in a north-south direction

through a steady series of population splits and founder effects? Was there more than one movement of peoples into South America? What are the forces creating the correlations between genes, language, social organization, ecology, and geography? Has the very recent admixture between Native Americans, Europeans and Africans confounded our ability to answer these questions? To what extent have biases in the genetic data and population samples, and the failure to distinguish among competing models for patterns of variation, affected our ability to answer these questions? We attempt to reconstruct major aspects of Native American prehistory by analyzing autosomal STR data recently published by Wang and colleagues and language data collected by several Native American linguists. Our strategy is to explore population genetic structure by fitting alternative evolutionary models to the genetic and linguistic data, and to examine the causes of residual deviations from these models. Our results lead to three major conclusions. First, evolution in North America was driven by population fissions and founder effects. Second, there is a deep genetic division between North and Central/South American populations. Third, secondary population movements, genetic exchanges across linguistic boundaries, and recent gene flow from Africa and Europe have disrupted the pre-Columbian pattern of genetic diversity in Central and South America.

An assessment of forest loss and habitat connectivity regarding *Alouatta pigra* in the Natural Protected Area of Mézabok, Chiapas, Mexico.

ASHLEY HURST¹, ELIZABETH ERHART¹ and NATHAN CURRIT². ¹Department of Anthropology, Texas State University-San Marcos, ²Department of Geography, Texas State University-San Marcos.

Black howler monkeys (*Alouatta pigra*) are limited to only a few sites in Central America and are considered to be endangered and threatened with extinction by the IUCN. The leading causes of their status are deforestation and forest fragmentation, both of which can result in isolated breeding populations, reduced fecundity, and local extinctions (Crocket 1998; Pavelka and Chapman 2006; Strier 2007; Van Belle and Estrada 2006). In collaboration with CONANP (Comisión Nacional de Áreas Naturales Protegidas), we collected preliminary data regarding the population, potential food resources, and habitat connectivity of *A. pigra* in the Natural Protected Area of Mézabok, Chiapas, Mexico between 4 June and 4 August 2009. To assess habitat connectivity, we recorded mutually exclusive GPS points from six distinct land cover types. We used these points along with remotely-sensed imagery and ERDAS Imagine software to create a land type classification of the park and a 20 km perimeter of influence. Statistical analyses with Fragstats show a break in structural connectivity of the forest canopy bordering Mézabok and potential isolation of the howler monkey population that resides there. To further understand this isolation, we used Normalized Difference

Vegetation Index to show macro forest change over four decades for Mézabok and proximal Natural Protected Areas representing potential *A. pigra* habitats. An overall trend of deforestation and connectivity loss is apparent. With the aid of information regarding the degree of fragmentation, connectivity, and isolation of potential *A. pigra* habitats, government programs can make informed decisions to prevent localized extinctions.

Metric, morphologic, and functional analysis of frontal bone ontogeny in *Homo sapiens*.

CAITLIN L. IBARRA¹, GARY D. RICHARDS^{1,2}, REBECCA S. JABBOUR^{1,3} and CAROLINE F. HORTON¹. ¹Human Evolution Research Center, University of California, Berkeley, ²Dept. of Physiological Sciences, A. A. Dugoni School of Dentistry, University of the Pacific, ³Dept. of Biology, Saint Mary's College of California.

Whereas bones cannot be equated with functional skeletal units, understanding their ontogeny provides a basis for delineating such units. To initiate the process of defining functional units in the frontofacial region, we made a broadly based metric and morphological assessment of frontal bone ontogeny. Our sample ($n=510$) comprises modern and archaeological crania (7th fetal month-adult). We measured 16 dimensions of the frontal bone and nasal capsule and recorded observations on the developmental course of the *sutura frontalis*, frontoparietal fontanel, superior sagittal sinus, and frontal crest. We also examined the relationship of the supraorbital region and nasal capsule to the frontal squama, including tuberosity positioning.

We found increases in interorbital and orbital breadths to diminish early in postnatal growth. This growth pattern reflects the early development of the nasal capsule and eyes. This accelerated growth of the basal frontal buffers the impact of early *sutura frontalis* closure on frontal squama morphology. Further, this growth pattern occurs in conjunction with minimum and maximum frontal breadths that are increasing equally, but at a faster rate relative to the orbitonasal region. Growth of the frontal squama, therefore, appears to occur by circumferentially directed expansion of the superolateral regions via high appositional and sutural growth rates. Biomechanical results of this developmental pattern appear to lead to the development of frontal tuberosities, internal crests, and suture-fontanel closure. Knowledge of the mosaic pattern of growth in a bone, when coupled with the morphological results of that growth mosaic, provides insights into the location of functional cranial matrices. Funding provided by A. A. Dugoni School of Dentistry, University of the Pacific, No. 03-Activity-059 to GDR.

The age of the 20 meter Solo River Terrace, Ngandong (Java, Indonesia) reconsidered.

E. INDRIATI¹, C.C. SWISHER III², C. LEPRE³, R.L. QUINN⁴, R.A. SURIYANTO¹, A.T. HASCARYO¹, C.S. FEIBEL², B.L. POBINER⁵ and S.C. ANTÓN⁶. ¹Laboratory of

Bio and Paleoanthropology, Faculty of Medicine, Gadjah Mada University, ²Department of Earth and Planetary Sciences, Rutgers University, ³Department of Anthropology, William Paterson University, ⁴Department of Anthropology, Loyola University ⁵Human Origins Program, National Museum of Natural History, Smithsonian Institution, ⁶Center for the Study of Human Origins, Department of Anthropology, New York University.

Homo erectus dispersed widely throughout the Old World and was likely ancestral to *H. sapiens*. The demise of this successful taxon remains obscure, however, in part because of uncertainties regarding the geological age of its populations. In 1996, we published 'open'-system (ESR/U-series) ages that suggested that the *H. erectus* sites of Ngandong and Sambungmacan and the faunal site Jigar were, surprisingly, as young as 35 to 50 ka. While initially encountering strong debate, this young age has become increasingly accepted. Here we report results of the Solo River Terrace (SoRT) project which began fieldwork in 2004. Stratigraphic and sedimentological evidence show a series of related depositional facies apparently accumulated over a short duration. SoRT recovered large pumices suitable for $^{40}\text{Ar}/^{39}\text{Ar}$ dating within the fossiliferous deposits of both Ngandong and Jigar. Although, previous attempts to date small pumices yielded insufficient gas, incremental heating analyses of hornblende from the new pumices give a significantly older age (mean = 546 ± 12 ka; sd ± 5 sem) than our ESR/U-series ages on teeth from the same deposits. Either the ESR/U-series ages are anomalously young or the pumices are reworked. For taphonomic reasons, we favor the former. Interestingly, the difference between the ages is similar to differences between "open" and "closed" system dating at other sites such as Zhoukoudian. We raise the possibility that our 'open'-system dates reflect postdepositional events. If verified, this would have important consequences for dating hominin evolution generally and would profoundly influence interpretations of the biogeographic and phylogenetic relationships of Pleistocene *Homo*. This study was funded by National Science Foundation grant BCS-0453752.

Chimpanzee behavioral anomalies: Possible sensory integration difficulties in a captive individual (*Pan troglodytes*).

ELLEN J. INGMANSON¹, TERESA A. MAY-BENSON², TERRI HUNNICUTT³, INGRID PORTON³, MARTHA A. WEBER³, JOHN R. PRUETT, JR.⁴, DAVID Q. BEVERSDORE⁵, and MARGARET L. BAUMAN⁶. ¹Department of Anthropology, Bridgewater State College, ²Occupational Therapy Associates-Watertown and The Spiral Foundation, ³Saint Louis Zoo, ⁴Department of Psychiatry, Division of Child Psychiatry, Washington University School of Medicine, ⁵Departments of Radiology, Neurology and Psychology and the Thompson Center, University of Missouri, ⁶Harvard Medical School/Massachusetts General Hospital.

Human/chimpanzee similarities have been crucial in understanding the evolution and ontogeny of human behavior. Less evident is whether chimpanzees experience neural disturbances resulting in behavioral anomalies that parallel those seen in children; and if so, whether therapeutic intervention would be effective. This project focuses on a young, adult female chimpanzee (*Pan troglodytes*), Holly, at the Saint Louis Zoo. Resulting from concerns over specific behaviors exhibited, especially rocking, self plucking, clutching items and tandem walking, the possibility of autism was considered. An interdisciplinary team gathered to examine Holly's behavior, its possible etiology, and consider potential interventions. Behavior was assessed through rearing and developmental history, video tapes and 40+ hours of direct observations. Data collection techniques included *ad libitum*, all occurrences of specific behaviors, and one-minute interval sampling.

Initial results ruled out a chimpanzee phenotypic equivalent of autism as likely causing Holly's behavior. Alternate explanations emerged emphasizing sensory integration and motor planning difficulties. Key behavioral elements included poor motor fluidity, posture rigidity, lack of restful postures, seeking tactile stimulation, and poor social awareness. Compared with other group members, Holly was conspicuous in range and frequency of stereotypies, restricted social interactions and lack of rest times. Her behavior resulted in some avoidance by group members, and disrupted social interactions of others. These behaviors are common in children diagnosed with sensory integration problems. For nonhumans, environmental enrichment is frequently used to reduce stress and stereotypic behaviors. In an attempt to address these issues for Holly, a sensori-motor therapy approach is being utilized. Funding for this project provided by a gift from the Roberts Family.

Nutritional and mineral composition of Diademed Sifaka foods in undisturbed and disturbed forest at Tsinjoarivo, Madagascar.

MICHELL T. IRWIN¹, JESSICA M. ROTHMAN², JEAN-LUC RAHARISON³ and COLIN A. CHAPMAN^{1,4}. ¹Redpath Museum, McGill University, ²Department of Anthropology, Hunter College, City University of New York, ³Département de Biologie Animale, Université d'Antananarivo, ⁴Department of Anthropology and McGill School of Environment, McGill University, Montreal.

Madagascar's lemurs vary in diet composition and habitat preference, and Madagascar itself is thought to have food quality and availability different from other regions harbouring primates. However, few studies have assessed the nutritional chemistry of lemur foods. Knowledge of lemur nutrition will allow improved understanding of how (and which) foods shape social behaviour, and improved management of lemurs in captivity and disturbed habitats.

From July 2006-July 2007, we collected 140 *Propithecus diadema* foods at Tsinjoarivo, in undisturbed and disturbed habitats, and analyzed

them for: crude protein, available protein, fiber (NDF, ADF, lignin), ash, fat, water-soluble carbohydrates, and minerals. From these data we estimated total non-structural carbohydrates and energy content for each food.

Available protein was high in foliage, and fruit pulp (average 13%) and lower (<7%) in other foods. Water-soluble carbohydrates were highest in seeds (26%) and flowers (20%). Fat (13%) and energy (299 kCal/g) were both highest in fruit pulp. Lignin, which is indigestible, was high (foliage, flowers: ~24%, fruits: 15-20%, seeds: 7%) while NDF was relatively low (foliage: 45%, flowers: 41%, fruits: 35-47%, seeds: 25%); thus a large proportion of fiber is indigestible. Foliage use did not correlate with protein:fiber ratio, but correlated positively with calcium content. Fragment groups consume large quantities of fruit of *Bakerella clavata* (a parasitic mistletoe) to replace canopy tree fruits available only in continuous forest; mistletoe fruits are similar in fat, but low-protein (<1%), higher-fiber and lower in sugars, implying nutritional consequences of this dietary shift consistent with lower body mass in fragments. This study was funded by: Margot Marsh Biodiversity Foundation, NSERC.

Foramen magnum growth in modern humans: The ventral component.

REBECCA S. JABBOUR^{1,2} and GARY D. RICHARDS^{2,3}. ¹Department of Biology, Saint Mary's College of California, ²Human Evolution Research Center, University of California, Berkeley, ³Department of Physiological Sciences, A. A. Dugoni School of Dentistry, University of the Pacific.

Foramen magnum (FM) shape differs among fossil hominid specimens, and fossil taxa have sometimes been differentiated according to FM shape (e.g., oval, heart-shaped). In addition, ontogenetic variation in FM shape has been observed in modern humans. In order to clarify the ontogenetic changes behind evolutionary transformations in FM shape, we documented patterns of FM growth using a large, well-aged sample of modern human crania (n=470). We divided the FM into two functional components, ventral and dorsal to a line connecting the interoccipital synchondroses anterior. The ventral component is the focus of this analysis. Three mid-sagittal measurements were collected from the FM region, permitting calculation of two indices. The FM component index (n=282) compares lengths of the ventral and dorsal components. The basioccipital invagination index (n=284) compares ventral component length to total basioccipital length. Data were collected only from individuals with unfused interoccipital synchondroses anterior. Results show that (1) proportional contribution of the ventral component increases significantly across ontogeny, and (2) invagination of the basioccipital by the ventral component increases significantly across ontogeny, notably in the first year after birth when skeleomotor demands on the infant's craniocervical region are changing rapidly. In addition, FM shape in the youngest age groups is consistently long and oval, which may relate to greater projection of

the dens into the FM. Shape variants among fossil hominids may be best understood in terms of modifications in FM-related synchondrosal growth patterns in relation to changing functional demands and constraints on the ventral component.

Predicting natal dispersal in male white-faced capuchins (*Cebus capucinus*).

KATHARINE JACK¹, CLAIRE SHIELLER¹ and LINDA FEDIGAN². ¹Department of Anthropology, Tulane University, ²Department of Anthropology, University of Calgary.

White-faced capuchin males disperse from their natal group at around 4.5 years of age, however, there is much variation in dispersal timing; our youngest confirmed disperser was 19 months and the oldest 11 years. Here we investigate possible factors influencing dispersal decisions in this species. Between 1988 and 2008, 60 males were born into 3 study groups in Área de Conservación Guanacaste, Costa Rica. As of January 2009, 20 were presumed dead (>14 months), 11 were natal residents, and 29 were presumed dispersers. We used a forward logistic regression to predict the probability of male natal dispersal for the 29 dispersed males and 6 resident natal males (excluding 5 males aged ≤11 months). Predictor variables were age, maternal rank, maternal presence, paternal presence, number of male siblings present, group size, number of adult males, and the occurrence of a takeover at the time of dispersal or during the life of a resident natal male. A test of the resultant model, which included the occurrence of a takeover, group size, number of adult males, and presence of the male's probable father in the group, versus a model with intercept only was statistically significant, $\chi^2(4, N=35)=28.251, p<.001$. The model was able to correctly classify 96.6% of dispersed and 100% of resident natal males, for an overall success rate of 97.1%. The occurrence of a group takeover was the strongest predictor of male dispersal, adding to our growing evidence of the profound effect takeovers exert on the lives of white-faced capuchins. This research was funded in part by the Department of Anthropology at Tulane University (KJ and CS), NSERC (LF), and the Canada Research Chairs Program (LF).

Relationship between waking-sleep blood pressure and catecholamine changes in Filipino-American and European-American women.

GARY D. JAMES¹, HELENE VAN BERGELANDRY¹ and DANIEL E. BROWN². ¹Department of Anthropology, Binghamton University, ²Department of Anthropology, University of Hawaii at Hilo.

While previous studies show that the diurnal blood pressure (BP) sensitivity to epinephrine (EPI) in African-American (AA) women is significantly greater than that of European-American (EA) women, there have been few if any studies examining diurnal catecholamine-BP relationships in women of other ethnic

groups. The purpose of this study was to compare the effects of diurnal changes in catecholamines (EPI and norepinephrine (NE)) on the diurnal changes in BP between Filipino-American (FA) ($N=38$, age=34.6 \pm 6.3) and EA ($N=46$, age=38.0 \pm 9.3) women. The subjects included 31 FA and 27 EA nurses and nurses aides and 8 FA and 19 EA hotel workers from Hawaii who wore an ambulatory BP monitor and collected timed urine specimens (4 hrs at work, 4 hrs at home and approx. 8 hrs overnight) for assay of EPI and NE. Proportional changes in systolic and diastolic BP from sleep to work and sleep to home were examined using ANCOVA, with ethnicity as a fixed factor, and BMI and the appropriate proportional change in EPI or NE as covariates. The results show that there was no association between changes in EPI and BP, either overall or by ethnic group; however, diastolic BP change from sleep to work tended to be smaller among the FAs ($p<.06$), and among FA women, as sleep to work diastolic BP increased, the corresponding NE change decreased ($p<.039$). These results contrast with those from previous AA-EA comparisons, and suggest that the diurnal variation of BP in FA women may be more reactive to change in NE. Funded by NIH grant S06-GM08073 and AHA (HI affiliate) grant HG-001-93.

The taphonomy of secondary burials at Carson Mounds, Coahoma County, Mississippi.

JENNA JAMES¹, GABRIEL WROBEL¹, JAY JOHNSON¹, JOHN CONNAWAY². ¹University of Mississippi, ²Mississippi Department of Archives and History.

Recent salvage excavations at the Carson Mounds site revealed a series of pits containing bundled secondary burials, as well as a related feature tentatively interpreted as a charnel house. The burial pits range in size and complexity, containing between 1 and approximately 40 individuals. The detailed excavation and preliminary analysis of Burial 4, the largest of the pits, demonstrates a range of taphonomic variation. Though all individuals appear to have been bundled in a similar fashion, variations were often noted in the articulation of elements indicating that the timing of secondary interment ceremonies was not necessarily based on an individual's stage of decomposition. The presence of mounds and diagnostic artifacts, as well as AMS dates of carbon samples from the pit features, place these mortuary activities within the Mississippian era. Other known instances of secondary burials in the Mississippian period are described as retainer sacrifice or specific to a particular corporate group, which would have over-representations of a particular age set or sex. However, the Burial 4 individuals demonstrate age and sex ratios, which do not differ significantly from the expected mortality curve for a general population. These data and the abundance of secondary burials suggest that the mortuary program of the Carson Mound population is culturally distinct from other documented Mississippian groups.

Fracture patterns in rhesus macaques (*Macaca mulatta*): Addressing locomotor behavior and managed care.

HEATHER JARRELL. Department of Anthropology, Ohio State University.

Studies addressing the relationship between locomotor behavior and fracture frequencies in nonhuman primates are scarce and the results often contradictory. This study presents preliminary data on fracture patterns in rhesus macaques (*Macaca mulatta*) inhabiting Cayo Santiago. The primary hypothesis, that higher degrees of arboreality are associated with higher fracture frequencies, will be tested by comparing fracture patterns in macaques with patterns Jarrell and McGraw (2009) reported previously in primates using different locomotor modes. A secondary hypothesis, that improvements in managed care have decreased fracture frequencies within the Cayo Santiago population, will be tested by comparing fracture frequencies in macaques born after 1975 with frequencies Buikstra (1975) reported in macaques who died prior to 1973. Long bones in a skeletal sample consisting of 352 macaques with known birth dates later than 1975 were examined macroscopically and radiographically. Forty individuals exhibited at least one fracture (11.4%), most commonly of the fibula (3.03%) or ulna (1.88%). These gross frequencies are similar to those recorded previously in *Gorilla gorilla* (11.3%) and lower than frequencies in more arboreal primates, including *Pan troglodytes* (17.9%) and *Hylobates spp.* (23.1%), thereby tentatively supporting the hypothesis that arboreality is associated with healed fractures. Of the 225 adult macaques, 44 fractures were observed (19.6%), compared to a fracture frequency of 35.1% per adult primate in Buikstra's pre-1973 sample. This supports the suggestion that improvements in population control measures and increased provisioning have reduced group conflicts over resources, thereby resulting in fewer fractures due to aggression. This study was partially funded by the National Institutes of Health (NIH), grant number P40 RR003640 and the OSU Alumni Grant for Graduate Research and Scholarship (AGGRS).

Father's education is a crucial predictor of the direction of relationship between the number of children and testosterone levels in Polish men.

GRAZYNA JASIENSKA¹ and PETER T. ELLISON². ¹Department of Epidemiology and Population Studies, Jagiellonian University, Collegium Medicum, Krakow, Poland, ²Department of Human Evolutionary Biology, Harvard University.

Testosterone (T) levels in males show variation in relation to mating and parenting effort. In human males, both pair-bounding and fatherhood are related to reduced T levels, and experimental parenting stimuli are capable to influence T levels. Our study further explores parenting and T by testing if in fathers number of children was related to their T levels. In Polish men there was a statistically significant

relationship between number of children and T levels, however a direction of this relationship was dependent on father's education. In men with below-college education the number of children was positively related to T, both for morning ($R^2 = 0.14$, $p = 0.005$) and evening levels ($R^2 = 0.19$, $p = 0.0008$), while in men with college education the number of children showed a negative relationship with morning ($R^2 = 0.23$, $p = 0.026$) and evening T levels ($R^2 = 0.21$, $p = 0.03$). We suggest that costs and benefits of having children differ in men depending on their socio-economic status. Differences in such costs and benefits among social classes were especially pronounced in the early years of political and economic transition in post-communist Poland, the period during which our study was conducted..

Sexual dimorphism of sub-cortical structures in the adult human brain using MRI.

PETRA E. JELINEK¹, KIRK ERICKSON² and STEVEN R. LEIGH¹. ¹Department of Anthropology, University of Illinois, Urbana-Champaign, ²Department of Psychology, University of Pittsburgh.

This study investigates patterns of size variation in sub-cortical structures of the adult human brain to better understand brain size variation between the sexes. Specifically, this research tests a series of research questions concerning relationships between size and shape (scaling relationships) in brains of adult modern humans using *in vivo* measurements from magnetic resonance imaging (MRI) scans.

Measurements of interest were comprised of total brain volume and 17 sub-cortical regions. Ratios of each of these sub-cortical regions to total brain size were measured. Relative size of these regions was also considered. Subjects include 204 healthy individuals, consisting of two age categories: 51 younger adults, ages 18 to 35, and 153 older adults, ages 50 to 80. MRI's were then segmented in an automated fashion using FSL (FMRIB Software Library).

Non-parametric tests indicate that the hippocampus to total brain size ratio is significantly larger in females, and the amygdala ratio is larger in males but does not approach significance. Results of a linear model indicate the female hippocampus ratio is significantly larger at younger ages. In males, the hippocampus ratio is also larger in the younger group; however, not significantly so. These results indicate the presence of age-regressive changes, particularly in areas related to emotion and memory. Age-based changes in the adult brain may reveal dynamic alterations throughout the course of life. The possible functional significance of these changes is discussed.

When home is the front: A paleopathological study in Medieval Britain.

JAIME JENNINGS. Department of Archaeology, Durham University.

Recent anthropological, historical, and medical studies report that stress caused by living in a

region of socio-political conflict is associated with nutritional deficiencies and decreased general health of local residents. The primary objective of this study was to explore health and disease patterns in Medieval (ca. 900 – 1600 AD) populations living along the English and Scottish border; a region which experienced long-term socio-political conflict according to historical documents of the period. Human skeletal remains excavated from cemeteries in the border region were hypothesized to express more metabolic disease and nutritional indicators of stress than their contemporary neighbors.

Archaeologically excavated skeletons from Medieval cemeteries were macroscopically analyzed using current research standards. Historical documentation states local populations experienced a chronic threat of military occupation or violent assault and probable nutritional deprivations throughout the use of the four border cemeteries included in this study. Four cemeteries from neighboring regions which did not experience chronic conflict stress were included as a control group for statistical comparison.

Results show differences only in infection rates between the border populations and their neighbors. Similar metabolic disease and nutritional indicators of stress rates were observed between samples. Without contemporary information provided by the Medieval historical record, the osteological evidence from the Anglo-Scottish border would not indicate local populations experienced great stress. The paleopathological results alone suggest a difference in pathogen load was present in the border populations. This study highlights the need for interdisciplinary approaches to research questions regarding the nature and extent of conflict in the past. Partial funding provided by British Association of Biological Anthropology and Osteoarchaeology and The Rosemary Cramp Fund, Durham University.

Maxillary sinusitis in Roman Colchester.

LINDSEY JENNY. Department of Anthropology, Michigan State University, Colleges of Medicine, Michigan State University.

Sinusitis is the result of inflammation of the paranasal sinuses. It can be an indicator of respiratory and dental health in past populations. While sinusitis has been studied in medieval European populations and 15th century AD Iroquoian populations, it is not widely reported in Roman populations. The Roman period cemetery from Butt Road, Colchester, UK, in use from the 1st-4th centuries AD, provides an opportunity to examine how Romanization may have affected respiratory health and dental disease. The adoption of Roman courtyard houses may have improved indoor air quality which may have decreased the prevalence of sinusitis among women, whose domestic duties likely increased their time at home. Prevalence rates of sinusitis in males may be reflective of occupation such as firing pottery or blacksmithing.

Stratified random sampling was used to select a sample of eighty-five individuals from the Butt

Road collection. Within this sample, thirty-eight individuals had at least one maxillary sinus available for observation. Nineteen individuals showed osseous changes within the sinus. Osseous changes varied but pitting, spicules, and lobules were most frequently observed. Dental disease played a role in the spread of infection into the maxillary sinus in some individuals while others showed no sign of dental disease. Previous bioarchaeological studies have found sinusitis rates to be higher in females than males. In this sample males and females appear to be equally affected.

Experimental tinkering with signaling and patterning during tooth development.

JUKKA JERNVALL^{1,2} and ENNI HARJUNMAA¹. ¹Institute of Biotechnology, University of Helsinki, ²Department of Ecology and Evolution, Stony Brook University.

It is often thought that tinkering with signaling networks produces small changes in development, leading to small changes in the phenotype, and ultimately to evolutionary change. We have experimented on such tinkering by controlling the amount of the signaling factor ectodysplasin (EDA) during mouse tooth development. Tabby-mice lack functional EDA, and consequently have abnormally small molars with a simplified cusp pattern. To study in detail the developmental variation between wild-type- and Tabby-teeth, we have made time-lapse monitoring of Tabby-molars cultured in different concentrations of EDA. Our Tabby-line has been crossed with transgenic mice that express Green Fluorescent Protein (GFP) under a Sonic Hedgehog promoter. Shh, and thus GFP, is expressed in the signaling centers of the tooth, the enamel knots, which direct growth and give rise to the cusps.

The results show that with increasing concentration of EDA, new enamel knots appear and normal, wild-type cusp pattern can be attained. Whereas the normal mean size and cusp number is reached with relatively low dosages of EDA, higher dosages are required to decrease the amount of variation to wild-type levels. Conversely, these results suggest that a small change in the amount of molecular signaling is likely to affect first the phenotypic variation, and larger changes in the signaling are required for a change in the mean phenotype.

The hungry brain: An assessment of liver size correlation with brain size as it relates to energy storage trade-offs across primate evolution.

JESSICA L. JOGANIC¹, HERMAN PONTZER¹ and BRIAN C. VERRELLI². ¹Department of Anthropology, Washington University, ²School of Life Sciences, Arizona State University.

The large brains typical of primates impose energetic and physiological demands, requiring both a high rate of energy production and continuous supply of glucose. The Expensive Tissue Hypothesis proposes that the enlargement of a metabolically expensive organ

like the brain necessitates reduction of another, such as the GI tract, to balance energy expense. However, the relationship between brain size and glucose demands remains unexplored. The liver is the primary organ involved in glucose metabolism/catabolism. Since a high degree of encephalization places significant demands on the liver for plasma glucose level homeostasis between bouts of dietary intake of sugar, species with larger brains may be expected to possess larger livers. In this study, species means for brain, liver, heart, spleen, and kidney sizes were collected from a broadly-distributed sample of primates (N=28) and correlations among organs were compared. As is typical, significant positive correlations among the abdominal viscera were found; however, no statistically significant correlation between liver and brain was observed, suggesting these two organ sizes are differentially associated across primates. To determine whether significant outliers influence this result, a further cluster analysis was performed to identify both potential trade-off groups within the overall primate sample and the residual primate trend after removal of these confounding trade-off groups. These results imply that specific ecologies and life histories can be identified that may have provided the evolutionary environments in which increased relative brain size emerged in the primate lineage.

Temporal continuity in mitochondrial DNA of Native American populations from the Northwest Coast.

JESSE W. JOHNSON¹, JEROME CYBULSKI² and RIPAN S. MALHI³. ¹Department of Integrative Biology, University of Illinois Urbana-Champaign, ²Canadian Museum of Civilization, Gatineau, Quebec, Canada, ³Department of Anthropology, University of Illinois Urbana-Champaign.

A high frequency of mitochondrial DNA (mtDNA) haplogroup A has been noted within contemporary Native American populations on the Pacific Coastline, including the Northwest Coast. This geographic pattern in mtDNA may be the result of recent movements facilitated by European colonization or of long-standing duration. Only a small number of ancient (pre-contact) individuals from the Northwest Coastal region have been analyzed for mtDNA, leaving researchers unsure of the nature of ancient genetic make-up in the region.

In order to test for the possible existence of temporal continuity, we extracted DNA from 31 Native American teeth dating from ~1000-3000 years before present (ybp) from two locations on the Northwest Coast. DNA was extracted from the samples using a phenol/chloroform/silica extraction procedure. Restriction Fragment Length Polymorphism (RFLP) was conducted along with sequencing of Hypervariable Region I (HVRI) to determine the haplotypes of the ancient samples. We report mitochondrial DNA haplotypes from the ancient samples that suggest temporal genetic continuity in the Northwest Coast populations.

Generating an equal effective limb length creates equal step lengths in four New World monkeys.

LAURA E. JOHNSON¹, DANIEL SCHMITT¹, MICHAEL D. ROSE¹ and JEAN E. TURNQUIST². ¹Department of Evolutionary Anthropology, Duke University, ²Department of Anatomy, University of Puerto Rico.

Recently there has been a strong interest in understanding the larger angular excursions in the forelimb compared with the hindlimb in most quadrupedal primates; a pattern potentially connected to a need for stability while walking on thin branches. Larson et al. (2001) argued this pattern ensures that primates with intermembral indices (IMI) less than 100 will have equal forelimb and hindlimb step lengths, whereas primates with IMI greater than 100 will have higher hindlimb excursions to achieve equal forelimb and hindlimb step length. However, considering IMI alone does not account for angular changes in limb posture that may influence the effective forelimb or hindlimb length (line between the shoulder/hip and wrist/ankle). To investigate these relationships, we compared the angular excursions, effective limb length, and step length of four New World monkeys (*A. geoffroyi*, *C. apella*, *A. seniculus*, *L. lagothrica*) walking on raised horizontal poles. Preliminary data shows the expected pattern of angular excursion, was only found in *Alouatta* (FL 98°, HL 86°) and *Lagothrix* (91°, 79°). *Cebus* (83°, 83°) and *Ateles* (77°, 75°) had equal forelimb and hindlimb angular excursions. Yet all subjects had the same forelimb and hindlimb step lengths. Thus angular excursion data does not seem related to IMI, which may be explained by the finding that all individual animals in this study have the same effective forelimb and hindlimb lengths, achieved by adjusting joint angles. These results provide new insight into the options quadrupedal primates may use to compensate for conflicting anatomical and behavioral constraints. This study was funded by NSF SBR 9222526, NSF SBR 9209004 and BCS-0452217

Social and ecological influences on the process of maturation: Growth, body size, and skill attainment in chacma baboons.

SARA E. JOHNSON. Department of Anthropology, California State University, Fullerton.

The unique primate characteristics of extended juvenility and complex sociality set the stage for developmental sensitivity to features of the social and physical environment. This paper examines age related changes in body size, foraging skills, and social skills as a set of interacting transitions in young chacma baboons (*Papio hamadryas ursinus*) in the Okavango Delta, Botswana.

In a previous study in this population, juveniles were shown to have lower feeding efficiency than adults for most extractive resources. Studies in different populations of baboons, including the study population, have demonstrated a relationship between maternal

rank and immature growth. The current study addresses the predictive power of social ability to explain variation in foraging ability. Additionally, body size and experience, measured as age, are contrasted as predictors of foraging and social ability. Social ability is measured as the rate at which an individual supplants others and the rate at which an individual is supplanted by others. Foraging ability is measured as bites per minute, bout length, and the time it takes to resume feeding once disrupted. Preliminary results indicate that juvenile females of low maternal rank take 2.3 times longer than those of high maternal rank to resume feeding on the same resource after being supplanted. Maternal rank significantly affects the number of neighbors observed while juvenile females are feeding (ANOVA: F=15.20, 2 df, p<0.0001) with high ranking juveniles feeding at three times the density of low ranking. These results underscore the importance of simultaneously addressing multiple dimensions of development. This study was funded by the LSB Leakey Foundation and the National Science Foundation

The circle is unbroken: hybridization occurs between Kinda and chacma baboons in the Kafue Valley, Zambia.

CLIFFORD J. JOLLY¹, JANE E. PHILLIPS-CONROY², ANDREW S. BURRELL¹, CHRISTINA BERGEY¹, EILEEN LARNEY³ and TODD R. DISOTELL¹. ¹Department of Anthropology/ CSHO, New York University & NYCEP, ²Department of Anthropology, Washington University, St Louis and Department of Anatomy & Neurobiology, Washington University Medical School, ³Department of Anthropology, SUNY Stony Brook.

Kinda baboons (*Papio cynocephalus kindae*) and grey-footed chacma baboons (*P. ursinus griseipes*) are, respectively, the smallest (mean adult male body mass, ~ 17 kg) and one of the largest (mean adult male body mass, ~ 30 kg) of the extant forms of *Papio*, and also differ in social behavior, coloration and physique. Our previous work has shown that each interbreeds naturally with neighboring, intermediate-sized yellow baboons (*Papio c. cynocephalus*) in eastern Zambia. Early accounts suggest that in the Kafue valley, where the ranges of Kinda and grayfooted chacma baboons directly adjoin, they do not hybridize with each other, thus forming a classic ring species. Our recent fieldwork found that phenotypically unmixed Kinda and grayfooted chacmas live within a few kilometers of each other, as described > 40 years ago. However, close to the boundary we located at least 4 social groups including animals with intermediate phenotypes. Analysis of mitochondrial and Y-chromosome genetic markers confirms the mixed origin of these groups, and the hybrid status of some individual group members. The finding that substantial mean body mass discrepancy does not necessarily prevent successful hybridization between catarrhine primate populations may be relevant to scenarios of hominin evolution. Funded by grants from: New York University,

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Setting up a Temporary Mortuary in Copenhagen. A multidisciplinary investigation of the 18th-20th Century Urban Cemetery of Assistens.

MARIE LOUISE JØRKOV^{1,2}, NIELS LYNNERUP². ¹Copenhagen City Museum, Denmark, ²Laboratory of Biological Anthropology, Copenhagen University, Denmark.

One of the largest urban archaeological excavations in Northern Europe, led by Copenhagen City Museum, is currently taking place in the centre of Copenhagen, Denmark. One thousand years of history will be exhumed when rescue excavations are carried in the city in connection to the establishment of a new underground city line. One of the projects involves the excavations of the Assistens Cemetery, an 18th-20th Century urban Cemetery. A total of 473 graves, containing more than 3000 individuals buried between 1805 and 1989 needs to be moved. All the remains are to be reburied and cannot leave the site. Furthermore, there are severe time-constraints leaving only one year to conduct the excavations and analysis in. However, it is an exceptional and rare opportunity for such an investigation to take place, where historical records document the identity and occupation of these individuals. A large field laboratory, functioning as a temporary mortuary, has therefore been set up and a multidisciplinary scientific team will analyze the remains and associated artifacts on site before reburial. The plan for this field laboratory builds upon our experience in handling large medieval churchyard excavations as well as experience as forensic anthropologists in investigating mass graves and setting up temporary lab facilities in relation to genocide (Iraq and Kosovo) and mass disasters (Thailand). We here present how our field laboratory has been planned and how we envisage the handling of such a large material when time, logistical, ethical and scientific considerations all have to be met.

Commensalism among humans, nonhuman primates, and duikers: Paths to evaluating wildlife populations and sustainable livelihoods.

CAROLYN A. JOST and MELISSA J. REMIS. Department of Anthropology, Purdue University.

Human communities across Africa rely on wild game meat as a primary protein source and an integral component of daily livelihoods and income. Species most often hunted include duikers (*Cephalophus* spp.) and primates. Previous research suggests that because duikers represent a preferred protein, the long-term viability of these populations has direct impacts on the presence of arboreal monkeys and apes as they become more frequently hunted once duiker availability declines. Shifting hunting practices, specifically increases in firearms and night hunting, have reduced prey population

size and resulted in behavioral changes in duikers and nonhuman primates within the Dzanga Sangha Dense Forest Reserve (RDS), Central African Republic. A decline in nonhuman primate sign on transects, specifically calls, from 2002 to 2008 ($F=4.728$, $p=.04$) most likely suggests an increase in cryptic behavior rather than declining populations as observations remain constant. In order to better understand prey responses and population trends it is necessary to combine multiple census techniques, including techniques which mimic hunter behavior and those that would detect cryptic animals (e.g. night and day transects of observations, calls, dung, and net drives). Over 300km of line transect data, coupled with standardized hunter off-take surveys ($n=34$ weeks), simulated net hunts ($n = 10$ days) ethnographic interviews ($n=210$), and prey preference surveys ($n=280$) are contextualized with long-term data in order examine changes between 1997 and 2009. Results suggest that a mixed-methods approach allows researchers to better understand wildlife population trends and behavioral responses, contributing more effectively to the development of adaptive policy and management.

This study was funded by Purdue Research Foundation, Primate Conservation Inc., American Society of Primatologists, and The Explorer's Club Exploration Fund.

Genetic analyses reveal a history of serial founder effects, admixture between long-separated founding populations in Oceania, and interbreeding with archaic humans.

SARAH JOYCE, KEITH HUNLEY and JEFFREY C LONG. Department of Anthropology, University of New Mexico.

Genetic anthropologists continue to debate whether human neutral genetic variation primarily reflects a continuum of demes connected by local gene flow or colonization and serial founder effects. A second unresolved issue concerns the genetic contribution of archaic species to the modern human gene pool. Some studies suggest that this contribution was substantial and that it played an important role in human adaptation. These issues remain unresolved because of inadequacies and biases in datasets, problems in statistical methodology, and the failure to recognize that different evolutionary processes may produce similar outcomes. This study redresses these limitations by analyzing gene identity within and between populations in a dataset comprised of 614 STRs assayed in 1,983 people from 99 widespread populations. Our strategy is to fit hierarchical models to these data and examine residual deviations from the models. Each model involves nesting smaller units such as populations into larger units such as continental regions. It is possible to restate many of these models as either expansions or reductions of each other and thereby identify aspects of population structure that have had a major impact on the overall pattern of diversity. The strong fit of a model estimated using the Neighbor Joining algorithm indicates that human genetic diversity primarily reflects a

history of successive founder effects associated with our exodus from Africa, not continuum of demes connected by gene flow. Residual deviations from the model suggest: 1) the genomes of Oceanic peoples are the product of two independent waves of migration to the region and admixture, and 2) genetic exchange occurred between archaic and modern humans after their initial divergence.

Defining the Isotopic Fingerprint in Modern Mexican Populations: Using Strontium, Carbon, Nitrogen and Oxygen to determine region of origin for deceased undocumented Border Crossers.

CHELSEY JUAREZ. Department of Anthropology, University of California Santa Cruz.

The goal of this presentation is to present the progress on a mass spectrometry-based method for the identification of region of origin in modern Mexican populations. Region of origin is determined through analysis of strontium, carbon, nitrogen and oxygen isotopes in human tooth enamel.

Isotope ratios in teeth and bones have been analyzed by archaeologist to investigate patterns of residential mobility and migration in prehistoric peoples. In this study, a similar methodology is applied to forensic material to determine the region of origin for Mexican individuals that died while crossing the border into the United States. The aim of this project is to develop a region of origin map derived from analysis of donated teeth from persons born in various Mexican states and regions. The map will be used for cross-comparison with deceased border-crossers of unknown origin.

The teeth used for this project came from clinics in Mexico and California that donated the extracted teeth of their Mexican born patients. This investigation utilized the permanent molar teeth of 90 individuals. These tooth samples retained the accompanying information on the individuals region of origin within Mexico, their age, and sex. Each tooth in the study was analyzed using MC-ICPMS, FISONS optima, and the Elemental analyzer.

The results of this isotopic analysis reveal the formation of five clearly distinct separate and identifiable isotopic populations that correspond to five specific geographical regions

Long-bone geometry and skeletal biomechanics in *Homo floresiensis*.

WILLIAM JUNGERS¹, ANDREW FARKE², THOMAS SUTIKNA³, CHRISTOPHER RUFF⁴, LAURA SHACKELFORD⁵, JAY STOCK⁶, KRISTIAN CARLSON⁷, OSBJORN PEARSON⁸, FREDERICK GRINE⁹ and MICHAEL MORWOOD¹⁰. ¹Department of Anatomical Sciences, Stony Brook University Medical Center, ²Raymond M. Alf Museum of Paleontology, Claremont, ³National Research and Development Centre for Archaeology, Jakarta, ⁴Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, ⁵Department of Anthropology, University of Illinois at Urbana-Champaign, ⁶Department of Biological Anthropology, University of Cambridge, ⁷Institute for Human

Evolution, University of the Witwatersrand, ⁸Department of Anthropology, University of New Mexico, ⁹Departments of Anthropology and Anatomical Sciences, Stony Brook University, ¹⁰School of Earth and Environmental Sciences, University of Wollongong.

In order to evaluate the skeletal biology and locomotor biomechanics of *Homo floresiensis*, the humerus, femora and tibiae of the type specimen (LB1) and the tibia of a smaller adult (LB8) were CT-scanned, and cross-sectional geometric parameters were calculated in ImageJ using MomentMacroJ (cortical area, %cortical area [%CA], second and polar moments of area, section moduli). Body mass was estimated in order to compute relative bending strength. These data were compared to a large sample of modern humans of various ethnicities and body sizes, other extinct hominins and African apes. All long bones of *H. floresiensis* are robust and possess %CAs that fall within the ranges of normal modern humans. However, they lack the hyperthick cortices of early *Homo*. Left-right asymmetries in the femora and tibiae of *H. floresiensis* can be matched in modern human samples. Relative bending strengths of hind-limb bones are very high, resembling the femur of "Lucy" (A.L.288-1) in this respect (Ruff, 2006). Claims of pathologically thin and abnormally asymmetrical cortices (Jacob et al., 2007) can be rejected.

Covariation between femoral and humeral strengths was also assessed. Like *H. habilis* (Ruff, 2009), LB1 plots close to the chimpanzee regression line and far away from *H. erectus* and most humans. This relationship is consistent with the high humerofemoral index of LB1 and could imply a more diverse locomotor repertoire in *H. floresiensis* than is observed in modern humans and typically inferred for *H. erectus*. No special affinities between *H. floresiensis* and *H. erectus* were observed in cross-sectional geometry.

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Mestizo identity in the Lower Huallaga region of Peruvian Amazonia: Molecular perspectives.

ANNE E. JUSTICE, BARTHOLOMEW C. DEAN and MICHAEL H. CRAWFORD, Department of Anthropology, University of Kansas.

The Lower Huallaga River Basin is part of the Huallaga, a prominent tributary of Amazon that runs through the tropical lowlands of northeastern Peru. The Cocama, Lamista Kichwa, Chayahuita, and Munichi are among the primary indigenous peoples residing in this poorly studied region. Most individuals along the Lower Huallaga River tend to self-identify as *mestizos*, a term used to describe Spanish-speaking individuals of mixed European and Native American ancestry. This study aims to characterize the genetic structure of the Lower Huallaga region by analyzing the area's mtDNA haplogroup and sequence

diversity and comparing its variability to surrounding Central and South Americans. Samples were collected in 2005 from several populations located along the Lower Huallaga River Basin, near the city of Yurimaguas, Loreto, Peru ($n=46$). A 400 bp fragment of HVS1 was sequenced and haplogroup assignment confirmed using standard RFLP methods. Despite the predominant self-identification of *mestizo*, 100% of the sample exhibited a Native American mtDNA lineage (A2: 22%, B: 30%, C1: 37%, D: 11%). High estimates for gene diversity compared to other indigenous populations ($h = 0.9952$) also indicate that the sample contains descendants of several different indigenous groups rather than a single ethnic group. MJ network analysis, mismatch analysis, MDS plots, and neutrality tests were performed in order to characterize the genetic structure of this area compared to surrounding regions. Sequences highlight a closer relationship to South American populations rather than to European, African and Asian colonists, with similar diversity measures to other regions in Amazonia. This research was funded by a General Research Fund grant from the University of Kansas.

Grandmothering and the strength of selection.

A. FRIEDERIKE KACHEL^{1,2}, LUKE S. PREMO¹ and JEAN-JACQUES HUBLIN¹. ¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ²MaxNetAging Research School, Max Planck Institute for Demographic Research.

In humans, unlike in most species, it is common for females to live for decades in a postmenopausal state. The grandmother hypothesis treats the postmenopausal lifespan as an adaptation that allows helpful postmenopausal females to accrue inclusive fitness benefits by decreasing their daughters' interbirth intervals and by increasing their matrilineal grandchildren's survival. Here, we use an evolutionary agent-based model to test whether the proposed benefits are large enough for selection to favor a human-like longevity in simulated populations. We show that the inclusive fitness benefits associated with grandmothering are insufficient for the relatively weak selection that applies to females near or beyond the end of their reproductive period to favor human-like longevity under a wide range of conditions. However, we find that helpful grandmothers can facilitate the evolution of a shorter reproductive period when their presence decreases the age at which their matrilineal grandchildren are weaned. More generally, we show that, holding total reproductive probability constant, selection favors a shorter reproductive period in the presence of shorter interbirth intervals. Thus, in the presence of any source of helping that decreases weaning age (not just grandmothering), selection will favor a shorter reproductive period. This result underscores the important role that allocare may have played in the evolution of the human reproductive strategy, which is characterized by shorter interbirth intervals, an older age at first

parturition and a shorter reproductive period than our closest living primate relatives. This research was funded by the Max Planck International Research Network on Aging of the Max Planck Society.

Rib shapes and thoracic cage morphology in prosimians and anthropoids.

MIYUKI KAGAYA^{1,2}, NAOMICHI OGIHARA^{2,3}, MASATO NAKATSUKASA² and BRIGITTE SENUT¹. ¹Département Histoire de la Terre, Muséum National d'Histoire Naturelle, UMR 7207 CNRS, ²Laboratory of Physical Anthropology, Graduate School of Science, Kyoto University, ³Department of Mechanical Engineering, Keio University.

Primates exhibit a wide spectrum of positional behaviors and adaptations. As the forces transmitted to thoracic cage from shoulder girdles in order to support body weight differ in quadrupedal (pronograde) and orthograde primates, the thoracic cage varies according to locomotor and/or postural adaptations. Previous 3-D analysis of 70 anthropoid skeletons (Kagaya et al. 2008, 2009) showed that apes share similarity in the shapes of ribs, but exhibit variation in the width of the upper thoracic cage. The variation could be correlated with the amount of orthograde postures and/or the frequency of arm-suspensory behaviors.

To refine this interpretation, prosimians such as *Indri* and *Propithecus* (orthograde leapers) and *Lemur* (terrestrial quadruped) are studied and compared with anthropoids for the thoracic morphology. It is shown that the average rib shape is quite similar in the three prosimian genera, especially in the upper ribs (1st to 3rd), but differs from that of apes, Old and New World monkeys. However, in *Indri* and *Propithecus* the strongly medially oriented sternal end in middle and lower ribs (5th to 9th) might imply a dorsoventrally flattened thoracic cage in its middle and lower part. This contrasts with the dorsoventrally elongated thoracic cage seen in quadrupedal *Lemur* and anthropoid monkeys. However, in apes the strongly curved ribs and a wide thoracic cage observed in the upper part of the thorax is unique among primates and could have evolved in relation with a specialization to orthograde and arm-suspensory behavior.

Effects of Weather, Temperature, and Humidity on Feeding Patterns of Mantled Howler Monkeys (*Alouatta palliata*).

SHANNON KAHRIG and ANDREW R. HALLORAN¹. ¹Department of Anthropology, Miami University, ²Florida Atlantic University - Department of Anthropology.

Mantled howler monkeys (*Alouatta palliata*) primarily consume low-energy foods such as leaves, supported by figs and seeds. Seasonal and phenological factors are known to have large-scale effects on the howler monkeys activity budget, but small-scale environmental effects are unknown. These effects, including weather, temperature, and humidity, change from hour to hour, and should influence behavior. Illuminating these effects should aid

our understanding of environmental destruction and climactic change on mantled howler monkeys. In an effort to discern such effects, the food intake rates for 3 groups of mantled howler monkeys on Ometepe Island, Nicaragua were examined. One-hour focal-animal samples on all group members daily for three weeks ($N=38$ samples) were conducted. Additionally, food-intake, weather patterns, temperature, and humidity were sampled at one-minute intervals ($N=2326$ minutes). During feeding, the volume of leaves, seeds, and figs consumed were noted. The proportion of food categories for each hour across specific weather patterns, temperature, and humidity, were compared using Pearson Correlation tests. Intake varied throughout the day, as well as during particular weather patterns, temperatures, and humidity ranges. During sunny, rainy, and windy weather patterns at average temperatures, significantly more leaves were consumed. During cloudy weather and high humidity levels, significantly more high energy foods such as figs and seeds were consumed. The results suggest that small-scale environmental factors influence food intake, indicating that environmental factor changes such as habitat destruction or global warming could force monkeys to abandon high energy foods, and ultimately become less active.

Factors influencing countershading diversity in primate coat coloration.

JASON M. KAMILAR and BRENDA J. BRADLEY. Department of Anthropology, Yale University.

Countershaded pelages (dark dorsal and light ventral surfaces) are often thought to be an adaptation for increasing crypsis, yet few quantitative studies exist. We tested this hypothesis using museum skins from more than 60 primate species. We predicted that species' activity pattern and body mass should be strong correlates of the degree of pelage countershading. As opposed to diurnal species, nocturnal species should exhibit weak countershading because light levels are low at night, reducing any crypsis benefit gained from pelage coloration. In addition, countershading should decrease as body mass increases because predation risk should be lower in large animals, reducing the need for crypsis. We used digital photographs of museum skins to quantify the luminance values on the ventral and dorsal surfaces of each specimen and defined the degree of countershading as the ratio of these values. We used these data in comparative analyses that accounted for phylogeny. Unexpectedly, we found little difference between the countershading patterns in nocturnal and diurnal primates. Several nocturnal species are more active when moonlight levels are high; a context where increased crypsis via countershading might be important for nocturnal primates. In addition, we found a negative relationship between body mass and the degree of countershading across species. There were some exceptions to this relationship, most notably the callitrichids. Many of these species exhibited little or no countershading, though they are all small bodied. This may be due to their frequent use of

vertical postural positions, which would reduce the crypsis benefit of countershading. This study was funded by the Leakey Foundation, the Field Museum, and Washington University, St. Louis

Temperate Migrations: Climatically-mediated movements north (and south again?)

JOHN KAPPELMAN and BRETT A NACHMAN. Department of Anthropology, The University of Texas, Austin.

A longstanding question in human evolution concerns the means by which a tropical group of large body size primates came to migrate to and populate more northerly latitudes. The recovery of new hominin fossils and archaeological sites from temperate regions clearly shows that these movements occurred early on in the Pleistocene and so were not, as believed previously, uniquely facilitated by advances in tool technologies. Given the range of climatic variability that marked the Pleistocene, it is interesting to ask whether or not these population expansions were "driven" by the warmer climates associated with interglacials. Increasingly high resolution data sets recovered from a combination of ice and deep sea cores along with orbitally-tuned time scales and advances in absolute dating techniques permit the construction of a detailed record of Pleistocene climates. Hominin and archaeological sites from temperate latitudes were evaluated and scored for absolute age reliability and plotted against the record of $\delta^{18}\text{O}$, and various means for testing the validity and evaluating the biases of this model were also investigated. The majority of the sites date to interglacial intervals, both before the mid-Pleistocene revolution, as well as after the mid-Brunhes event; only much later sites demonstrate a colder high latitude presence. These data suggest that hominin populations expanded northward with the onset of warmer conditions and either contacted or were isolated with the return of cold conditions. It is likely that behavioral changes in the last several hundred thousand years offered hominins the means to weather much colder climates.

Genome-Wide Association Studies (GWAS) of multiple related bone traits: How to deal with the information overflow.

DAVID KARASIK¹, YI-HSIANG HSU¹, MAYETRI GUPTA², SERKALEM DEMISSIE², L. ADRIENNE CUPPLES² and DOUGLAS P. KIEL¹. ¹Institute for Aging Research, Hebrew SeniorLife, Boston, ²Biostatistics, Boston University.

GWAS offer an unbiased approach to identify new candidate genes for human disease. GWAS frequently analyze many correlated phenotypes. We used phenotype data from the Framingham Osteoporosis Study and genotyping from the Affymetrix 550K SNP set to examine genome-wide associations with skeletal traits, to discern whether there are pleiotropic SNPs associated with multiple related phenotypes.

We evaluated 433,510 SNPs in 2,073 women (mean age 62.5 yrs), members of two-

generational families. Variance components analysis was performed to estimate phenotypic and genetic correlations (p_P and p_G) among multiple traits, including bone density (hip and spine), heel ultrasound, and geometric indices of the hip. Linear mixed effects models (LME) were used to test associations between SNPs and multivariable-adjusted residual trait values. We (a) evaluated the proportion of SNPs associated with pairs of the traits at a significance threshold $\alpha = 0.001$ and (b) performed cluster analysis, with a Bayesian block-clustering model, using an efficient Monte Carlo-based algorithm.

We found substantial correlation between the proportion of associated SNPs and the p_P and p_G ($r = 0.91$ and 0.84 , respectively). Further, a strong cluster of positively-associated SNPs was found for 10 bone belonging to the Skeletal and Muscular System Development and Function pathways.

In conclusion, we mined GWAS results to examine pleiotropic relationships between skeletal traits. Most of the similarity traits: Bone mineral density; both ultrasound measures; and strength indices of proximal femur. Candidate SNPs were further evaluated by the bioinformatic means. We found enrichment of the genes between the bone phenotypes may be attributed to pleiotropic effects of genes. This knowledge may prove helpful in exploring the genetic and phenotypic modularity. This work was supported by the National Heart, Lung and Blood Institute's Framingham Heart Study (Contract No. N01-HC-25195), the National Institute of Arthritis, Musculoskeletal and Skin Diseases and Aging (grants No. R01-AR050066 and R01-AR/AG41398).

Histomorphology of human ribs in methamphetamine users.

ROBERT KARINEN and MARGARET STREETER. Department of Anthropology, Boise State University.

Bone is a dynamic tissue that is capable of responding to metabolic stress. Studies have demonstrated lifestyle choices such as poor diet, insufficient exercise and substance abuse can negatively affect bone health. It is documented that habitual users of methamphetamines exhibit marked deterioration of their dentition and associated facial soft tissue. Another study has associated chronic methamphetamine abuse with lower bone densities. The purpose of this preliminary analysis is to determine if the connective tissue pathology associated with long term methamphetamine use is a localized response to poor dental hygiene or an indication of a more systemic response that is discernable in the bone microstructure. A comparison of the rib cortical bone microstructure between males that were known to be methamphetamine abusers ($N=18$) and individuals who did not abuse the drug was undertaken ($N=19$). Histomorphometric variables calculated in this analysis included mean osteon size, osteon population density (OPD) and cortical area measurement. OPD varied most significantly with lower osteon population densities in methamphetamine users. Mean osteon size was found to be statistically significantly larger in

methamphetamine users when compared to non-users but still within the limits of normal variation. Cortical area measurements were found to not vary significantly between populations. This study demonstrates methamphetamine abuse is associated with lower osteon population densities. These results have important implications for the application of histomorphological age at death estimation that rely on OPD. If methamphetamine does impact bone microstructure then age estimations based on the OPD of abusers could be significantly skewed.

Sexual dimorphism and social structure in *Australopithecus robustus*: How strong is the evidence for "hominid harems"?

KATARZYNA A. KASZYCKA. Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University, Poland.

Sexual dimorphism in primates is a significant phenomenon because of its species specificity, on one hand, and its correlation with patterns of social structure, on the other. In November 2007, a paper was published in *Science* in which the authors (Lockwood *et al.*) claimed evidence of an extended period of growth for males in an *Australopithecus robustus* sample, manifesting as "sexual bimaturism" (males being older than females when they first breed). According to these authors, this finding, combined with their estimates of sexual dimorphism, suggests a harem defense polygyny mating system similar to that of silverback gorillas today. This claim warrants further examination.

I believe that the line of reasoning taken is highly speculative and raises several questions regarding: (1) the actual sex proportion of the known individuals of *A. robustus*, (2) relations of sex and body size, (3) sex and the range of variation, (4) age and body size, and (5) the question whether unequal death risk for the sexes reflects the pattern of predator attack.

My own analysis, based on metrical analyses of craniofacial and dental remains of the South African 'robust' australopithecines, suggests that the conclusions of Lockwood *et al.* (2007) paper can be validly questioned, and that the evidence for "hominid harems" is neither strong nor convincing. Even though *Australopithecus robustus* seems to possess an increased (almost gorilla-like) level of facial dimorphism that may imply polygyny, I would argue that the harem social structure of gorillas is not a particularly good model for interpreting australopithecine behavior. This study was funded by MNiSW, grant number 2P04C 058 29.

Local predictors of primate response to tourists in the Central Suriname Nature Reserve.

Laurie KAUFFMAN. Department of Anthropology, University of Florida, Department of Biology, DePaul University.

Wildlife based tourism is a fast-growing industry, hoped by many to solve the twin problems of habitat loss and economic development. Our prior research on impacts of tourism in the Central Suriname Nature Reserve

(CSNR) indicates that some, although not all, species of primate respond to tourists as if the tourists were predators. By distinguishing the specific factors most associated with such impacts we can better manage tourism in order to lessen negative consequences for ecological communities.

This research asks: What ecological and species-specific characteristics can be used to predict primate response to tourists in the CSNR? We predicted that (1) primates alarm call and flee more often when encountered in open habitat, (2) average species body size is negatively correlated to rates of alarm calls and fleeing and (3) habituated monkeys alarm call and flee less than unhabituated animals.

After observing primate response to tourists during the activities of 48 tour groups, we found that, across species, animals encountered in open habitat alarm called more than those encountered in dense habitat, although there was no association between habitat type and occurrence of fleeing. We also found a positive correlation between alarm call frequency and body size, and that un-habituated are more likely to alarm call than habituated animals. Results differing from those predicted indicate that primate responses to tourists must be investigated for each species, and take into account the holistic evolutionary circumstances under which primate behavior develops.

William Hewson and the Craven Street anatomy school.

TANIA KAUSMALLY. Institute of Archaeology. University College London.

Archaeological evidence of anatomy schools is scarce but in recent years a number of discoveries have been made of hospital medical schools in the states, Ireland and England. Craven Street anatomy school is the only private anatomy school ever uncovered in an archaeological context. In 1997 a small excavation in the basement of 36 Craven Street near Charing Cross in London revealed over 3000 fragments of human and faunal remains, many of them had been dissected. An investigation was launched and revealed an anatomy school had existed at the premises between 1772 and 1778. The school was founded by Mr. William Hewson (1739-1774) and closed only six years later following the death of his successor Mr. Magnus Falconar (1758-1778). Hewson was only 36 when he died from septicemia after cutting himself during a dissection. The analysis of the skeletal remains displayed an interesting demographic profile with a large amount of perinatal and neonatal remains. The cut marks were examined and revealed differential dissection techniques as well as evidence of body sharing and surgical intervention. Compared to the hospital anatomy schools the profile of the pit was very different, suggesting that procurement of bodies for dissection was far more difficult for the smaller private establishment than the hospitals. The Faunal remains were treated very different from the human remains with evidence of being both the remains of food as well as subjects of dissection/vivisections. This study was funded by The Wellcome Trust (Grant: 083396)

Drifting osteons occur in higher concentrations in habitual tension environments: A microstructural toughening mechanism?

KENDRA E. KEENAN¹, ALEX N. KNIGHT¹, SPENCER D. TINGEY¹, CASEY J. KISER¹, SAMUEL C. THOMAS¹ and JOHN G. SKEDROS¹. ¹Dept. of Orthopaedics, Univ. of Utah School of Medicine, Salt Lake City, Utah

In cortical bone, drifting osteons (DOs) are unusual morphologic variants of secondary osteons with possible mechanical or metabolic importance. We hypothesized that, by increasing interfacial complexity, regional variations in the prevalence of DOs may represent a microstructural toughening mechanism that accommodates differences in microstructural failure in tension vs. compression. Alternatively, we postulated that if DOs preferentially migrate toward the medullary canal (endosteum) and/or other low strain regions (e.g., neutral axes) that this could support the inter-related metabolic or strain-gradient hypotheses. One femur was obtained from each of eight adult chimpanzees, and five cross-sections were evaluated: 1) mid-neck, 2) base neck, 3) sub-trochanteric (80%), 4) proximal shaft (70%), and 5) mid-shaft (50%). Undecalcified, unstained specimens were embedded in methacrylate, ultramilled, and imaged under circularly polarized light (CPL). Predominant collagen fiber orientation (CFO) was used to infer habitual tension and compression regions. Numbers of DOs were quantified in cortical octants. Pearson correlations were used to detect possible relationships between number of DOs and various microstructural characteristics including CFO and OPD. Relative percentages of DOs that migrated towards the endosteum, neutral axis, or both were determined. There were significantly more DOs in the "tension" regions ($p<0.01$) of the femoral neck and 70-80% sections (bending environments), but no regional variations at mid-shaft (relatively more torsion-loaded environment). There was no greater predilection of drifting toward the endosteum vs. neutral axis regions. These data suggest that DOs may help toughen cortical bone in tension regions where microstructural failure is more likely when compared with compression regions.

Aquatic habitat use in hominins.

ERICA N. KEMPF. University of York.

The use of aquatic resources has been well documented in *Homo sapiens*, and considered to a lesser extent in earlier hominin species. Modern primates, which are often used as models for hominin behaviour, also use water for a variety of purposes, including feeding, thermoregulation and escaping predation. I aim to examine whether hominins used aquatic resources in similar ways to modern primate species. Additionally, this use of aquatic resources may have differed between hominin species and therefore be indicative of ecological differences between hominin species. This is

tested by using the mammalian faunal assemblages from 250 hominin sites in Africa from 1 mya to 6 mya to calculate an overall aquatic score for each hominin site. These scores were then compared using the Mann-Whitney U test. This analysis shows that there is a statistically significant difference between the degree of aquatic habitat associated with different hominin species, for example species in the genus *Homo* are associated with sites with more aquatic components than australopiths. This suggests, probably unsurprisingly, that different hominin species may have been using aquatic habitats in different ways and hominin behaviour associated with aquatic habitat may have changed through time. Comparing these differences between hominin species with modern primate behaviour in and around the water may provide information about the importance of aquatic habitats in hominin diet, thermoregulation and predation. Funded by the European Commission under the Marie Curie Action of the Sixth Framework Programme (PALAEOL, MEST-CT 2005-020601).

Borders and boundaries: A clash between culture and biology in Southeast Asia.

MICHAEL KENYHERCZ¹, MICHAEL PIETRUSEWSKY², FRANKLIN DAMANN³ and STEPHEN OUSLEY¹. ¹Department of Applied Forensic Sciences, Mercyhurst College, ²Department of Anthropology, University of Hawaii, Honolulu, ³National Museum of Health and Medicine, Armed Forces Institute of Pathology.

Anthropologists have long investigated the interplay between culture and biology. Craniometrics are frequently used to investigate human variation within and among populations, though the labels associated with human groups can be arbitrarily defined. This study examines the interaction of culture and biology in southeast Asia through craniometric analyses. Craniometrics from 110 male skulls were analyzed: from Hanoi, Ho Chi Minh City and Ba Chuc, Vietnam, Cambodia, Laos, Bangkok, Thailand, and Mandalay, Burma (Pietruszewsky 1992). All samples are from 19th and 20th centuries. The Ba Chuc sample is from a Vietnamese village located near the disputed border with Cambodia that was part of the "Killing Fields" massacre. Until recently, Ba Chuc was part of Cambodia. At the time of the massacre, its residents were citizens of Vietnam, though many were probably ethnic Khmer and thus were culturally and linguistically Cambodian. Analyses were carried out using FORDISC 3.0 (Jantz and Ousley 2005) and R. Samples were analyzed using canonical variates analysis and cluster analysis. Natural groupings were discerned through sequentially pooling groups that showed no significant differences between them.

Our results show the North and South Vietnam crania clustered together, as did Laos and Burma, while Ba Chuc, Cambodia, and Thailand form a third cluster. Our results emphasize that while the people of Ba Chuc were citizens of Vietnam, they were craniometrically more similar to the Cambodians and Thai. The Ba Chuc massacre,

then, involved the slaying of Vietnamese citizens who were ethnically Khmer, by the Khmer Rouge communist party of Cambodia.

Do mate advertisement calls given by male mouse lemurs (*Microcebus murinus*) contain patrilineal signatures?

SHARON E. KESSLER^{1,2}, MARINA SCHEUMANN², LEANNE T. NASH¹ and ELKE ZIMMERMANN². ¹School of Human Evolution and Social Change, Arizona State University, ²Institute of Zoology, University of Veterinary Medicine Hannover.

Paternal kin recognition may facilitate inbreeding avoidance and/or kin selection, however the proximate mechanisms by which primate species recognize paternal kin have been difficult to determine. In this study, we investigated whether male mouse lemurs (*Microcebus murinus*) give mate advertisement calls that contain patrilineal signatures. We analyzed temporal and spectral characteristics of 10 calls per male for nine males housed at the University of Veterinary Medicine Hannover using Signal 4.0. Three patrilines were represented with three males per patriline. Principal components analysis conducted in SPSS 17 produced two components which accounted for 69% of the variation described by 49 acoustic variables. We performed a permuted discriminant function analysis (pDFA) with a nested design (individual nested within patriline) using the two components. We obtained a classification rate of 80% (pDFA, p=0.0434). These results suggest that male mouse lemurs give mate advertisement calls that are acoustically distinctive by patriline and that these calls may be an important mechanism for inbreeding avoidance and/or kin selection. This study was funded by the University of Veterinary Medicine Hannover, the German Research Foundation (DFG FOR 499), Sigma Xi, the Arizona State University School of Human Evolution and Social Change, and the Arizona State University Graduate and Professional Student Association.

Accounting for resolution effects in trabecular metrics.

RICHARD A. KETCHAM¹ and JAMES H. GOSMAN². ¹Department of Geological Sciences, University of Texas at Austin, ²Department of Anthropology, The Ohio State University.

Optimal metrical analysis of trabecular bone using high-resolution X-ray computed tomography requires imagery of sufficient detail. However, in many cases ideal imaging conditions cannot be achieved, particularly when analyzing specimens that cannot be sectioned or otherwise harmed. Because CT resolution is a function of object size, resolving small features within large specimens remains a challenge. This matter is of particular concern when making comparisons among individuals and/or taxa spanning a range of sizes, or scanned with different equipment.

To study this problem we scanned trabeculae from proximal tibiae of human skeletal remains

ranging from infant to young adult. Scans were acquired encompassing the entire elements, and one or two additional scans were made focusing in on smaller portions, at progressively higher resolutions. Voxel size ranged from 80µm to 10µm using one scanner down to 5µm and 2µm with another.

When all data are segmented using a standard algorithm, several trends are apparent. With increasing voxel size measured bone volume fraction (BV/TV) and thickness increase while trabecular number and degree of anisotropy decrease. Orientation determinations are largely unaffected, except when two of the three fabric eigenvalues have similar magnitudes, in which case there may be a rotation about the third axis. These divergences are largely a consequence of segmentation. Although algorithmic improvements could improve consistency, segmentation is by nature an information-losing operation. Our analysis suggests that retaining this information instead, by adapting measurement algorithms to process grayscale rather than binary data, may lead to more robust trabecular metrics across resolution scales. Grant Sponsors: National Science Foundation; Grant number: EAR-0646848, (RAK); National Science Foundation Dissertation Improvement; Grant number: BCS-0650727 (JHG).

Morphometric variations of the 7th Cervical Vertebrae of Zulu, Caucasian and Coloured South Africans.

JOB KIBII. Institute for Human Evolution (I.H.E), University of the Witwatersrand, Johannesburg, South Africa.

The 7th cervical vertebrae of 240 cadavers of South African Zulu, Caucasian and Coloured population groups were examined to determine morphometric variation. While females had narrower cervical anteroposterior diameters than males, the difference is statistically significant only among Caucasian and Coloured subjects, with no statistically significant difference between males and females of the Zulu population group. Additionally, while Zulu and Coloured females had statistically significant narrower cervical transverse diameters than their male counterparts, there was no statistically significant variation between Caucasian males and females in this respect.

The findings indicate that sexual dimorphism is more apparent in the vertebral centrum, across the three population groups, where males had significantly larger dimensions in centrum anteroposterior diameter, height and width than their female counterparts. The study further reveals that sexual dimorphism is more apparent when one compares aspects of the 7th cervical vertebra between sexes within the same population group. Overall, the dimensions of the various variates of the vertebra are substantially smaller in women than in men. The smaller dimensions, particularly of the centrum, may contribute to lower skeletal mass in women and render them more vulnerable to fractures resulting from compression forces. This study was funded by Palaeontological Scientific Trust (PAST), The Leakey Foundation, National Research Foundation

(South Africa), and the Institute for Human Evolution, University of the Witwatersrand.

Ancestry informative SNPs and haplotypes in Native American populations.

KENNETH K. KIDD¹, JUDITH R. KIDD¹, FRANCOISE FRIEDELAENDER² and ANDREW J. PAKSTIS¹. ¹Department of Genetics, Yale University Medical School, ²Independent Scientist.

A large number of SNPs genotyped on a large number of population samples (including nine Native American (NA) samples), allow comparison of haplotypes and AIMs in the evaluation of population structure in Native Americans (NA). Our study includes three populations from North America, one from Central America, and five from South America with a total N=425 (data being made public through ALFRED <<http://alfred.med.yale.edu>>). The SNP sets are (1) 2,556 SNPs assembled into 506 multiallelic haplotypes and (2) 128 AIMs from the literature stringently selected for admixture determination in U.S. populations.

Both analyses with STRUCTURE at seven clusters assumed show Europeans distinct from Siberians, both distinct from all NA populations, and the NA populations forming five clusters—three Amazonian clusters, two North American clusters, and the remaining four NA populations with partial assignments to five NA clusters. Both analyses show the three Amazonian populations as distinct from each other and all other populations; two west-of-the-Andes and the Central American population form one cluster. With the AIMs the plains Indians emerge as a sixth NA cluster at K=9, the Mexican HapMap sample appears heterogeneous at all K values, and up to K=5, there is partial assignment of the Plains Indians to the Siberian (Khanty and Yakut) cluster. The small set of 128 AIMs is more efficient than 506 unselected haplotypes in these analyses. The AIMs are candidates other research groups could use to allow SNP data on additional NA populations to be pooled for a comprehensive understanding of NA population structure. This study was funded by NIH GM05772 and NSF BCS-0840570.

Morphology to metric: Establishing a quantifiable sexing technique from the Rogers method for the humerus.

CRYSTAL KIEFFER^{1,2} and ANNA RAUTMAN². ¹Department of Anthropology, University of New Mexico, ²Maxwell Museum of Anthropology, University of New Mexico.

The Roger's morphological technique for estimating sex from the distal portion of the humerus has demonstrated to have accuracy rates of 92%, 79.1%, and 81% in separate studies (Rogers 1999, Falys et al. 2005, Rogers 2009). The goals of this study are to increase the accuracy and reduce the inter-observer error of the technique by converting it to a metric analysis. The 93 males and 52 females studied for this project represent a portion of the Maxwell Museum's Human Documented

Skeletal Collection. Data were collected from only right humeri from European American, right-handed individuals. However, to test whether asymmetry significantly affects morphology, comparison measurements were made on a subgroup of left humeri from 22 of the males and 19 of the females.

Six measurements were taken; five are based on the Roger's technique. Measurements included olecranon fossa width, height, and depth, medial epicondylar and trochlear restriction angles, and epicondylar width. Side differences were noted, with medium effects for male and female medial epicondylar angle (0.23 and 0.33 respectively), trochlear restriction in females (0.23), and olecranon fossa width in males (0.37). Inter- and intra-observer error rates are negligible, demonstrating the reliability of this method. While, all measurements demonstrated some size overlap between the sexes, a discriminant function using olecranon fossa and epicondylar width accurately estimated sex within the sample in 88% of cases. This new method can have application in improving sex estimation of fragmentary remains in forensic and bioarchaeological situations.

The Arctic effect: Does the inclusion of high latitude populations in ecogeographical study samples bias the results?

KATHRYN A. KING. Department of Sociology and Anthropology, University of Arkansas, Little Rock.

Biological adaptation to climate stressors as is reflected in skeletal morphology has been documented in both Old World and New World samples. Populations from circumpolar regions show some of the most extreme expression of climate related features, including foreshortened distal limb segments, broad bi-iliac breadths, and large femoral and humeral head diameters. Incorporating circumpolar samples into larger samples in order to study widespread ecogeographical patterning may introduce bias in the overall results of these studies.

Osteometric data collected from a widespread North American sample ($n = 854$) were analyzed with respect to site-specific temperature and precipitation data to determine if climate related patterning in long bone length and epiphyseal measurements was present. This same sample was then reanalyzed, excluding individuals from five Arctic populations.

Removing the Arctic samples from the analysis had a notable impact on the statistical relationships between the osteometric values and the climate variables. The strength of the correlations between temperature variables and long bone lengths decreased, most dramatically in the radius and tibia. However, many of the correlations between climate variables and epiphyseal measurements increased in strength, particularly in regard to latitude. The dimensions of the os coxa also showed a similarly robust relationship with latitude. These results support that for some measurements, particularly long bone lengths, including Arctic samples may bias the results in favor of stronger ecogeographical correlations. However, these same samples decrease the strength of the correlations between climate

variables and measurements of the long bone epiphyses and os coxa.

The Solcor *Ayllu*: Exploring variation in biological and cultural elements from contemporary cemeteries in pre-Columbian North Chile.

LAURA M. KING¹, BLAIR M. DAVERMAN², KRISTIN L. NADO³, SARA J. MARSTELLER³, CHRISTINA TORRES-ROUFF¹ and KELLY J. KNUDSON³. ¹Department of Anthropology, Colorado College, ²Department of Anthropology, Purdue University, ³School of Human Evolution and Social Change, Arizona State University.

Complex polities exert influence through the movement of goods and individuals. Although the nature of the interaction between the Tiwanaku state (AD 500-1000) and San Pedro de Atacama is unclear, we argue that it encompassed both biological and cultural spheres. To elucidate this, we collected data on stable isotope values, discrete traits, cranial modification, and the mortuary context from two contemporary cemeteries in the Solcor *ayllu* (Solcor-3: $n=122$ and Solcor Plaza: $n=77$).

Strontium and oxygen isotope analyses revealed 20 individuals with values outside the local range as determined through faunal signatures, including some potential *altiplano* migrants. Biodistance analyses show no significant difference between the two Solcor populations, while they are both significantly different from the contemporary Solar 3 cemetery. Together, these suggest that foreign influence may have included human mobility.

Patterns of cranial modification are distinct from those seen in other periods with a much higher incidence of annular forms. Interestingly, these data do not seem to coincide with the presence of Tiwanaku objects. Of the 19 foreign objects, only five Tiwanaku and one southern Bolivian object were found with individuals whose isotope values suggest they might have spent time away from the oases. None of these individuals display the annular shape that is affiliated with outside groups. Consideration of these multiple lines of evidence suggests that Tiwanaku's influence in the Atacama was multifaceted instead of a monolithic force and, moreover, that their impact affected not only the cultural practices of this group, but may have altered its composition. This study was funded by generous grants from the NSF (BCS-0721229 and BCS-0721388) the School of Human Evolution and Social Change at Arizona State University, and Colorado College.

Lemur habitat and dental senescence at Ranomafana National Park, Madagascar.

STEPHEN J. KING^{1,3}, DOUG M. BOYER⁴, STACEY TECOT^{2,4,5}, SUZANNE G. STRAIT⁶, PATRICIA C. WRIGHT^{1,2,4,5,7}, and JUKKA JERNVALL^{4,7}. ¹Department of Anthropology, Stony Brook University, ²Institute for the Conservation of Tropical Environments, ³Department of Anthropology, University of Massachusetts, ⁴Department of Ecology and Evolution, Stony Brook University, Stony Brook, NY, ⁵Centre ValBio, Ranomafana,

Madagascar, ⁶Department of Biological Sciences, Marshall University, Huntington, WV, ⁷University of Helsinki.

Previous research documented dental senescence in a wild population of *Propithecus edwardsi* (Milne-Edwards' sifaka) in the Talatakely area of Ranomafana National Park (RNP), Madagascar. Advanced tooth attrition was found to diminish female reproductive success by decreasing infant survival even as fertility levels were maintained. A potential explanation for this premature dental failure is an evolutionary disequilibrium model whereby these sifakas are posited to have recently been restricted to a resource-poor habitat to which their teeth are poorly adapted. We tested this model by comparing the rates of sifaka tooth wear in two ecologically different but geographically close habitats in RNP, Talatakely and Vatoharanana. Compared to Talatakely, Vatoharanana is a richer habitat with more abundant and diverse fruit, flowers, and young leaves. We predicted that tooth wear in Vatoharanana would accumulate more slowly than in Talatakely. Using standard dental topographic tools, we quantified tooth wear from 3D scans of tooth impressions taken in successive years from identified, wild-caught individuals at the two sites (Talatakely, $n=14$; Vatoharanana, $n=5$ individuals). We defined tooth wear as the square root of the 2D area of dentine exposed by the loss of overlying enamel in the second mandibular molars. Contrary to our prediction, we found no statistically significant difference ($p = 0.47$) in wear rates by site. This result, together with the lack of paleobiological evidence of a recent habitat shift for RNP sifakas, leads us to reject evolutionary disequilibrium as an explanatory model of dental senescence in these sifakas. This research was funded in part by the NSF-BCS 0721233.

Forward shift of the foramen magnum in humans and other bipedal mammals.

E. CHRISTOPHER KIRK and GABRIELLE A. RUSSO. Department of Anthropology, University of Texas at Austin.

Postcranial features associated with bipedalism are often used to assess the hominin status of fossil taxa. By contrast, claims that bipedalism is also associated with a rostral shift of the foramen magnum have met with greater skepticism. Here we examine the influence of bipedal locomotion and orthograde postures on the position of the foramen magnum by measuring basicranial morphology in three mammalian clades that include habitually bipedal taxa: primates, rodents, and marsupials. We measured foramen magnum position for 48 species using digital photographs of crania in norma basilaris. Foramen magnum position was quantified relative to three landmarks: the posterior-most cheek tooth, the posterior midline margin of the hard palate, and the anterior margin of the temporal fossa. The distance between basion and each of the three landmarks was standardized across species by dividing each linear distance by the geometric mean of cranial length and width.

Our analyses support prior claims that humans have rostrally-shifted foramina magna compared to other primates. Our data further demonstrate that three clades of bipedal saltatory mammals (gerbilline rodents, dipodid rodents, and macropodid marsupials) exhibit rostrally-shifted foramina magna compared to quadrupedal close phyletic relatives. Among strepsirrhines, orthograde species have rostrally-shifted foramina magna compared to pronograde species, but the magnitude of this displacement is relatively small. These data reveal that rostral displacement of the foramen magnum is a feature shared by multiple clades of bipedal mammals. Our analysis thus provides further support for the use of foramen magnum position to reconstruct locomotor behavior in fossil species.

Assessing diagenetic alteration of carbon and oxygen isotope values in fossil faunal enamel from Kromdraai, South Africa.

KAROLA KIRSANOW and NOREEN TUROSS. Department of Human Evolutionary Biology, Harvard University,

The analysis of carbon and oxygen isotopes in mammalian enamel has been successfully incorporated into studies of the palaeoenvironmental context of hominin evolution. However, diagenetic alteration of tissue values and fractionation effects introduced during sample preparation may obscure biogenic isotopic information.

This study presents faunal enamel isotopic data from Kromdraai, a hominid locale in South Africa comprised of two adjacent sites of significantly different ages, and describes methods of detecting different modes of diagenetic alteration in this fossil assemblage. Isotopic and compositional analyses of the Kromdraai material suggest that significant alteration of enamel carbonate $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ has occurred, although enamel phosphate $\delta^{18}\text{O}$ values may still reflect authentic biogenic information. A comparison of faunal isotopic values from Kromdraai A and Kromdraai B reveals significant differences between animals having different feeding ecologies, as well as between animals of the same feeding ecology in Kromdraai B versus Kromdraai A. We discuss possible diagenetic overprinting of ecological and environmental distinctions between taxa and time periods, and suggest that examination of the phosphate $\delta^{18}\text{O}$ – carbonate $\delta^{18}\text{O}$ relationship can reveal diagenetic alteration in fossil enamel. We also report on the effects of isotopic fractionation on enamel phosphate samples prepared using a micro-precipitation protocol, and the associated implications for the analysis of phosphate $\delta^{18}\text{O}$ – carbonate $\delta^{18}\text{O}$ relationships in fossil enamel samples. This study was funded by the L.S.B. Leakey Foundation.

Twelve-point osteon morphotype scoring schemes are not better than a six-point scoring scheme for interpreting habitual bending: Evaluation in chimpanzee femora.

CASEY J. KISER, JOHN G. SKEDROS, KENDRA E. KEENAN, SAMUEL C.

THOMAS and ADAM B. BECKSTROM. Dept. of Orthopaedics, Univ. of Utah School of Medicine, Salt Lake City, Utah.

A new osteon morphotype score (MTS) allows for quantifying regional mechanically important collagen/lamellar variations between secondary osteons. We modified the method of R.B. Martin and co-workers and reported its superior utility in various non-anthropoid bones (Skedros et al., 2009 BONE). In chimpanzee femora, however, some osteons did not fit well within this method. We further modified our six-point scoring system (6A) into two new 12-point scoring methods and hypothesized that they would out-perform 6A. Milled methacrylate-embedded sections from each of eight adult chimpanzees were obtained at the proximal (70%) diaphysis and scored in circularly polarized images using: 6A scoring method, first 12-point method (12A, more importance on “hoop” birefringence), and second 12-point method (12B, more importance on the “alternating” birefringence patterns). Average image MTSs were analyzed to determine medial vs. lateral (“compression” vs. “tension”) differences. Statistically significant differences in predominant collagen fiber orientation (CFO, expressed as image graylevels) (158.7 medial vs. 134.2 lateral) are consistent with habitual compression vs. tension. Statistically significant differences ($p<0.05$) in MTS were also shown between the medial and lateral regions using all scores. Predominant CFO correlated significantly and positively with each score method: 6A ($r=0.77$), 12A ($r=0.76$), and 12B ($r=0.67$). These results reject the hypothesis that the 12-point scoring methods out-perform the six-point method. The 6A method was either stronger or equivalent in correlating with predominant CFO. These results show that the extra time and tedium required in assigning six additional scores in the 12-point schemes is not necessary when evaluating adaptation for habitual bending.

Platyrrhine incisal curvature and diet: An independent test of the incisor morphological correlates with dietary proportions reported for extant hominoids.

ZACHARY M. KISER, DUSTIN B. STEPHENS and ANDREW S. DEANE. Department of Anatomy and Neurobiology, University of Kentucky.

Despite the relatively large size of anthropoid incisors in relation to the remainder of the dental arcade and the prominent role that these teeth occupy in the pre-processing of food prior to ingestion, comparatively little is known about the functional morphology of anthropoid incisor shape and crown curvature. The relationship between incisor allometry and dietary proportions has been well documented for both platyrhines and catarrhines, however similar relationships between incisor shape and crown curvature have to date been reported for only living and fossil members of the superfamily Hominoidea. Given the limited taxonomic diversity among the extant members of that group, it has been difficult to firmly establish the relative influence of phylogeny and dietary function in the governance

of incisor crown curvature. Unlike hominoids, which are represented by only five living genera, extant platyrhines are a more varied group that includes 16 ecologically diverse genera. The present study employs high-resolution polynomial curve fitting in an effort to clarify the functional relationship between maxillary and mandibular incisor crown curvature and dietary proportions for a taxonomically diverse platyrhine sample ($n=104$). Results were consistent with prior studies of hominoid incisor curvature and identify a significant and positive correlation between incisor crown curvature and dietary proportions such that increasing curvature is associated with a proportionate increase in frugivory. These results are independent confirmation of findings from previous analyses of hominoid incisor curvature and provide new evidence to suggest that diet, rather than phylogeny, is the primary governing factor influencing anthropoid incisor curvature.

Statistical analysis demonstrating the species distinctions of the Lothagam and Tabarin mandibles.

MARC KISSEL and JOHN HAWKS. Department of Anthropology, University of Wisconsin.

A lack of fossils from the late Miocene/early Pliocene makes informed discussions of the early periods of human evolution difficult. Three new genera have been described since the mid-1990's (*Ardipithecus*, *Orrorin* and *Sahelanthropus*), yet before these discoveries hominid fossils older than 5 million years were limited to only two specimens. The Lothagam (KNM-LT 329) specimen is a fragment of the right mandibular corpus, with the crown of M1 and the roots of M2 and M3 present. Mandibular morphology for this specimen indicates that it shares some features with nonhuman apes, such as a narrow, shallow molar sulcus, and thin corpus base, and some with humans, such as the anterior position of the origin of the ascending ramus. The Tabarin mandible (KNM-ER TH 13150) is somewhat more complete, bearing the crowns of both M1 and M2. Due to their fragmentary nature these mandibular corpora have unclear species designations and have been mostly overlooked in recent attempts to understand variability in fossil hominids. Here we test the hypothesis that these two specimens represent unique hominid species based on the current paleoanthropological record. Our results, based on buccolingual and mesiodistal measurements, suggest that Lothagam is most likely an example of *Australopithecus anamensis*, while the Tabarin mandible is within the range of variation for *Ardipithecus*, though its enamel thickness suggests more variability. The inclusion of these mandibles as part of these fossil genera allows for a better understanding of the species variability and richness at the time of the Chimp-Human LCA.

Genetic analysis of human head and clothing lice indicates an early origin of clothing use in archaic hominins.

ANDREW KITCHEN¹, MELISSA A. TOUPS²,

JESSICA E. LIGHT³ and DAVID L. REED⁴.

¹Center for Infectious Disease Dynamics, Department of Biology, The Pennsylvania State University

²Department of Biology, Indiana University

³Department of Wildlife and Fisheries Science, Texas A&M University,

⁴Florida Museum of Natural History, University of Florida.

Clothing use is an important modern behavior that may have played a role in the expansion of humans into northern latitudes and cold climates. Scientists have estimated that clothing use originated somewhere between 1.2 MYA and 40 KYA, but there is little direct archaeological, fossil, or genetic evidence available to support these estimates. Therefore, novel markers, such as host-specific parasites, are necessary to complement existing evidence and provide new insights into the evolution of clothing use. Human head and clothing lice, which are obligate, host specific human parasites and occupy distinct ecological niches (i.e. head hair and clothing), are uniquely qualified to elucidate this aspect of human evolution as clothing lice are not likely to have evolved prior to the advent of clothing. Here we report how the genetic analysis of human lice provides new direct estimates for the origin of clothing use that are far earlier than previously believed. Using a coalescent modeling approach to investigate a multilocus louse dataset, we find that head and clothing lice initially diverged, and clothing use likely originated, between 0.22 MYA and 1 MYA. This suggests that the use of rudimentary clothing originated not with anatomically modern humans or even late-surviving species such as *H. neanderthalensis* in the Late Pleistocene, but much earlier. This genetic analysis of lice reinforces a broad trend of archaic hominin developments, including the evolution of clothing use, during the Early to Middle Pleistocene.

A comparative analysis of sexual shape dimorphism in the human midcarpal joint.

TRACY L. KIVELL¹ and ISABELLE GUIMONT². ¹Dpt. Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, ²Dpt. Anthropology, University of Toronto.

This study investigated shape variation and allometry in the human midcarpal joint in comparison to other hominoids. Since humans have a relatively low degree of body mass dimorphism, differences in size and shape are not expected. However, recent research has revealed significant size differences between male and female carpal bones and it is not known if there are significant shape differences as well. If shape differences exist, they may represent a phylogenetic retention from our more sexually-dimorphic evolutionary relatives or, (2) imply autapomorphic functional or developmental differences between the human male and female wrist.

A comparative analysis of size-corrected morphometric variables of the scaphoid, lunate, triquetrum, capitate and hamate revealed that the human midcarpal joint displayed nearly

twice as many significantly sexually dimorphic shape variables compared to other hominoids. Pearson's correlations showed that half of these variables were not correlated with the size-surrogate, suggesting these are non-allometric shape differences between human males and females. Although some sexual shape dimorphism was also found in other hominoids, including monomorphic *Hylobates*, the morphological patterns displayed in humans suggest the development of novel shape variation rather than phylogenetic lag. This shape variation may be the result of sex differences in developmental timing, hormone levels during the growth period, or functional differences in the movement of the midcarpal joint. The latter has interesting implications for the locomotor reconstruction of morphological variation in *Australopithecus* carpal bones and may support a hypothesis of locomotor differences implied by smaller (female) and larger (male) postcranial remains. This study was generously funded by NSERC and the University of Toronto.

Bio-archeological analysis of a faunal assemblage from the Castro de Chao Samartín, Asturias, Spain.

ALEXANDRA KLALES¹, ANNE MARJENIN¹, ALLISON NESBITT¹, ÁNGEL VILLA VALDÉS² and LUÍS LORENZO CABO¹. ¹Department of Applied Forensic Sciences, Mercyhurst College, ²Servicio de Patrimonio Histórico, Consejería de Cultura, Gobierno del Principado de Asturias, Spain.

This presentation examines a faunal assemblage from the Chao Samartín Hillfort site in Asturias, Spain, and its contribution to the interpretation of the abundant archeological, anthropological and paleoenvironmental information garnered from this location. The sample corresponds to Early Roman Empire levels excavated during the 2003-2004 field seasons. The Chao Samartín site is located at the locality of Castro, in Grandas de Salime, Northern Spain. During the previous decade, it has provided vital information regarding Roman colonization along the Early Empire boundaries, serving to alter previous paradigms regarding the pre-Roman populations of the northern Iberian Peninsula. Chao Samartín has yielded evidence of fortified settlements and urban social organization extending from Bronze Age to Roman times (roughly, from 3000 to 1800 BP). This served to contradict the previous belief of urban organization of the Asturian tribes appearing only after the Asturian-Cantabrian wars of Emperor Augustus (1st Century BC), thus being a mere consequence of Roman colonization.

The study of the sample (n=652) included taxonomic, anatomic and trauma analysis. The identifiable bones in the assemblage consisted of both juveniles and adults from a minimum of four different species. Over eleven percent of the sample displayed clear human modification in the form of cut marks and other surface alterations. The majority of cut marks affected bovid elements, with *Bos taurus*, *Ovis aries* and *Capra* sp. as the most common species. Over 60% of cut marks were located on appendicular

elements and ribs, indicating a clear consumption pattern. This study was funded by Mercyhurst College Diversity Fund and the Government of the Principality of Asturias, Spain.

Bioarchaeology of structural violence: Theoretical model and case study.

HAAGEN D. KLAUS. Behavioral Science Department, Utah Valley University, Museo Nacional Sicán, Peru, Museo Nacional de Arqueología y Etnografía Hans Henrich Brüning, Peru.

Bioarchaeology has long examined the nature of human violence across time and space. Current disciplinary strengths include the sophisticated analyses of traumatic injury to elucidate the nature, scope, and motivation of interpersonal, intergroup, and ritualized violence. Still, bioarchaeological engagements with violence tend to be shaped mostly by functional explanations of skeletal trauma. Here, we entertain the position that broken bones reflect only one of several modes of violence humans inflict upon each other.

This paper first presents a theoretical model of a bioarchaeology of structural violence. Within complex societies, social marginalization, political oppression, and economic exploitation can systematically inflict multiple forms of morbidity, physical suffering and biological damage observable in human skeletal remains. The model integrates perspectives from social and health theory, physiological understandings of biological stress, and archaeological-historic contexts. Skeletal health phenotypes are understood as a composite of individually canalized epigenetic factors and intermediate ecological stressors—ultimately shaped by overarching economic inequalities and social ideologies. Second, we examine a bioarchaeological case study that illustrates structural violence during Peru's colonial era. Archaeological and ethnohistoric demonstrates gross power imbalances between the Spanish and local Muchik people. These relationships appear to have inflicted direct biological harm on Muchik children and adults (particularly women), reflected in skeletal evidence of compromised immune function, growth retardation, poor oral health, and destruction of load-bearing joint systems. This paper hopes to broaden bioarchaeological conceptions of violence to include social theory and health outcome variation and provide a fuller vision of violence in the human past and present. This research was generously funded by the Wenner-Gren Foundation (Grant number 7302) and The Ohio State University's Center for Latin American Studies, Center for International Affairs, and Department of Anthropology.

Isolation of C-reactive protein from human urine.

LAURA D. KLEIN¹, TALIA N. MELBER² and KATHRYN CLANCY². ¹School of Integrative Biology, University of Illinois at Urbana-Champaign; ²Department of Anthropology, University of Illinois at Urbana-Champaign.

C -reactive protein (CRP) is a useful biomarker to evaluate chronic inflammation caused by disease, obesity, as well as other ecological stressors. Human CRP concentrations can currently be analyzed from serum samples using enzyme immunoassays. No published literature exists that assesses CRP from human urine, thus we have modified a rat urine protocol to achieve this end. Urine samples were eluted through an immobilized p-aminophenyl phosphoryl choline gel column with alkaline buffer solutions, resulting in a concentrate that, when utilized in an enzyme immunoassay, produced similar CRP concentrations to those detected in the expected range of variation seen in human serum. Application of this method will allow for noninvasive collection methods of samples, as well as longitudinal data collection, decreasing the risk of infection due to blood collection methods, and increasing the ease and likelihood of subject participation. As this method can also be applied to archived samples, it will allow further research on existing data sets, reducing the need for funding and time spent recruiting new participants.

Signatures of selection at obesity-implicated genes in a worldwide sample.

YANN KLIMENTIDIS¹, MARSHALL ABRAMS², JOSE FERNANDEZ³ and DAVID ALLISON¹. ¹Section on Statistical Genetics, Department of Biostatistics, University of Alabama at Birmingham; Department of Philosophy², University of Alabama at Birmingham; ³Department of Nutrition Sciences, University of Alabama at Birmingham.

The prevalence of obesity-related traits and associated disease outcomes varies by ethnic/racial group. Recent genome-wide association studies (GWAS) have shed light on some of the specific loci that may influence variation in obesity, mainly among populations of European descent. Given the history of human adaptation to different environments and subsistence modes, and given the differences we currently observe in obesity-related traits between populations, natural selection may have shaped worldwide genetic variation at loci implicated in modern-day variation in body weight. Using the CEPH-HGDP panel of 938 individuals in 53 worldwide populations, we search for evidence of differentiation and natural selection at 17 loci implicated in body weight variation by GWASs. Methods to detect these signatures include examining the distribution of allele frequencies, as well as measures of population differentiation and extended haplotype homozygosity. Our findings suggest that significant differentiation has occurred at several loci, most notably among East Asian and Native American populations. These findings have implications for our understanding of the evolutionary-genetic basis of population differences in obesity, and have the potential to guide future research on the etiology of health disparities. This study was funded by NIH Grant Number T32HL007457 from the National Heart, Lung, and Blood Institute

Functional imaging and dental topographic analysis of chimpanzees.

ZACHARY KLUKKERT^{1,2}, PETER UNGAR³ and MARK TEAFORD⁴. ¹Department of Anthropology, City University of New York, ²New York Consortium in Evolutionary Primate Biology, ³Department of Anthropology, University of Arkansas, ⁴Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine.

Molar tooth morphology is understood to reflect a compromise between phylogenetic and functional influences. Chimpanzee subspecies exhibit reported differences in molar dimensions and nonmetric traits, but these have not been related to differences in their diets. The diet of chimpanzees has been shown to vary in food type and proportion between the three subspecies. However, it is not known whether this variation influences the selective pressures on occlusal morphology. This study uses dental topographic analyses, shown to reveal diet-related differences in occlusal morphology between hominoid species, to assess within species differences among chimpanzee subspecies. High-resolution casts from museum collections were laser scanned, and resulting data were analyzed using GIS algorithms. While differences were noted between wear stages within subspecies in surface slope, relief and angularity, none were found to distinguish the subspecies in these attributes. This might reflect the limitations to the resolving power of dental topography in cross-sectional data samples, or a lack of differences in functionally relevant aspects of occlusal morphology. If the latter is the case, previously reported differences might reflect drift rather than adaptation.

Ecological risk aversion in juvenile Bornean orangutans.

CHERYL D. KNOTT. Department of Anthropology, Boston University.

Orangutans inhabiting the lowland rainforests of Borneo experience dramatic fluctuations in food availability. These are periods of potentially high ecological risk and instability. In this environment I test the hypothesis that during periods of low food availability juvenile orangutans show ecological risk aversion. Data come from 9 years and over 45,000 hours of observation of wild orangutans in Gunung Palung National Park, on the island of Borneo in Indonesia. Measures of developmental independence decreased during periods of low fruit availability. Juveniles spent less time engaging in play, including building play nests, during these periods. Distance separation from the mother also decreased during low food periods, and juveniles engaged in less independent foraging. I tested the hypothesis that juveniles are more vulnerable to starvation during periods of low fruit availability because of their masticatory and digestive immaturity, smaller body size, and reduced ability for hind gut fermentation. Hind gut fermentation of fiber may be particularly important in orangutans because of the high fiber content found in their fallback foods. Using simultaneous follows of

mother-infant pairs, the nutritional and caloric content of food consumed was compared to food excreted to test whether juveniles were less able to extract nutrients from poor quality food as compared to their mothers. Results indicate that juvenile orangutans in these highly fluctuating habitats do show evidence of ecological risk aversion, which I argue is important to our understanding of the long interbirth intervals of wild orangutans. Principle supporters: National Science Foundation; National Geographic Society; Leakey Foundation; US Fish and Wildlife; Orangutan Conservancy; Conservation, Food and Health Foundation.

Life and death of an Andean traveler: Isotopic evidence for geographic origins and paleodiet in an individual buried along a route connecting the coast and interior of the Atacama Desert, northern Chile.

KELLY J. KNUDSON¹, WILLIAM J. PESTLE², CHRISTINA TORRES-ROUFF³ and GONZALO PIMENTEL⁴. ¹School of Human Evolution and Social Change, Arizona State University, ²Department of Anthropology, University of Illinois at Chicago, ³Department of Anthropology, Colorado College, ⁴Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica del Norte.

A single individual (A299) was found interred along a pre-Columbian route connecting the northern Chilean coast to the Loa River Valley in the Depresión Intermedia. This well-preserved burial yielded a nearly complete adult male skeleton with clothes and a small array of goods. Textile fragments produced radiocarbon dates of 1890 ± 40 and 1870 ± 40 BP. Given that he was found in a vast, uninhabited portion of this incredibly arid desert questions arose as to his place of origin.

Strontium isotopes vary geologically, while variation in carbon and nitrogen isotopes reflects dietary differences. In concert with other archaeological evidence, we use these data concerning geographic origins and paleodiet to assess whether this was a coastal traveler seeking provisions from the interior or vice versa. Strontium isotopes in enamel and bone that formed at different times in this individual's life range from $^{87}\text{Sr}/^{86}\text{Sr}=0.70745$ to $^{87}\text{Sr}/^{86}\text{Sr}=0.70883$; in these samples, Ca/P=2.1-2.2, indicating biogenic enamel and bone values. These data are consistent with residence on the coast or in the Atacama Desert, but are lower than strontium isotope signatures from higher altitudes. Results of the light element stable isotope analyses ($\delta^{13}\text{C}_{\text{co}}=-12.69\text{\textperthousand}$, $\delta^{15}\text{N}_{\text{co}}=21.62\text{\textperthousand}$, and $\delta^{13}\text{C}_{\text{ap}}=-8.63\text{\textperthousand}$) indicate habitual consumption of marine foodstuffs (particularly high trophic level marine protein) over the last 10-30 years of this individual's life. Such a dietary pattern is reconcilable with coastal residency. These data are consistent with foodstuffs and textiles with the burial. Therefore, we argue that this individual was moving from the coast following strategic interzonal routes that provided access to particular resources.

Courteous knights, holy blissful martyrs, and cruel avengers: A consideration of the changing social milieu of medieval warfare from the perspective of human remains.

CHRISTOPHER J. KNUSEL. Department of Archaeology, University of Exeter, UK.

Medieval society was highly socially regimented. Religiously symbolic ceremonies (and often payments and gifts) accompanied the rites of passage of birth, marriage, coming-of-age, and especially death, when rights, land, and privileges embedded in inherited titles governed funerary rites that re-enforced the established social order. Potentates and their adherents were tied to one another through oaths of fealty (i.e. fidelity), marriage and kinship. Violent encounters were mediated through an elaborate network of feudal obligation that could generate large numbers of hostile combatants. The use of arms in warfare formed a component of masculine identity, especially of the medieval aristocrat and monarch; his up-bringing and training, his demeanour and appearance, his politics, the type of weapons he carried, the horse he rode, and the clothes he wore all alluded to this pre-eminent martial occupation upon which dynastic success was predicated. The European High and Late Middle Ages (c. 11th-15th centuries A.D.) provide ample opportunity to examine battle-related casualties in the context of the documented socio-political atmosphere of the state-level societies (i.e. kingdoms) of the period. Beyond providing support for textual sources skeletal remains were rarely, until recently, subjected to further scrutiny, with no attempt to place remains in a social context. This contribution assesses the influence of changing social circumstances on the pattern of injuries sustained by medieval combatants. Although only a few well-analyzed samples are at present available, a diachronic trend emerges that indicates a shift from a more diffuse pattern of injuries to one that specifically favours the crano-facial area. This project developed as an out-growth of a Leverhulme Research Fellowship, grant reference RF/6/RFG/2008/0253.

An evolutionary and population genetic approach to malaria susceptibility in Africa.

WEN-YA KO¹, FELICIA GOMEZ^{1,2} AND SARAH A. TISHKOFF¹. ¹Departments of Genetics and Biology, School of Medicine and School of Arts and Sciences, University of Pennsylvania, ²Hominid Paleobiology Doctoral Program, Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University.

Infectious disease is an important selective pressure in modern human evolution. Long-standing struggles for survival have left numerous "footprints" of natural selection within the genomes of both hosts and parasites. Understanding the mechanisms that shaped the evolution of candidate genes involved in host-parasite interaction is critical for identifying variants that play a role in infectious disease susceptibility. Malaria in particular is known to be an important selective force in recent human

evolution. Although extensive efforts to discover variants associated with malaria susceptibility have been conducted, ambiguous results are often obtained. Our recent study reveals that human populations are highly substructured. Genetic substructure complicates studies that seek to identify the genetic basis of human disease because each subpopulation may have experienced different evolutionary processes caused by local adaptation and genetic drift. Therefore, a fine-scaled investigation across different subpopulations may be important for a better understanding of malaria. Here, we studied several erythrocyte and adhesion glycoproteins that serve as receptors that interact with malaria parasites. Our samples consist of ethnically diverse human populations who live in geographical regions with different levels of malaria endemicity. Because the expected configurations of allele frequencies differ between classes of mutations with different fitness effects, we looked for signatures of selection by comparing frequency distributions and rates of fixation of SNPs between candidate regions targeted by selection and putatively neutral regions. Our results show strong evidence of different forms of Darwinian selection and identify several candidate variants that may be critical for malaria resistance. This research was supported by: US National Science Foundation IGERT grant 9987590 (FG, ST); NSF grants BCS-0196183 and BCS-0552486, NIH grant R01GM076637; Human Frontiers in Science grant; David and Lucile Packard Career Award (ST) A Ford Foundation Diversity Predoctoral Award (FG); Sigma Xi Student Research Grant (FG); Cosmo Club Young Scholars Award (FG).

Assessing the practicality of ancient mitochondrial DNA analysis through extraction, amplification and sequencing.

ANTHONY J. KOEHL, M. RITKE, S. P. NAWROCKI and K. E. LATHAM. University of Indianapolis, Archeology and Forensics Laboratory.

Ancient DNA (aDNA) is an inherently difficult material with which to conduct PCR-based studies. The aDNA collected from bone is often limited because taphonomic forces degrade the skeletal remains and associated DNA. Furthermore, contamination is a pressing issue in any genetics research but is especially problematic in aDNA applications. This research highlights the challenges associated with aDNA analysis of skeletal remains from an historic cemetery in Indianapolis, Indiana. The bone specimens from this sample were highly eroded, saturated with water, and permeated with tannins from the ground and accompanying wooden caskets. Once the DNA was extracted and purified from the bone, the feasibility of subsequent analysis via PCR amplification was tested using a 95 base pair (bp) target from Region V of the mitochondrial genome. The screening process yielded proper amplicon size and legible sequence data. However, later amplification attempts employing larger targets of interest (217 to 291 bp) were not as successful. They had limited amplification yield and produced virtually no reliable

sequence information. New primers were designed to decrease the size of the DNA target. For example, an original primer pair used for HVR I that amplified a 249 bp target was divided into two smaller primer sets designed to amplify 120 bp and 128 bp targets, respectively. These smaller targets showed improved amplification and sequencing. This paper will outline the difficulty associated with analyzing aDNA, and how various methods may be implemented to overcome these obstacles.

Changes in the trabeculae of spongy bone as an indicator of anemia?

K. KOEL and M. SCHULTZ. Zentrum Anatomie, Georg-August-University of Goettingen.

During the examination of adult skeletal remains ($n = 276$) from the Early Bronze Age cemetery of Jelsovice, Slovakia, irregular trabecular structures were observed within the spongy bone suspicious of pathological processes. These skeletal changes were classified as neoplastic processes and non-neoplastic processes. Both, functional physical stress and disease processes are factors determining morphologically variable bone trabeculae. Four different groups of new spongiosa structures were distinguished: (1) thread-like spongiosa, (2) plate-like spongiosa, (3) "fiber glass"-like spongiosa and (4) a combination of thread-like and plate-like spongiosa. The thread-like spongiosa is represented by thin to thick bone trabeculae, appearing as a narrow or a wide mesh and is mainly observed in the tubular bones. Plate-like spongiosa is made up of short or longer layers of thin to thick plates that develop along trajectory lines of tension and compression forces in tubular bones. "Fiber glass"-like spongiosa is similar to the thread-like spongiosa, but the new trabecular bone is very thin and irregular, reminiscent of a ball of fiber glass. This type was mostly observed in ribs. By differential diagnosis, these changes in the trabeculae of the spongiosa are mainly indicative of anemia, but also of inflammatory processes (i.e. osteomyelitis) and processes of unidentified origin (e.g., tumors, cf. Roumelis 2007).

Territories and reproductive opportunities: Do male Phayre's leaf monkeys benefit from cooperation?

ANDREAS KOENIG, KATHERINE M. CARL and CAROLA BORRIES. Department of Anthropology, Stony Brook University.

In most primate species with male-biased dispersal, it appears that males may form coalitions to break up consorts or to take over and defend groups of females. However, in species with female-biased dispersal, females can actively choose group membership and males may use cooperation in other ways to attract females and to increase reproductive rates. Here, we ask what benefits males might gain from joint defense in terms of territory size and quality, number of females, and reproductive rates. We investigated these factors

in Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*), a species in which males regularly mature and breed in their natal group and in which coalitions of males jointly defend territories. We used long-term records of ranging behavior, food quality, female dispersal, and interbirth intervals collected since the end of 2000 for four habituated groups at Phu Khieo Wildlife Sanctuary, Thailand (279 contact months, i.e., 23.3 group-years). We found that both group size and the number of males significantly affected territory size (GLM; $P<0.001$) with multi-male groups having larger territories than one-male groups. In addition, multi-male groups experienced more immigrations and fewer emigrations relative to one-male groups (G-test; $P<0.02$). However, mixed model ANOVAs showed that the number of females in a group was only weakly affected by the number of males and interbirth intervals were more dependent on group identity and size than on social organization. Thus, while male cooperation seems to help in territorial disputes, the benefits in terms of reproduction might be weak. Supported by the National Science Foundation (BCS-0215542, BCS-0542035), the Leakey Foundation, National Geographic CRE, and Stony Brook University.

New data on the biological age estimation of children using bone measurements.

KATHERINE KONDOR¹, SÁNDOR ÉVINGER², TAMÁS HAJDU³ and ZSOLT BERNERT². ¹Department of Anthropology, University of Colorado at Boulder, ²Department of Anthropology, Hungarian Natural History Museum, ³Department of Biological Anthropology, Eötvös Loránd University.

The majority of biological age estimation methods for the longbones of children of historical populations are applicable only in the case of intact bones. The described method could be helpful when one must use badly preserved children's bones.

To devise the method, altogether 535 children (0–14 years old) from 17 Carpathian Basin historical series were examined. Measurements were taken from seven bones on the complete skeleton (clavicle, humerus, radius, ulna, femur, tibia and fibula), but incomplete skeletons with lesser measurable bones were also involved. Three measurements were taken on each bone: the maximum length (without the unfused epiphyses), the antero-posterior diameter at the middle part of the midshaft, and the transversal diameter at the same point. The fibula was an exception: here the maximum and minimum diameter were measured at the middle portion of the midshaft.

We found a strong correlation between the maximum lengths and diameters in every bone. Thus, we could make equations that are suitable, although with a somewhat less accuracy, to estimate the biological age of children when only the midshaft of the bones are available. In addition, using our data, we made linear regression equations which describe the length relations of the bones. This way, by knowing the length of an immature bone, it is possible to calculate the theoretical length of the other

bones. This could prove useful for separating children in ossuaries.

Traumatic injury and physical activity: Correlations between robust musculoskeletal markers and fractures on the clavicle.

CASSANDRA S KOONTZ and TIFFINY A TUNG. Department of Anthropology, Vanderbilt University.

Observations for robusticity, stress lesions, and ossification at musculoskeletal marker (MSM) sites can reveal physical activity patterns in ancient populations (Hawkey and Merbs 1995; Weiss 2003). This study examines the correlation between high MSM scores and trauma among comingled human remains dating to the Late Intermediate Period (AD 1000–1400) Monqachayoc sector at the site of Huari, Peru. We compare average MSM scores between adults with fractured and unfractured clavicles to evaluate whether significantly higher MSM scores on fractured clavicles might suggest that greater physical activity contributes to risk for traumatic injury. Conversely, the fractured clavicle could have contributed to lower MSM scores from longterm disuse. This study documented MSM scores at five muscle and ligament attachments sites on 185 adult clavicles (individuals over 15 years old), scoring them for robusticity (0–6) and ossification (0–3).

Results show that among the 13 fractured and 172 unfractured clavicles, the deltoid, pectoralis, and trapezoid muscle ligaments exhibited the highest discrepancies in average scores. Three robusticity scores were, on average, markedly higher in individuals with fractures: trapezoid ligament, 4.091 fractured versus 3.713 unfractured; deltoid, 5.0 fractured versus 3.65 unfractured; and pectoralis, 1.36 fractured versus .588 unfractured. However, a Mann-Whitney-Wilcoxon test shows that the differences are not significant ($z=-1.270$; $p=0.102$), suggesting that higher physical activity may not be related to risk for injury. This study was funded in part by the Vanderbilt Discovery Grant.

What happened at five finger ridge?

DERINNA KOPP^{1,2}, DEBORAH GRAHAM² and KARI CARLISLE³. ¹Antiquities Section, Utah Division of State History, ²Department of Anthropology, University of Utah, ³Fremont Indian State Park.

Five Finger Ridge (42SV1686) was a large Fremont village site located in Clear Creek Canyon in Central Utah that was excavated in the mid 1980's as part of the mitigation for the massive I-70 construction through Central Utah. The site was situated on top of a large five-fingered knoll and consisted of a total of 117 separate architectural features including 81 structures, 33 activity areas, and three unknown features. The habitation period for the village spans 350 years between A.D. 1000 and 1350, which corresponds to the senescence period of the Fremont. Human remains were recovered from nine structures within the site. The majority of the human remains were recovered from discrete concentrations on the floors of

two structures. The remains were fractured, fragmented, disarticulated, comingled, and mixed with animal bones and other artifacts.

A detailed examination of the remains revealed extensive perimortem fracturing of nearly all skeletal elements, numerous perimortem cut marks, chop marks, and anvil abrasion marks on the majority of elements, and burning of some fragments. While this type of perimortem processing and destruction of human remains has been well documented and debated among the Anasazi of the American Southwest, it has only been clearly identified and described in two other Fremont sites both located near Five Finger Ridge. Assemblages with this type of modification have been interpreted as evidence of cannibalism, interpersonal violence and warfare, and ritual execution of witches. This poster will present the skeletal evidence of the perimortem processing and evaluate the possible interpretations.

First metatarsal adduction: How "inline" are humans?

PATRICIA A KRAMER. University of Washington.

Conventional anthropological wisdom dictates that an effective bipedal foot is one with an adducted first metatarsal (MT) and medial longitudinal arch (MLA). First MT position relative to the long axis of the foot (2nd/3rd MT) is usually characterized qualitatively in modern humans as "inline" and MLA as "present," but I wondered how much quantitative variation exists and whether or not fossil hominid feet fall within that distribution.

Using anterior-posterior and lateral radiographs of 35 osteological adults (aged 15–78 years, 18 women), arch height and the angle between MTs (MT12, MT23, MT34, MT45, MT15) were measured. These weight-bearing radiographs were taken to "rule-out" the presence of fracture or as comparison films in order to reconstruct contralateral foot trauma. MT12 of STW 575 and MT angles of OH 8 were measured on photographs/drawings of reconstructions.

In the modern sample, MT12 ranged from 3–15° (mean = 9°, $\pm 3^\circ$) and feet with more abducted 1st MT tended to have more abducted 5th MT ($p = 0.051$) and higher arches ($p=0.018$). MT12 measured 20° on STW 575 and 10° on OH 8. For MT12, STW 575 is $> 3^\circ$ from the human mean, while OH 8 exhibits the human mean value. If the fossil reconstructions are accurate representations of weight-bearing position, then the 1st MT of STW 575 was more abducted than is typically seen in modern humans, but what, if any, functional consequences accrue from this difference are less clear. As with other morphological features, effective bipedal feet can come in many forms.

Cioclovina: A virtual assessment of endocranial morphology in an early European fossil.

ELENA F. KRANIOTI¹, KATERINA HARVATI², TUDOR CIPRUT³ and DAN GRIGORESCU⁴. ¹Museo Nacional de Ciencias Naturales (SCIC), Madrid, ²Tübingen-

Senckenberg Center for Human Evolution and Paleoecology, University of Tuebingen, Germany, ³Radiology Department, Elias University Hospital, Bucharest, ⁴Laboratory of Paleontology, University of Bucharest.

Endocasts and virtual endocasts can provide evidence on size and shape characteristics, blood supply trajectories and neurological features of the brain that could not be assessed otherwise for fossil individuals, allowing comparative analyses that are crucial to our understanding of the evolution of the human brain. The current study aims to assess the morphological features of the virtual endocast of the Cioclovina Upper Paleolithic calvaria, one of the earliest reliably dated European modern human fossils. This study was conducted on a computing tomography (CT) scan of the original specimen taken by a Siemens sensation 64 medical CT scanner (slice thickness=0.625 mm).

The endocranial profile was approximated via a manual segmentation of the CT data. Virtual reconstructions were used for visually assessing the morphological features of the endocranum. The analysis, segmentation and measurements were performed using the Amira 4.1 software. The endocranial volume was measured based on the statistics of all segmented pixels on each CT slice, slice interval, and the number of segmented slices.

Cioclovina exhibits a clockwise torque with a small extension of the left frontal lobe over the right one and at the same time a protrusion of the right occipital lobe over the left. There is an obvious right predominance of the posterior drainage system in Cioclovina. Interestingly the area of the frontal sinus is occupied by dense bony tissue with small air shells corresponding probably to a natural bony loss in the diploe and to vascular spaces. An averaged endocranial volume of 1480 cc. was calculated. Grant Number: MRTN-CT-2005-019564-EVAN

Teeth as tools? Anterior dental microwear textures of the Krapina Neandertals.

KRISTIN L. KRUEGER¹, PETER S. UNGAR¹ and DAVID W. FRAYER². ¹Department of Anthropology, University of Arkansas, ²Department of Anthropology, University of Kansas.

The heavy anterior dental wear typical of most Neandertals has been the focus of research for years. The most common explanation is use of the front teeth as a clamp or 'third' hand, inferred by analogy from ethnographic reports of Arctic human populations. Previous micro-wear studies have proven useful in teasing information about this topic, but have been limited by factors such as comparative diet and abrasive loads. Here we re-examine Neandertal anterior dental wear patterns by investigating the large Neandertal sample from Krapina.

Point clouds representing incisor or canine labial surfaces of seventeen individuals were collected using a confocal profiler. Each sampled area totaled 276 μm x 204 μm , with 0.18 μm lateral spacing and 0.005 μm vertical resolution. Point clouds were imported into Toothfrax and SFrax SSFA software for surface texture characterization. Results of the Krapina

specimens were compared with five bioarchaeological samples with known or inferred diet, abrasive load, and non-dietary anterior tooth use (Aleut, Arikara, Chinese, Illinois Bluff, and Puye).

There are significant differences between Krapina and the bioarchaeological samples in complexity, anisotropy, textual fill volume, and heterogeneity. The Krapina Neandertals most closely resemble Aleuts, differing from other groups in low anisotropy and high textual fill volume values. Our results provide further microscopic evidence that the Krapina Neandertals engaged in repetitive or high-magnitude loading of the front teeth, which is most similar to the pattern found in historic Aleuts. These results reinforce previous work suggesting the use of anterior teeth as tools by Krapina Neandertals.

Bioarchaeological signatures of strife in terminal Pueblo III settlements in the northern San Juan.

KRISTIN A. KUCKELMAN. Crow Canyon Archaeological Center.

The complete depopulation of the northern San Juan region of the American Southwest by Pueblo farmers about A.D. 1280 was stimulated by numerous and interrelated factors such as drought, resource depletion, cooler temperatures, environmental degradation, dense population, social disruption, and violence in the mid-A.D. 1270s. Recent bioarchaeological and contextual analyses of human remains from terminal Pueblo III sites in the region reveal a variety of lethal and nonlethal trauma and other evidence of aggression including cranial depression fractures, broken noses, teeth fractured from blows to the mouth, trophy-taking, and inconsiderate disposition of bodies, as well as evidence of anthropophagy such as disarticulation, spiral fracturing, cutmarks, and burning.

This study examines roles of violence and aggression in late Pueblo society in the northern San Juan as reflected in the signatures of strife found on human remains in abandonment contexts. The empirical evidence mentioned above and other data, including the depopulation-associated trauma and indicators of conflict revealed during the past four years of excavations at Goodman Point Pueblo in southwestern Colorado, suggest that violent attacks on these late Pueblo villages served numerous purposes: to eliminate or reduce competition for limited resources; to gain access to consumables such as turkeys and stored food within settlements; to intimidate, demoralize, and display dominance over other Pueblo communities; and to engage in anthropophagy. The bioarchaeological evidence of strife temporally associated with regional depopulation thus illuminates important and complex facets of the cultural role of aggression and violence at an especially significant hinge point in Pueblo prehistory.

Comparative morphology of incisor and molar roots in Neanderthals, Middle Pleistocene *Homo* and *Homo sapiens*.

KORNELIUS KUPCZIK, ADELINE LE CABEC and JEAN-JACQUES HUBLIN. Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany.

Neanderthals are known for a distinctive suite of dental features including large anterior crown dimensions, long incisor roots and molars with enlarged pulp cavities. Beyond this, little is known about variations in root morphology in Neanderthals and other recent and fossil *Homo*. Here we provide a metric analysis of permanent mandibular incisor and molar root morphology in Neanderthals, the Middle Pleistocene *Homo* from Mauer and in Late Pleistocene (Aterian) and recent *H. sapiens*. We address whether molar root form can be used to discriminate between these groups and assess whether any variation in root form can be related to differences in tooth function. A microtomographic imaging approach was applied to visualise and quantify root morphology of both isolated teeth and teeth embedded in the mandible (incisors N = 118, molars N = 130). Univariate and multivariate analyses reveal significantly larger absolute molar root surface areas, volumes and lengths in Neanderthals than in recent *H. sapiens*, while molar root dimensions of Mauer and Aterian *H. sapiens* fall within the upper end of the Neanderthal range. Likewise, incisor root surface areas were found to be markedly different between Neanderthals and modern humans. Furthermore, while Neandertals show a similar mean root surface area in M₁ and M₂, recent *H. sapiens* have the largest root surface area in M₁, and the Aterian *H. sapiens* and Mauer demonstrate the largest values in M₂. This suggests a distinct incisor and molar loading regime in Neanderthals compared to *H. sapiens* and the Middle Pleistocene *Homo* from Mauer. This research was supported by the Max Planck Society and the EVAN Marie Curie Research Training Network MRTN-CT-019564.

The calcar femorale in the fossilized partial femur BAR 1003'00 and its relation to bipedal locomotion.

ADAM J. KUPERAVAGE and ROBERT B. ECKHARDT. Laboratory for the Comparative Study of Morphology, Mechanics and Molecules, Department of Kinesiology, The Pennsylvania State University.

The calcar femorale (CF) is a plate of dense bone internal to the lesser trochanter and continuing to approximately the mid-point of the posterior medial femoral neck wall in humans. It is visible in computerized tomographic images of the 6 million year old femoral fragment BAR 1003'00, among the oldest specimens pertinent to reconstructing the evolution of human bipedal locomotion. A strongly expressed CF has been used as an indicator of bipedality. If true, then there should be a quantifiable difference in the CF among hominoids. The extent of CF expression in apes has not been reported previously. To test the claim that its strong presence is indicative of bipedal locomotion, in this study the normalized

CF length was measured from computerized tomographic images at five locations along the proximal portion of BAR 1003'00 plus samples of the 9 human, 10 chimpanzee, and 10 orangutan femora. The human sample exhibited CF lengths that were consistently greater at each location than the chimpanzees. The BAR 1003'00 CF was more similar to humans. Orangutans exhibited variable but generally negligible CF expression. The chimpanzee and human CF ranges overlapped heavily; therefore, if its expression is unquantified, CF presence alone is not suitable as a diagnostic characteristic for bipedality. The chimpanzee femora were more variable both in the occurrence of the trait and, where present, its extent in the proximal femur. A plausible explanation for the greater CF variation in chimpanzee femora is that they are loaded more variably than in humans. This study was funded by The American Philosophical Society and Sigma Xi.

Is pelvic dimorphism related to body size dimorphism in humans?

HELEN KURKI. Department of Anthropology, University of Victoria.

Many mammalian species display sexual dimorphism in the pelvis, where females possess larger dimensions of the obstetric canal than males. This is contrary to the general pattern of skeletal size dimorphism, where males are larger than females. This pelvic dimorphism is often attributed to selection relating to parturition, or as a developmental consequence of secondary sexual differentiation. Tague (2005) has argued that among primates, species with higher body size dimorphism have higher pelvic dimorphism (in converse directions) due to the sensitivity to testosterone, rather than specifically obstetric requirements. This study investigates whether this pattern holds in humans by asking: Do human populations with high body size dimorphism, also display high pelvic dimorphism? Previous research demonstrated that in some small-bodied populations, relative pelvic canal size can be larger than in large-bodied populations, while others have suggested that larger-bodied human populations display greater body size dimorphism. Climate has also been implicated in human size dimorphism. Nine human skeletal samples (total n: male=144, female=137) were utilized, representing a range of body sizes and geographical regions. Indices of pelvic and body size dimorphism [$\ln(M/F)$] of skeletal dimensions were examined using correlation and least squares regression. The results suggest pelvic dimorphism in humans is generally not correlated with body size dimorphism, although some canal dimensions show a greater magnitude of dimorphism in populations with lower body size dimorphism. Larger samples, more populations, and phylogenetic contrasts could further elucidate these patterns to help us better understand the selective factors that have led to pelvic dimorphism. This research was supported by the Social Sciences and Humanities Research Council of Canada (Grant #410-2008-2344).

Carbon and nitrogen stable isotope analysis of dietary differences among the Jomon population in Japan.

SOICHIRO KUSAKA¹, FUJIO HYODO², TAKAKAZU YUMOTO³ and MASATO NAKATSUKASA¹. ¹Department of Zoology, Kyoto University, ²Research Core for Interdisciplinary Sciences, Okayama University, ³Research Institute for Humanity and Nature.

We report on a stable isotope paleodietary reconstruction of the Jomon population in Japan during the Middle to Final Jomon period (ca. 5000–2300 years BP), considering of both intra- and inter-population dietary differences. Carbon and nitrogen isotope analysis was performed on human and faunal bone collagen from six coastal sites in the Sanyo and Tokai districts of Japan. We found that carbon and nitrogen isotope ratios were positively correlated, indicating the Jomon population consumed a mixed diet of marine (shellfish and marine finfish) and terrestrial (C3 plants and terrestrial mammals) protein. Analysis of the data from the Ota site (n=25, Middle Jomon period, 5000–4000 years BP) indicated that sex is one of the factors determining an intra-population dietary difference. Specifically, data indicated that Ota males consumed greater amounts of marine food, while Ota females consumed greater amounts of terrestrial food; dissimilar diets that might have resulted from the sexual division of labor. Moreover, comparison of isotopic values between two regions clearly showed inter-population dietary differences. Nitrogen isotope ratios of individuals from the Ota, Tsubue, and Tsugumo sites in the Sanyo district (coastal area along the Inland Sea) were significantly higher than those of individuals from the Kawaji, Inariyama, and Yoshigo sites in the Tokai district (coastal area along the Pacific Ocean). A Sanyo population would have consumed a diet high in marine food, in particular, high trophic level marine finfish. This study was funded by the Japan Society for the Promotion of Science (JSPS) Research Fellowships for Young Scientists.

A new approach to facial reconstruction based on 3D morphometrics.

AGNES KUSTAR¹, IVETT KOVARI², ILDIKO KALINA³ and MARTIN FRIESS⁴. ¹Department of Anthropology, Natural History Museum of Hungary, Budapest, ²Department of Archaeology, Herman Ottó Museum, Miskolc, ³Department of Oncotherapy and Radiology Semmelweis University, Budapest, ⁴Département HNS & UMR 7206 du CNRS, Musée de l'Homme, Paris.

A Methodological improvement in craniofacial reconstruction is necessary, as there are few recommendations, and these are partly based on uncertain, or unproven data. The main purpose of our study is to improve our understanding of soft and hard tissue covariation, with the ultimate goal to more accurately predict the face morphology from underlying bony structures. In order to achieve this goal, we have created a large database of 3D skull and face morphology

from living humans. 300 adults, males and females, were subjected to medical CT scan and optical surface scanning specifically developed for living faces (www.breuckmann.com). Preliminary testing revealed that CT scanning alone was not suitable for reproducing the soft tissue, because of gravity-induced shifts, whereas fitting a surface scan of the face to the CT scan of the corresponding skull provided reliable 3D models of both tissues. Once the two scans were matched, 50 landmarks were extracted by one of us and subjected to a Generalized Procrustes Analysis. 2-Block partial least-squares analysis was applied to determine those landmarks in both the skull and the face that show the largest amount of covariation. Regression models were used to predict soft tissue variability from bony features. This approach more accurately reveals patterns of correlation and covariation, while identifying facial features seemingly unrelated to skeletal anatomy. Ultimately, both the assembled database and the proposed methodology can provide a more ample guidance to practitioners and all those interested in facial reconstruction, such as forensic anthropologists. This study was supported by OTKA (K73441).

Sexual dimorphism in the elbow using Zobek measurements.

ALICJA K. KUTYLA, REBECCA J. WILSON and HELI MAIJANEN. Department of Anthropology, University of Tennessee.

The pelvis followed by the cranium have long been considered the most reliable sex indicators; however, postcranial metrics have been shown to be highly effective. This poster expands on recent research indicating that the elements of the elbow have the potential of being highly reliable indicators of sex. A sub-sample of 95 white males and 95 white females, with known ages, was selected from the postcranial database of Zobek (1983) measurements from the William M. Bass Donated Skeletal Collection. Individuals with all measurements of the distal humerus, proximal ulna and radius were selected for analysis. A discriminant function with variable selection was performed using NCSS (2004). This analysis indicates that out of the 9 variables selected, only 3 (The maximum breadth and minimum breadth of the ulna and the maximum diameter of the radial head) were needed to correctly classified individuals at the 88% level. Of those individuals misclassified, females were more likely to be grouped as males. Using all 9 variables produced a 92% classification rate. These often overlooked and underused measurements require further investigation to determine their efficacy in comparison to more traditional measurements like the humeral head diameter; however, they do indicate potential in being added to the suite of measurements that can be used in metric sex estimation.

The fate of patients in a 19th century insane asylum.

MICHAEL G. LACY¹ and ANN L. MAGENNIS². ¹Department of Sociology,

²Department of Anthropology, Colorado State University.

This study reports on a series of $N = 1782$ residents who were admitted to the Colorado State Insane Asylum between 1879 and 1899. This analysis differs from other reports on 19th century asylums in using data pertaining to a frontier population, and in using a quantitative epidemiological approach. In the current report, two key outcomes, death in the asylum and discharge from the asylum, are examined in a competing risks survival analysis that examine each outcome simultaneously in relation to sex, age, nativity, occupational position, and two diagnostic categories, syphilis and drug use. The risk of mortality differed little with respect to the demographic variables, but patients diagnosed as syphilitic had nearly twice the hazard of death of others, while those entering with a drug use diagnosis were one-third less likely than others to die. A similar analysis of discharge again showed minimal effects from the demographic variables, except that older patients were more likely to be discharged, with each five year increment of age corresponding to a 10% greater rate of discharge. Patients with syphilis were about half as likely as others to be discharged, while those admitted for drug use were about one-third more likely to gain discharge. By contrast to a previous analysis showing distinct effects of demographic characteristics on rates of admission, the current work suggests that life within the institution may have been relatively unaffected by residents' social characteristics.

The dish on DISH: A "severe" case of Diffuse Idiopathic Skeletal Hyperostosis from Medieval Nubia with implications for etiology of DISH and the progression of knowledge on this disorder.

MARNI LAFLEUR, MORGAN SEAMONT, PAUL SANDBERG and DENNIS VAN GERVEN. Department of Anthropology, University of Colorado Boulder.

DISH (Diffuse Idiopathic Skeletal Hyperostosis) is a condition characterized by the hyper-production of coarse flowing osteophytes which cause an ossification of the lateral anterior ligament of the spine. DISH is found as far back as the middle Paleolithic, is common clinically, occurs more frequently in men, and is likely associated with certain metabolic disorders. We examined 146 adult skeletons originating from two cemeteries at Kulubnarti in Medieval Nubia, and found one case of DISH in an adult male. At less than 0.6% prevalence, the condition seems unusually rare considering a 13.4% prevalence in the temporally and spatially nearby Semna South region. Preliminary oxygen isotopic data suggest the individual with DISH may be non-local, which would indicate no cases of DISH in locals from Kulubnarti. This disparity in prevalence may indicate that the condition has a genetic component or potentially that the individuals at Kulubnarti and Semna South were faced with different environmental or dietary causative influences. However, it is also possible that prevalence of DISH, as that reported by

previous authors, is inflated because of relaxed diagnostic criteria. We call for an adherence to the clinical definition of DISH (requiring at least 4 adjacent affected vertebrae), suggest that a ranked scale be used to assess severity of cases, and note that the causative agent of adult-onset diabetes and/or obesity are highly-unlikely to be responsible for DISH in Medieval Nubia. If paleopathology is to progress as a discipline, we must use standardized, transparent methods which lend to comparative analyses.

Scaling of the hominoid distal humerus: Implications for shape variation among early hominins.

MICHAEL R. LAGUE. The Richard Stockton College of New Jersey.

Numerous studies have examined morphometric variation among early hominin humeri, though their conclusions vary. Some researchers, for example, note shape heterogeneity among Koobi Fora humeri (c. 2-1.5 Ma), while others note a morphological cohesiveness befitting conspecifics. Although humeral fossils vary widely in size, investigators have largely ignored the potential effect of allometry on shape variation. This study investigates fossil humerus morphology in light of hominoid scaling patterns to elucidate the biological basis of early hominin variation.

Humeral measurements were made on hominin fossils (e.g., those attributed to *Australopithecus anamensis*, *A. afarensis*, *Paranthropus robustus*, and specimens of less secure attribution) and all extant hominoid species. Regression analyses were used to quantify scaling relationships among extant taxa to provide a basis for evaluating fossil morphology. Dimensions were assessed against a measure of overall joint size and against each other.

For some dimensions, hominoids share a common scaling trajectory. More typically, two or more parallel trends (similar slope, different y-intercept) are apparent, indicating similar structural responses to size variation among morphologically diverse taxa. In several ways, chimpanzees exhibit morphology expected for a comparably-sized modern human rather than a gorilla. Despite their temporal/taxonomic diversity, the fossils typically fall along a common trend line parallel to or defined by extant taxa. Koobi Fora specimens differ consistently from other fossils for multiple comparisons, exhibiting a unique total morphological pattern. This study provides insights into hominoid skeletal variation and demonstrates the importance of considering size-related shape variation when interpreting the morphology of extinct species. This research was supported by grants from the National Science Foundation (9712585 and 0647557), as well as a grant from the Wenner-Gren Foundation (to J.M. Plavcan and C.V. Ward).

The influence of lower facial projection on the mandibular curve of Spee in extant humans.

MYRA F. LAIRD¹, NATHAN E. HOLTON^{1,2}, JILL E. SCOTT¹, ROBERT G.

FRANCISCUS^{1,2}, STEVEN D. MARSHALL² and THOMAS E. SOUTHDARD². ¹Department of Anthropology, University of Iowa, ²Department of Orthodontics, University of Iowa.

The curve of Spee (COS), a concave arc technically measured from the mandibular condyles across the tooth occlusal surfaces from M3 to the canine, is of importance during orthodontic treatment, and its presence is also occasionally mentioned in discussions of fossil hominins. Nonetheless, COS configuration is variable, and the precise developmental mechanisms that affect its variability are poorly understood. A recent analysis of longitudinal ontogenetic data derived from a Euro-American sample (Marshall et al., 2008) documented that the COS is affected by differential eruption of the permanent molars. However, craniomandibular form can influence both dental eruption and the maintenance of normal occlusion, and it is important to consider overall facial morphology when assessing COS variation.

Given that COS curvature is oriented anteroposteriorly, we tested the hypothesis that COS configuration covaries with lower facial prognathism, such that more orthognathous lower faces should exhibit greater occlusal curvature. We tested this hypothesis on a sample of Euroamericans and African-Americans (total n=291, Cleveland Museum of Natural History) who collectively exhibit a large range of lower facial orthognathism to prognathism. Several 3-D coordinate landmarks that defined the occlusal surface of the dentition and broader aspects of the facial skeleton and mandible were assessed using principal components analysis of Procrustes scaled shape variables. Our results support the hypothesis that the COS is associated with the degree of subnasal alveolar projection, with the European derived sample exhibiting a more pronounced curve on average and the African derived sample characterized by a flatter occlusal surface. This study was supported by the University of Iowa Executive Council of Graduate and Professional Students, Dewey Stuit Award, and the Iowa Center for Research by Undergraduates.

Digestive physiology and use of carbohydrates by arboreal, frugivorous Carnivora (*Arctictis binturong*, *Potos flavus*): a test of convergent evolution with the primate pattern.

JOANNA E. LAMBERT¹, ADAM HARTSTONE-ROSE² and VIVEK FELLNER³.

¹Department of Anthropology, The University of Texas at San Antonio, ²Department of Biology, Pennsylvania State University at Altoona, ³Department of Animal Science, North Carolina State University.

Comparative investigation into traits that have evolved convergently can lend insight into the circumstances under which those features evolved. While most Carnivora species consume animal diets, *Arctictis binturong* (binturong) and *Potos flavus* (kinkajou) are - like many primates - flexible omnivores and frugivores. Other convergent traits include an

arboreal niche reflected in adaptations of the elbow, wrist, and tail. Our aim was to evaluate whether these species also exhibit convergence with primates in their digestive physiology.

Data on digestive retention (MRT), carbohydrate fermentation, short-chain fatty acid (SCFA) production, and fiber digestion were collected on eight animals at the Carnivore Preservation Trust, NC. MRT was measured via markers fed to animals in four trials. Carbohydrate fermentation, SCFAs, and fiber digestibility data were measured on fecal samples assayed in the laboratory. Carbohydrate fermentation samples were incubated anaerobically and analyzed for methane, pH, and SCFA. Digestibility and fiber were assayed using standard NDF and ADF methods (Van Soest *et al.*, 1991).

Preliminary results indicate that both species digest food several orders of magnitude faster than comparably-sized frugivorous/omnivorous primates (binturong: 13–27kg; MRT = 38mins; kinkajou: 2–5kg; MRT: 27mins). Data on carbohydrate fermentation and fiber digestion are consistent with this pattern. NDF assays indicate fiber digestion at only 14.22% and ADF at 28.82%; only trace SCFAs were found. All data suggest that these species concentrate on extraction of simple sugars/disaccharides in the small intestine rather than fermentation of polysaccharides in the large intestine. Implications for interpreting niche evolution and competition with primates will be discussed.

Male-female social relationships and reproductive success in wild chimpanzees.

KEVIN LANGERGRABER¹, JOHN MITANI², DAVID WATTS³ and LINDA VIGILANT¹.

¹Primate Department, Max Planck Institute for Evolutionary Anthropology, ²Department of Anthropology, University of Michigan, ³Department of Anthropology, Yale University.

Although humans show great cross-cultural diversity in their social and mating systems, “pair-bonded” male and female dyads are a universal feature of human societies, and most reproduction takes place within the context of these long-term, affiliative relationships. While male-female pair bonds have long been thought to play an important role in human evolution, their evolutionary history is poorly understood. Here we examine “proto”-pair-bonding in the unusually large Ngogo community of chimpanzees in Kibale National Park, Uganda. We show that some male-female dyads have very strong tendencies to associate in the same party and to preferentially use the same area of the community territory, and that these preferences are stable across time. In contrast to results from smaller chimpanzee communities which showed that male reproduction is strongly biased in favor of the alpha male, at Ngogo our two measures of dyadic bond strength (party association and space use similarity) have approximately as strong effects on the probability that a male-female dyad will produce an offspring with each other as does male dominance rank. These results suggest that an increase in group size may have played a key role in the transition in hominids from a promiscuous/polygynous to a pair-bonded

multi-male/multi-female social system. This study was funded by the NSF (USA), the Max Planck Society, the Wenner-Gren Foundation, the Leakey Foundation, and the Alexander von Humboldt Foundation.

Molar crown variation in *Homo erectus*.

JUSTIN W. LANTZ, JENNIFER L. THOMPSON and DEBRA L. MARTIN. Department of Anthropology, University of Nevada, Las Vegas.

Are there multiple species within *Homo erectus sensu lato*? According to the single-species view, *H. erectus* is described as a temporally and geographically diverse fossil hominid species. Conversely, others have proposed the presence of two distinct, yet phylogenetically related fossil hominid species, *H. ergaster* and *H. erectus*. The current study uses traditional metric and geometric morphometric (GM) techniques to assess whether mandibular first molar (M1) size and shape variation in *H. erectus s. l.*, can be accommodated by the variability exhibited by modern human comparative samples.

Coefficients of variation (CVs) were calculated for the posterior dentition of both fossil (n=49) and modern human (n=2,525) comparative samples. Modern human metric data were resampled and bootstrapped 1,000 times following parameters of the fossil sample. Fossil CVs were ranked among distributions of resampled and bootstrapped comparative sample CVs ($p<0.05$). In addition, GM analyses were conducted using occlusal views of modern human (n=25) and fossil (n=18) M1s. Canonical variates analysis (CVA) and principal components analysis (PCA) were applied to examine variation within and between fossil and comparative samples.

PCA and fossil sample ranks among modern human bootstrapped CVs show that the Asian subsample contributes a particularly large amount of M1 size and shape variation to the hypodigm. Specifically, most of the variability in M1 crown morphology is derived from the Zhoukoudian *H. erectus* subsample. Based on these results, the current study supports a taxonomic distinction between African *H. ergaster* and the Zhoukoudian *H. erectus* subsamples.

Javan gibbon (*Hylobates moloch*) feeding and ranging behavior in lower montane forest in the Gunung Halimun-Salak National Park, Indonesia.

SUSAN LAPPAN¹, SANHA KIM² and JAE CHUN CHOE³. ¹Appalachian State University,

²Seoul National University, ³Ewha Womans University, South Korea.

The vast majority of wild Javan gibbons (*Hylobates moloch*) remaining inhabit hill (500–1000 m asl) and lower montane (1000–1500 m asl) forests, yet long-term behavioral research on Javan gibbons has been conducted at only two sites, both in lowland forests. This is problematic, as behavioral information is often used to calibrate census methods and in conservation planning. We conducted a 12-

month study of feeding and ranging behavior in three groups of Javan gibbons in the Citalahab area of the Gunung Halimun-Salak National Park (950–1150 m asl) to provide comparative data from a higher-elevation population. Estimated Javan gibbon density at Citalahab was relatively high (~3.3 groups/ha), despite the site's elevation and proximity to a habitat edge. Gibbon diets and activity patterns at Citalahab were generally similar to those reported from lowland sites, but gibbons at Citalahab ate fewer leaves (24.5±4.8% of feeding time) and more flowers (11.8±3.4%) than gibbons at other sites, and vocalized less frequently. Javan gibbons spent ~60% of feeding time eating fruit in all studies to date, but the most important fruit species eaten differed among sites. Gibbon home ranges at Citalahab were substantially larger (range = 32–43 ha) than those reported from lowland sites (range = 6–22 ha). Our results emphasize the importance of using site-specific data when estimating population sizes, assessing habitat quality, or projecting Javan gibbon space needs, and suggest that conservationists should make conservative assumptions when local data are unavailable. This study was funded by the Amore Pacific Foundation, Ewha University, and Primate Conservation, Inc.

Predicted compared to observed limb support asymmetry during quadrupedal walking in *Ateles* and *Cebus*.

SUSAN G. LARSON and BRIGITTE DEMES. Department of Anatomical Sciences, Stony Brook University Medical School, Stony Brook.

While it is well known that primate quadrupeds are distinctive in supporting more body weight on their hind limbs than their forelimbs, an explanation for how this support asymmetry comes about has proven to be elusive. The simple explanation of a difference in body center of mass (COM) position is not supported by empirical data, leaving two less intuitive proposals. The first suggests that higher hind limb forces are due to the position of the hands and feet relative to the COM, and has recently received support by Raichlen *et al.* (2009) who document that chimpanzees walk with a relatively protracted hind limb, bringing their feet closer to the COM for greater hind limb weight support. The second posits the use of hip retractor muscles to actively shift weight off the forelimbs and onto the hind limbs, and has also received recent support by Larson and Stern (2009) who report higher levels of hip extensor activity in primates that bear more weight on their hind limbs. While these two proposals are not mutually exclusive, since the study by Raichlen *et al.* (2009) is based on a limited empirical dataset, we have undertaken a replicate study to document average limb posture and weight support distribution in two additional primate species: *Ateles* and *Cebus*. Using the equations presented by Raichlen *et al.* (2009), predicted forelimb weight support based on limb posture was compared to observed based on vertical impulses. Unlike their study, limb posture dramatically overestimated actual forelimb weight support, calling into question the general applicability of this model. Research

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The ontogenetic covariance structure of postcranial elements in sifaka.

RICHARD R. LAWLER¹ and ROSHNA E. WUNDERLICH². ¹Department of Anthropology, James Madison University, ²Department of Biology, James Madison University.

Primates are characterized by a relatively long juvenile period, and this period is often assumed to be adaptive. If juvenility itself is adaptive, then it is expected that patterns of growth among traits are adaptively buffered from selection pressures that can disrupt trait complexes during ontogeny. One testable prediction of this hypothesis is that young primates will exhibit more integrated traits for any trait complex that is more important to juvenile fitness than to adult fitness. The high degree of integration among traits "forces" selection to act simultaneously on numerous developmentally integrated elements, thereby precluding selection from modifying any single trait that is part of a larger trait complex. In this study, we compare patterns of morphological integration across four age classes using data collected from a wild population of sifakas (*Propithecus verreauxi verreauxi*) inhabiting a protected reserve in southwest Madagascar. We examine the covariance structure among seven linear measurements of the postcranium (lengths of humerus, radius, hand, femur, tibia, foot, and tail) in 60+ animals from each age class. We represent patterns of integration as conditional independence graphs and use information theoretic statistics in order to analyze the patterns of integration among the four age classes. Compared to the other three age classes, yearlings retain more statistical associations among traits. This implies that in the first year of life postcranial growth is more tightly regulated during the period when yearlings are developing locomotor coordination. These age-specific patterns of integration are discussed with respect to how selection targets locomotor development in sifaka.

Tool use and inter-population variation in metacarpal trabecular microarchitecture in *Pan troglodytes*.

RICHARD LAZENBY¹, MATTHEW M SKINNER², JEAN-JACQUES HUBLIN², CHRISTOPHE BOESCH³. ¹Anthropology Program, University of Northern British Columbia, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ³Department of Primatology, Max Planck Institute for Evolutionary Anthropology.

Diverse stimuli affect trabecular bone morphology, though among these functional loading is paramount. Trabecular mass and structure vary by anatomical location within species, and within anatomical location between species. Using 3D microcomputed tomography we assessed trabecular architecture from spherical volumes of interest (VOI) within the head and base of the 1st, 2nd and 5th metacarpals from two populations of adult common

chimpanzee, *Pan troglodytes verus* from the Tai Forest (n = 12) and *P. t. troglodytes* from Cameroon (n = 7). With the exception of the MC 5 base, the Cameroon chimpanzees have a significantly more robust trabecular architecture (greater bone volume fraction, thicker trabeculae, and a predominance of plates versus rods [significant K-W ANOVA ranges from 5.36, p = 0.02 for the MC 2 base to 17.47, p = 0.00 for the MC 2 head]). These differences are not explicable in terms of differences in body size, degree of arboreality or daily travel distance, but most likely reflect the more diverse mechanical loading (hand postures and precision handling) associated with nut-cracking by *P. t. verus*, a behaviour absent in *P. t. troglodytes*. We argue that this added technological competence in Tai chimpanzees constrains the ontogenetic development of trabecular architecture adapted to strains associated with knuckle-walking locomotion, providing a structure suited to more diverse manipulative functional loading. This interpretation is supported by the similarity of trabecular architecture in the MC 2 for *P. t. verus* and a recent human sample, both of which differ significantly from *P. t. troglodytes*. This study was funded by the Natural Science and Engineering Research Council of Canada (Grant 183660-03), the Max Planck Society, and the EVAN Marie Curie Research Training Network (MRTN-CT-019564).

Incisor and Molar Root Morphology of the Juvenile Neanderthal from Seladina Cave (Belgium).

ADELINE LE CABEC^{1,2}, KORNELIUS KUPCZIK¹, MICHEL TOUSSAINT³, JOSE BRAGA² and JEAN-JACQUES HUBLIN¹.

¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ²FRE 2960, Anthropologie Moléculaire et Imagerie de Synthèse, Université Paul Sabatier, Toulouse, ³Direction de l'Archéologie, Ministère de la Région Wallonne, Namur, Belgium.

Tooth root length and root surface area have been shown to provide information about taxonomy and functional adaptations of teeth, especially regarding diet. Previous studies have shown that Neanderthal tooth crown and root dimensions exceed those of modern humans. This study compares the maxillary and mandibular root morphology (incisor and molar) of the eight year-old juvenile Neanderthal from Seladina to a sample of Neanderthals (N=87) and recent modern humans (N=108). All specimens were subjected to micro-computed tomography, from which 3D models of incisors and molars were generated. Root length and surface area were subsequently measured from surface models using Avizo software. Our results show that Seladina has shorter tooth roots than would be expected for a Neanderthal individual. In particular, I¹, I₁ and I₂ fall outside of the Neanderthal range of variation, and within the upper end of the modern human range of variation. Similarly, root surface area of all incisors is also below the Neanderthal range of variation. The short tooth roots of Seladina are striking when compared to the contemporaneous sample from Krapina, which

exhibits among the largest dental dimensions within the Neanderthal hypodigm. We discuss these findings in the light of interpopulation variability and sexual dimorphism. This research was supported by the Max Planck Society and the EVAN Marie Curie Research Training Network MRTN-CT-019564.

Funerary practices and biological relationships at Barbuise-La Saulsotte (Aube, France) at the beginning of the late Bronze Age.

RACHAEL LEAHY, PASCALE MURAIL and STÉPHANE ROTTIER. UMR PACEA, Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux I, Bordeaux, France.

Diversification of funerary practices characterizes the transition between the middle and late Bronze Ages in Western Europe. Concordant radiometric and typological dates situate Barbuise-La Saulsotte (Aube, France) at the beginning of the late Bronze Age (1400-1200 B.C.), making it one of the principle sites demonstrating this evolution. At the site, inhumed bodies were discovered in sitting as well as lying positions. We hypothesized that the differing funerary practices may be explained by biological relationships among certain individuals.

Testing this hypothesis required calculating the mean measure of divergence (MMD) between several sub-groups of the population. Sub-groups were defined by the archaeological data. The MMD was calculated between: the two principal zones of the site, groups of sepulchers assembled topographically, individuals buried in sitting and lying positions and groups of individuals associated with different types of ornamental bronze pins. These calculations were based on non metric dental characteristics for two primary reasons: these traits seem to be under stronger genetic control than non metric skeletal characteristics and teeth were significantly better conserved than skeletal material in this collection.

Based on the analysis of the MMDs, no sub-group proved to be biologically distinct from any other. The different funerary practices discovered at Barbuise-La Saulsotte do not therefore seem to be associated with the biological relationships among the individuals. These results may also suggest that the diversification of funerary practices at the beginning of the late Bronze Age in Western Europe was not linked to biological relationships but rather to other, perhaps cultural, factors. This study was funded by the UMR PACEA, Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux I, Bordeaux, France

Does anthropoid labyrinthine morphology reflect phylogeny or locomotion?

RENAUD LEBRUN, MARCIA S. PONCE DE LEÓN and CHRISTOPH P. E. ZOLLIKOFER. Anthropological Institute and Museum, University of Zürich.

The cavity system of the inner ear (the bony labyrinth) of mammals is a complex three-

dimensional structure that houses the senses of equilibrium and hearing. Morphological variation of the bony labyrinth across taxa reflects differences in locomotor behavior and hearing performance, and the good preservation of this structure in many fossil specimens permits analogous inferences. Also, the bony labyrinth conveys a phylogenetic signal; for example, in strepsirrhine primates, morphological variation of the bony labyrinth is well-correlated with neutral genetic variation (Lebrun et al. *in revision*). Here we ask whether this is also the case in anthropoid primates. Using 3D geometric morphometric methods, we show that the labyrinthine morphology of extant anthropoids contains a mixed locomotor, allometric, and phylogenetic signal. Labyrinthine shape is a good taxonomic marker to discriminate between anthropoid families. Size-allometry-corrected labyrinthine phenetic distances between taxa are well correlated with neutral genetic distances. However, correlations are lower for anthropoids than for strepsirrhines, indicating that anthropoid internal otic morphology is more constrained by locomotor modes than by common ancestry. Our analyses demonstrate that geometric morphometric methods provide a suitable means to distinguish between locomotor, allometric and phylogenetic components of extant primate labyrinthine shape variability. This comparative evidence can also be used to provide new insights into the evolutionary history and functional specialization of fossil primates.

Enlarged jaw proportions: Load magnitude or load frequency?

JUSTIN A. LEDOGAR. Department of Anthropology, Stony Brook University.

Several recent studies have noted that it is unclear if stronger jaws are related to an increase in load magnitude or a greater number of loading cycles. This study employs stepwise discriminant function analysis of 20 size-free craniomandibular variables and a sample of durophagous (e.g., *Cebus apella*) and folivorous (e.g., *Colobus guereza*) primates. Discriminant scores were then correlated with linear corpus and symphysis dimensions. In the absence of food material properties and chewing frequency data, discriminant scores can serve as a proxy for "heavy loading" and "repetitive loading." The relative importance of the independent variables in classifying each group was also assessed. Results show that the discriminant function correctly classified 99.3% of originally grouped and cross-validated cases. Low, yet significant, positive correlations with the discriminant scores were found for corpus width and corpus depth which indicates a positive relationship between "heavy loading" and corpus robusticity. A negative correlation was found between the discriminant scores and symphysis depth which indicates a positive relationship between "repetitive loading" and symphysis depth. Symphysis width did not correlate significantly. These results suggest that larger corpora are related to increased load magnitude, symphysis depth is related to cyclical loading, and symphysis width may not be indicative of either loading regime. Variables

most related to dietary group distinctions include jaw adductor muscle leverage, medial pterygoid and masseter insertion angle, and dental arcade width. The discriminating power of variables such as facial projection, condylar width and condylar length is low.

Do all Asians look alike: A dental nonmetric analysis of population diversity at the dawn of the Chinese Empire.

CHRISTINE LEE and LINHU ZHANG. Research Center for Chinese Frontier Archaeology, Jilin University, Changchun, China.

Northeast Asia is the homeland to a diverse group of people including the Chinese, Mongolians, Manchurians, Tibetans, and Uighurs. The ancient origins of these populations began sometime before the foundation of the Chinese and Xiongnu (Mongolia) empires around 200 BC. This study examined 14 archaeological populations dating from before the formation of these empires (2000 BC) to after their collapse (400 AD) to determine how many population centers existed, what was the relationship among these samples, and did their relationship change with increasing social and political complexity.

Twenty one dental nonmetric traits were scored from 1098 crania. The archaeological samples include sites from the Central Plains (Shang, Zhou, Qin, Zhao, Han), northeastern China (Upper Xiajadian, Xianbei), northwestern China (Qijia, Kayue), Mongolia (Xiongnu), and western China and Mongolia (Chandman, Nileke, Yanghai, Yingpan). Mean measure of divergence, cluster analysis, and multidimensional scaling statistics were run.

All three statistical analyses show four main clusters present during this time period: (1) the non-Asian samples from western China and Mongolia, (2) the Xiongnu in Mongolia, (3) the samples from northwestern China and the Central Plains, and (4) the samples from northeastern China. These four clusters condense further into two interaction spheres, one located in Mongolia and Xinjiang Province, the other in northwestern, central, and northeastern China. These two spheres may represent a division caused by shared subsistence strategies (pastoral nomads versus sedentary agriculturalists), and/or a limitation of movement due to political boundaries and alliances (Mongolia and the Western Regions versus China and Manchuria). Funding for this research was provided by a Wenner Gren dissertation fieldwork grant (Gr-7263), Arizona State University travel grants, and a Chinese Ministry of Education, China Scholarship Council study abroad grant.

Observations of multiple live births in wild geladas (*Theropithecus gelada*) at Guassa, Ethiopia.

LAURA LEE¹, NIINA NURMI², NGA NGUYEN¹ and Peter J. Fashing¹. ¹Dept. of Anthropology, California State University Fullerton, Fullerton, ²Guassa Gelada Research Project, Guassa, Ethiopia.

Internal gestation, parturition and lactation are important hallmarks of mammalian evolution. Though much is known about maternal investment in offspring before and after birth, the process through which females give birth has rarely been documented in free-living mammals, including primates. The descriptions of parturition in the literature typically consist of accounts of only one or two births. During a recent one-year period of research on an approximately 220-member study band of geladas (*Theropithecus gelada*) at Guassa, Ethiopia, we observed four live births and recorded behaviors following a fifth live birth. All observed births began within close proximity (≤ 5 m) of other group members. In addition, during all births, females assumed crouching positions and pulled at the vulva throughout. Several other behaviors, such as aiding the infant out of the birth canal, placentophagy, and licking blood off the ground after parturition, occurred during some births but not others. Given that at least five of the 20 live births that occurred over the study period took place during afternoon and twilight hours, it appears that diurnal parturition may be more common in geladas than in other primates. We suggest that giving birth during the day time may be a means of avoiding the risk posed by parturition in darkness on the ledges of sleeping cliffs where geladas spend their nights. We also suggest that several characteristics (e.g. presence of intact amniotic sacs, ventrally facing infants) of gelada births may help ease delivery of infants from the birth canal. This study was funded by Margot Marsh Biodiversity Foundation, Pittsburgh Zoo, Cleveland Metroparks Zoo, and Primate Conservation Inc.

Lower molar cusp pattern variation in *Gorilla gorilla gorilla* and *Gorilla beringei graueri*.

SCOTT S. LEGGE. Department of Anthropology, Macalester College, St. Paul, Minnesota.

Great ape molar metric and non-metric variations have been observed in a variety of affinity studies attempting to clarify the complex relationships between closely related species and subspecies. Gorillas, like many primates, have a rather convoluted history of classification. At present, gorillas can be divided into two separate species with two subspecies each of *Gorilla gorilla* and *Gorilla beringei* (Grubb et al. 2003). While numerous studies have looked at metric variations in the skull and teeth, relatively few have observed overall variability within and among the species and subspecies using non-metric dental traits. This study presents data from observations of the lower molars of 98 Western Lowland Gorillas (*Gorilla gorilla gorilla*) and 66 Grauer's Gorillas (or Eastern Lowland Gorillas, *Gorilla beringei graueri*). Groove patterns and cusp numbers on mandibular first, second, and third molars are examined and analyzed for variation both within and among the two species. This study found similar results to those of Swindler (2005) with very little variation in the lower first molars and greater variation in lower second and third molars for groove pattern and cusp

numbers in both *G.g. gorilla* and *G.g. beringei*. Finally, groove patterns and cusp numbers of the second and third lower molars may provide an additional data set to aid in further defining the variations between these closely related and remarkably similar species.

Texture complexity in Swartkrans bone tools.

JULIE LESNIK. Department of Anthropology, University of Michigan.

Brain and Shipman suggested that the bone tools excavated from the early Pleistocene site of Swartkrans in South Africa were used by hominids to dig for edible subterranean tubers. Backwell and d'Errico suggested the wear pattern on the Swartkrans tools matched the parallel orientation of narrow striations produced on experimental tools used to break into the hard outer crust of termite mounds. These two studies used small, minimally overlapping samples, providing non-mutually exclusive results. In this study a larger sample of Swartkrans bone tools are analyzed in order to test the hypothesis of multiple tasks being conducted with the bone tools. The artifacts and experimental tools were analyzed using scale-sensitive fractal analysis of three-dimensional surfaces, methods developed for and previously only used for dental microwear. Anisotropy, or orientation, and textural fill volume are the variables most like those identified by Backwell and d'Errico as significant. In this study, these variables show no significant difference between tasks or the artifacts from Swartkrans. The variable of significance in this study is complexity, the measure of change in surface roughness with scale of observation. This variable suggests that the Swartkrans tools most closely resemble tools used to break into mounds created by termites of the genus *Trinervitermes* or to perforate the exit holes in mounds created by the genus *Macrotermes*. The latter task is one conducted regularly by chimpanzees and therefore a plausible explanation for early hominid tool-use. This study was funded by The University of Michigan Graduate School and Department of Anthropology and the Transvaal Museum Project France.

Sexual dimorphism in the human mandible: Fourier descriptors.

PETE E. LESTREL¹, FUMIO OHTSUKI², YUJI MIZOGUCHI³ and CHARLES A. WOLFE⁴. ¹Formerly, UCLA School of Dentistry, ²Formerly, Tokyo Metropolitan University, Tokyo, ³National Museum of Nature and Science, Tokyo, ⁴Wolfe Associates, Sylmar, California.

The presence of sexually dimorphic size differences in the mandible (MD) has long been established. In contrast, few studies are available that have focused solely on shape differences and some of those that are available have been controversial. It can be argued that shape changes due to sexual dimorphism have potentially important ramifications in such disciplines as forensics, anthropology, dentistry and medicine. We have been focusing for some

time on documenting the presence of sexual dimorphism in the craniofacial complex using Fourier Descriptors (FDs). FDs are useful in that they allow for: [1] a precise quantitative description of the boundary outline and [2] size-standardization. In a previous study of the inferior MD border, we found significant dimorphic shape differences with females displaying a relatively longer mean mandibular length (AJPA, Supp 42:121, 2006). That study prompted a re-evaluation using a larger dataset and a different anatomical view. A Japanese sample of MDs (n=61 ♂; n=97 ♀) was obtained from the Edo Period (1600-1868 CE) and digitally photographed in the more familiar lateral view. Only specimens with largely intact dentitions were utilized to minimize the effects of bone resorption due to tooth loss. The lateral MD outlines were digitized with 84 points. Superimposition on the body of the mean MD outlines displayed a statistically significant posterior repositioning of the female condyle head and coronoid process, which generates a relatively longer MD length from Menton to the superior aspect of the condyle head. These results re-enforce the earlier 2006 study.

Pathogen-Mediated Selection of the Major Histocompatibility Complex in Great Apes.

CARI M. LEWIS. Department of Anthropology, Indiana University.

The major histocompatibility complex (MHC) proteins of the immune system are crucial for the function of adaptive immunity processes. The class I major histocompatibility complex, encoded by the class I genes HLA-A, HLA-B, and HLA-C on Chromosome 6, resides on the membranes of all nucleated cells. The class II MHC is encoded by the class II genes HLA-DP, DQ, and DR, and is found on specific antigen-presenting cells. The MHC molecules have come under recent scrutiny because of their extreme polymorphic nature. This study explores the pathogen-mediated selection hypothesis in great ape species, suggesting that species with the greatest pathogen exposure should display the greatest polymorphisms in Class I and II MHC loci. More specifically, this study tests the predictions that the number of reported class I and II MHC alleles will be positively correlated with parasite prevalence and group size in the great apes. To test these predictions, a major-axis regression analysis of

number of reported alleles in a species for each MHC class I and II locus against both mean group size and mean reported parasite prevalence to date was performed. In the case of group size, the class I loci MHC-A and -B demonstrated significant positive correlations. In the case of parasite prevalence, neither class I nor class II MHC alleles demonstrated statistically significant relationships. Overall, the pathogen-mediated selection hypothesis is supported in great apes at the MHC class I loci, and only conditionally supported at the class II loci.

The influence of shared benefits on cooperation in chimpanzee (*Pan troglodytes*) groups.

REBECCA J. LEWIS^{1,2}, MARY CATHERINE MARENO^{1,2}, MARIE BUTCHER¹, SUSAN P. LAMBETH², STEVEN J. SCHAPIRO². ¹Department of Anthropology, University of Texas at Austin, ²Department of Veterinary Sciences, University of Texas M. D. Anderson Cancer Center.

Wild chimpanzees exhibit cooperative behaviors that are often difficult to replicate in captivity, perhaps because the experiments generally do not occur within the group context. The goal of this study was to examine cooperation within social groups using both monopolizable and shared rewards. A task, pushing two buttons simultaneously, was presented to three mixed-sex groups of chimpanzees (n=23 individuals) housed at the UT MD Anderson Cancer Center Science Park in Bastrop, Texas. Test I: the task resulted in a single Skittle. Test II: Skittles were dispensed to the entire group. Test III: the buttons were moved 1.5m apart and Skittles were dispensed to the entire group. Group members could solve the task alone, cooperatively, or not participate in Tests I and II, while the choices were constrained to cooperate or nonparticipation for Test III. In Test I, nearly all individuals participated, but dominant individuals monopolized the apparatus. Even though only one individual received the reward, the task was unexpectedly completed cooperatively 35% of the time. In Test II, fewer individuals participated and cooperation decreased to 2%. Cooperation was observed most frequently in Test III, although participation ceased completely in one study group. In all three tests, a male near the apparatus had significantly negative impacts on participation, and rank effects were only significant for the males. These findings suggest that some individuals cooperate even when it is not required and when they do not receive direct benefits. Moreover, when benefits are shared and can be received without participation, free-riding occurs. This study was funded by A University of Texas Research Grant.

Pelvic biomechanics and locomotor adaptation within the Order Primates.

KRISTI L. LEWTON, School of Human Evolution and Social Change and Institute of Human Origins, Arizona State University.

The pelvis occupies a central position in the locomotor system and its shape is therefore expected to reflect habitual locomotor behavior. Despite this, research into the relationship between locomotion and pelvic morphology is relatively limited, particularly with regard to stress resistance. The broad goals of this study were to (1) develop a theoretical model of pelvic stress resistance and (2) test hypotheses derived from this model that link pelvic morphology to locomotion. A series of biomechanical predictions of pelvic shape were tested on 3D morphometric data collected from a broad, comparative sample of extant primates (876 individuals from 42 genera of haplorhines and strepsirrhines) using univariate and geometric morphometric methods. Overall, pairwise comparisons support the expected association

between pelvic form and locomotor mechanics (e.g., relative superior pubic ramus cross-sectional area: *Otolemur* > *Galago*, $p < 0.001$), and suggest specific features that vary in a patterned way with locomotion. They further indicate that certain aspects of the pelvis can be partly understood in relation to stress resistance (e.g., pubic morphology), while other features previously found to differ according to locomotion do not vary as predicted and appear to have a more complex relationship with presumed loading conditions (e.g., ilium and ischium lengths). This work provides a biomechanical foundation for understanding pelvic adaptation to locomotion, identifies aspects of the pelvis that are not well-explained by current mechanical models, and informs directions for future research. This study was funded by The National Science Foundation, grant number 0752575, The L.S.B. Leakey Foundation, the Graduate and Professional Student Association and SHESC at Arizona State University.

Testosterone and life-history stages in adult male chacma baboons (*Papio ursinus*).

SHAYNA A. LIBERMAN^{1,2}, THORE J. BERGMAN^{2,3} and JACINTA C. BEEHNER^{1,2}.
¹Department of Anthropology, University of Michigan, ²Department of Psychology, University of Michigan, ³Department of Ecology and Evolutionary Biology, University of Michigan.

Although we know much about the relationship between the steroid hormone testosterone (T) and male life-history stages for seasonal species (particularly temperate birds), we know comparatively little about how T modulates behavior across the lifespan for non-seasonal species. Chacma baboons (*Papio ursinus*) provide a good model for evaluating such patterns. Chacma baboons are large-bodied, highly social, polygynous, non-seasonal breeders with varying degrees of paternal care. Importantly, male mating opportunities are strictly determined by dominance rank, mediated by aggressive competitive encounters with other males. Moreover, many chacma males have distinct ‘mating’ versus ‘parenting’ stages. Here we examined chacma male T profiles in conjunction with behavioral and demographic data to establish whether age or life-history stage is a better predictor of T levels. Subjects were 28 males from a population of wild chacma baboons living in the Okavango Delta of Botswana. Fecal samples ($n=1,453$) collected across 5 years were radioimmunoassayed for fecal metabolites of T. Similar to previous findings, results indicate that rank trajectory (whether a male is rising or falling in the dominance hierarchy) was more closely associated with T levels than absolute rank. Although age explained much of the variability in T, we also found evidence that T levels were partially explained by broad life-history categories such as “mating” and “parenting”. Such results found across the lifespan for chacma males mirror results found for seasonal species within each breeding season. This study was funded by the University of Michigan.

Fluctuating asymmetry in the face is negatively correlated with genetic ancestry.

DENISE K. LIBERTON¹, RINALDO W. PEREIRA², TONY FRUDAKIS³, DAVID A. PUTS¹ and MARK D. SHRIVER^{1,1}¹Department of Anthropology, Pennsylvania State University,

²Catholic University of Brazil, Brasilia, Brazil,

³DNAPrint Genomics, Sarasota, Florida.

By investigating the relationship between fluctuating asymmetry in facial features and genetic ancestry in admixed populations, we hope to explore the roles of sexual and natural selection on the human face. The study consists of 254 subjects ($n=170$ females, $n=84$ males), ages 18–35, of West African and European genetic ancestry sampled in the United States and Brazil. Maximum likelihood genetic ancestry estimates were determined from 176 ancestry informative markers, which allowed for the proportional estimation of genetic ancestry from four parental populations. Three-dimensional photographs of faces were acquired using the 3dMDface imaging system and 22 standard anthropometric landmarks were placed on each image. From the landmark coordinates, linear distances on the right and left sides of the face were calculated.

Fluctuating asymmetry was measured using linear distances both before and after scaling to controlling for size differences and then tested against genetic ancestry estimates. Higher proportions of West African genetic ancestry may indicate greater levels of heterozygosity, which is believed to affect facial symmetry. Regardless of whether a scaling measure was used, fluctuating asymmetry was negatively associated with West African genetic ancestry estimates ($p < 0.05$). We then tested for an interaction between sex and genetic ancestry by testing for differences in the slopes of the ancestry association between males and females. The slope in males was not significantly different than zero, while in females the association remained significant. The results suggest that females with higher proportions of West African genetic ancestry have lower levels of fluctuating asymmetry. This study was funded by the National Institute for Justice, Grant 2008-DN-BX-K125; the National Science Foundation, Doctoral Dissertation Improvement Grant #0851815; and the Wenner-Gren Foundation, Dissertation Fieldwork Grant #7967.

Frequency of long bones fractures in Early Medieval European populations: Frankish Empire vs. Great Moravian Empire.

JAKUB LIKOVSKY¹, PETR VELEMINSKY², JANA VELEMINSKA³, JAROSLAV BRUZEK^{3,4}, MILAN THURZO⁵, ALENA SEFCAKOVA⁶, LUMIR POLACEK⁷ and ARNAUD LEFEBVRE⁸. ¹Department of the Archaeology of Landscape and Archaeobiology, Institute of Archaeology, Academy of Sciences of the Czech Republic, Prague, ²Department of Anthropology, National Museum, Prague, ³Department of Anthropology and Human Genetic, Faculty of Science, Charles University, Prague, ⁴PACEA - Laboratory of Anthropology of Past Populations, UMR 5199 CNRS,

University Bordeaux I, Talence, France,

⁵Department of Anthropology, Faculty of Science, Comenius University in Bratislava,

⁶Department of Anthropology, Slovak National Museum, Bratislava, ⁷Centre for Slavonic and Medieval Archaeology, Institute of Archaeology, Academy of Sciences of the Czech Republic, Brno, ⁸National Institute for Preventive Archaeological Research, Metz, France.

The frequency of bone fractures in past European populations has been conducted in a number of Middle Ages collections, mostly from Great Britain. Data relating to continental Europe of the Middle Ages have not been available to date. Our study focused on two population groups. The skeletons of 266 adult individuals from the Merovingian cemetery at Norroy-le-Veneur (Lorraine, France, 5th – 7th century AD) and 531 adult individuals from the Great-Moravian cemetery in Mikulcice (Czech Republic, 9th – 10th century AD) were studied. The modified five segment method (Judd 2002) was used for the evaluation of fracture frequency. X-rays of all suspected traumatic lesions were assessed, in order to verify the presence and to determine the extent of the given lesions.

The incidence of fractures in both studied groups was relatively low (7 - 8 %). In both samples, the frequency of fractures of the clavicle and forearm bones was statistically significantly higher (above 9%) compared to that of the other bones. Sex differences in the incidence of fractures were not confirmed. Most of the fractures may be considered to be accidental injuries. While the cemetery at Norroy-le-Veneur has a rural character and the presence of numerous war wounds was not expected, in the case of the cemetery at Mikulcice, considered to have been one of the economic and power centres of the Great Moravian Empire and thus the burial site of the military retinue, the presence of exclusively accidental injuries is surprising. This study was supported by following research grants: GACR 206/07/0699, ECO-NET No. 16368PB, VZ AV ČR AV0Z80020508 and PAI-Barrande (MEB020936),

Changes in “health” through time: A temporal analysis of non-specific skeletal pathologies in the southern Lower Mississippi Valley.

GINESSE A LISTI. Department of Geography and Anthropology, Louisiana State University, Baton Rouge.

Within the southern Lower Mississippi Valley, the Coles Creek period (AD 700-1200) was a dynamic time during which significant changes occurred including increases in population size, site size and complexity, and changes in diet. Previous research on dental pathologies indicates that while carbohydrate consumption increased, Coles Creek subsistence was not based on maize agriculture. The present study assesses non-specific pathologies for the purpose of gaining additional insight into diet and nutritional adequacy during the Coles Creek period.

Three non-specific pathologies were evaluated. Porous lesions in the skull and enamel hypoplasias were assessed macroscopically and x-rays of the tibiae were examined for Harris lines. The sample, which consisted of individuals from eight sites ranging in date from 800 BC to AD 1200, was separated into Coles Creek (n=84) and Pre-Coles Creek (n=91) populations. Summary statistics for each population were calculated and temporal changes in the frequency and severity of pathologies were assessed using ANOVA and the Kruskal-Wallis test.

Results demonstrate that the frequency of Harris lines and porous lesions in the occipitals and the severity of porous lesions in the occipitals, parietals, and orbits increase through time; however, only the change in occipital lesions is significant ($p < .01$). Alternatively, enamel hypoplasias show a significant decrease through time ($p < .001$). These results suggest that while periodic episodes of nutritional deficiency may have occurred, other stressors associated with increased population density (i.e., infectious disease or parasitic infections) likely contributed to the slight decline in health evident during the Coles Creek period.

Competition increases during resource abundance in wild Verreaux's sifaka (*Propithecus verreauxi*).

BRANDIE L. LITTLEFIELD and PATRICIA L. WHITTEN. Department of Anthropology, Emory University

The unique aspects of lemur social organization and behavior have made it particularly challenging to categorize them within socioecological models. Lemurs have been classified as Dispersal Egalitarian due to the fact that dominance hierarchies are often either non-existent or unstable and female intrasexual competition is low. However, researchers have suggested that this may be an oversimplification of species-specific differences in lemur social structure, particularly with respect to *Lemur catta* and species within the genus *Propithecus*. We hypothesized that dominance hierarchies are seasonally dependent as competition fluctuates with the availability of resources.

This study examines changes in female behavior during the transitional period between the dry and wet seasons in wild Verreaux's sifaka (*Propithecus verreauxi*) in southwest Madagascar. 606 hours of focal sampling data were collected over a five month period (July to December) from eight females with infants in four separate groups. Both travelling and genital marking increased significantly from the pre-rain to post-rain periods, while grooming received significantly decreased and feeding was not significantly different. The presence of nearest neighbors within 2m decreased significantly from pre- to post-rain. Subordinate females travelled more and had more nearest neighbors compared to dominants. Season was also a significant predictor of rates of aggression with most aggression being directed towards males. These results offer preliminary evidence that competition increases after the onset of rains with the increased availability of high-quality resources, and that subordinate females

may suffer costs associated with competition. This study was funded by NSF BCS-0648726.

Bioarchaeology at the emergence of social status: An example from Iron Age central Thailand (Promtin Tai, Lopburi Province).

CHIN-HSIN LIU¹ and THANIK LERTCHARNRIT². ¹Department of Anthropology, University of Florida, ²Faculty of Archaeology, Silpakorn University, Bangkok, Thailand.

In Mainland Southeast Asia, Metal Age sites (2000 B.C.-A.D. 500) frequently record marked shifts in subsistence, craft specialization, and sociopolitical organization. In central Thailand, intensified smelting correlates with inferred population growth. However, the depauperate soils and periodic drought of the region suggest to some that the exchange of metal goods was linked to the outsourcing of foodstuffs to satisfy the demands of population expansion. Interestingly, the emergence of social status in central Thailand appears later (at the beginning of the Iron Age, ~500 B.C.) compared to other regions in Thailand. In this paper, we hypothesize that differences in social status would lead to unequal access to quality foods and/or affect overall health that manifests as increased variation of health within each site.

As part of a larger regional bioarchaeological project, this research evaluates the hypothesis by examining intrasite patterns of paleopathology at Promtin Tai (Lopburi Province). Thirty-three human burials are divided into temporal groups and are assessed for dental pathology, porotic hyperostosis, stature, osteoarthritis, trauma, and generalized bone infection. While osteoarthritis is more common, other markers observed suggest Promtin Tai was a generally healthy community. There are no statistical differences between temporal groups to imply increased intrasite pathology variability through time. We suggest that either social status was manifested in a non-biological manner or that the short lifespan (~35-40 years) precludes the presence of certain pathologies in the skeleton. Stable isotope analysis is ongoing and should provide an independent assessment to infer potential dietary change over time in Central Thailand. This study was funded by Henry Luce Foundation/ACLS Grants to Individuals in East and Southeast Asian Archaeology and Early History Dissertation Fellowship

Variation and adaptation in the human MMP9 gene.

AMANDA LOBELL. Department of Human Evolutionary Biology, Harvard University.

Humans are unique among haplorhine primates in having an extreme degree of placental invasion. Humans' deeply invasive placenta allows for increased nutrient transfer from mother to fetus. Nucleotide polymorphisms in the MMP9 gene have been causally linked to variation in human placental invasion. These variations in placental invasion have direct fitness consequences, as insufficient placental

invasion is a leading cause of poor pregnancy outcomes that reduce the fitness of both the mother and fetus. Despite the phenotypic importance of this genetic variation and a history of positive natural selection in hominoids, little is known about the evolutionary history of MMP9 within modern humans.

This study investigates the evolutionary history of nucleotide variation in human MMP9. Fifty chromosomes from geographically diverse HapMap individuals were resequenced along a 10.5 Kb region of MMP9. These data are analyzed for signals of population differentiation and positive natural selection using standard population genetic methods. Preliminary results indicate significant population differentiation, particularly among phenotypically relevant alleles. Allele frequency patterns match known differences in the frequency of insufficient placental invasion among human populations. The origin of derived alleles that promote placental invasion is dated using likelihood and Bayesian coalescent models. The origin and patterning of nucleotide variation in human MMP9 will be discussed in the contexts of evolutionary pressures on the reproductive system and the resulting clinical effects. This study was funded by the National Science Foundation Award #0621586.

How do different methods and data sets affect measures of female dominance?

JESSICA L. LODWICK¹ and DIANE DORAN-SHEEHY². ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Department of Anthropology, Stony Brook University.

Fundamental to ecological models of female social relationships is assessing whether individual females differ in rank. However, previous studies have shown that results may vary with the data set and method of analysis used to examine rank differences. Here we examine wild female western gorilla rank differences using four data sets and three methods of analysis to test their effect on female rank outcomes. We recorded all occurrences of female agonism (vocal signals and acts of aggression) during 19 months of focal follows at the Mondika Research Center, Republic of Congo. We divided data into four data sets based on the type [all agonism (n = 551 events) or vocal signals (n = 484 events)] and outcome [(decided with a clear winner (n = 263 events) or undecided (n = 288 events))] of agonism. For each data set we tested for rank differences using three methods: MatMan, normalized David's scores, and tests for asymmetry in each female dyad. Results indicate that the hierarchy was significantly steep and clear rank differences were present in all four data sets, even though linear hierarchies were not always present. Our results suggest that conventional measures of linearity (MatMan) may obscure the degree to which individuals differ in rank. We argue that normalized David's scores and dyadic tests for asymmetry are more useful for assessing the degree to which individuals differ in rank, thereby permitting more refined

predictions about resource holding potential and differential individual resource acquisition. This study was funded by The Leakey Foundation, U.S. Fish and Wildlife, and the National Science Foundation.

Bacterial fermentation of resistant starch in an in vitro model of the large intestine.

NICHOLAS LONERGAN¹, HAROLD CORKE² and KOEN VENEMA³. ¹Hominid Paleobiology Doctoral Program, George Washington University, ²School of Biological Sciences, University of Hong Kong, ³TNO Quality of Life, Zeist, the Netherlands.

Recent research indicates an important role for the large intestine microbiome in intestinal health and body weight. The various groups of bacteria colonizing the large intestine are thought to respond differently to the starch and amino and fatty acids that reach it. This study examines bacterial fermentation of resistant (undigested) starch in the large intestine, and its potential involvement in the development of disease and obesity. We hypothesize that cooking and starch type will affect fermentation and energy production. The fermentation byproducts of resistant starch were measured in vitro as short chain fatty acids (SCFA) in the TIM-2 large intestine model developed by TNO. Cooked starches were fermented faster than their uncooked preparations and generally led to more SCFA production. Additionally, fermentation of uncooked starches led to the production of different short-chain fatty acids, both in amount and the acetate:propionate:butyrate ratio.

We conclude that cooking leads to better accessibility of the sugar chain to the microbiota with consecutive faster fermentation of the substrate. Uncooked starch ferments more slowly and may reach the distal colon. We anticipate that this would lead to a health-benefit, as in the distal colon protein fermentation normally occurs, with concomitant production of putrefactive, toxic metabolites. If the uncooked starch is fermented there instead, protein fermentation would be lowered, and hence production of toxic metabolites reduced. This might have health benefits with respect to inflammatory bowel disease and colon cancer, and has relevance for modern cooking practices and the evolution of human diet. This study was funded by IGERT, grant number 0801634.

New evidence for natural selection acting at the ALDH2 locus.

JEFFREY C. LONG and KEITH HUNLEY. Department of Anthropology, University of New Mexico.

We are interested in testing the hypothesis that natural selection has shaped allelic variation at the human *ALDH2* gene locus. The enzyme product of this locus catalyzes the oxidation of aldehydes and is important in alcohol metabolism. There is a deficiency variant, *ALDH2*2*, that is common in East Asian populations but absent elsewhere in the world. The restriction of the *ALDH2*2* allele to one geographic region is unusual for a human

polymorphism and suggests that natural selection has favored *ALDH2*2*. In this study, we have sequenced portions of the *ALDH2* gene in 123 people who represent four populations from each of four continental regions: Africa, Europe, Asia, and the Americas. For each individual, we collected 5,387 base pairs of DNA sequence from within the *ALDH2* gene. We found 30 variable sites. Based on these sequences, African populations are more variable than non-African populations, while non-African populations have comparable variation. We inferred eleven haplotype frameworks. Only three haplotypes occurred in samples from all continents. One haplotype reaches a very high frequency in non-African samples but is conspicuously absent in all African samples. This haplotype does not occur on the *ALDH2*2* lineage. The statistic F_{ST} shows greater differentiation among populations for this new haplotype than for the *ALDH2*2* allele, and therefore our new non-African haplotype appears to define a novel target for natural selection within the *ALDH2* gene. This research was supported in part by NSF 0321610 to JCL.

The influence of relative brain size on basicranial morphology in a mouse model of prenatal encephalization.

ELISABETH K. N. LOPEZ¹, ANJEN CHENN², MAKOTO M. TAKETO³ and MATTHEW J. RAVOSA⁴. ¹Department of Cell and Molecular Biology, Northwestern University Feinberg School of Medicine; ²Department of Pathology, Northwestern University Feinberg School of Medicine; ³Department of Pharmacology, Graduate School of Medicine, Kyoto University; ⁴Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine.

Increased relative brain size is known to be correlated with increased basicranial flexion in various primate clades. However, the mechanistic bases of this relationship are not well known. To isolate the effects of encephalization on basicranial development, we examined transgenic mice expressing a stabilized form of β -catenin. These mice develop highly encephalized brains due to a prenatal increase in neural precursor cells. As the transgene is expressed only in neuro-epithelial precursors and does not affect overall growth and development, morphological differences between transgenic and wild-type littermates are predicted to result solely from variation in encephalization.

Comparisons of wild-type and transgenic mice employed MRI, histology, and geometric morphometrics. Three fetal ages were sampled in normal and transgenic mice, and differences between ages and genotypes were examined using two-way ANOVA.

Transgenic mice did not differ from wild-type mice in the size of their basicranium, but did vary in overall morphology. At all ages examined, transgenic mice had a more flexed angle between the cribriform plate and the rest of the cranial base than wild-type mice. Wild-type and transgenic mice also differed in the angulation between individual basicranial

bones. At a given age, versus wild-type mice, transgenic mice had a relatively wider, more anteriorly positioned, and more horizontally angled foramen magnum; a flatter (less retroflexed) cribriform plate; and a more flexed angle between the basisphenoid and basioccipital bones. These analyses suggest that increases in basicranial flexion in living and fossil primates may be causally linked to increases in relative brain size. This study was funded by: National Science Foundation Doctoral Dissertation Improvement Grant (BCS-0725338), L.S.B. Leakey Foundation General Research Grant, NIH/NCRR Shared Instrumentation Grant (1S10 RR13880-01), and Alumnae Association of Barnard College Fellowship for Graduate Study.

Did Akhenaten bite off more than he could chew? Dental analysis of the Commoners' Cemetery of ancient Akhetaten.

ANDREW M. LOPINTO and JEROME C. ROSE. Department of Anthropology, University of Arkansas.

The Amarna Period (BC 1351-1334) represents a radical cultural shift in Egyptian history. Coupled with this cultural shift is a shift in the diet and health profile of the average Egyptian. This study examines the health and well-being of the commoners of Akhetaten as reflected in the dentition. From a sample of 120 individuals, occurrence of linear enamel hypoplasia, caries, and periodontal abscess were observed as indicators of overall health. Reflections of stress in the teeth, either from dietary deficiencies or overwhelming disease load resulted in frequent linear enamel hypoplasias. Hypoplastic defects presented in 51.7% of the sample (62 individuals). Carious lesions were observed in 20% of the sample (24 individuals), while 12.5% (15 individuals) exhibited evidence of periodontal abscess. These findings, particularly the prevalence of linear enamel hypoplasia, are indicative of a population under stress. Consumption of protein at Akhetaten was demonstrably low based on aggregate stature estimates, which corroborate the high frequency of enamel hypoplasias. Faunal analysis has shown a paucity of animal remains, also indicative of low animal protein consumption. The implication of the prevalence of carious lesions also lends support to the argument that the commoners of Akhetaten consumed primarily carbohydrates. This examination ultimately demonstrates that the commoners of Akhetaten were under considerable stress, either from a protein-poor diet, unsanitary conditions leading to widespread disease, or a suite of factors caused by the upheaval and migration of a large group.

Genetic variation among geographically widespread populations of vervets (*Chlorocebus aethiops*) in southern and eastern Africa.

JOSEPH G. LORENZ¹, J. PAUL GROBLER², KERRY McAULIFFE DORF³, NELSON B. FREIMER⁴, ANNA JASINKA⁴ and TRUDY TURNER³. ¹Department of Anthropology, Central Washington University, ²Department of

Genetics, University of the Free State, South Africa, ³Department of Anthropology, University of Wisconsin-Milwaukee, ⁴Center for Neuro-behavioral Genetics, UCLA.

Vervets (*Chlorocebus aethiops*) have been extensively used as a model organism for the study of many human diseases and physiological processes. Given that the genetic variation within any given species underlies some portion of the observed phenotypic variation it is important to understand the genetic structure of the various species that are used as biomedical models as the conclusions drawn from the study of subjects drawn from one population may or may not apply to animals derived from different populations.

In an effort to characterize the structure of genetic variation among vervets a total of 324 vervets from over 30 populations in Kenya and over 240 vervets from 24 groups in South Africa were sampled. Individuals from each of the populations were assayed for sequence variation at mitochondrial coxl locus, autosomal microsatellite variation at 10 STR loci and 38 individuals were typed at 158 SNP loci. Results of coxl sequencing show Kenyan and South African mtDNAs form separate clades. AMOVA analysis of the autosomal variation shows that most variation is found within groups however there is some differentiation between regions. This is confirmed by Bayesian (STRUCTURE-based) analyses of nuclear STRs in the South African animals, which show the highest probability for a real structure consisting of a single genetically exchangeable population. The results of this study indicate that there is some genetic differentiation among vervets from different regions of their distribution and that the geographic origin of animals may play a role in the types of results observed. This study was supported in part by NSF grants BCS0094928 & BCS0629321 and NIH grant R01RR016300.

Grooming and ectoparasitism in ring-tailed lemurs (*Lemur catta*) and Verreaux's sifaka (*Propithecus verreauxi*).

JAMES E. LOUDON and MICHELLE L. SAUTHER. ¹Department of Anthropology, University of Colorado-Boulder.

Recently, the dynamics between parasites and their primate hosts have received considerable attention from primatologists. Here we report the interplay between ring-tailed lemur (*Lemur catta*) and Verreaux's sifaka (*Propithecus verreauxi*) grooming behavior and its effects on their ectoparasitic burdens over a nine month period. All ectoparasites analyzed in this study were retrieved from fecal matter and were the result of extraction via toothcombs during allo- and autogrooming bouts. Sifaka harbored five species of ectoparasites and lemurs harbored six. For each primate host, ectoparasite intensity fluctuated monthly as did rates of grooming. During the mating and birthing seasons grooming increased as did ectoparasite intensity. Both primates correlate their mating and birthing seasons to periods of food abundance and during these periods rates of grooming and huddling increased. Huddling and other forms

of social contact provide ectoparasites with modes of transmission and increased grooming rates resulted in higher ectoparasite yields in fecal matter. Interspecific comparisons revealed that ring-tailed lemurs harbored significantly more total ectoparasites than sifaka ($P < 0.05$) but these differences dissolved when analyzing the intensity of specific ectoparasite species. Among the lemur population, groups living in the protected reserve harbored more ectoparasites ($P < 0.01$) than groups living in anthropogenically-disturbed habitats. Lemurs also harbored more ectoparasites in the dry season ($P < 0.0001$), while sifaka harbored more ectoparasites in the wet season ($P < 0.0001$). Thus, this study demonstrates how environmental variables influence behavioral patterns which in turn influence ectoparasite patterns of intensity as well the effectiveness of the toothcomb to remove ectoparasites. This study was funded by the National Science Foundation Grant #0525109

Vegetation heterogeneity as a predictor of large mammal community structure in palaeoecology and conservation.

JULIEN LOUYS¹, SARAH ELTON², CARLO MELORO², PETER DITCHFIELD³ and LAURA C. BISHOP¹. ¹Research Centre in Evolutionary Anthropology and Palaeoecology, School of Natural Sciences and Psychology, Liverpool John Moores University, UK, ²Functional Morphology and Evolution Unit, Hull York Medical School, University of Hull, UK, ³Research Laboratory for Archaeology and the History of Art, School of Archaeology, University of Oxford, UK.

The structure of any community is the net result of both environmental and historical factors. Understanding which environmental factors impact most strongly on the structure of communities is an objective central to ecology and conservation. We investigated how the heterogeneity of vegetation relates to mammal community structure. Analysis of satellite photos of worldwide protected areas using GIS yielded information about proportions of vegetation cover which was compared with ecological category data from consensus faunal lists of animals $> 1\text{kg}$ in body mass. Canonical correlation analysis shows that the guild structure of mammalian communities across habitats in Africa, Asia and Central and South America is significantly correlated with vegetation heterogeneity ($\text{Corr} = 0.923, \text{df} = 60, 174, p < 0.0001$). *A posteriori* Hotelling's pairwise comparison between habitat types across continents supports a convergence of mammalian community structure living in African and American closed habitats. Because degree of tree cover correlates strongly with faunal community, it is possible to predict the heterogeneity of vegetation of a particular area on the basis of guild structure of a faunal community, and *vice versa*. This relationship can be used to predict the effects of deforestation on the structure of modern faunal communities, with obvious implications for conservation. Equally, it allows us to reconstruct the relative proportion of tree cover from extinct faunal communities. Preliminary reconstructions

of the habitats of Olduvai Bed II on this basis yields 0% heavy tree cover, 0% moderate tree cover, 28% light tree cover and 72% absent tree cover. We acknowledge the support of the Leverhulme Trust (FC00754C).

The physical properties of Northeast Bornean Orangutan plant foods.

LAURA C. LOYOLA¹, ERIN VOGEL², ACHI ZULFA³ and ROBERTO DELGADO^{1,4}.

¹Department of Biological Sciences, University of Southern California, ²Department of Anthropology, George Washington University, ³Universitas Nasional, Jakarta, ⁴Department of Anthropology, University of Southern California.

It is well documented that primate mandibular morphology is linked to diet. The Northeast Bornean orangutan (*Pongo pygmaeus morio*) have more robust jaws than the Sumatran orangutan (*P. abelii*), allowing for higher mechanical load resistance during mastication and perhaps permitting them to feed upon tougher foods. Whether differences in orangutan jaw morphology can be attributed to material properties of foods or to other factors remains to be examined. I measured the fracture toughness and Young's modulus of plant foods in Kutai National Park, Indonesia to test predictions about the functional relationship between craniodontal morphology and diet, and to examine possible determinants of orangutan food choices. I hypothesized that differences in physical properties of food items are related to jaw morphology in *P.p. morio* and predicted that the foods utilized by *P.p. morio* are tougher than foods consumed by other orangutan subspecies.

I collected plant foods and tested the toughness of various parts *in situ* using a Darvell Portable Tester. During the sampling period, *P.p. morio* was observed to consume a greater quantity of leaves and bark than non-fig fruits. Preliminary results show toughness levels of outer bark are up to ten times greater than non-fig fruits and that the mechanical properties of food items consumed by the orangutan subspecies vary. Characterizing the material properties of *P.p. morio* foods and their relationship to craniodontal morphology is vital for understanding life history variables including smaller cranial capacity and shorter interbirth intervals in this resource-limited population. This study was funded in part by the University of Southern California, the National Science Foundation, grant number 0643122, The L.S.B. Leakey Foundation.

Female mating tactics in wild Phayre's leaf monkeys.

AMY LU^{1,2}, JACINTA C. BEEHNER^{2,3}, NANCY M. CZEKALA⁴, CAROLA BORRIES⁵. ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Department of Psychology, University of Michigan, ³Department of Anthropology, University of Michigan, ⁴Papoose Conservation Wildlife Foundation, ⁵Department of Anthropology, Stony Brook University.

Continuous sexual receptivity is considered to be a female adaptation to increase paternity confusion, thus decreasing the risk of infanticide. However, females might also provide some indication of ovulation in order to attract preferred (e.g. dominant) males during fertile periods. We examined sexual behavior during defined receptive periods in a group of wild Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*) at Phu Khieo Wildlife Sanctuary (Feb-Sep 2006; 2,603 hours). The group contained seven mating, adult females and two mating males, one adult and one subadult. We predicted that females would be more proceptive and receptive during periovulatory receptive periods (POP; N=17) compared to non-periovulatory receptive periods (NPOP; N=18) and post-conceptive receptive periods (PC; N=24). Furthermore, we predicted females would prefer the adult male during POP, but both males equally, or the subadult male more during NPOP and PC periods. We collected focal and ad libitum data on proceptive and receptive behaviors, and fecal samples (N=1,277) for analyses of estrogen and progestin metabolites to determine reproductive state and ovulation. We found that rates of proceptive and receptive behaviors were indeed higher during POP compared to NPOP and PC receptive periods. Sexual behaviors more frequently involved the adult male during POP as well as NPOP, but the subadult male during PC periods. Although these results indicate that females provide some information on ovulation, they also suggest that certain males (e.g., adult, dominant) might be better able to discriminate female reproductive state (cycling vs. pregnant) compared to younger, less experienced males.

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Another small head from Flores.

NIELS LYNNERUP. Laboratory of Biological Anthropology, University of Copenhagen.

The find in 2003 of skeletal remains ("LB1") in a cave on the island of Flores, Indonesia, has provoked some debate. The skull was very small and differed so much from any other modern human skulls that it was proposed to belong to a new species called *Homo floresiensis*. However, other scientists and archaeologists did not agree with this hypothesis: they proposed instead that LB1 belonged to an earlier pygmy *Homo sapiens* population or that the individual suffered from microcephaly, a condition which is characterized by a small skull and brain.

We present a small skull found in a cave on the same island. The skull had been retrieved by a Danish district physician who worked in the Alor island group, of which Flores is part. The skull was, together with numerous Indonesian ethnographical artefacts, given to the Danish National Museum in 1924, and then sent on to our collections of human remains at the University of Copenhagen. The skull "resurfaced" a couple of years ago when the collections were re-inventoried.

Although the skull has manifestedly modern features, and a subsequent radiocarbon dating has dated it to the 18th and 19th century, we find

it of interest to present this skull in detail, given the above-mentioned discussion about LB1. We compare the craniometric data with LB1 and modern data, and the results of using FORDISC when comparing to extant South East Asian craniometric data. Furthermore, we have CT-scanned the skull, and dental morphology is also presented.

Population variation in human skeletal growth prior to adolescence.

KATHERINE MACCORD¹, JAMES CRAY². ¹Dept. of Biological Anthropology, University of Cambridge, ²Dept. of Anthropology, University of Pittsburgh.

There is much debate about variation in human skeletal growth between populations that are geographically, genetically, and socio-economically disparate. Long bones of subadult individuals, aged birth through 12 years, from three contemporaneous and geographically separate skeletal collections were analyzed to clarify the nature of human skeletal growth prior to adolescence: the Hamann-Todd Collection (n=33) at the Cleveland Museum of Natural History in Cleveland, the Luis Lopes Collection (n=44) at the Museu Bocage, in Lisbon, Portugal, and the Raymond Dart Anatomical Collection (n=31) at the University of Witwatersrand, in Johannesburg, South Africa. Diaphyseal lengths were measured for all individuals using an osteometric board and sliding calipers (where applicable). ANOVA of femoral lengths (adjusted for age) between the three samples was conducted in order to determine the amount of variation between the three populations. The results of this study indicate that the degree of population variation in skeletal growth prior to adolescence is insignificant ($p=0.203$).

Male-female friendships in chimpanzees and the effect of sex-biased dispersal.

ZARIN MACHANDA, IAN GILBY, and RICHARD WRANGHAM. Department of Human Evolutionary Biology, Harvard University.

Among several species of baboons, males and females exhibit differential association resulting in friendships. Despite anecdotal evidence suggesting the existence of friendships among chimpanzees, differentiated male-female relationships have not been examined in this species. We used 12 years of data from the Kanyawara community in Kibale National Park, Uganda to determine if males and females exhibit differential association patterns similar to those found among baboons. We calculated a composite association index for 249 male-female dyads using both temporal and spatial association data. Differential association was determined using the same method used by baboon researchers to distinguish friendly and non-friendly male-female dyads. We found that male-female association patterns among chimpanzees were different to those exhibited by baboons. Unlike baboons where the majority of females have at least one male friend, the majority of chimpanzee females at this site did

not exhibit differential association with a male. In further contrast to baboon friendships, high-ranking males and mothers of young infants at Kanyawara were not more likely to form differential association with a member of the opposite sex. We suggest that differences between chimpanzees and baboons are related to sex-biased dispersal patterns in these species and we propose a new model to explain variation in male-female relationships across primates. This study was funded by the National Science Foundation, Grant 0416125

Three-dimensional analysis of the scapular glenoid fossa: Neandertals and morphological adaptations to habitual behavior.

MARISA MACIAS. Department of Evolutionary Anthropology, Duke University.

The scapula glenoid fossa is a functionally significant joint surface to upper limb mobility and activity. The scapular glenoid fossae of Neandertals have been described as superiorly-inferiorly elongated and shallow relative to those of modern humans. Functional interpretations of this morphology include infrequent dorsoventral glenohumeral movement in Neandertals potentially related to contrasts in tool use. This study tests the influence of habitual activity on glenoid shape and the hypothesis that morphological adaptations to habitual activity are correlated with subsistence strategy. The scapulae of six populations of anatomically modern humans were analyzed in three-dimensions to test morphological adaptations to three different subsistence strategies: foraging, agriculturalism, and urban-dwelling. Glenoid depth relative to the glenoid fossae rim was significantly different between populations with different subsistence strategy, indicating that habitual activity is indeed reflected in glenoid fossa morphology. Neandertals were significantly different from foraging and urban-dwelling populations but not agriculturalists, which are known to be morphologically adapted to gross physical strength rather than dominant limb manipulation. Results suggest that Neandertals engaged in comparable habitually activity, which may be useful in making behavioral inferences regarding Neandertal subsistence strategy with respect to long range projectile weaponry use.

Individual variation in the social interactions of wild juvenile capuchins: What is the role of temperament and an evolved behavioral plasticity?

KATHERINE C. MACKINNON. Department of Sociology and Criminal Justice, and Center for International Studies, Saint Louis University.

Behavioral plasticity during a prolonged period of growth and development is a hallmark of the Order Primates. Throughout the juvenile stage young primates employ a range of behavioral responses to social situations. Here I will present data on juveniles (n = 18) from two species of capuchins (*Cebus capucinus* in Costa

Rica, *C. apella* in Suriname) living in three wild habituated groups. Preferential social partners, sex differences, and the range of responses in social interactions will be highlighted. While there are common patterns of social behavior repertoires and developmental parameters found among most capuchins, there exists a surprising range of variation in juvenile behaviors within and across the two species. For example, in one group there were significant individual differences for rates of approach by small juveniles toward adult males ($K-W = 10.26$, $p = 0.0165$); among small and large juveniles in two social groups ($n= 13$), rates per hour of approach to the alpha males varied from .10 to 1.44 (mean = .67). The genus *Cebus* displays an extended period of socially-mediated learning. Evidence suggests they may need a longer period of development compared to many primate species, for brain growth and cognitive functioning associated with learning their foraging and social behavior repertoires. In light of this, I will discuss the possible role of variable individual temperaments and behavioral plasticity as evolved mechanisms that benefit young capuchins as they traverse the lengthy developmental landscape. This abstract is part of the symposium titled "Juvenile primates: it's about time," organized by Connie D. Fellmann and Christopher A. Schmitt.

Evidence for dietary niche separation in the Miocene hominoids *Morotopithecus* and *Afropithecus*.

LAURA MACLATCHY¹, JAMES ROSSIE², TANYA M. SMITH³ and PAUL TAFFOREAU⁴. ¹Department of Anthropology, University of Michigan, ²Department of Anthropology, State University of New York, Stony Brook, ³Department of Human Evolutionary Biology, Harvard University, ⁴European Synchrotron Radiation Facility, Grenoble, France.

Numerous researchers have noted similarities between the type specimens of *Afropithecus turkanensis* (<17.5 Ma, Kenya) and *Morotopithecus bishopi* (>20.6 Ma, Uganda). These similarities, such as a long snout that sweeps backward at a low angle, have been interpreted as symplesiomorphies, or as homologues indicating congeneric or even conspecific status. Here we review previous taxonomic (and chronometric) disagreements and present new data (from published and unpublished specimens) indicating distinctive dietary niches for the hominoids, and supporting separate generic status. *Afropithecus* has been previously reconstructed as a sclerocarp frugivore, exhibiting often heavy apical wear on stout canines; procumbent incisors; and bunodont molars with thick enamel. This study finds the molar shear quotient of an unworn M2 to be relatively low (-17.47%), supporting the dietary reconstruction of frugivory. The type specimen of *Morotopithecus* shows exposed dentine in II-M2 but the left canine tip (the only one preserved) retains enamel and the incisors lack the procumbent orientation seen in *Afropithecus*. The M3 from the type and two lower molars from Moroto II were scanned with phase contrast synchrotron microtomography (10-20 micron voxel sizes), and enamel

thickness was measured following established procedures. Molar relative enamel thickness values ranged from ~11-14, similar to those of living African apes, and thinner than in most Miocene hominoids, including *Afropithecus*. In addition, upper and lower molars are mesiodistally elongated and a lower M2 crown has a relatively high molar shear quotient (-1.7%). Thus *Morotopithecus* lacks evidence for sclerocarp feeding and is reconstructed as partly folivorous.

This study was funded by the NSF, grant number BSC0215877, the LSB Leakey Foundation, and the European Synchrotron Radiation Facility.

A profile of bone health in an Ecuadorian forager-horticulturalist population.

FELICIA C. MADIMENOS¹, MELISSA A. LIEBERT¹, J. JOSH SNODGRASS¹, AARON D. BLACKWELL¹ and LAWRENCE S. SUGIYAMA^{1,2}. ¹Department of Anthropology, Institute of Cognitive and Decision Sciences, University of Oregon; ²Center for Evolutionary Psychology, University of California, Santa Barbara.

Bone mineral density (BMD) is the most important diagnostic parameter of bone health and is frequently used in clinical settings as an objective and reliable predictor of future fracture risk. Obviously, the mechanisms and life history tradeoffs affecting bone formation and maintenance evolved under conditions quite different from those experienced by western/industrialized populations, yet minimal data on bone health are available from subsistence groups or other non-western populations. This limits our understanding of the factors that affect bone health, as well as the life history trade-offs underlying age-related bone loss. Such data is particularly important because people in subsistence-based, natural fertility populations have diets, fertility patterns, physical activity levels, and family composition (factors reported to significantly affect bone health in clinical settings) more like those of our evolutionary past than do western/industrialized populations. Lack of available bone health data from non-western groups is due in large part to technological issues which have limited the availability of measurement of bone density in field conditions. However, recent advancements in ultrasound technology have allowed for increased portability of bone density machines. The current study presents the first available data on bone health, using bone mineral density, in an indigenous neo-tropical population. BMD was measured among Shuar children and adults from the Amazonian region of Ecuador using a Sahara calcaneal ultrasonometer, and anthropometric, physical activity and dietary data were collected. Bone density data are compared to standard US population data. Support: Wenner Gren Foundation; Leakey Foundation; University of Oregon; NIH 5DP1OD000516-04 (via the Center for Evolutionary Psychology, UCSB)

Lesions of the humerus rotator cuff muscles insertions in a French historical population.

BERTRAND MAFART. Antenne de l'Institut de Paléontologie Humaine, UMR 7194, Europôle Méditerranéen de l'Arbois, Aix en Provence, France.

In modern populations, rotator cuff tears are mainly due to micro-traumatisms in young people and degenerative tendinopathies in the elderly. The rotator cuff muscles insertions (m.supraspinatus, infraspinatus, teres minor, subscapularis) on the head of the humerus are often used as stress markers in studies on past populations. These lesions were studied in an archeological sample to determine what differences existed depending on side, sex, age at death and lifestyle.

This study was carried out on 394 humerus bones from the historical burial site at Notre-Dame-du-Bourg in Digne, France (4th-17th centuries). Sex was determined using Bruzek's pelvic method. Age at death was assessed using a modified version of Lovejoy's method. Three age groups were defined: under 30, between 30 and 60, and over 60 years of age. The diachronic variations were studied in two archeological periods (11th-13th century and 11th-13th century). The lesions were classified as absent (smooth surface or roughness without exostosis > 1 mm, no osseous lacuna) or present (exostosis > 1mm, osseous lacuna or impingement area).

The interobserver, intraobserver and side variations/differences were not significant. The lesions were more frequent in males, rare in young people and correlated with age at death. The subscapularis insertion lesions were significantly more frequent in the 16th-17th century male sample.

Lesions of the humerus rotator cuff muscle insertions were found to be mainly sex and age dependent in this archeological sample, as in modern populations. They should therefore be used as stress markers only with great caution.

Tertiary syphilis and admission to the late 19th century Colorado insane asylum.

ANN L. MAGENNIS and LESLIE A. JOHNSON. Department of Anthropology, Colorado State University.

Tertiary syphilis and its attendant dementia (neurosyphilis) was the condition responsible for 1 in 9 individuals committed to mental institutions in early 20th century America. Admission records from the late 19th century Colorado Insane Asylum provide an opportunity to compare the extent of neurosyphilis at this institution with nationwide statistics. In addition, skeletal remains from a portion of an unmarked asylum cemetery are used to test whether the bony changes associated with neurosyphilis are present in the sample and if the frequency is similar to that which we estimated to be present based on the admission records. Syphilis has been called the "great imitator" because it mimics the symptoms of many other conditions; we employ both a narrow and broad definition of syphilis here. Hospital records indicate that 156 individuals were admitted to the asylum with syphilis or general paresis between 1879 and 1899. Of this 156, 75 patients died. Of those with the broader

disease definition, 156 died during the 1879-1899 period of cemetery use. In the cemetery sample, we document one clear case and four likely cases of syphilis. The number of cases is lower than expected and the lesion pattern was different than what is shown in the literature. In sum, our analysis suggests a lower frequency of syphilis lesions than expected given the frequency of the disease indicated in the medical records. An altered pattern of skeletal lesions in late 19th century Euroamericans is one possible explanation.

Using a human assay to discover and type SNPs in orthologous regions of the baboon genome: The “spaghetti-on-the-wall” experiment.

MICHAEL C. MAHANEY, CLAIRE BELLIS, MELANIE A. CARLESS, DEBORAH E. NEWMAN and LAURA A. COX. Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio, Texas.

With a whole genome linkage map based primarily on “human” STR marker loci, the baboon (*Papio hamadryas ssp.*) is a useful animal model for identifying genes influencing variation in complex phenotypes and diseases also present in humans. Anticipating completion of the first draft baboon genome sequence assembly this year, we desired to develop a new, higher density marker set that could be typed efficiently on newer platforms while retaining comparative genomics utility. Given baboon-human sequence similarities facilitating our past successful use of human STRs and gene expression arrays in baboons and *in silico* cross-species comparisons, we hypothesized there exist single nucleotide polymorphisms (SNPs) common to both species to make up such a linkage set. As a preliminary test of this hypothesis, we used the Illumina Human610 Quad BeadChip to screen DNA from 4 founder mating pairs, each with 2 full sib offspring (16 chromosomes), against single-base primer extension probes for approximately 550,000 human tag SNPs. Although observing hybridization between DNA from at least 1 baboon and 80,474 probes, we focused first on probes to which DNA from all 16 baboons had hybridized (N=14,332). 1009 “human” SNPs that exhibited a) heterozygosity, b) minor allele frequency ≥ 0.4 , and c) no Mendelian errors were hypothesized as possibly conserved within the baboon genome. Application of similar criteria to probes to which DNA of only 15 and 14 animals had hybridized, we identified 2,024 additional candidates for planned SNP validation experiments in the larger baboon pedigree. This work was made possible in part by grants from the National Institutes of Health (P01HL029872 & P51RR013986) and by donations from the Azar family and the Mahaney family.

Molar crown formation times in ethnic groups from Cameroon: Preliminary findings.

PATRICK MAHONEY¹, MICHAEL AGBOR² and DAVID ZEITLYN¹. ¹School of Anthro-

pology and Conservation, University of Kent, ²Banso Baptist Hospital, Kumbo, Cameroon.

Incremental dental development can be quantified and reconstructed from enamel and dentine microstructure. This methodology is often applied in studies of hominoids to estimate age at death, characterize growth patterns, and to identify taxonomic differences. Detecting causes that influence incremental dental development, such as the duration over which enamel forms, increases the precision of the methodology. Here, we present preliminary findings for two modern day human groups (Fulbe; Nso) from Cameroon, where ethnic differences are projected in dietary differences. Traditional Fulbe pastoralist subsistence is aimed at the production of milk; Nso subsistence is more varied (predominantly agricultural).

Informed consent was granted by the participants (n=7). Maxillary and mandibular molars (M₁-M₃) were extracted for clinical purposes by dental services of two hospitals in Cameroon. Teeth were sectioned using standard methods, examined at 40x and 60x, and digital images were taken. Crown enamel formation times were calculated from short and long period incremental lines using image analysis software.

Crown formation times for Nso agriculturalists were 2.67-2.96yrs (M₁ protoconid), 3.13yrs (M₂ protoconid), and 3.36yrs (M₃ protocone). Formation times for Fulbe pastoralists were 4.21yrs (M₁ protoconid), 3.35yrs (M₂ metaconid), and 4.45yrs (M₃ protocone).

These preliminary findings suggest considerable variation in the duration of enamel formation between these ethnic groups. Formation times for Fulbe pastoralists also lies outside of the range reported for modern South Africans. Ongoing research using larger samples will determine if the group variation in formation times, as well as other aspects of enamel growth, correlates with diet.

The residents of Tecolote Pueblo (LA296): Were they Plains or Pueblo?

ROBIN E. MAINS. Department of Social and Behavioral Sciences, New Mexico Highlands University, Las Vegas NM.

The purpose of this study is to document, describe, and interpret the human skeletal remains from Tecolote Pueblo archaeological site (LA296), and to assess the population's demography, diet, and health, as well as their possible affiliations with Eastern Puebloan and/or Plains populations of similar time period. Comprehensive analysis of the Tecolote skeletal remains accessioned at Harvard University, Texas Tech University, and New Mexico Highlands University was conducted, examining skeletal sex, age at death, living stature, and various pathologies and traumas. Metric and nonmetric data collected from the remains is statistically compared to selected Ancient Puebloan and Plains skeletal samples. The results of the study were limited, due to the extremely fragmentary and incomplete nature of the Tecolote remains. The demographic analysis of the sample revealed the minimum number of

individuals to be 73, with nearly twice as many adults as subadults, and a similar number of adult males and females. Adults' and subadults' average ages at death are demonstrated, as well as the age and sex distribution of observed skeletal anomalies and pathologies. Overall, the metric and non-metric analyses, including cranial deformation assessment, demonstrate that the Tecolote skeletal population is more similar to Ancient Puebloan than to Plains skeletal populations. These results lend support to the expectation that the Tecolote Pueblo occupants were similar in osteological traits to other Ancient Eastern Pueblo populations from the same time period. Further analysis might provide additional information regarding possible biological non-biological relationships between the Tecolote population and other nearby Pueblo populations. This study was completed in partial fulfillment of the requirements for the degree Master of Arts in Southwest Studies/Anthropology Emphasis, and was primarily funded by the author, with minimal research and travel grants from the Archaeological Society of New Mexico (2004) and NMHU Office of Research and Sponsored Programs (2005).

Grasping, clasping, and claw climbing: Locomotor specializations of non-hallucal distal phalanges in plesiadapiform primates.

STEPHANIE MAIOLINO¹, DOUG M. BOYER² and JONATHAN I. BLOCH³.

¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Department of Ecology and Evolution, Stony Brook University, ³Florida Museum of Natural History, University of Florida.

Paleogene “Plesiadapiformes” are euarctian mammals thought to be closely related to Euprimates. Unlike most Euprimates, nearly all plesiadapiforms lack flat, nail-bearing distal phalanges and possess claws resembling those of extant non-primate arborealists. *Carpolestes simpsoni* is an exception with an opposable, nail-bearing hallux, but claws on other digits. Here we assess the utility of quantitative claw morphology in reconstructing plesiadapiform arboreal locomotor behavior.

Fifteen linear and angular measurements from seventeen non-hallucal claws of seven plesiadapiforms [*Nannodectes intermedius*, *Plesiadapis cookei*, *Plesiadapis tricuspidens*, *Plesiadapis n. sp.*, *Plesiadapis churchilli*, *Ignacius clarkforkensis*, and *Carpolestes simpsoni*] were compared to those from 192 claws representing 44 extant arboreal mammal species. Extant species were divided into three groups based on known locomotor specializations: grasping, claw-climbing and claw-clasping. Graspers habitually grasp small diameter supports employing opposable halluces and well developed apical pads. Claw-climbers primarily use their claws to climb on relatively large diameter supports and do not possess opposable halluces. Claw-claspers grasp by clasping the support between the volar surface of enlarged claws and volar pads. Principal coordinates and discriminant function analyses show that extant locomotor groups are

distinguished on the basis of claw morphology. *Carpolestes simpsoni* groups with extant graspers while *Ignacius clarkforkensis* resembles claw-climbers. *Plesiadapis cookei* is most similar to claw-claspers, while the other plesiadapid species fall between claw-claspers and graspers with *Nannodectes intermedius* and *Plesiadapis churchilli* somewhat closer to claw-climbers. The locomotor specializations indicated by this claw analysis for different plesiadapiforms are consistent with reconstructions based on other regions of the skeleton.

Ecological determinants of morphological integration in the capuchin face.

JANA MAKEDONSKA¹, BARTH W. WRIGHT² and DAVID S. STRAIT¹. ¹Department of Anthropology, State University of New York at Albany, ² Department of Anatomy, Kansas City University of Medicine and Biosciences.

The functional utility of morphological integration is generally implicitly assumed, yet studies of the factors that select for enhanced integration are limited. This study examines the relationship between patterned variation and 1) mechanical constraints imposed by diet, and 2) sex-specific differences in ontogeny. Two cebine species differing in diet were examined - the hard-object feeding *Cebus libidinosus* (N = 37) and the soft-fruit eating *Cebus albifrons* (N = 37). A set of 30 three-dimensional landmarks was chosen either to sample facial regions known to experience high strains during mastication in anthropoids, or to assess muscular mechanical advantage. The correlation structure between and within the oronasal and zygomatic orbital subunits was compared and quantified interspecifically and intraspecifically as a function of sex using singular warps analysis. Results suggest that taxa adapted to the consumption of selectively important but mechanically challenging foods might possess more strongly morphologically integrated faces compared to mechanically unchallenged taxa. It is hypothesized that unconstrained variation in the feeding apparatus that decreases masticatory performance would be selected against so as to avoid a deleterious impact on fitness. Links among integration, development, and ecology are additionally bolstered by our finding that males in sexually dimorphic species appear to be characterized by more integrated faces than females, possibly due to their prolonged growth periods and/or accelerated growth rates, which arguably provides an enhanced opportunity to adapt to the environment before maturity.

Developing and genotyping SNPs for non-model organisms: Examples from the genus *Macaca*.

RIPAN S. MALHI¹, JESSICA SATKOSKI TRASK² and DAVID GLENN SMITH³. ¹Department of Anthropology, University of Illinois Urbana-Champaign, ²Department of Anthropology, University of California, Davis.

An extraordinarily large investment in funds and time was once required to develop DNA

markers for use in evolutionary studies of wild populations. Markers selected, usually microsatellites, exhibited a large amount of variation, but the analysis was very time consuming and subjective due to the presence of stutter band artifacts and allelic dropout. As a result, sufficient numbers of DNA markers have not been developed for most primate species. Recent advances in DNA sequencing technology have permitted single nucleotide polymorphisms (SNPs) to be identified more cheaply and efficiently than microsatellites. In addition, SNPs are easier to analyze and genotypes can probably be called with less error and subjectivity compared to microsatellites.

A large number of candidate SNPs in *Macaca mulatta* and *Macaca radiata* were developed using the Roche Genome Sequencer FLX. Over 700 of the SNPs developed for *M. mulatta* were validated through Sanger DNA Sequencing and the Illumina Golden Gate Genotyping Array technologies. A significant number of these validated SNPs were successfully amplified across species and genotyped in individuals from a wide range of other species of macaques. Non-invasive samples in wild macaque populations can be genotyped for these SNPs to study kinship, dispersal patterns, population history and other related topics.

The preservation of non-adult skeletal remains from British samples.

BERNADETTE MANIFOLD. Department of Archaeology, University of Reading, UK, and School of Science, University of Derby, UK.

The type and amount of information derived from the skeletal remains of non-adults is dependent on their overall skeletal preservation. This study evaluated the skeletal preservation of six assemblages, comprising over 700 non-adult skeletons from the United Kingdom. The state of preservation of each bone element was assessed using three preservation indexes; the anatomical preservation index (API); the bone representation index (BRI) and the qualitative bone index (QBI). The results suggest that non-adult skeletons are less well preserved, with large numbers of bone elements not present; however, the results also suggest that infant skeletal remains are less likely to be affected by taphonomic factors than those of older children. It is concluded that taphonomic processes are not the dominating factor in the preservation of children, and therefore other factors such as cultural beliefs and burial practices appear to have a greater influence on the recovery and long-term survival of non-adult skeletons. This study was funded by a University of Reading Studentship.

Late hunter-gatherer and early agro-pastoral diets in the Mediterranean: The isotopic evidence from the skeletal remains of Grotta dell'Uzzo (Sicily).

MARCELLO A. MANNINO¹, ROSARIA DI SALVO², MARCELLO PIPERNO³, SEBASTIANO TUSA⁴, MICHAEL P. RICHARDS^{1,5}. ¹Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, ²Museo

Archeologico Regionale 'Antonino Salinas', Palermo, Italy, ³Dipartimento di Scienze Storiche, Archeologiche ed Antropologiche dell'Antichità, Università di Roma 'La Sapienza', Roma, Italy, ⁴Soprintendenza del Mare, Palermo, Italy, ⁵Department of Anthropology, University of British Columbia, Vancouver, Canada.

A large body of isotope data on prehistoric humans from Atlantic Europe attests that a sudden change in diet occurred with the adoption of agriculture (Richards *et al.* 2003). For other areas of Europe, such as the Mediterranean, similar isotopic data on prehistoric humans is scarce. Archaeological studies have suggested that, in the Mediterranean region, areas inhabited by hunter-gatherers at the time of the introduction of agropastoralism (e.g. Franchthi cave in Greece and Grotta dell'Uzzo in Italy), changes in subsistence were gradual and humans continued to rely on local resources for some time after the introduction of the Neolithic economy.

In this paper, we will present the results of carbon and nitrogen stable isotope analyses on bone collagen of Mesolithic and Neolithic humans and animals from Grotta dell'Uzzo (Sicily). Excavations at this cave site have unearthed burials containing 13 Mesolithic individuals. AMS radiocarbon dating, undertaken as part of the present research on isolated bones from the cave, has confirmed that Neolithic human remains are also present at the site.

The isotope analyses on the bones from Grotta dell'Uzzo suggest that, both in the Mesolithic and the Neolithic, the main source of dietary protein was terrestrial and that marine resources were a minor component of the diet. The slight shifts in carbon and nitrogen values between Mesolithic and Neolithic individuals will be discussed in relation to the gradual changes that took place in human diets and in Mediterranean environments at the time of the transition to agriculture. This research was supported by a Marie Curie Intra European Fellowship within the 7th European Community Framework Programme, grant number PIEF-GA-2008-219965.

Chimpanzee insectivory detected: resource availability, monitoring, and consumption.

LINDA F. MARCHANT^{1,2}, TIMOTHY H WEBSTER^{1,2,3}, WILLIAM C. McGREW², CHARLOTTE L.R. PAYNE² and KEVIN D. HUNT⁴. ¹Department of Anthropology, Miami University, ²Leverhulme Centre for Human Evolutionary Studies, University of Cambridge, ³Department of Anthropology, Yale University, ⁴Department of Anthropology, Indiana University.

This study sought to test the relationship between abundance and distribution of key social insect species, their use as measured by intensive monitoring of individual colonies, and overall consumption of these species of ants, termites and bees by semi-habituated chimpanzees. We studied the Mugiri community in Toro-Semliki Wildlife Reserve, Uganda,

May–November, 2008. Webster et al. (2009) reported these chimpanzees to be among the most insectivorous of known chimpanzee populations. Here we focused on those well-known, pan-African taxa: *Apis* (honey bee), *Macrotermes* (termite) and *Oecophyllia* (weaver ant). We hypothesized that prevalence of the resources in the diet of the apes would reflect the insects' relative abundance and distribution, and the indirect evidence of their exploitation at source.

We did 5000 m. of 6-m. belt transects divided between pre-existing trails and undisturbed vegetation. We monitored signs of use (tools, feeding remains, footprints, hairs, etc.) at 14 bee hives, 13 termite mounds and 12 weaver ant colonies. We sliced 111 chimpanzee fecal samples for macroscopic analysis.

Oecophyllia were super-abundant, constituting 66% of the colonies found on the transects and they were found in 45% of fecal samples, yet none of the monitored colonies was harvested. *Apis* were found in 24% of fecal samples and 21% of hives were exploited, yet none was found on a transect. *Macrotermes* were 35% of the colonies found on transects, yet their mounds were undisturbed and the insects uneaten by the chimpanzees. We conclude that chimpanzees are selective insectivores, whose strategies of exploitation do not reflect simple availability. Supported by National Science Foundation award #BCS-0321893.

Does variation in fibular robusticity reflect variation in mobility patterns?

DAMIANO MARCHI¹ and COLIN N. SHAW².
¹Department of Evolutionary Anthropology, Duke University. ²Leverhulme Center for Human Evolutionary Studies, Cambridge University, UK. ³Department of Anthropology, Pennsylvania State University.

The fibula is rarely considered in studies of morphological variation. This may be due to the presumption of its relatively minor role in carrying mechanical loads. Differences in relative fibular diaphyseal robusticity have however been found within hominidae, and relate to variation in positional behaviour (Marchi, 2007). Nevertheless, whether variation in fibular robusticity is influenced by habitual activity patterns in hominins remains uncertain. This study examines cross-sectional geometric properties of the tibia and fibula at mid-shaft across a sample (N=53) of male varsity cross-country runners, field hockey players, and sedentary controls. Fibular robusticity (relative to tibial robusticity) is compared between groups. Runners display low relative fibular robusticity compared to the other groups, while hockey players display significantly greater relative fibular robusticity ($P < 0.05$) compared to runners. Values for the control sample fall between these two groups. Differences between the runners and hockey players appear to correspond with athletic history. Generally, cross-country running requires the athlete to proceed in a relatively straight line. In contrast, movement patterns associated with field hockey require repeated directional changes. The more robust fibulae of hockey players may be a consequence of a training regime requiring

profound mediolateral biomechanical loading of the lower limb, which would induce fibular loading more so than would uni-directional cross-country running. These results (1) provide support for the use of variation in fibular robusticity to infer locomotor patterns in living hominoids and, (2) present an additional tool for inferring hominin mobility patterns from skeletal and fossil remains. This study was funded by Royal Anthropological Institute (UK).

Traumatic lesions and other pathological conditions observed in subadult human remains from Chaco Canyon

KERRIANN MARDEN^{1,2}, DAVID R. HUNT¹.

¹Department of Anthropology, National Museum of Natural History, Smithsonian Institution, ²Department of Anthropology, Tulane University.

The human remains recovered from the pre-Columbian site of Pueblo Bonito in Chaco Canyon have presented an archaeological enigma since the initial archaeological investigations in the late 1800s. Because these burials were concentrated in just two small clusters of rooms within the massive structure, archaeologists have speculated that these individuals might represent sociopolitical elites or privileged family groups within the Chaco social structure. However, the remains were found in a commingled and disturbed condition, generally inconsistent with the mortuary treatment of persons of high status. Re-association and re-analysis of the remains in the Chaco Canyon collection at the National Museum of Natural History has revealed unique patterns of traumatic and pathological lesions among the subadults of this distinctive burial population. This study has found traumatic lesions such as multiple healing fractures, healed antemortem fracture and perimortem fracture among the subadults, as well as skeletal indicators of pathological conditions including enlarged long bone shafts, bowed lower limbs, pronounced endocranial gyri, marked dental caries, abnormal porosity and periodontitis. This presentation describes and illustrates the pattern of distribution of these lesions both within individuals and across the subadult burial population. Patterns of injury suggesting repeated traumatic episodes are evaluated for a possible etiology of battery or child abuse. Differential diagnoses for the observed lesions and possible explanations for the traumatic insult are compared and evaluated in relation to other skeletal defects and their causes. This study was funded by the support of two Smithsonian Predoctoral Fellowships, 2007–2008 and 2008–2009.

Dmanisi hominin dentognathic variation: phylogeny, pathology or in-vivo compensatory mechanisms?

ANN MARGVELASHVILI^{1,2}, MARCIA S. PONCE DE LEÓN¹, TIMO PELTOMÄKI³, DAVID LORDKIPANIDZE² and CHRISTOPH P. E. ZOLLIKOFER¹. ¹Anthropological Institute and Museum, University of Zurich,

²Georgian National Museum, Tbilisi, Georgia,

³Clinic for Orthodontics and Pediatric Dentistry, University of Zurich.

The Plio-Pleistocene hominin sample from Dmanisi (Georgia) is unique in offering detailed insights into patterns of morphological variation within a paleopopulation of early *Homo*. A particularly high degree of diversity is found in cranial and dentognathic morphologies, but the causes underlying variation are still relatively unexplored. Here we analyze the dentognathic morphology of the Dmanisi specimens with a focus on potential in-vivo factors bringing about variation, such as growth, aging, trauma and pathology. Applying clinical standard protocols of dentognathic diagnostics shows that the Dmanisi sample exhibits a wide range of pathologies, which are well known from modern humans, and which are also found in the great apes. Further, we identify heavy masticatory loading, severe tooth wear and aging as principal causes of dentognathic variation in Dmanisi. Inferred patterns of age-related alteration in Dmanisi were similar to those found in modern humans and great apes, suggesting common basic mechanisms of in-vivo compensation of the effects of tooth wear. Our findings indicate that assessment of in-vivo processes of dentognathic remodeling in fossil hominins is of critical importance for the taxonomic and phyletic interpretation of dentognathic features, especially of the mandibular symphyseal region.

A new species of *Anchomomys* (Cercamoniinae, Primates) from the Sant Jaume de Frontanyà fossil site (Eastern Pyrenees, Catalonia, Spain).

JUDIT MARIGÓ¹, RAEF MINWER-BARAKAT¹ and SALVADOR MOYÀ-SOLA².

¹Institut Català de Paleontologia (ICP), Universitat Autònoma de Barcelona, ²CREA at the Institut Català de Paleontologia (ICP), Universitat Autònoma de Barcelona.

A new species of adapoid primate assigned to the genus *Anchomomys* from the Sant Jaume de Frontanyà fossil site (Eastern Pyrenees, Catalonia, Spain) with typical Robiacian fauna (MP14–15) is presented. From this locality several Eocene mammals have been identified, apart from three different primates, one of which is presented here.

More than 200 pieces with almost all the dental elements represented have been recovered from two different levels called SJF-3C and SJF-3D, constituting the richest material on Eocene primates of the Iberian Peninsula. The new material is assigned to the genus *Anchomomys* because of its tiny size, its relatively small hypocone, the lack of a pericone, the lack of a distinct metaconule, the entoconid located distolingual to the hypoconid, the lack of metaconid in the P/4, the presence of a paraconid in M/1–2, with a hypoconulid in the M/3 located centered in the mesiodistal axis of the tooth.

It differs from all the other species of this genus except for *A. gailliardi* in having a much more reduced hypocone and paraconule and in the more subtriangular than subquadrate upper molar shape.

Moreover, it differs from *A. guillardi* in its larger size, in its M3/ less mesiodistally compressed, in the hypoconulid more lingually placed, in the mesiodistally compressed M3 with a shorter talonid basin and a much more buccal cristid obliqua.

This new species will contribute to the knowledge of middle Eocene adapoid faunas from the Iberian Peninsula and help understand the relationships between different *Anchomomys* species found throughout Europe. This study was funded by the project "Grandes simios fósiles (Hominoidea) del Mioceno del área mediterránea: origen, paleobiología y evolución" of the Ministerio de Educación y Ciencia (Spain), grant number CGL2008-00325/BTE.

Sex differences in tool use: Chimpanzees vs. Hadza hunter-gatherers.

FRANK W. MARLOWE and JULIA C. BERBESQUE. Department of Anthropology, Florida State University.

Among the primates that use tools chimpanzees are notably impressive. There is no reason to think the last common ancestor (LCA) we share with them did not also use tools. However, early hominin tools (like those of chimpanzees) were not likely to preserve well or to have been sufficiently altered to be recognized as anthropogenic. To explore the gap between chimpanzees (as a proxy for the LCA) and humans we compare the subsistence-related tool kits and tool use of chimpanzees at Gombe and Tai to a contemporary hunter-gatherer population, the Hadza of Tanzania. McGrew has compared chimpanzees to the Tasmanians, using Oswalt's taxonomy for "Subsistants" and their number of techno-units. Here we do the same, but focus instead on a comparison of sex differences in tool use and manufacture. Among chimpanzees, females excel at tool use involving more complex tasks. Among the Hadza, men make tools with significantly more techno-units than women. They also spend much more time making and repairing their tools and the time spent is correlated with amount of food acquired. Women use simple tools like digging sticks and hammerstones, which are nevertheless responsible for a major part of the diet. Men's tools yield an unpredictable return but occasional bonanzas when large animals are killed. Similar patterns occur in many other human foragers. We discuss the reasons for the contrast between sex differences in tool use among chimpanzees and humans and when they likely emerged.

Color of dentine as an age indicator for Hispanic populations in Southwest Texas.

INGRID MARRERO. Department of Anthropology, Texas State University-San Marcos.

This study will evaluate a quantifiable, non-subjective method for measuring tooth dentine color in order to identify trends in shading that may yield a technique for the estimation of age at death in modern individuals of Hispanic ancestry, the largest minority population in the

United States. Dentine shade was evaluated in a known, documented sample of molars from 72 modern Hispanic adult individuals from a dental practice in San Antonio, Texas in order to determine if dentine coloration differences existed, and whether these differences were correlated with advancing age. Although this is not the first study where dentine has been used as an age estimation indicator, it is the first attempt to utilize a specific technological appliance towards assessing and quantifying shade. Using Hunter Lab's Mini Scan XE Plus® color measurement scanner, a yellowness index was formulated from the shades obtained by the scanner and an average of the yellowness index was calculated for each of the age decades represented by individuals in the study. The results yielded a positive correlation between the shade of dentine and the age of males, but not for females. These findings are important because they address one component of the data deficiency in regards to Hispanic populations via examination of the dental hard structures and their relationship to age.

Beyond thick versus thin: Sex and cranial vault thickness in recent humans.

HANNAH E. MARSH. Department of Anthropology, University of Iowa.

Previous research into cranial vault thickness (CVT) found males have thicker vaults than females in samples from Australia, Britain and China (Brown 1994), while a study of European Americans and African Americans found females to have thicker vaults than males (Moreira-Gonzalez et al. 2006). Many other studies are inconclusive. Most of these studies have represented CVT variation from a few vault osteometric landmarks, which leave large areas of the vault unmeasured. This study focuses on any variation by sex that may occur in the entire vault by applying a deformable grid system of 219 sampling points. Using computed tomography scans the grid is fitted relative to the size and shape of an individual, thus ensuring sampling point homology across a sample of 100 eco-geographically diverse recent humans.

Females are thicker than males lateral to the parietal eminences. Males are thicker at the sagittal suture, bregma, and the frontal. Both sexes exhibit similar patterns of thickness, the most common of which is a 4-Leaf Clover, where the parietal and frontal eminences are the thickest regions. All patterns of thickness are exhibited in each sex, and each sex encompasses individuals at the extremes of thickness variation. CVT variation is dominated by the ossification centers of the vault, with the parietal and frontal eminences representing the thickest regions. This work suggests sex does not play a large role in dictating CVT variation, and that thickness should not be used to identify sex in the fossil record. This study was funded by Sigma Xi, Grant-In-Aid of Research, and the University of Iowa, Graduate College Summer Fellowship.

Affiliative and agonistic social behavior in *Pan troglodytes verus*; a pilot study.

JOSHUA L. MARSHACK. Department of Anthropology, Washington University, St. Louis.

From June to August 2009, I conducted a pilot study for my dissertation research examining affiliative and agonistic social behavior in *Pan troglodytes verus*. Research comprised sampling all occurrences of affiliative and aggressive social behavior in all-day focal-animal follows, five-minute interval focal-animal sampling of basic activity budget, and supplementary ad libitum sampling for the nine-adult males in the Fongoli chimpanzee community of Kedougou region in Senegal. I divided both aggressive and affiliative behaviors into two categories, active and subtle, and further divided each of these into low and high intensity depending on the level of physical contact and movement. Such highly specific classifications represent an attempt to elucidate the often contentious issue of chimpanzee aggression, affiliation, and reconciliation. The context of social behavior as well as proximity of individuals involved was also noted. Though results are preliminary, it is clear that at least in this particular subspecies, at this site, subtle affiliation is much more common than subtle aggression, active affiliation more common than active aggression, and agonistic physical contact in particular is incredibly rare. However, that aggression is mild and infrequent does not mean that it plays an unimportant role in the mechanics of chimpanzee society. It also appears that food competition and sexual coercion may not be the primary driving forces for agonistic behavior at this site. A long-term study of the social behavior of the species is planned. I thank Jill Pruetz of Iowa State University for assistance and the Washington University Department of Anthropology for funding. This study was funded by a Washington University Department of Anthropology summer seed research grant.

Neutrality, niches, and the assembly of primate communities.

ANDREW J. MARSHALL^{1,2} and LYDIA H. BEAUDROT². ¹Department of Anthropology, University of California at Davis, ²Graduate Group in Ecology, University of California at Davis.

A major goal in primate community ecology is to identify the mechanisms that govern the assembly of ecological communities. Over the past three decades, the neutral theory of biodiversity has emerged as an influential and controversial framework to explain patterns of species diversity in space and time. In contrast to traditional niche-assembly theories in which species are thought to sort along environmental gradients, neutral theory proposes that community composition is the outcome of dispersal and recruitment limitation coupled with demographic stochasticity, or ecological drift. Currently, evidence supporting neutral theory is strongest for tropical plant communities but surprisingly few tests have been conducted using vertebrate communities. Here we test neutral theory using data on primate communities from Africa, South America, Madagascar, and Borneo. We

examined the relative importance of geographic distance and ecological distance (i.e., dissimilarity) in explaining the similarity of primate communities. Multivariate analyses that considered variables simultaneously showed stronger relationships between community similarity and geographic distance than ecological distance in all four metacommunities. Results are similar using all primate species, diurnal species only, and when data were analyzed at the level of genera. This supports predictions of neutral models and suggests that dispersal and recruitment limitation may influence primate community assembly, as has been found for sessile taxa. We end by considering the extent to which the fundamental assumptions underlying neutral theory (e.g., functional equivalence of species, dispersal limitation) might apply to primate communities. This study was funded by a National Science Foundation Graduate Research Fellowship to LHB.

The reconstruction of Neanderthal hyoid position – a new approach using three-dimensional geometric morphometrics.

SANDRA A. MARTELLI and JAMES STEELE. AHRC Centre for the Evolution of Cultural Diversity, Institute of Archaeology, UCL, London.

The position of the hyoid is notoriously difficult to reconstruct once the soft tissue connections of this "free-floating" bone have disappeared. However, if it were possible to reconstruct the position of the hyoid from the surrounding hard tissue, this would greatly enhance the accuracy of reconstructions of fossil hominin vocal tract and of their acoustic potential. We present the potential envelope of hyoid positions for adult Neanderthals based on linear regression analysis, in which we predict their hyoid positions from inter-landmark distances of skull and mandible in three dimensions (using human and chimpanzee as alternative reference models). The human models (based on a sample of 20 adult head-and-neck CT scans) result in anatomically-viable hyoid positions for Neanderthals whereas the chimpanzee models (based on a sample of five adolescent and adult head-and-neck CT scans) result in less anatomically plausible Neanderthal hyoid positions. The Neanderthal hyoid bone most likely occupied similar positions in relation to skull and mandible (and the vertebral column) to those observed in modern humans, meeting one of the several necessary conditions for the presence of human-like speech in this species. This study is part of HANDTOMOUTH, funded by the EUROPEAN COMMISSION (Grant No. 029065).

A view from Black Mesa: Integrating bioarchaeological data from individuals to hamlets and regions.

DEBRA L. MARTIN. Department of Anthropology, University of Nevada, Las Vegas.

The Black Mesa Archaeological Project (BMAP) was a large CRM-University run excavation in the northern Arizona. For 15 years

(1968-1983) a variety of teams operating out of the University of Southern Illinois, Carbondale, worked to locate and excavate BMIII-II sites within areas that would be destroyed by strip mining the following year. Although pre-NAGPRA, there were representatives from the major tribes involved in many of the decisions that were made particularly regarding the human remains. This project explores issues of scale in integrating bioarchaeological data that was accumulated over many years from a relatively small area (155 sq. miles). In the earliest years, the analysis of the human remains was focused on individual burials and there were no bioarchaeologists associated with the project. These early descriptive reports were disassociated from any mortuary or archaeological context and provided little interpretive information. In subsequent years, the skeletal population size grew and newer analytical techniques were applied. Population-level data included the mortuary and context of the burials. Interpretations documented the stresses and strains of farmers over several generations living in small hamlets spread across the study area. More recently, we have begun to situate the demographic and health data within larger dynamic regional and inter-regional perspective. This has yielded many new insights. And, it has overturned some original interpretations that were based on isolated individuals and single sites. These insights from 25 years of continued study demonstrates the importance of context and scale in Southwest bioarchaeology.

Indigenous intestinal flora, polyparasitism, and immune responses in the Bolivian lowland tropics.

MELANIE MARTIN¹, MICHAEL GURVEN¹, HILLARD KAPLAN² and DAVID SELA³. ¹Department of Anthropology, University of California, Santa Barbara, ²Department of Anthropology, University of New Mexico, ³Department of Microbiology, University of California, Davis.

Humans share similar gut microbial populations at the highest taxonomic levels, although the relative proportions of key phyla (e.g. Firmicutes and Bacteroidetes) and prevalence of particular genera (e.g. *Clostridium*) and/or species (e.g. *L. acidophilus*) vary widely among individuals. In recent animal and human studies, higher proportions of Firmicutes and *Clostridium* species have been associated with obesity, atopic disorders, birth method, and infant diet. However, few studies have examined microbial compositions of individuals living in natural disease ecologies at subsistence level, where, in the absence of modern dietary, medicinal, and hygenic influences, lower proportions of these bacteria may be expected. The majority of the Tsimane--a hunter-horticulturalist population residing in the Bolivian Amazon--exhibit lean body mass, no atopic disorders, have natural births, prolonged breastfeeding, and little access to processed foods or modern medicine. Yet Tsimane also exhibit high levels of pathogenic exposure; our medical examinations and fecal analyses from 2004-2009 show that 20-40% of Tsimane report

gastrointestinal distress at any given time, with 60% of the population infected with at least one intestinal parasite, 40% infected with more than one parasite, and 24% infected with pathogenic protozoa. Tsimane gut microbiota compositions thus may also reflect pressures from the local disease ecology, including parasite-commensal competition, persistent GI distress, and/or impaired mucosal immunity and barrier resistance owing to polyparasitism and repeated bacterial infections. This study was funded by the National Institute of Health-National Institute on Aging, grant number R01AG023119-01, and the National Science Foundation, grant number BCS-0422690.

Dental morphology of European Middle Pleistocene populations.

MARÍA MARTÍN-TORRES¹, JOSÉ-MARÍA BERMÚDEZ DE CASTRO¹, AIDA GÓMEZ-ROBLES¹, LEYRE PRADOSIMÓN¹, ANTHONY OLEJNICZAK¹, JUAN-LUIS ARSUAGA². ¹Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain, ²Centro de Evolución y Comportamiento Humanos (UCM-ISCIII), Madrid.

Recent studies suggest that Neanderthals exhibit a unique dental morphological pattern among hominins. However, approaches to studying "uniqueness" in their dentition and the evolutionary weight of the traits recorded requires a concomitant analysis of dental morphology in European Middle Pleistocene populations, considered directly ancestral to the Neanderthal lineage.

Systematic excavation of the Sima de los Huesos (SH) site in the Sierra de Atapuerca (Burgos, Spain) has provided the largest Middle Pleistocene hominin collection world-wide, with more than 5,000 fossils representing all skeletal elements and assigned to at least 28 individuals. At present, the SH dental collection contains more than 500 permanent teeth, providing an exceptional opportunity to investigate the origins of Neanderthal morphological "uniqueness".

The SH dental sample presents all the morphological traits that are generally considered (either in their degree of expression, frequency, or particular combination) typical of *H. neanderthalensis*. These traits include expression of *triangular shovel shape* in I^1 s, a rhomboidal contour with a bulging hypocone in M^1 s, and a deep anterior fovea combined with a continuous mesial trigonid crest in lower molars, among others traits. The latest radiometric study of the SH site provides an earlier age interval for the hominin assemblage, with a minimum age of 530 kyr. Thus, we conclude that the dental morphological pattern of Neanderthals was already present in Europe more than half a million years ago. Further comparisons with other European Middle Pleistocene populations will provide crucial insights into the so-called "Neanderthalization" process. This study was funded by the Spanish Ministry of Ciencia e Innovación (project DGI CGL2006-1352-C03, Juan de la Cierva research contract and FPU grant), Fundación Atapuerca,

Fundación Duques de Soria and Consejería de Cultura y Turismo of Junta de Castilla y León.

Assesing maternal lactation costs, infant postnatal growth and weaning: New issues in human and non human primates reproductive strategies.

ANA MATEOS, IDOIA GOIKOETXEA, JESÚS A. MARTÍN, JESÚS RODRÍGUEZ and JOSÉ MARÍA BERMÚDEZ DE CASTRO. Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain.

As a result of their large brain size and body mass humans differ from other primates in their life-history patterns. The relationship between prenatal and postnatal brain ontogeny with maternal metabolism has been widely studied in humans and other non-human primates, but few analysis are devoted to examine intraspecific variation in birth mass, growth rates, age at weaning and lactation bioenergetics. This study investigates the maternal reproductive investment in humans and non human primates in order to obtain an integrated life history model including topics as the female energy allocation through breast feeding, the brain and body postnatal growth in infants and the age at weaning. The three following aspects of the human life history pattern will be compared against the patterns of non human primates. First, duration of lactation in humans is limited by the differences in newborn body and brain growth rates. Second, during the first year of life brain growth is prolonged at the same rate as prenatal growth, otherwise, body growth rate is delayed in favour of the brain. Third, the cost of lactation is determined by the daily milk yield (710-800 gr/day), its caloric content (0,67 kcal/g) and the energy transferred to the baby. Data on weight, encephalic volume, lactation length, age at weaning and postnatal growth rates have been collected for humans and other primates and the relationships were analysed using correlations and multivariate approaches. The results are explained in terms of maternal energetic investment and reproductive strategy, significantly different in primates. This research was funded by the Spanish Ministerio de Ciencia e Innovación (MICINN), Project No CGL2006-13532-C03/BTE, and the JCyl GR 249-2008, Excellence Research Group "Evolución Humana en Europa". Jesús A. Martín is funded by the Cátedra Tomás Pascual Sanz-CENIEH and Idoia Goikoetxea has the benefit of a Predoctoral FPI Grant of the Spanish MICINN.

Niche construction and the evolution of primate sex-biased dispersal patterns.

LUKE J. MATTHEWS, CHRISTIAN ARNOLD and CHARLES L. NUNN. Department of Human Evolutionary Biology, Harvard University.

Most phylogenetic comparative analyses assume that descendent species tend to resemble ancestral ones, with more closely related species displaying similar trait values simply through inheritance. Niche construction is a different process in which one generation's trait values

influence patterns of selection experienced by subsequent generations. Here, we applied this framework to study primate sex-biased dispersal patterns, which are a central focus of socioecological models.

Using a niche construction framework, we predicted that dispersal patterns show 1) significant phylogenetic signal, 2) ordered transition rates, with shifts through an intermediate category of unbiased dispersal rather than direct transitions between male- and female-biased dispersal, and 3) asymmetric transition rates involving a higher rate of transition to either of the biased dispersal states than to unbiased dispersal. The last prediction arises because philopatry is thought to produce kin-bonded social structures that would inhibit subsequent dispersal. While simple inheritance of trait values also makes Prediction 1, it makes neither of the other two predictions.

We obtained dispersal data for males and females for 78 primate species. Using likelihood and Bayesian phylogenetic models and a recent Bayesian inference of primate phylogeny, we found strong evidence for phylogenetic signal and ordered transition rates (Predictions 1 and 2). Prediction 3 also was supported, but only for transitions to male dispersal (a stable evolutionary state). In contrast, female dispersal was unstable, possibly because females benefit from philopatry more than males. Collectively, our model-based phylogenetic results provide new insights to primate dispersal patterns and, more generally, to primate socioecological models.

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The effects of age, sex and geographic location on diet in Dark Age England.

SIMON MAYS¹ and NANCY BEAVANT-HFIELD². ¹English Heritage, Portsmouth, UK. ²Rafter Radiocarbon, Lower Hutt, New Zealand.

The work investigates diet in 5th-7th century AD England, and explores variation with age, sex and geographic location, using $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. Bone from 76 adult skeletons (38 males, 38 females) from 17 burial sites was analysed. Sites were classified as coastal, inland, or on the lower reaches of major rivers. Median $\delta^{13}\text{C}$ varied from -19.8 to -20.7‰; mean $\delta^{15}\text{N}$ ranged from 9.5 to 10.3‰. There were some statistically significant patterns: coastal sites showed a somewhat less negative $\delta^{13}\text{C}$ and riverine sites slightly elevated $\delta^{15}\text{N}$ when compared with other locations. There were no sex differences, but for males those over 30 yrs showed slightly elevated $\delta^{15}\text{N}$ (9.7‰, compared with 9.1‰ for those under 30).

Results suggest that, at each location, dietary protein was dominated by terrestrial foods. Diets varied little: despite the geographic diversity of the sample, variation was similar to that reported within single communities in the later mediaeval period. Nevertheless, the results suggest that coastal communities may have consumed slightly more seafood, and riverine communities more freshwater resources. This may indicate that, despite the emphasis on agrarian output in Dark Age subsistence,

communities may have made some use of wild resources, either as minor but regular supplements to diet, or else as fall-backs in times of shortage. The dietary shift with age in males, perhaps toward a more meat- or freshwater fish-rich diet may, given bone turnover rates, have occurred toward the end of the growth period, perhaps marking a social transition to adulthood.

The role of phylogenetic theory in taxonomic practice.

ROBERT C. McCARTHY and THOMAS A. DiVITO. Department of Anthropology, Florida Atlantic University.

Palaeontologists rely on a combination of primitive, derived and unique characteristics to diagnose species. Once species taxa have been proposed, additional taxonomic hypotheses are tested using a more limited set of anatomical traits. Bootstrapping and other methods used to compare variation in fossil and comparative samples fail to consider the phylogenetic utility of such traits, instead grouping specimens according to overall similarity. Paleotaxonomy is therefore, by design, a largely phenetic operation. However, similarity can be the result of common ancestry (homology), parallelism or convergence. If homologous, characteristics can be uniquely derived in one species (autapomorphy), or derived in two species, either recently (synapomorphy) or in a more distant ancestor (symplesiomorphy). In other words, samples sharing similar characteristics are not necessarily from the same species. It is difficult – if not impossible – to identify the differences between these classes of data in the absence of prior phylogenetic information. Palaeontological studies often, by necessity, employ small numbers of characters, greatly decreasing the probability of sampling autapomorphies rather than symplesiomorphies, synapomorphies or homoplasies. We therefore show that failure to distinguish between primitive, derived and unique character states, the *modus operandi* of phylogenetic systematics, can lead to errors in taxonomy. We present several potential solutions to this problem (increasing the number of characters sampled, applying alternate methods of homology assessment, and employing specimens, not species, as terminal taxa), but acknowledge that none of them are ideal. At small sample sizes, it is likely that this problem is intractable.

***Australopithecus afarensis* exhibited a chimpanzee-like pattern of female transfer.**

MONTE L. MCCROSSIN and LAURA D. REYES. Department of Anthropology, New Mexico State University.

Previous literature equates high body mass and canine sexual dimorphism with elevated male-male competition, indicating polygyny. *Australopithecus afarensis* exhibits a high degree of body mass sexual dimorphism, suggesting polygyny, yet low/moderate degree of canine sexual dimorphism, suggesting monogamy. Some argue *A. afarensis* was

polygynous and lived in harem-like social groups, while others assert its monogamy. Early hominid sex ratios and sexual dispersal patterns have not yet been examined. We examined the sex ratio and non-metric traits of 14 mandibular molars representing eight individuals from the "First Family" site at Hadar (A.L. 333/333w). We used the distribution of molar areas to determine sex, with larger molars deemed male, and smaller molars deemed female. The non-metric traits employed are protostyloid, postmetaconulid, hypoconulid, tuberculum sextum, and groove pattern. To determine which sex is more similar, we calculated the range of scores for each trait and compared the amount of intra-sexual variation between the sexes. We identified four males and four females within the sample. Analyses show males demonstrate more similarity in the hypoconulid, protostyloid, postmetaconulid, and groove pattern. In contrast, females demonstrate more similarity only in the tuberculum sextum. Results suggest *A. afarensis* had a social organization with an even sex ratio and more similarity among males than females. Despite arguments for both monogamy and polygyny based on body mass and canine size dimorphism, an analysis of A.L. 333/333w molars does not support either type of social organization. *A. afarensis* likely practiced male philopatry in a multi-male, multi-female group, much like *Pan*.

Diet and ingestive behaviors of a hard object feeder; Feeding and foraging of sooty mangabeys (*Cercocebus atys*) in Tai Forest, Ivory Coast.

W. SCOTT McGRAW¹, DAVID J. DAEGLING², ANNA E. VICK², ANDERSON BITTY³ and RICHARD PAACHO⁴. ¹Department of Anthropology, Ohio State University, ²Department of Anthropology, University of Florida, ³University of Cocody, Ivory Coast, ⁴Tai Monkey Project.

Members of the *Cercocebus-Mandrillus* clade are distinguished from other African papionins by expanded premolars and it has been argued that this feature is related to reliance on obdurate foods harvested from the forest floor. While the foraging behavior characterizing this clade is becoming increasingly known, there exist little data on ingestive behaviors with which to test the presumed association between durophagy and premolar expansion. Here we present results of a 12 month study on diet and oral processing activities of sooty mangabeys (*Cercocebus atys*) in Ivory Coast's Tai Forest. Feeding and foraging data were collected from July 2008 – August 2009 using focal animal sampling. During each scan we recorded age and sex of individuals, foods consumed, and oral processing behaviors scored as: number of incisal events, number of canine events, number of post-canine crushes, and chewing cycles. These data were combined to generate overall and food-specific rates for each processing activity and interpreted via food hardness values. For all foods combined, mangabeys averaged 35.6 incisal events, 3.6 post-canine crushes and 78 masticatory cycles per scan. The diet profile confirms that sooty mangabeys are dedicated hard object feeders: the most

preferred (34%) food - *Saccoglossus gabonensis* – is among the hardest ingested items and its processing requires elevated incisal preparation and post-canine crushing relative to other foods. Oral processing activities are sex and food specific; moreover, reliance on obdurate foods in these papionins requires extensive incisal and pre-molar preparation prior to mastication. Dietary hardness weakly predicts masticatory counts per ingestive event. Supported by National Science Foundation grants BCS-06017683, 0921770, and 0922429.

Spontaneous ingestion of alcohol by non-human primates: Seven hypotheses and some preliminary findings.

WILLIAM C MCGREW¹. ¹Leverhulme Centre for Human Evolutionary Studies, Department of Biological Anthropology, University of Cambridge.

Why should any organism habitually ingest a toxic substance? If ethanol negatively affects fitness, then it should be avoided, yet anecdotes abound as to its ingestion, such as drunken elephants, tipsy baboons, etc. Both vertebrates and invertebrates in nature ingest ethanol, from fruitflies to large-brained mammals, so do the benefits outweigh the costs? At least seven, non-exclusive hypotheses might explain ethanol ingestion: (1) accident, e.g. by-product of frugivory; (2) pathology, e.g. anomaly from genetic or epigenetic modification; (3) nutrition, e.g. energy-seeking; (4) medicine, e.g. health-enhancing; (5) gustation, e.g. taste-rewarding; (6) hedonism, e.g. psychologically disinhibiting and so enhancing pleasure or relieving pain; (7) cognition, e.g. affects mental processing and so increases risk-taking or alters states of consciousness. Published behavioral and physiological data on alcohol consumption by wild vertebrates, e.g. pre-migratory cedar waxwings, are available, but until recently all such data on nonhuman primates were natural history notes (e.g. Marais, 1969). Many studies of experimental induction of alcohol addiction in apes and monkeys exist, but all involve contrived manipulation (e.g. Pieper et al., 1972). Most hypotheses cannot yet be tested with existing data from nature, but some can be excluded. Recent work by Dudley (2002) on capuchin monkeys (*Cebus capucinus*) points to hypothesis 3, while Wiens et al. (2008) on slow lorises (*Nycticebus coucang*) suggests hypothesis 5. Tests of the hypotheses are proposed, and some preliminary data from Bossou, Guinea, on chimpanzees (*Pan troglodytes*) are reported that may shed light on the evolutionary origins of human ethanol imbibing.

Life and death at Jamestown: Bioarchaeology of an early 17th century colonial cemetery.

ASHLEY H. MCKEOWN¹, JAMIE E. MAY², DOUGLAS W. OWSLEY³, WILLIAM M. KELSO² and BEVERLY A. STRAUBE².

¹Department of Anthropology, University of Montana, ²Jamestown Rediscovery, Historic Jamestown, ³Department of Anthropology,

National Museum of Natural History, Smithsonian Institution.

Recent excavations of an early 17th-century cemetery at Jamestown, Virginia have provided unique insights into the lives and deaths of settlers associated with the first permanent English colony in the New World. Established in 1607, Jamestown started as a frontier outpost and quickly became the capital of the Virginia Colony and remained so until 1699. Nevertheless, life was tenuous at Jamestown with high mortality rates leaving few to survive the 'seasoning period.' While many written accounts of life at Jamestown exist, they have little to say about the working class men who arrived with every supply and the women and children who began arriving as early as 1608. Seventy-eight burials from what was once known as the 'Starving Time Cemetery' were excavated by the Jamestown Rediscovery archaeological project. The cemetery was detected by excavations in the 1950s, and the apparently random grave distribution led archaeologists to believe that this cemetery was associated with the 'Starving Time' winter of 1609-1610, when over 70% of the colonists perished. However, analysis of data such as grave and burial orientation, burial treatments and sequences, demographic parameters, and artifacts provides a better understanding of the settlers interred in this cemetery as well as the status of the colony during the turbulent early years. Integrating these variables across the cemetery demonstrates that instead of being used for one brief period of high community stress, it is more likely that this was the common cemetery for all Jamestonians during the early years of the colony. This research was funded by grants from Patricia Cornwell and National Geographic Society (#7165-01).

Diet, ranging, and activity budget of white-faced capuchins (*Cebus capucinus*) in an anthropogenic habitat.

TRACIE MCKINNEY. Department of Anthropology, The Ohio State University.

Non-human primates have long been sympatric with humans throughout their range. Many primate populations are diminished or locally exterminated by anthropogenic disturbance, while some respond well to habitat modification. To better understand the effects of habitat disturbance, this study examined activity budgets, ranging, and diet in a troop of commensal white-faced capuchins. Data were collected over 24 months at the Refugio de Vida Silvestre Curú, a small wildlife refuge and farm in western Costa Rica. The study troop was in daily contact with tourists, was provisioned, and had access to plantations. A control group living on the same property but several kilometers from any human interference was used for comparison.

The commensal troop was characterized by a highly frugivorous diet, with roughly 70% of feeding time devoted to fruits. The two troops differed in the prevalence of fruit (Kruskal-Wallis $H=27.98$, $p=0.00$) and leaves ($H=10.18$, $p=0.001$) in the diet, but did not differ in the rates of insect ($H=0.63$, $p=0.426$), flower

($H=1.90$, $p=0.168$) or exudate ($H=0.01$, $p=0.933$) consumption. Ranging was also dramatically altered by the commensal troop, which maintained a home range of 66.2 hectares, roughly twice the size of the control group's range. Activity budgets did not differ between the two groups (eat: $H=1.25$, $p=0.263$; social: $H=0.25$, $p=0.62$; travel $H=0.01$, $p=0.932$; rest: $H=1.85$, $p=0.174$). These results suggest that white-faced capuchins survive in modified habitats primarily by exploiting alternative food resources, with little modification of activity patterns. This study was funded by generous support from Earthwatch Institute, Conservation International, and The Ohio State University.

Demographic, lifestyle, and socioeconomic variation in bone mineral density.

MARY S. MEGYESI. Department of Anthropology, Wayne State University.

The purpose of this investigation was to examine factors that may contribute to what is frequently and erroneously presumed to be inherent racial difference in Bone Mineral Density (BMD). Systematic racial differences in BMD are commonly reported in U.S. populations, where African-Americans tend to have 5% to 15% greater BMD than European-Americans. Quite often, interpretations of racial differences in BMD default to biological explanations, without carefully measuring other social or environmental covariates. The concept of race, as understood in anthropology, is inconsistent with presumptions of biological differences.

This analysis explores intra-group variation of BMD in a sample of 438 African-American participants from Detroit, Michigan. Systematic differences in BMD may be effectively captured by demographic (age, sex, and body size), lifestyle (diet, physical activity, and smoking), and socioeconomic status (income, education, occupation and other social features). The findings of this analysis indicate that racial differences in BMD are not likely to be inherent or innate, but are instead an artifact of systematic variation in individual and non-biological traits. The results revealed that bone density is sensitive to economic strain, but that the relationship is discordant; meaning that measures of economic strain are associated with both increases and decreases in BMD. In addition, this analysis determined that body size was one of the most important factors to BMD differences. This analysis serves as a model for future studies examining the intersection of racial classifications and human skeletal variation and health.

The hallux metatarsal sesamoid complex in the evolution of hominin gait.

JEFF MELDRUM¹, ESTEBAN SARMIENTO² and RALPH CHAPMAN³. ¹Department of Biological Sciences, Idaho State University, ²Human Evolution Foundation, East Brunswick, NJ, ³Eryops Consulting, Los Alamos, NM.

Among the few pedal remains of Pleistocene hominins is a hallux metatarsal (KNM BK 63) attributed to *Homo ergaster* from Baringo

District, Kenya (ca. 500 kya). Primitive aspects of its distal morphology associated with the sesamoid complex, raise questions about the modernity of this hominin's gait, i.e. whether weight was transmitted differentially through the hallux metatarsophalangeal joint in a distinct toe-off. Comparative osseotendinous anatomy was described for the sesamoid complex of a sample of extant hominoids. Geometric morphometric analysis of the hallux metatarsal included ten linear measurements of an expanded sample of chimp, bonobo, lowland and mountain gorilla, and representative human populations. Particular emphasis was placed on correlations with distal metatarsal head shape. Individual outline files were generated using equally-spaced pseudolandmarks extracted between a set of true landmarks along the outline of the metatarsal head. Procrustes analysis was conducted using both the Least Squares and Resistance Fit algorithms to generate average outlines and perform selected pair-wise comparisons. These data addressed the mosaic of primitive and derived features functionally correlated with either a flat flexible foot, or an arched foot associated with a push-off through the ball and first toe. This analysis has implications for the prevailing notions regarding the temporal pattern of the evolution of the modern human striding gait, and indicates that it was a much more recent locomotor innovation than previously recognized.

Microevolutionary analysis of Y-chromosome variation in five Native American populations from Lower Central America.

PHILLIP E. MELTON¹, NORBERTO BALDISALAS^{2,3}, RAMIRO BARRANTES⁴ and MICHAEL H. CRAWFORD². ¹Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio, TX; ²Department of Anthropology, University of Kansas, Lawrence, KS; ³Escuela de Antropología, Universidad de Costa Rica, San José, Costa Rica; ⁴Escuela de Biología, Universidad de Costa Rica, San José, Costa Rica.

This study investigated Y-chromosomal genetic variation in 88 male participants from five lower Central American populations inhabiting Nicaragua (Rama) and Costa Rica (Chorotega, Maleku, Zapotón Huéstar, and Guaymí-Abrojo) in order to determine male population dynamics that have occurred since European contact. We investigated eight short tandem repeats (STRs) (DYS19, DYS389I, DYS389II, DYS390, DYS391, DYS392, DYS393, and DYS439) and Y haplogroup characteristic single nucleotide polymorphisms (SNPs). All five populations contained the Native American specific haplogroup, Q3, ranging in frequencies from 0.85 (Zapatón Huéstar) to 0.35 (Chorotega). These populations were also characterized by the presence of Y haplogroup R1b representing European admixture. A total of 70 haplotypes were identified, of which 69 (97%) were population specific and 55 (80%) were found in only a single individual. Phylogenetic analysis using a multiple dimensional scaling plot demonstrated genetic similarities between Otomanguaen, Nahua Mesoamericans and Votic-

speaking Chibchan groups that are not demonstrated by data from mitochondrial DNA. These populations demonstrate a high degree of paternal genetic differentiation indicating the importance of genetic structure in the region even in geographic proximate and linguistically related indigenous groups. We propose that this high amount of paternal genetic differentiation is due to two demographic events. The first of these events is the rise of the Toltec empire in central Mexico around 1200 years before present and the second is the arrival of Europeans in the region at the beginning of the sixteenth century. This study was funded by a General Research Fund grant and a Carroll Clark Research grant from the University of Kansas.

Craniofacial developmental instability and masticatory behavior.

RACHEL A. MENEGAZ¹, SAMANTHA V. SUBLETT², SAID D. FIGUEROA², TIMOTHY J. HOFFMAN^{2,3} and MATTHEW J. RAVOSA¹.

¹Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine, ²VA Biomolecular Imaging Center, Harry S. Truman Memorial Veterans Hospital, ³Department of Internal Medicine, University of Missouri School of Medicine.

Environmental stress, originating from the encounter of a new or changing habitat, may alter the course of ontogeny, manifesting in the phenotype as developmental instability. Two potential measures of instability, morphological integration (MI) and fluctuating asymmetry (FA), vary ontogenetically and may indicate exposure to stressful conditions during an animal's lifetime. These parameters may provide insight into altered behaviors, such as food choice, affected by environmental conditions. To evaluate the effect of dietary properties and correlated masticatory stress on facial integration and asymmetry, sibling groups of weanling white rabbits (*Oryctolagus cuniculus*) were divided into two dietary treatment groups for 3.5 months until subadult. The 'over-use' cohort ($n=10$) was raised on a fracture-resistant diet of intact rabbit pellets and hay blocks. The 'under-use' cohort ($n=10$) was raised on a soft diet of powdered pellets. Bootstrap analyses (1000 nonparametric resamples; $p \leq 0.05$) of 378 linear distance pairs revealed significant differences in MI of the facial skeleton between cohorts with appreciable differences in the directions of many linear distance pair correlations. Accounting for directional asymmetry, 'over-use' rabbits also exhibit significantly greater FA ($p \leq 0.05$) between 48 bilateral landmark distances versus 'under-use' rabbits. Therefore, long-term variation in masticatory behavior linked to differences in dietary physical properties may result in differential growth of the facial skeleton within individuals. Measures of developmental instability such as MI and FA thus warrant further consideration as indicators of resource utilization during an organism's lifespan, and may potentially yield insights into ecomorphological questions regarding dietary composition and breadth in living and fossil primates.

Histological estimation of age at death in lower-limb amputees.

AMY MICHAEL, WENDY LACKEY and NORMAN SAUER. Department of Anthropology, Michigan State University.

Anthropologists may use microscopic aging techniques in cases when macroscopic bone features are compromised or absent. Due to the lack of precision of estimations of gross morphological bone after the fifth decade of life, microscopic analyses are often performed in order to create a biological profile and provide a refined estimation of age at death. This research focused on the histological analysis of femoral midshafts of seven unilateral amputees in addition to an age and sex-matched comparative sample of non-amputees. Because histological age at death formulae were initially developed on the skeletal remains of individuals with intact non-pathological limbs, there are no forensic or bioarchaeological correlates for estimating age at death in amputees. The results of this study will highlight the difficulties associated with accurate histological age at death estimations of individuals with extenuating physical conditions like amputations.

Using the Kerley (1965) method of analysis, each individual was bilaterally sampled and three thin sections were created from each sample. It was hypothesized that disuse osteoporosis and osteophytic activity at the removal site may affect the remodeling process and distort accurate age at death estimations. The amputees in this study had estimated histological ages higher than each individual's chronological age. Furthermore, the amputees were aged considerably older than the individuals from the age and sex-matched comparative sample. Ultimately, this poster will address limitations in examining microstructural changes at the femoral midshaft subsequent to medical amputation of a weight-bearing limb.

The effect of spatial variation in the arboreal environment on gibbon brachiation mechanics.

FANA MICHILSENS^{1,2}, KRISTIAAN D'AOÛT^{1,2} and PETER AERTS^{1,3}. ¹Department of biology, University of Antwerp, Belgium; ²Centre for Research and Conservation, Antwerp, Belgium; ³Department of movement and sport sciences, University of Ghent, Belgium.

Little is known about how animals react biomechanically to an unpredictable, complex substrate, like the rainforest. However this is exactly the sort of environment where primates, such as gibbons, live in and constantly have to move around in. Gibbons use a pendular mechanism, brachiation, which is thought to be very energy efficient. However, it has never been tested how robust brachiation efficiency is with respect to support variation. We do a kinematic and kinetic comparison (in captivity) of three siamangs using three setups: two with handholds placed at the same height either parallel or perpendicular to the direction of movement (setups 1 and 2 respectively) and one

with the handholds placed at different heights and perpendicular (setup 3). We found that the average recovery (a measure for pendular energy exchange) in setup 3 (58%) is significantly lower than in setup 2 (68%). However, setup 1 (53%) also differs significantly from setup 2, and not from setup 3. Another result is that continuous contact brachiation has always a higher recovery than ricochet, regardless of the setup. This indicates that continuous contact brachiation on handholds placed perpendicular and at equal heights is more beneficial for a higher energy recovery. Nevertheless, these percentages are still rather low and it has been suggested earlier that the avoidance of energy-dissipating inelastic collisions might be the key behavioral feature of brachiation. We will estimate these collisional losses during brachiation on different setups and will use additional setups to investigate the effect of an increasing complexity of the environment. This study was funded by the National Fund for Scientific Research (Belgium)

Paleoenvironmental reconstruction of the Old World monkey locality; Wadi Moghra, early Miocene, Egypt.

ELLEN MILLER¹, MARK CLEMENTZ², AHMED EL-BARKOOKY³, MOHAMED HAMDAN³, MOHAMED ADBEL GAWAD³ and SAFIA MOHAMED ALI HASSAN³. ¹Department of Anthropology, Wake Forest University, ²Department of Geology and Geophysics, University of Wyoming, ³Geology Department, Cairo University.

Wadi Moghra, Egypt, is a fossil locality preserving an array of extinct mammals (ca. 27 species), including remains of *Prohylobates tandyi* (Victoriapithecidae; Cercopithecoidea), the most morphologically primitive Old World monkey known. Information about the paleoenvironment(s) occupied by *P. tandyi* -- and other victoriapithecids -- is virtually nonexistent, mostly owing to the fragmentary nature of collections, but also because species in Victoriapithecidae span wide geographic (ca. 4500 km) and temporal ranges (ca. 20-12.5 Ma). The one exception to this is work on the cercopithecid *Victoriapithecus macinnesi* (ca. 15 Ma, Kenya), which indicates that the species was a terrestrial forager, likely utilizing widely dispersed resources in riparian woodland, and seasonally wet, wooded grassland. However, whether the adaptations of *V. macinnesi* are broadly representative of victoriapithecids as a whole, including earlier and more primitive victoriapithecids such as *P. tandyi*, remains unknown.

Stable isotope compositions of tooth enamel from fossil species can serve as proxies for diet (carbon isotopes: $\delta^{13}\text{C}$) and habitat preferences (oxygen isotopes: $\delta^{18}\text{O}$), which in turn can be used for paleoenvironmental reconstruction. Here, we have sampled a diverse assemblage of proboscideans and large ungulates, including multiple species of anthracothere, other artiodactyls (e.g. suids, giraffoids), and perissodactyls to reconstruct the early Miocene environment of Wadi Moghra. Preliminary isotope results appear to indicate a relatively

humid, tropical environment of woodlands and coastal forests. These findings are compared with previous isotope results from older, northern Egypt localities (Fayum, early Oligocene), to interpret how changing environmental conditions may have favored victoriapithecid diversification. Funding provided by the National Science Foundation (0808283), Leakey Foundation, and Wake Forest University.

Preliminary evidence for maize consumption on the Taraco Peninsula, Bolivia, 1500 B.C. – A.D. 1000: Human tooth enamel stable carbon isotope data.

MELANIE J. MILLER and CHRISTINE A. HASTORF. Department of Anthropology, University of California, Berkeley.

Archaeological human tooth enamel samples (n=30) were analyzed for stable carbon isotopes of individuals excavated from sites on the Taraco Peninsula, Bolivia, in order to investigate prehistoric human diets. Additionally, samples of known food sources (modern and archaeological) such as plants (potatoes, maize, quinoa), fish, and camelids were analyzed for stable carbon isotope composition to establish the range of potential carbon sources in human diets. Human enamel samples were selected from individuals across different time periods (Early Formative 1500B.C. to Post-Formative/Tiwanaku A.D.1000) and came from variable contexts. Resulting data indicates a dietary shift through time from a diet with more C3-based components (potatoes, legumes, chenopodium, camelids) to early evidence of foods with very enriched carbon isotope compositions (C4-type foods such as maize, or freshwater fish) during later time periods. Human enamel carbon isotope values ($\delta^{13}\text{C}$) range from -13.48 to -9.05 per mil, with the most enriched values associated with individuals from the Late Formative Period. Archaeological evidence of relatively consistent fish consumption through time suggests that the associated change in human carbon isotope values is more likely related to the introduction of maize to highland Bolivia. The human enamel carbon isotopes become more enriched during the same time period that maize appears in the archaeological record for the first time in this area. This study was funded by the National Science Foundation, grant # BCS Archaeology 0234011.

Putting pieces together again: Statistical formula for os coxae and femora.

MICKI MILLER. Department of Anthropology, Western Michigan University.

Ancient and modern mass graves with commingled human remains are in need of investigation all over the world. Important collections include those of the Holocaust, Iraqi Kurds, the Battle of Wisby, and The Battleship Mary Rose, just to name a few. One major hindrance to this investigation is the sometimes difficult task of putting individuals back together again due to postmortem processes

such as water, grave site disturbances or the setting of dirt separating different elements. Many bones can be matched by color or general fit as belonging to a given individual, but when these methods do not work due to investigator bias or inexperience, more than one element is a possible fit or there are no matching colors, a statistical formula may be helpful. This study explores the possibility of deriving a formula to statistically match femora with the respective os coxae. Approximately one hundred individuals from four different groups from the Hamann-Todd collection housed at the Cleveland Museum of Natural History were examined. Three different measurements each were taken from the left and right acetabula and femora heads for a total of twelve measurements from four groups: black male, white male, black female and white female. The values were statistically assessed using regression formulae.

Preliminary results suggest there is a statistical formula that can assist investigators in reconstructing commingled femora and hip elements of human skeletons from mass graves.

The impact of dental impairment on food processing in ring-tailed lemurs.

JAMES B. MILLETTE¹, MICHELLE L. SAUTHER¹ and FRANK P. CUOZZO².

¹Department of Anthropology, University of Colorado at Boulder, ²Department of Anthropology, University of North Dakota.

Extensive tooth wear and/or tooth loss is presumed to impair the mastication of food items, resulting in the ingestion of larger-sized food particles. Larger particles exhibit reduced surface area to volume ratios than smaller particles, and may limit an individual's ability to efficiently digest foods. Our data indicate relationships between tooth wear, tooth loss and fecal food particle size in wild *Lemur catta* from a population with high frequencies of tooth wear and loss living at the Beza Mahafaly Special Reserve, Madagascar. We collected 57 fecal samples during the 2006-2008 field-seasons from 45 individuals with known degrees of tooth wear and loss. Each sample was filtered through three sieves of decreasing size (11.2mm, 4.75mm and 1.0mm). Food particles were then weighed and assessed in relation to dental impairment for each individual, determined during yearly health examinations. As tooth wear increases, the percentage of each sample collected by the 1.0mm sieve decreases significantly, while that from the 11.2mm sieve increases. In individuals without tooth loss, a greater proportion of fecal material is between 4.75mm and 1.0mm in size while a lower proportion is >11.2mm. No such pattern is present for individuals with tooth wear but without tooth loss, suggesting tooth absence is a primary source of variation in excreted particle size. We suggest that dentally-impaired individuals may attempt to compensate for reduced nutritional intake through behavioral mechanisms including: 1) non-dental oral food processing, 2) use of the hands during food processing, and 3) alterations to the activity budget. This study was funded by: University of North Dakota, ND EPSCoR, University of Colorado, the St. Louis Zoo (FRC 06-01),

Primate Conservation Inc., the International Society of Primatologists, the American Society of Primatologists, The National Geographic Society

Paleopathology and public health in "America's healthiest city": A comparative study of health from the Milwaukee County Indigent Grounds Cemetery.

COLLEEN MILLIGAN. Department of Anthropology, Michigan State University.

Nineteenth century America saw major disruptions in their cities due to the impact of virulent epidemics. Rapid population growth and overcrowding overwhelmed cities. As a result, the impact of disease of urban populations reached epidemic proportions. The emphasis placed on the public health movement was a direct result of the attempt to mitigate the impact of disease in America's cities. This study examines the health of the most vulnerable members of an urban center once given the distinction of 'America's Healthiest City'. A sample of 531 adults and 392 subadults from the MCIG cemetery #2 (1882-1925) was used to examine several skeletal indicators of health, including both infectious and degenerative processes. The results indicate that the number of adult individuals exhibiting signs of pathology, either as a result of a disease process or degenerative process, is high at 95% of the sample. A total of 47 individuals or 8.9% of the sample show evidence for either a nonspecific or specific response to infection. Of these, 5 individuals exhibited evidence of Tuberculosis. Unlike the adult sample, the 393 subadults exhibited low levels of observable pathologies, with less than 5% of the sample exhibiting a nonspecific response to infection or stress. The results are correlated with Milwaukee's efforts to reduce the impact of disease on its growing city. The emphasis of the study is on the comparisons that can be made with other similar samples in the United States, and its contribution to ongoing discussions about the evolution of human health.

New *Pseudoloris* (Microchoerinae, Omomyidae, Primates) from the Robiacian of Northeastern Spain.

RAEF MINWER-BARAKAT¹, JUDIT MARIGÓ¹ and SALVADOR MOYÀ-SOLÀ².

¹Institut Català de Paleontologia (ICP), Universitat Autònoma de Barcelona, ²CREA at the Institut Català de Paleontologia (ICP), Universitat Autònoma de Barcelona.

In this work we present a new species of *Pseudoloris* (Omomyidae, Primates) from the Robiacian (middle Eocene) locality of Sant Jaume de Frontanyà (Eastern Pyrenees, Spain). Three different Primates have been identified from this locality: a new species of *Anchomomys*, which is the most abundant one; *Adapis* sp.; and a new form of *Pseudoloris*. The material assigned to *Pseudoloris* constitutes the most abundant sample of the genus found until now in the Iberian Peninsula. Almost all the dental elements have been recovered, including those teeth hardly known for other species of the

genus, such as lower and upper incisors.

This new species is characterized by its medium size, its thickened paracristid, the absence of a distinct paraconid, and the presence of a well-developed labial cingulid in the lower molars. Moreover, it presents a large hypoconulid in the M3/3, paracone and hypocone reduced in the M1/1 and M2/2 and absent in the M3/3.

The genus *Pseudoloris* are known from several European localities ranging in age between the middle Eocene (MP11) and the early Oligocene (MP22) and its remains are generally very scarce.

The new material from Sant Jaume de Frontanyà shows halfway features between *Pseudoloris isabenae* from Capella and *Pseudoloris parvulus*, present in different Spanish and French sites; therefore, we consider that the new *Pseudoloris* species is an intermediate form between the other two. This study was funded by the project "Grandes simios fósiles (Hominoidea) del Mioceno del área mediterránea: origen, paleobiología y evolución" of the Ministerio de Educación y Ciencia (Spain), grant number CGL2008-00325/BTE.

Coalescent simulation models of modern human migrations out of Africa give insight into complex demographic scenarios.

AIDA MIRÓ-HERRANS¹ and CONNIE J. MULLIGAN². ¹Genetics and Genomics Graduate Program, University of Florida, ²Department of Anthropology, University of Florida.

Genetic data have been used to reconstruct the historic and demographic processes of populations. Summary statistics of genetic data are often calculated to make inferences about such processes. While summary statistics work reasonably well with simple and idealized scenarios, it is less clear if summary statistics can accurately capture demographic processes as the evolutionary scenarios become more complex. Here, we use coalescent simulations to model the migration of modern humans out of Africa. Eight scenarios were developed using variations of the following parameters: time of migration, proportion of effective individuals migrating, and subsequent rate of gene flow. We compared the ability of common summary statistics such as number of haplotypes, number of private alleles, number of segregating sites, pairwise differences, haplotype diversity, nucleotide diversity, and Tajima's D, to distinguish between different demographic processes (as represented by the variable parameters). The number of private alleles was the only summary statistic that differed significantly for almost all values of time of migration, except when there was a high proportion of individuals migrating and high subsequent gene flow. It was also significantly different for all values of gene flow. Segregating sites, pairwise differences, haplotype diversity, nucleotide diversity, and Tajima's D differed significantly for all values of proportion of migrants. These results suggest that different summary statistics may be required to investigate specific parameters of a complex demographic process.

Significant among-population associations found between dental characters and environmental factors.

YUJI MIZOGUCHI. Department of Anthropology, National Museum of Nature and Science, Tokyo.

To determine the genetic and evolutionary causes that generated and fixed specific dental characters in modern human populations, we need both morphological and paleoenvironmental data. At present, we do not have sufficient data on paleoenvironmental factors. Therefore, using data on environments inhabited by modern humans, I have searched indirectly for causes for the appearance of some dental characters. Further, I examined the possibility that some biochemical/physiological characters are associated with the presence of particular dental characteristics in certain natural or cultural environments.

All the data used in this analysis were collected from the literature, with a focus on five metric and two nonmetric dental characters, 37 biochemical/physiological characters, and ten environmental variables. Samples from various regions in the world were combined to form 21 pooled samples. Principal component analyses of the inter-group correlations between dental and the other variables show, for example, that Carabelli's trait is significantly associated with allele Jk*a of the Kidd system ($P<0.05$) and simultaneously with hunting-gathering and milking ($P<0.10$). Although the role of allele Jk*a in forming a Carabelli's cusp remains to be specified, the strong association between these two characters is possibly due to adaptation to shared unknown environmental factors relating to hunting-gathering and/or milking rather than to genetic drift.

Numerical asymmetries influence range use in two neighboring chimpanzees communities in Gombe National Park, Tanzania.

DEUS C. MJUNGU¹, MICHAEL L. WILSON^{1,2}, LILIAN PINTEA³ and ANNE E. PUSEY¹. ¹Department of Ecology, Evolution and Behavior, University of Minnesota, ²Department of Anthropology, University of Minnesota, ³the Jane Goodall Institute, Arlington, VA.

Game theoretical models predict that in fights between groups, larger groups should tend to win against smaller groups. In species that defend group territories, larger groups might therefore be expected to gain larger and/or higher quality territories. In practice, however, additional factors may complicate the relationship between group size and territory size, including habitat quality and the competitive ability of neighboring groups. To test whether differences in numerical strength influenced the size, location, and quality of home ranges in chimpanzees (*Pan troglodytes*), we analyzed 14 years of ranging and demographic data collected from two neighboring communities in Gombe National Park, Tanzania. We focused on the smaller Mitumba community, whose territory occupies the land between the larger Kasekela

community and the park boundary, and thus presents an opportunity to understand intergroup competition in a simplified system. Range use patterns depended on the number of males but not females in the two communities. The relative number of males did not predict the overall size of the Mitumba community's range, but instead predicted the percentage of time spent by both communities in the contested area between the two. As the Mitumba community grew numerically weaker, its center of activity moved further north. A corresponding decrease in the percentage of forest cover indicated that the Mitumba community was forced into lower quality range as its relative numerical strength declined. This study thus demonstrates that numerical asymmetries can severely constrain access to resources. This work was supported by the National Science Foundation grant BSC-0648481, the University of Minnesota, and the Jane Goodall Institute.

A bioarchaeological assessment of health and trauma in post-imperial Peru.

ANGELY MONDESTIN¹ and DANIELLE SHAWN KURIN². ¹Department of Anthropology, Haverford College, ²Department of Anthropology, Vanderbilt University.

Intentional, traumatic violence may result in the subsequent compromised health of individuals. This paper reports on the bioarchaeological evidence for violence and general health among different skeletal populations in highland prehistoric Peru. Human skeletal remains affiliated with the "bellicose" Chanka society (AD 1000-1400) were examined to see if patterns of antemortem traumatic injury due to violent conflict are associated with Porotic Hyperostosis (PH) and Cribra Orbitalia (CO). Cranial remains (n = 35) from four Chanka sites currently housed in the Municipal Museum in Andahuaylas, Peru were examined.

This study systematically characterizes PH and CO—a known indicator of compromised health with diverse etiologies, and tests associations between the presence or absence of PH and CO, and patterns of healed traumatic injury. 60% (n = 21) of skulls show healed cranial fractures, indicating non-lethal trauma. Among the total sample, 74% (n = 26) demonstrate evidence of PH, and 91% (n = 32) show signs of CO. This study also examines the distribution and lethality of cranial trauma along age, gender lines and ethnic lines, which demonstrate significant correlations. Initial results suggest that sub-population segments in Chanka society which received intentional, non-lethal cranial trauma, present significantly higher frequencies of PH and CO than their un-injured neighbors. Research was supported by the F De Laguna Fund and Summer Internship Fund, Bryn Mawr C; and a Humanities Research Grant, Haverford C.

The social and cultural implications of violence at Qasr Hallabat.

ROBERT MONTGOMERY¹ and MEGAN A. PERRY². ¹Department of Anthropology, University of Arkansas, ²Department of Anthropology, East Carolina University.

The 8th-10th centuries A.D. in Jordan remains relatively undocumented archaeologically and historically. A fascinating glimpse of this period emerged with the discovery of six individuals within one of the cisterns in Qasr Hallabat, an Umayyad period (636-750 A.D.) castle located in Jordan's eastern desert. ¹⁴C dating of skeletal samples (n=2) indicates that these individuals perished between 772 and 895 CAL A.D., after the qasr when out of official use with the end of Umayyad rule. The picture generated by these six individuals is of a generally healthy population involved in repeated episodes of interpersonal violence. Five of the six individuals have perimortem cranial blunt force trauma (BFT), and four out of those five skulls also display healed antemortem BFT. Furthermore, three of the six postcranial skeletons exhibit perimortem sharp force trauma.

The violence and unique interment experienced by this small sample of individuals illuminates the political and cultural circumstances experienced by other 8-10th century individuals in the area, regardless of their direct exposure to conflict. For instance, the desecration of a major water source in a desert region indicates that non-locals were responsible for the homicide. Furthermore, assessment of military equipment and comparing trauma in skeletons from Islamic-period battle sites signifies that violence at Hallabat was likely not committed by an organized military. Evidence for similar antemortem injuries implies that these skirmishes, with the same or multiple groups, occurred relatively regularly. Therefore, violence in this sample provides a glimpse of a population invisible on the archaeological and historical landscape.

Dental fluctuating asymmetry as a measure of developmental stability in the Shiloh Methodist community.

MICHAEL W. MORAMARCO. School of Human Evolution and Social Change, Arizona State University.

Investigating dental fluctuating asymmetry (FA) is an important technique used to quantify degrees of nutritional and environmental stress of past population samples. An African American skeletal sample from the mid-nineteenth century (n = 12) was used to investigate the amount of environmental stress experienced by the sample using dental FA. Given the temporal proximity to emancipation and a contemporaneous skeletal sample from Cedar Grove (Rose and Hartnady, 1988), it was predicted that the Shiloh Methodists would express significant deviations from zero (0) in FA measurements. Bucco-lingual measurements were taken for the entire sample and were subjected to Student *t*-tests and a mixed-model ANOVA. Comparative data from the Gullah (Guatelli-Steinberg et al., 2006) and a group of enslaved Africans from Barbados (Corruccini, 1982) was also used. The results were consistent with historical evidence suggesting that environmental stress would have been high in the Shiloh community. Documented infectious disease in the sample, specifically congenital

syphilis, and nutritional stresses such as iron and calcium deficiencies would have been likely causes of FA. This study funded in part by the Undergraduate Research Mentorship Fellowship from the University of Missouri.

The curation of the Clyde C. Snow Forensic Anthropology Collection.

CHRISTOPHER L MORGAN. Department of Anthropology, University of Oklahoma.

Research collections consisting of human skeletal remains are an invaluable asset for the advancement of knowledge relating to the human condition. Forensic collections, such as the one outlined below, are important repositories of data that can be a window into perspectives of society concerning gender and socio-economic issues. The unclaimed or unidentified human remains of forensic anthropology cases accumulated by Dr. Clyde C. Snow from 1965 to 1993 have been donated to the University of Oklahoma. Numbering 145 cases, recovered from eleven different states, the individuals within this series are a cross-section of the American populace representing all age ranges, ethnicities, and sexes. Males represent 36% of the cases, while females represent 18%, the remainder being indeterminate. Approximately 10 % of the individuals are sub-adults. Dental health indicates most of the individuals were of low socio-economic status. The representation of various pathological conditions and trauma associated with homicide victims present will be beneficial for future research in both skeletal biology and forensic anthropology. The inclusion of unidentified homicide victims entails following a protocol that ensures that the chain of evidence is maintained in the process of properly curating and documenting a forensic collection of this nature. This aspect also underscores the importance of the preservation and continued investigations into collections such as this, where current organizations such as NamUs, and advancing technologies, such as DNA analysis can be utilized in future identifications.

Stable carbon and nitrogen isotope analysis of human hair reveals substantial intraindividual seasonal variation in the diet of early southwestern US maize-based agriculturalists.

MICHELE E. MORGAN¹, STEVEN A. LEBLANC¹ and JASON H. CURTIS².
¹Peabody Museum of Archaeology and Ethnology, Harvard University. ²Department of Geological Sciences, University of Florida.

By 2300 years B.P., corn was a significant dietary component of Basketmaker II populations living in the southwestern United States. This general consensus is based on archaeological analyses, and is supported by isotopic analyses of human remains. To date, dietary reconstructions have reflected an overall average assessment of human diet. Our approach of serially sampling along individual strands of human hair from several Basketmaker II cave sites reveals considerable intraindividual variation in both eastern and western

Basketmaker II diet over the annual procurement cycle. We report hair keratin stable carbon and nitrogen isotope data for 30 individuals from three Basketmaker II sites: White Dog Cave (n=10) and Kinboko Canyon Cave 1 (n=10) near Marsh Pass, Arizona, and North Cave (n=10) near Falls Creek, Colorado. A total of 46 hairs were analyzed. Median hair length was 8 cm (range 2 to 30 cm). Hairs were cleaned, defatted and isotopically analyzed following standard procedures. Average stable carbon isotope values for the three sites are very similar ranging between -9.9 and -11.1‰, and indicate substantial dependence on C₄ plants, namely maize. Stable carbon isotope profiles from individual hairs typically yield roughly sinusoidal-shaped curves with amplitudes of 0.5 to 3.2‰. Average stable nitrogen isotope values for the three sites are more variable (range 4.9 to 7.1‰); White Dog Cave individuals have the lowest stable nitrogen isotope values. Intra-hair isotopic analyses permit fine-scale study of seasonal variation in Basketmaker II subsistence behaviors. This newly emerging technique can be usefully applied to other populations.

Ontogenetic patterns of long bone shape of humans and great apes.

NAOKI MORIMOTO, MARCIA S. PONCE DE LEÓN and CHRISTOPH P. E. ZOLLIKOFER. Anthropological Institute and Museum, University of Zurich, Switzerland.

Our understanding of the evolution of human bipedal walking requires detailed quantitative comparisons of the long bone morphology of fossil and extant humans and great apes. However, detailed quantitative knowledge about extant long bone morphology is scarce compared to the wealth of experimental data and model simulations about different locomotor modes. In this study, we present an integrated method to quantify, visualize and analyze patterns of morphological variation in long bone diaphyses. Three-dimensional data of entire long bones of *Homo sapiens*, *Pan troglodytes*, *Pan paniscus*, *Gorilla gorilla* and *Pongo pygmaeus* are acquired using medical and micro computed tomography (CT and uCT). Cross-sectional features such as cortical bone thickness, surface curvature, radius, second moments of area and diaphyseal torsion are measured along the entire length of the long bone shaft, using methods of elliptical Fourier analysis and concepts of morphometric mapping. Morphometric maps are then further analyzed with a combination of multi-dimensional Fourier analysis and multivariate analysis of shape to identify patterns of diaphyseal shape variation along species-specific ontogenetic trajectories, as well as across species, independent of ontogeny. Our data show considerable intraspecific variability in patterns of cortical bone distribution and biomechanical properties, both along and across ontogenetic trajectories. Furthermore, comparative analysis of ontogenetic trajectories shows that species-specific morphologies are already established at birth, and that postnatal ontogenies follow largely similar trajectories.

Together, these data indicate that long bone shape is determined to a larger extent by species-specific developmental programs than by environmental influences.

The visual ecology of *Tarsius*.

G.L. MORITZ¹ and N.J. DOMINY^{1,2}.

¹Department of Ecology and Evolutionary Biology, University of California, Santa Cruz,

²Department of Anthropology, University of California, Santa Cruz.

Whereas the evolution of trichromatic vision among diurnal primates has been linked to the foraging advantages of detecting ripe fruit or young red leaves against a background of mature foliage, the adaptive significance of color vision among nocturnal primates is relatively unstudied. Many nocturnal mammals including some primates possess monochromatic vision, which results from the functional loss of the short (S) wavelength sensitive opsin gene, yet others have maintained functional S- and M/L-opsin genes and thus the capacity for dichromatic color vision. For instance, tarsiers (genus *Tarsius*) are small-bodied, nocturnal, faunivorous primates found in Sumatra, Borneo, Sulawesi, and the Philippines. They have dichromatic color vision, but the spectral sensitivities of the M/L-opsin pigments can vary between species by as much as 15 nm. Such variation could be the result of genetic drift or natural selection. To test the relative adaptive advantages of the two dichromatic phenotypes, we measured the reflectance spectra of typical prey items in the tarsier diet (mostly orthopteran insects). Next, we used irradiance spectra under twilight, full moon, and new moon conditions to calculate the radiance spectrum of each insect and to estimate the relative quantum catches for *Tarsius bancanus* and *T. syrichta*. Lastly, we determined the chromatic and achromatic contrast of each insect against a background of mature leaves or leaf litter under varying scotopic light environments. The findings from this model are expected to inform hypotheses on the functional adaptive significance of divergent dichromatic vision phenotypes among tarsiers. This study was funded by Sigma Xi and the David and Lucile Packard Foundation.

Health and nutrition: A paleopathological and paleochemical study of the historical Euro-Quebecois population from the protestant St-Matthew cemetery (Quebec City, Canada, 1771-1860).

FANNY MORLAND and ISABELLE RIBOT. Department of Anthropology, University of Montreal.

Combined paleopathological and paleochemical studies offer increasingly a new way to explore paleonutritional research issues, such as the relationships between health and nutrition. In the same perspective, this research presents results obtained for the first time on a historical Euro-Quebecois population from the protestant upper and middle classes in Quebec City (St-Matthew cemetery, 1771-1860, N=95). Firstly, standard paleopathological criteria allowed us to

quantify the health status through various aspects (infections, growth, nutritional deficiencies, dental health and physical stress). Secondly, carbon and nitrogen stable isotopes from bone collagen were analyzed to evaluate nutritional practices. Certain results showed considerable variation in relation to demographical data (age, sex, mortality) within the St-Matthew population. Some pathologies (*cribra orbitalia*, endocranial lesions) often occurred in children younger than 5 years old, explaining therefore their higher mortality rate. High frequencies of both dental caries and *cribra orbitalia* also suggested a slightly lower health status in women than in men. According to the isotopic data, the weaning process was identified between 1.5 and 2 years of age, and some homogeneity in food consumption practices was noted in both sexes for adults. By comparing paleopathological with isotopic data, it was observed that the individuals with the highest degrees of certain deficiencies (*cribra orbitalia*) also presented the lowest isotopic ratios. To interpret these possible combined effects between health and nutrition in both children and adults, a hypothesis is proposed as the differential access to food within this 19th century English-speaking society of Quebec City. This study was funded by Social Sciences and Humanities Research Council of Canada, grant number 766-2008-4015.

Sexual dimorphism in growth of human manual digital proportions.

DEANNA M. MORRIS, STEPHEN R. FROST, ROBERT PASTOR, J. JOSH SNODGRASS, LARRY SUGIYAMA and FRANCES J. WHITE. Department of Anthropology, University of Oregon.

Sexual dimorphism in manual digital proportions, specifically between the 2nd and 4th digit (2D:4D), is linked to many factors, including health, attractiveness, and reproductive parameters. The 2D:4D ratio, if shaped by exposure to sex hormones in utero as believed, should be observable at an early age. Alternatively, sexual dimorphism in 2D:4D may be a consequence of normal patterns of hand growth, and because males have a relatively longer period of growth. In order to evaluate these hypotheses about 2D:4D ratio, we measured lengths of all metacarpals and phalanges from 15 males and 15 females at two ages: 2-3 and 17-18. Data were collected from radiographs housed at the Oregon Health and Science University, School of Dentistry. Measurements were made by tracing hand bones onto acetate paper and then measured with digital calipers. The 2D:4D was calculated by summing all phalangeal lengths for the second digit and dividing it by those for the fourth. Despite overlap, males and females differed in their 2D:4D ratio, with females having higher values in both age classes. The difference, however, was stronger in the adult age class, as the 2D:4D ratio increased in both sexes with age. Principal components analysis of all 19 hand bone lengths reveals other aspects of hand shape besides 2D:4D ratios, including the relative length of metacarpals vs. phalanges differing strongly between males and females.

Our results support that dimorphism in 2D:4D ratio is established by 2-3 years, but age is also a major factor in hand shape variation. This study was supported by a McNair Scholarship (DM).

Is there an association between BMI and hot flashes: The Hilo Women's Health Study.

LYNN MORRISON¹, DANIEL BROWN¹, LYNNETTE SIEVERT², ANGELA REZA² and NICHOLE RAHBERG¹. ¹Department of Anthropology, University of Hawaii at Hilo, ²Department of Anthropology, University of Massachusetts-Amherst.

Controversy surrounds the role of BMI and the etiology of hot flashes (HFs). Extra body fat may serve as insulation, lowering the body's sweating threshold and increasing the frequency of HFs. Conversely, adipose tissue may increase the conversion of androgen to estrone, resulting in a dampening of HFs. This study examined 208 women age 45-55 (pre-, peri-, and post-menopausal) during a 24-hr ambulatory study when objective (sternal skin conductance) and subjective (survey, diary, monitor, and verbal response) hot flashes were recorded. Total number of subjective and objective HFs and whether or not they had an objective or subjective HF (yes/no) were used in the analyses. Height and weight were taken to calculate BMI. Women with increasing BMI were more likely to report ever having a hot flash on a questionnaire when logistic regression analyses controlled for menopausal status (BMI OR=1.10; p=.02; pre-menopausal women OR=0.07; p<.001). Peri-menopausal, but not other, women showed a significant inverse relationship between BMI and number of objective ambulatory HFs ($r = 0.25$; $p=.02$). No significant differences were found between BMI and whether or not a woman reported a HF during ambulatory monitoring. Our measures of ambulatory objective HFs indicate that as perimenopausal women increase in BMI, their number of objective HFs decrease. When all women were included, recalled subjective HFs increased as BMI increased which suggests heavier women in the menopausal transition may have greater difficulty in distinguishing a HF from a regular heat response. Supported by NIH-MBRS S06 GM08073-33.

Are sex-specific effects of dietary phytosterol intake on adiponectin levels an underlying factor explaining variation in TG/HDL ratio associated with APOE polymorphisms: The Kansas Nutrition Study.

MJ MOSHER¹, DARIO DEMARCHI², ROIIINA RUBICZ³, MARK ZLOJUTRO⁴, PHILLIP E MELTON⁴ and MICHAEL H CRAWFORD³. ¹Department of Anthropology, Western Washington University, Bellingham, ²Department of Anthropology, University of Cordoba, Argentina, ³Lab of Biological Anthropology, University of Kansas, ⁴Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio, TX.

Dietary manipulation of plasma lipids remains an integral part of treatment for dyslipidemias

and their sequelae of coronary artery disease (CAD). However, substantial conflicting evidence reported in the literature suggests that undetermined gene- by- sex- variation affects dietary response. We examined blood samples for APOE polymorphisms and determined nutrient profiles from dietary diaries of 75 male and 83 female Central Kansas Mennonites. Previously we reported sex-specific associations of plasma lipids to plasma adiponectin, and APOE. Adiponectin, a hormone affecting lipid metabolism, is sexually dimorphic, lowered by both testosterone and higher percentages of visceral adipose tissue (VAT). Here we examine effects of phytosterol intake and APOE on adiponectin and the triglyceride/high-density lipoprotein (TG/HDL) ratio, an indicator of atherogenic dyslipidemias and a marker for (CAD).

An inverse relationship between plasma adiponectin levels and TG/HDL ratio was significant in males only ($P = 0.005$ for males, $P=0.106$ for females). No significant change was noted after adjustments for age, location, or measures of central fat patterning. No sex-specific variation was found in dietary percent of fatty acids from animal sources. However, phytosterol intake was decidedly higher in females ($P=0.007$), yet had no statistical affects on adiponectin levels in females. Sex-specific tertiles denoting the percent of dietary phytosterol were compared. Males whose phytosterol intake was highest were the only ones to have adiponectin matching their female counterparts ($P=0.041$). Furthermore, 25% of the variation in male TG/HDL ratios can be explained by APOE by adiponectin interaction ($P = 0.015$). Further sex-specific nutrigenetics comparisons are recommended. This study was funded by: the Kansas Attorney General Settlement Fund, KAN 30471

Variation in lingual fungiform papillae taste buds among primates.

MAGDALENA N MUCHLINSKI¹, ANNE M. BURROWS^{2,3}, TIMOTHY D SMITH^{3,4} and LAURA J ALPORT⁵. ¹Department of Anatomy and Pathology, Marshall University School of Medicine, ²School of Physical Therapy, Duquesne University, ³Department of Anthropology, University of Pittsburgh, ⁴School of Physical Therapy, Slippery Rock University, ⁵Department of Anthropology, University of Texas at Austin.

Fungiform papillae (FP) are the only gustatory structures on the anterior two-thirds of the tongue. Gustatory papillae contain taste buds (TBs), where taste receptors are located. In humans, the density of FP and TBs is associated with taste sensitivity and food preferences. Alport (2009) also found significant correlations between FP density, behavior, and diet among non-human primates, but not always with the same patterns as in humans. An underlying assumption of her research was that TB count, and thus sensitivity, correlates positively with the density of FP across species as well as within species. To better understand the relationship between FP density and primate feeding ecology, TBs were counted on formalin fixed tongues of *Otolemur garnetti*, *Otolemur*

crassicaudatus, *Saimiri sciureus*, *Saguinus oedipus*. Anterior tongue samples were paraffin embedded, serially sectioned and stained with hematoxylin-and-eosin. Microscopic examination revealed the average TB count per FP sampled was 3.2. There was no observable variation in TB counts among the FPs of a single individual. However, there were differences in TB count per FP across species. *Saguinus* had the highest TB counts per FP. *Saguinus* is also reported to have more FP as well, which implies this species has increased taste sensitivity. This is surprising because *Saguinus* is the most insectivorous of the animals sampled, and insectivores are hypothesized to have fewer FP and TB. Findings suggest that TB count needs to be considered when evaluating the trends between FP and primate ecology, and requires further exploration. This study was funded by MU-Advance.

Predation on subfossil *Prolemur* by multiple predator species: Evidence from Ankaranana Massif, northern Madagascar.

KATHLEEN M. MULDOON^{1,2}, LAURIE R. GODFREY³ and ELWYN L. SIMONS⁴. ¹Department of Anatomy, Dartmouth Medical School, ²Department of Anthropology, Dartmouth College, ³Department of Anthropology, University of Massachusetts-Amherst, ⁴Division of Fossil Primates, Duke University Lemur Center.

Increasing evidence indicates that predators strongly impact extant lemur populations. Predation not only alters rates of mortality, but may also drive behavioral and life history patterns in prey species. Documenting past predation on lemurs has important implications for understanding the role that predators play in molding lemur biology, and also for understanding the taphonomic accumulation of subfossil deposits.

We present evidence for predation by multiple predator species on *Prolemur simus* from the Ankaranana Massif cave system in the far north of Madagascar. Approximately 3000 mammalian subfossils have been collected from Ankaranana, dating to the late Pleistocene and Holocene. More than 800 of these specimens can be definitively attributed to *Prolemur simus*, a species that is currently restricted to Madagascar's south-central humid forests. Skeletal evidence of mammal predation on *Prolemur* includes punctures (rounded holes) on the posterior neurocranium and angle of the mandible. The size and distribution of skeletal damage signals a stalk-ambush mode of attack that is characteristic of *Cryptoprocta ferox*. Skeletal evidence of raptor predation is demonstrated by talon nicks (V-shaped holes), punctures, and "can-opener" perforations (producing bony flaps), often in places convenient for obtaining a good grip, such as within the orbits, maxillae, or palate.

These findings indicate the feasibility of recognizing specific taphonomic signatures of predators in subfossil assemblages. Further, given the importance of subfossil mammals to paleoenvironmental reconstruction, establishing the taphonomic stability of subfossil sites has

implications for the interpretation of environmental change through time in Madagascar.

This study was supported by the American Philosophical Society and The Claire Garber Goodman Fund, Dartmouth College, to KMM. Fieldwork at Ankaranana was supported by the National Science Foundation (DBS-9207084) to ELS.

Skeletal and dental health during the Basketmaker and Pueblo Periods in Durango, Colorado.

DAWN M. MULHERN and MONA C. CHARLES. Department of Anthropology, Fort Lewis College.

In this study, skeletal remains of 49 individuals from the Basketmaker II Period (300 B.C. to A.D. 500) were compared with 60 individuals from the Pueblo I Period (A.D. 700-840) from sites in the Durango area, located in southwest Colorado. Skeletal indicators of porotic hyperostosis and cribra orbitalia were observed, as well as dental hypoplastic and carious lesions to assess health status, particularly as it relates to diet. Overall results indicate continuity over time in these health indicators, with 25% of the Basketmaker II sample exhibiting evidence of cribra orbitalia compared to 33% of the Pueblo I sample. Porotic hyperostosis of the vault was present in 3 individuals from the Basketmaker II sample, and was absent in the Pueblo I sample. Indicators of dental health were also similar, with carious lesions observed in 35% of individuals with observable permanent dentition in both samples. Hypoplastic lesions were found in 26% of the Basketmaker II sample and 32% of the Pueblo I sample. Regional comparisons with other contemporaneous southwest populations suggest that the frequencies of these skeletal and dental indicators are relatively low in Durango populations. These findings may have implications about the availability of resources, particularly wild game, in the Durango area compared to surrounding regions in the Southwest.

Reproduction and resistance to stress in wild chimpanzees.

MARTIN N. MULLER¹, MELISSA EMERY THOMPSON¹, SONYA KAHLENBERG² and RICHARD W. WRANGHAM³. ¹Department of Anthropology, University of New Mexico, ²Department of Biology, Bates College, ³Department of Anthropology, Harvard University.

Stress, whether ecological or social, impairs reproductive function in a wide range of vertebrates. It has been suggested, however, that some species should be resistant to the adverse physiological effects of stress, trading off long-term survival for current reproduction. We used 6 years of behavioral and endocrine data from chimpanzees in the Kanyawara community, Kibale National Park, Uganda, to examine the relationship between stress and reproduction in both males and females. Estrous females were frequent targets of male sexual coercion, resulting in elevated stress hormone (cortisol)

levels during mating periods. In the presence of estrous females, adult males were involved in aggressive competition at high rates, leading to acute elevations in cortisol. Dominant males, and the alpha male in particular, generally maintained high levels of cortisol, and low levels of c-peptide, suggesting chronic social and energetic stress associated with maintaining rank. Nevertheless, activation of the HPA axis did not appear to suppress reproductive function in either males or females. These findings support the idea that, in groups where dominance is transient, and limited opportunities exist for monopolizing fecund females, male reproductive physiology should be resistant to the adverse effects of both social and energetic stress. Female reproduction, on the other hand, appears highly resistant to the effects of social, but not energetic stress. We propose that female resistance to social stress may be a widespread phenomenon in primates living in multi-male multi-female groups with high levels of male-male and male-female aggression in mating contexts.

Three stages in the evolution of Native American genetic diversity.

CONNIE J. MULLIGAN¹ and ANDREW KITCHEN². ¹Department of Anthropology, University of Florida, ²Center for Infectious Disease Dynamics, Department of Biology, The Pennsylvania State University.

For decades, intense and interdisciplinary attention has focused on the colonization of the last habitable landmass on the planet - the peopling of the Americas. A wealth of genetic data has been collected on indigenous populations in the Americas and Asia and these data consistently support a single migration from East Asia that crossed over the Bering land bridge before entering the Americas. Intense debate continues, however, on the timing, size, and movement of this migration. By integrating genetic data with archaeological, geological, and paleoecological data, we have proposed a three-stage colonization model in which a recent, rapid expansion into the Americas ~16kya was preceded by a long period of population stability in greater Beringia after divergence from an ancestral Asian population ~40kya. We have new Bayesian skyline analyses of microsatellite data to bolster our estimates of the effective size of the founding population; these estimates center around 500-1000 individuals. We also focus on the support for different entry dates to the Americas as well as the occupation time of Beringia based on recent estimates of the mitochondrial substitution rate. In general, 'fast' substitution rates support a post-LGM entry to the Americas and a shorter occupation of Beringia compared to 'slow' substitution rates.

Was heat retention important in determining *Homo* infant limb lengths?

MARCI MYERS¹, MELVINA KETTER¹, ANNA HEITHOFF¹, KELSEY BOEFF¹, KAREN STEUDEL-NUMBERS² and CARA WALL-SCHEFFLER³. ¹Department of Biology, St. Catherine University, ²Department of

Zoology, University of Wisconsin-Madison,
³Department of Biology, Seattle Pacific University.

The relationship between body proportions and thermoregulation in early *Homo* adults is well-established: adults with wider bodies and relatively short limbs retain heat better than individuals with narrower bodies and longer limbs. A significant genetic basis for relative limb length has been proposed based on evidence of length differences among modern human populations from a very early age. Because heat retention is critical to infant survival, some researchers have extended the principles of heat conservation to explain infant limb length differences. We predict the amount of extra heat lost by infants as the result of relatively longer limbs is not an important factor in their thermoregulation compared with the extensive heat loss resulting from overall small body size and narrow limb diameters (and thus large surface area to volume ratios). We developed a mathematical model (6 cylindrical body segments) (validated by measuring heat loss from a water-filled cylinder) to determine dry heat transfers between infants and their environment as a function of air temperature and wind speed. A 2 cm increase in both arm and lower limb lengths of newborn-sized infants made only a small (6 %) difference in overall rate of heat loss, even though, if uninsulated, a large proportion of heat (70 %) would be lost from the limbs due to their small diameters. Thus, the critical need of infants to retain heat probably explains why their limbs are well-insulated and show strong positive ontogenetic length allometry, but likely does not explain early limb length differences among populations. This study was funded by the McNair Scholars Program and a 3M Faculty/Student Collaborative Grant through the Center of Excellence for Women, Science, and Technology of St. Catherine University, St. Paul, Minnesota.

A 3D reconstruction of the first *Homo erectus* specimen from Turkey.

BRETT A. NACHMAN¹, SERDAR AKYAR², MEHMET CIHAT ALÇİÇEK³, JOHN KAPPELMAN¹, and NIZAMETTIN KAZANCI². ¹The University of Texas, Austin, ²Ankara University, Ankara, Turkey, ³Pamukkale University, Denizli, Turkey.

Kappelman et al. (2008) recently described the first hominin specimen found in Turkey, a partial calvarium dating to ~500 Ka that consists of fragments of both the right and left partials and the frontal. This new specimen is important in that it preserves rare evidence of hominin occupation in a temperate region of the Old World during the Middle Pleistocene. Here we report a virtual reconstruction of the calvarium using computed tomography (CT) scans. The calvarium was discovered at a factory near the village of Kocabas (Turkish definition: "big head") in a solid block of travertine and shows excellent bone preservation. CT scans were made in Ankara with a Toshiba Aquilion 64 slice Scanner (0.5mm x 64, 120 kV, 470 mA). Because the specimen retains evidence of the

oblique superior and inferior saw cuts made at the factory, these planes could be virtually recreated with 3D visualization software (VGStudio Max). These saw planes, along with a virtual sagittal plane and other relevant morphological landmarks, were used as guides to produce a virtual reconstruction of the specimen. It was also possible to mirror the right frontal fragment as a left to produce a largely complete frontal profile that includes much of the supraorbital torus (SOT). In addition to reconstructing the calvarium, we used the VGStudio software to segment out the remaining paranasal sinuses and take linear and volumetric measurements. We present values of the extremely thick cranial vault, SOT, and sinuses, and compare these features with those from other Middle Pleistocene hominins. This study was funded by The University of Texas and Ankara University, with thanks due to the Leakey Foundation.

Isotopic analysis of diet and residential mobility at San Pedro de Atacama, Chile: Understanding the Tiwanaku phenomenon through patterns of local social organization in the Solcor *ayllu*.

KRISTIN L. NADO¹, SARA J. MARSTELLER¹, LAURA M. KING², BLAIR M. DAVERMAN³, CHRISTINA TORRES-ROUFF², and KELLY J. KNUDSON¹. ¹Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University, ²Department of Anthropology, Colorado College, ³Department of Anthropology, Purdue University.

Studies of local social organization in peripheral areas enrich understanding of the internal composition of large, expansive polities. Here, we investigate local processes of immigration and social differentiation within the periphery of the Andean Middle Horizon Tiwanaku polity using isotopic indicators of residential mobility and diet in the tooth enamel and bone of 40 individuals from the Solcor-3 and Solcor Plaza cemeteries of San Pedro de Atacama, Chile.

Consistent with the hypothesis that common identification with the Tiwanaku core would have facilitated migration between San Pedro and different areas in the Tiwanaku polity, oxygen and strontium isotope analyses indicate that both local individuals and first-generation migrants were present within these cemeteries. Five individuals display $\delta^{18}\text{O}$ or $\delta^{87}\text{Sr}/\delta^{86}\text{Sr}$ values outside the local range and appear to have originated from two or more separate geographical areas. These results suggest more extensive immigration into San Pedro than previously identified, potentially due to interregional trade and contacts during Tiwanaku expansion. Contrary to expectations that dietary variability within San Pedro may have resulted from different geographic identities as well as from variation in individual affiliation with the Tiwanaku polity, carbon isotope data suggest a largely homogeneous diet among local residents. Cranial modification data show the exclusive use of tabular forms—the local variant—among the potential migrants despite the high incidence of annular forms within these cemeteries

(Solcor-3: 19.5%; Solcor Plaza: 26.7%). Interestingly, none of the individuals with non-local values were buried with Tiwanaku objects, despite their presence elsewhere in these cemeteries. This study was funded by the National Science Foundation (BCS-0721229 and BCS-0721388), the School of Human Evolution and Social Change at Arizona State University, and Colorado College.

Earliest colobine skeletons from Nakali, Kenya.

MASATO NAKATSUKASA¹, EMMA MBUA², SAWADA YOSHIHIRO³, TETESUYA SAKAI³, HIDEO NAKAYA⁴ and YUTAKA KUNIMATSU⁵. ¹Laboratory of Physical Anthropology, Kyoto University, ²Earth Science Department, National Museums of Kenya, ³Department of Geoscience, Shimane University, ⁴Graduate School of Science and Engineering, Kagoshima University, ⁵Primate Research Institute, Kyoto University.

Old World monkeys represent one of the most successful adaptive radiations of modern primates, but a sparse fossil record has limited our knowledge about the early evolution of this clade. We report the discovery of two partial skeletons of a colobine monkey from the Nakali Formation (9.8–9.9 Ma) in Kenya that show anatomical specializations for arboreality and differ from the terrestrial stem cercopithecoid *Victoriapithecus*. This colobus was tentatively assigned to as *Microcolobus*, which has been known from the penecontemporaneous Ngengerowa, Tugen Hills. The Nakali colobus shares a number of postcranial synapomorphies with extant colobines. However, degeneration of the thumb, a hallmark of modern colobines, is not observed, suggesting that this was a late event in colobine evolution. This discovery contradicts the prevailing hypothesis that the forest invasion by cercopithecids first occurred in the Plio-Pleistocene, and shows that this event occurred by the late Miocene at a time when ape diversity declined. Supported by grants from the JSPS (Grants 18255006, 19207019, 19107007).

The A.L. 333-106 cervical vertebra: a detailed description with implications for positional behavior in *Australopithecus afarensis*.

THIERRA K. NALLEY. School of Human Evolution and Social Change, Institute of Human Origins, Arizona State University.

The cervical spine has the potential to provide insight into the changes in positional behavior that occurred in the hominin lineage during the Plio-Pleistocene, but well-preserved cervical vertebrae are rare in the early part of the hominin fossil record. One exception is A.L. 333-106, a complete, relatively undamaged sixth or seventh cervical vertebra assigned to *Australopithecus afarensis* (3.2 million years old). The A.L. 333-106 vertebra was initially described as exhibiting a *Pan*-like morphology, but its degree of similarity to apes and the functional significance of its morphology remain unclear. The goal of this study was to

evaluate the affinity and functional morphology of A.L. 333-106. Linear dimensions, angular measurements, and cross-sectional areas of most aspects of both sixth and seventh cervical vertebrae were collected on six anthropoid species. Additionally, finite element models of four species (including A.L. 333-106) were compared. Results support the initial description of a *Pan*-like shape, but a number of features appear to be intermediate to the ranges of variation of modern humans and *Pan*. Moreover, certain features seem morphologically unique. The relevance of these features to the positional behavior of *A. afarensis* is discussed. The retention of *Pan*-like features in the *A. afarensis* cervical spine may be related to suspensory adaptations in the upper limb exhibited by this early hominin, consistent with a decoupling of the selective pressures acting on the lower and upper limbs during the initial shift to bipedality.

Eurasian middle and late Miocene hominoid paleobiogeography: Perspectives from non-primate terrestrial mammals.

MARIAM C. NARGOLWALLA. Department of Anthropology, University of Toronto.

Although the Eurasian Miocene fossil record preserves a remarkable diversity of apes, the relations among taxa are complicated by morphological, spatial and temporal discontinuities in their fossil record and lack of agreement in interpretations of their phylogeny. Here, questions regarding the chronology of first appearances (FAs) and relatedness among Eurasian hominoids are examined using the paleobiogeographic patterns of *in situ* evolution and dispersal of non-primate terrestrial mammals that are similarly adapted and/or commonly associated with Eurasian apes. Since primates are rare in the fossil record, mammals preserving more complete spatial and temporal ranges were used as a framework for the dispersal patterns and biogeographic relations in the Eurasian apes. Faunal resemblance and degree of spatial autocorrelation were assessed in a sample of ~550 localities taken from the NOW Database, spanning Europe and Western Asia from ~16-7Ma. The resulting matrices were examined to define faunal bioprovinces and identify patterns of endemism and dispersal. The results of this analysis identify four distinct bioprovinces. Within these bioprovinces, the fauna strongly support a FA of *Griphopithecus* in Central Europe at ~16Ma, followed by both *in situ* evolution and range extension into western Asia, although significant taphonomic bias evident in Turkish faunas must also be considered. In the late Miocene, *Dryopithecus* and its relatives (i.e., *Hispanopithecus*, *Rudapithecus*, *Neopithecus*, *Udabnopithecus*) are most likely biogeographically derived from locally occurring *Griphopithecus*, rather than the result of a separate intercontinental dispersal from Africa. Whether *Ouranopithecus* represents a European descendant or an African immigrant, however, is less clear.

Differential response to the audio broadcasts of harpy eagle (*Harpia harpyja*) vocalizations by three populations of brown capuchins

(*Cebus apella*) under presumed differential risk of predation.

ORIN J. NEAL¹, MARILYN A. NORCONK¹ and KIMBERLEY A. PHILLIPS². ¹Departments of Anthropology and Biomedical Sciences, Kent State University, ²Department of Psychology, Trinity University.

Predation is thought to be an important factor in shaping social behavior, and even infrequent encounters with predators can lead to significant behavioral responses by prey. Perception of risk may influence behavioral responses and also explain variability in anti-predator strategies. We conducted 13 playback trials during which we broadcasted harpy eagle (predator) and screaming piha (non-predator) vocalizations to social groups of brown capuchins at three locations. Two locations in Suriname, South America (A and B) contained several social groups. Location C consisted of two captive-born groups housed at Hiram College, OH. Each location varied in its presumed level of predation risk. Two groups at location A had a harpy eagle nest site within their home range and sightings were common. One group at location B had no nest site within its home range and sightings were very rare. Location C groups had no prior exposure to raptors. We found that free-ranging groups emitted 85% of their alarm vocalizations during the "predator" interval, whereas captive-born groups emitted fewer alarms in the same interval. Groups at location A exhibited higher frequencies of alarm vocalizations than groups at location B or captive-born groups ($F_2=12.03$; $p<0.005$; $n=13$). Further, only groups at location A exhibited significant differences in the frequency of alarm vocalizations emitted during "predator" versus "non-predator" playback intervals ($F_{2,3}=7.99$; $p<0.02$; $n=3$). These results add empirical evidence to recent studies that suggest that reinforcement from predator/prey interactions is an important aspect of the efficacy of prey species' predator avoidance and deterrence strategies.

Temporal and spatial variation in Southwestern cranial variation.

GREG C. NELSON. Department of Anthropology, University of Oregon.

Artificial cranial deformation is a hallmark of the skeletal biology of Ancestral Puebloan peoples of the American Southwest and has been used as a diagnostic tool for separating temporal phases particularly at the Basketmaker-Pueblo I and Pueblo III-Pueblo IV transitions. Although the major types of deformation (lambdoidal and occipital) and their temporal and spatial ranges have been basically known since the early twentieth century the discovery of a rare third type (obelionice) has warranted a reevaluation of the apparently well defined distribution of this skeletal marker. In keeping with the theme of this symposium, the distribution of cranial deformation types was examined on both large (regional, millennial, and cultural period) and small (sub-regional, decadal or less, and individual) scales. At the macro level cranial deformation is generally

well, and easily, defined both temporally and spatially. However, at the micro level numerous factors, some unquantifiable, produce a picture of cranial deformation variation that is much more difficult to interpret or easily classify. In other words, the results of this reevaluation show that, as with ancient human DNA studies, variation in cranial deformation is greater within areas and time periods than it is between them. The ramifications of this discovery may cause a further reevaluation of the value of cranial deformation as a cultural marker in the Southwest. Because the unquantifiable, confounding, factors make it nearly impossible to accurately determine the etiological processes involved in the formation of individual deformations, extrapolating large scale cultural trends could be considered problematic.

Paleoecology of *Oreopithecus* faunas based on stable isotopic analyses

SHERRY NELSON¹ and LORENZO ROOK². ¹Department of Anthropology, University of New Mexico, ²Department of Earth Sciences, University of Florence.

Oreopithecus, the last Miocene ape in Europe, is the most enigmatic ape, for its head and tooth morphology suggest an animal unlike any ape known. However, it shares suspensory postcranial features with modern apes and may have included bipedalism in its locomotor repertoire. A question remains, why did *Oreopithecus* survive outside of modern ape habitat range when no other ape could in the late Miocene? Was *Oreopithecus* living in a forest refugia that would have supported a modern ape, or did *Oreopithecus* differ in its dietary and habitat requirements from all other apes such that it could survive where no other ape could? The purpose of this investigation is to reconstruct habitat and dietary adaptations of *Oreopithecus* and its contemporaneous faunas in order to better understand the climatic and habitat changes that led to the demise of Miocene apes. Carbon and oxygen isotopes are informative for reconstructing paleodiets, habitats, and climates. Here we analyzed tooth enamel carbonate from 58 individuals of nine species from *Oreopithecus* faunas, including bovids, suid, giraffid, ursid, and *Oreopithecus*. Carbon values of *Oreopithecus* faunas overlap with other Miocene hominoid habitats. However, *Oreopithecus* carbon values are enriched compared to other apes, possibly indicative of feeding on aquatic vegetation. Furthermore, *Oreopithecus* values suggest that it made use of a wider range of habitats or food items than do most apes. Finally, oxygen values sampled throughout the length of a hypsodont tooth can reflect seasonality of a geographic region. Here we serially sample one bovid, yielding a seasonal oscillation.

Size and shape dimorphism in the human cranium.

ALLISON NESBITT and STEPHEN D. OUSLEY. Department of Applied Forensic Sciences, Mercyhurst College.

Sex determination in the human crania has been frequently studied in physical and forensic anthropology but multivariate analyses of sexual dimorphism in crania have been rare. Most recently, Rosas and Bastir (2002) determined that shape dimorphism was influenced by size, while Kimmerlee et al (2008) concluded that size differences do not influence shape dimorphism. One explanation for these divergent results may be the composition of and variation within each sample. We used craniometrics from the Howells data set to investigate sexual dimorphism on a worldwide scale. Twenty-six male and female groups ($n=2412$) were analyzed. Shape variables were calculated by scaling measurements to the geometric mean of all variables (Darroch & Mosimann, 1985). Canonical Variates analysis was performed on the raw measurements (representing size and shape), shape variables, and the geometric mean (size alone) from individuals. In our examination of eighteen vault and face measurements, the Howells Pacific groups were the largest in terms of overall size and African groups were the smallest. Larger groups showed greater sexual dimorphism than smaller groups, but the most significant shape differences within groups varied by size. Bzygomatic breadth was the most dimorphic measurement in general, but vault lengths, breadths, and additional facial dimensions were relatively more dimorphic in the smaller groups. We conclude that size influences shape in the human cranium, and that sexual dimorphism is a phenomenon with size, shape, and an interaction of these components.

Comparison of endocranial ontogenetic trajectories with implications for hominin brain evolution.

SIMON NEUBAUER, PHILIPP GUNZ and JEAN-JACQUES HUBLIN. Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig.

The size, morphology, and function of the human brain set us apart from other extant primates as well as extinct hominins. By comparing the ontogenetic trajectories of extant species, we examine the evolutionary changes in growth and development of the brain within the hominin lineage.

As the brain does not fossilize, we use endocasts as proxies to analyze the size and outer morphology of the brain. Based on CT scans of 65 human and 65 chimpanzee specimens from newborns to adults, we generate virtual endocasts and measure three-dimensional endocranial landmarks as well as semilandmarks on curves and surfaces to capture endocranial form. We also obtain endocranial data from adult fossil endocasts of archaic *Homo* specimens. These three-dimensional coordinate data are analyzed by means of Procrustes methods. Postnatal ontogenetic trajectories for humans and chimpanzees are not linear. Humans show three distinct phases of shape change and chimpanzees only two. While the second human phase and the first chimpanzee phase appear to represent a common pattern of development, the first human phase is absent in chimpanzees.

Using developmental simulations, we show that the endocranial developmental pattern in the first year after birth may be unique to modern humans within the genus *Homo*. This supports the idea that modern humans and archaic *Homo* reach comparable levels of encephalization through different ontogenetic shape trajectories. As these differences are most prominent in the first year after birth, they may have implications for the internal organization of the developing brain and thus for cognitive abilities. Supported by EU FP6 Marie Curie Actions grant MRTN-CT-2005-019564 "EVAN" and by the Max Planck Society.

Sex differences in the mother-infant relationship in wild baboons (*Papio cynocephalus*): Social, experiential, and hormonal correlates.

NGA NGUYEN¹, LAURENCE GESQUIRE², SUSAN C. ALBERTS³ and JEANNE ALTMANN². ¹Department of Anthropology, California State University Fullerton, ²Department of Ecology & Evolutionary Biology, Princeton University, ³Department of Biology, Duke University.

Mothering behavior is an essential determinant of offspring survival and development in mammals, yet data on the causes and consequences of naturally-occurring variation in maternal care are scarce. We examine several hormonal and non-hormonal predictors of variation in the mother-infant relationship during the first 8 weeks of infancy in 34 baboon (*Papio cynocephalus*) mother-infant dyads in Amboseli, Kenya. We use contact and nursing behavior as measures of the mother-offspring relationship, and evaluate the extent to which variation in this relationship is predictable from perinatal ovarian steroids (fecal estrogens and progesterone), previous infant care experience, maternal dominance rank, and offspring sex. We found that infants of more experienced mothers initiated higher rates of changes in mother-infant contact compared to infants of less experienced mothers. This pattern was more pronounced in male than in female infants. We also found that maternal dominance rank and prenatal fecal estrogen concentrations were predictive of suckling patterns in female, but not male, infants; female infants of high ranking mothers characterized by high prenatal fecal estrogen concentrations spent the least amount of time on the nipple. Our results are among the first to document (1) the influence of cumulative maternal experience on the mother-offspring relationship and (2) the emergence of sex differences in the mother-infant relationship during the first few weeks of life in wild primates. These results suggest that the well-documented behavioral differences between adults of each sex in many primate species may be rooted in the earliest stages of infancy.

This study was funded by the National Science Foundation (NSF), the L.S.B. Leakey Foundation and Princeton University.

The ontogeny of variation in internal nasal floor configuration in extant *H. sapiens*.

CHRISTINA L. NICHOLAS and ROBERT G. FRANCISCUS^{1,2}. ¹Department of Anthropology, ²Department of Orthodontics, University of Iowa, Iowa City.

Differences in the shape of the internal nasal floor (INF) have been documented across hominin taxa. In *Homo*, three distinct shapes have been recognized: flat, sloped and depressed (or bilevel). Of these, the depressed configuration occurs in 80% of Neandertals, while the dominant pattern among extant *H. sapiens* is either a flat or sloped configuration, with variation in frequency occurring between populations (Franciscus, 2003). Research by McCollum and Ward (1997) has indicated that this trait appears early in human development and is present in the same frequencies as in adult populations by 6 years of age. Recently, Nicholas and Franciscus (2008) documented that the depressed configuration is entirely absent at fetal stages in *H. sapiens*, however, no further conclusions could be drawn about the subsequent developmental trajectory of this trait. The current study builds upon this previous work, adding additional samples (current $n=383$) which augment both the age classes and range of ethnic groups. Previously, small post-birth sample sizes (especially birth to 3 years) impeded an accurate determination of first appearance for this trait (the youngest specimen displaying a depressed INF configuration was a 3-year-old), and we therefore hypothesized that this trait likely develops in tandem with the development of the permanent dentition. The results of the present study confirm that a depressed INF configuration appears no earlier than 3 years post-birth, and provide additional insight into the developmental trajectory of the internal nasal floor in extant humans. This research was funded by the Stanley Graduate Award for International Research.

Dental health of a 19th century skeletal sample from the Mid-Hudson Valley.

VICTORIA NICHOLS and KENNETH C. NYSTROM. SUNY New Paltz. SUNY.

In 2008, while renovating the Broadway School in Newburgh, New York, a 19th century African-American cemetery was re-discovered. Archaeological excavations identified a total of 114 individuals. Of the 99 skeletons were analyzed in the laboratory, 56 adults and 14 subadults possessed observable permanent dentition. The goal of the current project was to reconstruct the dental health of this population through the collection of frequency data on caries and linear enamel hypoplasias. Eighty-seven percent of all adult individuals had at least one caries (87.5% of males and 85.7% of females) with an average of 8.89 caries per individual. Fourteen percent of the subadult sample had at least one caries. Twenty-eight individuals, or 40% of the population, expressed at least one LEH on their anterior dentition, which is lower than in other contemporaneous African American populations. These results are similar to those reported for the First African Baptist cemeteries from Philadelphia, but are higher than for the 18th century remains from the New York City African Burial Ground.

This little piggy went running, that little piggy stayed home: a forelimb perspective of limb loading.

JIE NING, KIMBERLY A. CONGDON, ASHLEY S. HAMMOND and MATTHEW J. RAVOSA. Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine.

Variation in mechanical loading is known to influence chondral modeling. However, the interaction between chondrocyte behavior, skeletal morphology, and ontogenetic variation in activity patterns are variably understood. This hinders our knowledge of limb formation and function, whether plasticity varies within/among skeletal joints, and the limits of paleobiological inference. Here, the role of endurance exercise on the development of articular and growth plate cartilage in the humeral head was examined in 14 miniature swine (*Sus scrofa domesticus*). One group ($n=7$) was subjected to graded treadmill running over a period of 17 weeks. A matched group ($n=7$) was kept pen-confined sedentary. Gross and microanatomical dimensions between groups were compared multivariately. H&E and Safranin-O staining were performed for histomorphometry and evaluation of variation in proteoglycan content of the cartilage extracellular matrix, respectively. Versus sedentary pigs, exercised pigs possessed relatively increased cellularity, thinner cartilage zones, larger chondrocytes, and greater humeral proportions. While articular and growth plate cartilage demonstrated between-cohort differences, growth plate cartilage in the humerus exhibited a greater load-induced response. Likewise, external measures were less effective than histomorphometry in diagnosing group membership. When compared to similar data on the femur from the same individuals, humerus parameters evinced similar patterns of variation between loading cohorts. Given the primary role of growth plate cartilage in limb elongation, this constitutes further experimental evidence that ontogenetic variation in locomotor activity can influence limb length in mammals. These findings regarding joint plasticity during high endurance behaviors have important implications for understanding limb biomechanics and locomotor reconstruction in fossils.

Nasal anatomy of *Paradolichopithecus gansuensis* (early Pleistocene, Longdan, China) and its phyletic relationships with the other species of this genus.

TAKESHI D. NISHIMURA¹, ZHANGXIAN QIU², MASANARU TAKAI¹, YINGQI ZHANG² and CHANGHUA JIN². ¹Primate Research Institute, Kyoto University, Japan, ²Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences.

Paradolichopithecus is the largest representative of fossil cercopithecines known from the middle Pliocene to the early Pleistocene of Europe and central Asia. The geological and geographical

distributions suggest that *Paradolichopithecus* probably arose in the early Pliocene of western Eurasia and then dispersed eastward. The cranial specimen of *Para. arvernensis* from the late Pliocene of Senèze in France shows no maxillary sinus, whereas *Para. sushkini* from the late Pliocene of Kuruksay, Tajikistan, had this feature. Among extant cercopithecines, the maxillary sinus exists only in macaques. Therefore, such a discrepancy might reflect an intergeneric distinction between the Senèze and Kuruksay specimens. Here we examined a maxillary specimen of *Para. gansuensis* recently reported from the early Pleistocene of Longdan, gansu province, north western China. The Longdan maxilla had lost its facial part, which has exposed the internal floor of the nasal region. The nasal floor expands laterally at the P^3-M^2 level and the maxillary body is thick at the M^3 level to extend to the maxillary tubercle, as seen in the Senèze and Kuruksay crania. The specimen shows no evidence for the formation of a maxillary sinus within the inferior portion of the thick maxillary body, as is seen in the Senèze cranium. Such a configuration could reflect the absence of a maxillary sinus in the Longdan specimen. If this is true, eastern *Para. gansuensis* might have dispersed eastward retaining a primitive condition, while central *Para. sushkini* would have acquired this feature independently in central Eurasia in the lineage of *Paradolichopithecus*. This study was founded by Grant-in-Aid from the JSPS (#16405018, #21770263) and Ito Foundation, Tokyo

Three-dimensional scanning of the biceps brachii attachment site, advances and challenges of a new method.

MONICA L. S. NOLTE and CYNTHIA WILCZAK. San Francisco State University.

Three dimensional surface areas of the biceps brachii attachments of 80 white individuals from the Terry Collection were quantified with a Nextengine™ 3D scanner. The project goal was to assess the relationship between body size and the attachment areas. Body size was approximated by measurements of distal articular breadth, vertical head diameter and maximum length of the humerus. The total surface area of the bicipital tuberosity and footprint of the attachment along the medial tuberosity with the associated reactive bone were quantified separately. The decision to separate these two measurements was partially based on observations of the tuberosity in human cadavers ($n=3$). Advantages of the new method include high resolution (0.127 mm), low cost and ease of data sharing. Challenges included the need to define the boundary of each surface area measurement in a consistent manner and questions regarding the most meaningful aspect of the tuberosity morphology. Initial data analysis was conducted on a subsample of the right tuberosity of 25 individuals. Visually defining borders with chalk resulted in an undesirably high error rate of 3 to 26% (mean = 10.6%) for the total tuberosity and 2 to 27% (mean = 13.5%) for the attachment footprint. The method for defining

these areas needs refining to reduce the error rate. Despite the high error rate, the surface area and humeral measurement correlation results were robust. Correlations were strongest for the vertical head diameter with both surface areas ($r = 0.642$ total tuberosity; $r = 0.677$ attachment footprint). This study was funded by California State University Mini-grant and the Sacramento Archaeological Society.

Sight vs. sound: visual stimuli elicit stronger behavioral responses than vocalizations from wild white-faced sakis in Suriname.

MARILYN NORCONK^{1,2} SHANNON POLING¹ and CYNTHIA THOMPSON².

¹Department of Anthropology, Kent State University, ²School of Biomedical Sciences, Kent State University.

White-faced sakis (*Pithecia pithecia*) are medium-sized platyrhines that are sexually dimorphic in color and engage in inter-troop encounters (ITEs) (monthly max = 1:2.5 days of observation). Over several years of observations we noted that saki territorial defense is male-biased and as such the white face of adult males may provide the salient cue to initiate aggressive encounters. Since auditory cues may also be important, we tested the reactions of adult males and females to playbacks of Z-trill vocalizations (given during ITEs) and presentations of a decoy (plush toy saki) to four habituated wild saki groups at Brownsberg Nature Park, Suriname. Nine vocal playbacks, nine decoy presentations, and controls for both modalities were conducted over a two-week period in May-June, 2009. A behavioral ethogram of 15 behaviors was divided into two categories: "curious" ($n = 6$) and "alarm" ($n = 9$). Decoys elicited twice the frequency of responses than vocal playbacks in the "curious" category and three times the response rate in the "alarm" category. Our results suggest that 1) the appearance of the white face (even in the absence of vocalizations) can elicit behaviors commonly expressed during ITE's, and 2) adult males and females generally respond differently to decoys: males are more likely to approach the decoy, and females are more likely to move away from the decoy. These results contribute to observational data suggesting that male-male competition underlies the evolution of the white face in male sakis..

Modern human origins revisited: Perspectives from Luna Cave (Guangxi, China).

CHRISTOPHER J. NORTON¹, WEI WANG² and JENNIE JH JIN³. ¹Department of Anthropology, University of Hawaii, ²Natural History Museum of Guangxi Zhuang Autonomous Region, Nanning, China, ³Department of Anthropology, Pennsylvania State University.

In general, some recent paleoanthropological and genetics studies have argued that the Replacement/Out of Africa 2 hypothesis is the best model to explain modern human origins. Even in East Asia where the evidence

supporting the Replacement hypothesis has traditionally been weakest, some studies published in the past decade found support for this model in this region. However, we suggest that the picture in East Asia is more complex than traditionally considered by paleoanthropologists and geneticists, particularly when accounting for the growing number of Late Pleistocene hominin fossils present in the region. In this study, we offer evidence of modern humans that were excavated from stratified deposits in Luna Cave, located in Guangxi Zhuang Autonomous Region, southern China. The primary evidence of modern *Homo sapiens* from Luna Cave is two teeth (one permanent right lower M2 and one permanent left upper M1) that morphologically fall within the range of modern Chinese and outside the range of *Homo erectus*. The Luna Cave modern human teeth were found in association with speleothems that were uranium-series dated to ~70 ka. The data from Luna Cave, along with similar evidence of modern humans from other penecontemporaneous localities throughout southern and central China (e.g., Liujiang, Huanglongdong) suggests that the nature of modern human evolution in East Asia is more complicated than currently viewed. This study was funded by the Wenner-Gren Foundation for Anthropological Research (ICRG #82) and the National Geographic Society (#8372-07).

Sequence variation at the *TYRPI* gene suggests positive selection for darker pigmentation in the African Mandenka population.

HEATHER L. NORTON and MICHAEL F. HAMMER. ARL Division of Biotechnology, University of Arizona.

Variation in levels of melanin, the primary pigment of the skin, can be explained as an evolutionary adaptation to the intensity of ultraviolet radiation (UVR). To assess the potential role of natural selection in shaping patterns of variation at *TYRPI*, a gene involved in melanin production, we collected 10.7 kb of DNA sequence (including all exons and the 3' and 5' UTR regions) in 154 individuals from three African (Biaka Pygmy, San, and Mandenka) and three non-African (Han Chinese, French Basque, and Melanesian) populations. Only two nonsynonymous mutations were detected, both occurring as singletons, suggesting that coding variation in *TYRPI* cannot explain major phenotypic differences between populations. To determine whether patterns of variation across the entire sequenced region were consistent with neutrality, we used a nonparametric test to compare summaries of the frequency spectrum of polymorphism at the *TYRPI* gene with those from 61 independent non-coding intergenic regions on the autosomes sequenced in the same individuals. Only the Mandenka of Africa showed evidence of a departure from neutrality when compared to these neutral regions (Tajima's D = -1.14, p < 0.05; Fay and Wu's H = -2.30, p < 0.01). These results are consistent with the hypothesis that a distal regulatory element affecting *TYRPI* expression levels may contribute to inter-population differences and may have been a target of recent positive

directional selection. Although many pigmentation genes have shown evidence of positive selection in low UVR populations, signals of positive selection in high UVR population like the Mandenka are highly unusual. This study was funded by an NIH NIGMS Kirschstein postdoctoral fellowship to HLN (#F32GM080144), a grant from the Wenner Gren Foundation (#7568) to HLN, and a grant from the NSF (BCS-0423670) to MFH.

Genetic diversity of European population isolates in the context of neighboring populations.

JOHN NOVEMBRE¹, KRISHNA VEERAMAH², ANKE TONJES³, PETER KOVACS³ and MICHAEL STUMVOLL³.

¹Dept of Ecology and Evolutionary Biology, University of California-Los Angeles, ²Dept of History and Center for Society and Genetics, University of California-Los Angeles, ³Medical Department, University of Leipzig, Germany.

Recent advances in technologies for surveying single nucleotide polymorphisms (SNPs) at a genome-wide scale provide novel opportunities to study patterns of genetic diversity and gain insights about demographic history. Here we compare genomic-scale SNP patterns of variation in several European population isolates (Adygei, Basque, Orcadian, Roma (gypsies) from Romania, Sardinians, and Sorbs) to geographically proximal non-isolate populations. Our results reveal insights for the demographic history of each of these unique isolate populations, suggesting substantial variation among these population isolates in patterns of diversity and in historical relationships with their neighboring populations. This study was funded by the Mellow Foundation and the Seale Scholars Program.

Towards a new methodology for the documentation of cremated remains.

TERESA GOTAY NUGENT. Department of Anthropology, Texas State University, San Marcos.

Previous research in bioarchaeology on cremated remains focused on the condition of bone prior to burning, changes in size and color, and fracture patterns (Webb and Snow, 1945; Baby, 1954; Binford, 1972; Buikstra and Swegle, 1989). These studies provided information related to cultural cremation patterns and evidence for survival of recognizable human skeletal remains after prolonged exposure to high temperatures. With the exception of studies on processed cremains weights (Warren and Maples, 1997; Bass and Jantz, 2004), most prior investigations of cremated remains do not focus on the biological information of the remains themselves. The present study examines commercially cremated remains that have not undergone mechanical pulverization, allowing for documentation of diagnostic skeletal features. The thermal destruction and associated fragmentation of cremated remains makes establishing a biological profile difficult. This research will contribute information on the patterning of

preservation and a new method for the documentation of cremated remains in bioarchaeological and forensic anthropological contexts. A blind macroscopic analysis of a cremains collection (N=18) of known individuals was conducted. The completeness of each skeletal element that survived cremation was scored using the 3-point scale found in Ubelaker and Buikstra (1994). Preliminary results show that 64% of the preserved elements, scored a "2" within the *Standards* scale, which underrepresented the variation in preservation observed in the current study. Therefore a 5-point Amended scale was developed to more accurately reflect the differential preservation. Implications for assessing the biological profile using the amended scale will be discussed.

Dental metric variation among Late Paleoindian of Lagoa Santa, Central Brazil.

TATIANA L. NUNES¹, WALTER A. NEVES¹ and TSUNEHICO HANIHARA². ¹Laboratório de Estudos Evolutivos Humanos, Instituto de Biociências, Universidade de São Paulo, SP e

²Department of Anatomy and Biological Anthropology, Saga Medical School, Japan.

The "Two Main Biological Component Model" (TMBCM) postulated that the New World was settled by two distinct biological populations (Paleoamericans and Amerindians). The empirical base used to support this model is the distinctive cranial morphology of the first Americans compared to their recent counterparts. However, cranial morphology might be influenced by forces like natural selection and developmental plasticity potentially erasing its phylogenetic signal. Testing if the same pattern is observed with another phenotypic system is fundamental to verify how robust the TMBCM is. Dental morphology has high heritability, stable morphogenesis, high archaeological presence, and are less influenced by environmental factors than the cranium, being well suited to trace human micro-evolution. Thirty-two odontometric traits (mesiodistal and buclolingual diameters) were measured on 85 individuals from Lagoa Santa region, Central Brazil (11500-7000BP). Hanihara World's database with 9369 individuals divided in 256 local populations was used as comparative data. Morphological affinities of Lagoa Santa specimens were assessed by multivariate statistical techniques: Principal Components Analysis and Mahalanobis Distances followed by Cluster Analysis. Different steps of analysis were performed (sex separated, sexes pooled, raw data, and size corrected). The results are in accordance with the TMBCM. They show that Early Americans from Lagoa Santa do not resemble at all the recent populations of the New World as far as dental metrics are concerned. On the other hand while the TMBCM postulate a strong similarity of the first Americans with Australo-Melanesians and Africans, our results show that they are closely related to Southeast Asians and Polynesians. This study was funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (process 04/01253-0; 07/51947-7) and Conselho

Nacional de Desenvolvimento Científico e Tecnológico (process 301126-046).

Infectious disease dynamics in socially-structured populations.

CHARLES L. NUNN. Department of Human Evolutionary Biology, Harvard University.

Infectious diseases are ubiquitous in wild primates, yet we find variation in the parasites and pathogens that infect different primate species. This heterogeneity could arise from variation in susceptibility or exposure to infectious agents, or from variation in socioecological factors that influence disease spread. I provide an overview of my recent theoretical models of socioecological drivers of disease dynamics, focusing on two questions as examples: (1) Can mating systems influence the spread of virulent, socially-transmitted diseases, such as Ebola? (2) Does ranging behavior influence the spread of fecally transmitted pathogens? The agent-based model investigates disease dynamics in a population of distinct social groups. Each run simulates disease transmission based on parameters involving group size and composition, dispersal rates, ranging behavior, background and disease-related mortality, disease transmission rate, and incubation period. As these parameters are varied across simulation runs, one can generate predictions for how they influence disease spread. From the simulations, two major links were established between behavior and disease dynamics. First, socially-transmitted diseases that are more virulent (i.e., cause higher mortality) spread more effectively in polygynous than multimale social groups. This effect arises because females disperse and carry infections to new groups when the male dies in a polygynous group. Second, more intensive ranging in a fixed home range increases the probability that fecally-transmitted infections establish, which provides theoretical backing for the prediction that animals in defended ranges experience greater infection risk from intestinal parasites. Collectively, the results reveal how epidemiological models can generate new insights to disease dynamics.

This research was supported by the NSF (DEB-0212096), The National Center for Ecological Analysis and Synthesis (NCEAS), Conservation International, The Max Planck Society, and Harvard University.

Dental microwear as indicator of diet in recent human populations. A case study from an early Neolithic site in the Czech Republic.

PIA NYSTROM. Department of Archaeology, University of Sheffield, U.K.

Teeth are good indicators of dietary adaptation. Size, shape and form can be informative, and through the study of wear and damage on tooth surfaces diet inferences can be made. Many indicators are available when elucidating diets of human populations. For example, dental calculus and caries may indicate a high-protein and a high-carbohydrate diet respectively. The presence of macroscopic wear planes and interproximal facets give indication on food

toughness or how well food was processed prior to consumption. Locked within the microstructure of teeth there are stable isotope signatures reflecting general diet during development. However, all these approaches reflect an accumulated diet effect on the teeth. In contrast, dental microwear, especially occlusal microwear, is ephemeral and thus provides information as to what was consumed by an individual shortly before death.

Here I use results from different methodologies to examine dietary adaptation. As a case study I present the results from an early Neolithic population from the site of Vedrovice in southern Moravia, the Czech Republic. This project was based on a holistic approach where many methodologies were used to reconstruct the diet, including isotope analyses, dental health, molar macrowear, and occlusal and buccal microwear analysis. Even though occlusal and buccal microwear signatures tended to agree, the results presented some interesting contradictions that may relate to different dietary/lifestyle regimes at different time periods over the human lifespan.

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Climatic and physiological constraints on human body size and shape.

CARA OCBOCK¹, HERMAN PONTZER¹, TOM FREQZ² and JULIA MAKI¹. ¹Department of Anthropology, Washington University in St. Louis, ²Department of Computer Science and Engineering, Washington University in St. Louis.

What is the driving force behind the observed latitudinal clines for human body shape and size? The answer to this question has been sought since the late 19th century, beginning with Bergmann and Allen, whose rules remain widely accepted today. Here, we present a computer based optimality model that explores the range of survivable body sizes and proportions across latitudes. This model focuses on two limiting factors to survivability: change in core body temperature, which is driven by the ratio of surface area to body mass, and the energy expended on ranging and thermoregulation, which are affected by hind limb length and surface area, respectively. Our model shows that changes in core body temperature may affect body proportions at high latitudes, resulting in low surface area to mass ratios. Furthermore, our model demonstrates that the dual demands of ranging and thermoregulation result in an optimal body shape and size for given latitude, such that low surface area to mass ratios are optimal at high latitudes and high surface area to mass ratios are optimal at equatorial latitudes.

Published measurements of human body size and proportions follow a similar pattern to that presented by our model; however, this living human data encompasses a different range suggesting the importance of cultural buffering to exploitation of inhospitable habitats. This optimality model allows us to explore the impact of human body proportions on survivability in different environments and

offers a better understanding variation seen both in extant and extinct hominids.

First terahertz imaging of ancient mummies and bone

LENA OEHRSSTROEM¹, ANDREAS BITZER², MARKUS WALther², THOMAS BOENI³, GIOVANNI COLACICCO¹ and FRANK RUEHIL¹. ¹Swiss Mummy Project, Institute of Anatomy, University of Zurich, ²Department of Molecular and Optical Physics, Albert-Ludwigs-University, Freiburg im Breisgau, Germany, ³Orthopedic University Clinic Balgrist, University of Zurich.

Investigations of ancient mummified soft-tissues and bones are an important source to learn more about evolution of disease. Computed tomography (CT) and x-ray are currently the gold-standard in non-invasive diagnostic imaging of such historic remains. Terahertz imaging (THz) allows diagnostic close-to-surface tissue differentiation or bone morphology while being completely harmless to human cells. In this study, we apply THz time domain imaging for the very first time to historic specimens. An artificially embalmed ancient Egyptian human mummy hand (ex-collection Musée d'Orbe Switzerland, ca. 1300 BC) and a macerated human lumbar vertebra (Galler collection, Pathology Department University Hospital Zurich Switzerland, ca. 1950 AD) were examined by a standard THz time-domain spectroscopy system. Correlative multislice conventional X-ray and CT images were performed. Terahertz transmission images could be obtained with a spatial resolution due to wave diffraction on the order of 1 mm (at 0.3 THz). Bone and cartilaginous structures can be differentiated from surrounding soft-tissues and bandage-wrappings by THz imaging. One of the great advantages of THz radiation is the very low photon energy which guarantees a non-invasive investigation and prevents the tissue from destruction e.g. of the ancient DNA. THz time-domain imaging also provides spectroscopic information within a wide frequency range, which makes it possible to identify different tissue types or characteristic absorbing chemical substances. So there is potential in identifying ingredients of the embalming resin. Terahertz waves provide a completely non-invasive diagnostic imaging modality for historic dry specimen in paleoanthropological, paleopathological or forensic research. Grant support: The study has been supported by a Swiss National Science Foundation grant (No. 325100_120662) and by a Deutsche Forschungsgemeinschaft grant (No. WA 2641). C: to the relative time-delay of the THz pulse after passing through the sample

Quantifying the impact of mesh decimation and smoothing on the accuracy of three-dimensional enamel-dentine junction topographic models.

ANTHONY J. OLEJNICZAK¹, AIDA GÓMEZ-ROBLES¹, LEYRE PRADO-SIMÓN¹, JOSÉ MARÍA BERMÚDEZ DE CASTRO¹ and MARÍA MARTINÓN-

TORRES¹. ¹Centro Nacional de Investigación sobre la Evolución Humana (CENIEH). Burgos, Spain.

Various types of dental topographic analysis (DTA) are widely employed in dietary reconstructions, including studies of enamel microwear and texture analysis. Recently, microtomographic techniques have been applied to non-destructively study an internal dental surface, the enamel-dentine junction (EDJ). The EDJ has a strong influence on the shape of the outer enamel surface, and its development is likely under strong genetic control. Although the accuracy of microtomographic studies of dental tissues is well-established, production of 3D models suitable for DSA involves several steps during which artificial variation in the topography could be introduced, such as mesh decimation (reduction of the number of polygons representing the surface) and surface smoothing. Here we subjected microtomographic models of modern human and other mammalian teeth to DTA, recording EDJ surface areas and counts of surface orientation patches under several different smoothing and decimation parameters. Results reveal that decimation and smoothing can improve the accuracy of DTA by removing microtomographic or segmentation artifacts; however, either parameter can also result in artificial reduction of topographic features. Analyzing each specimen with multiple decimation and smoothing parameters yields an optimal protocol for every individual tooth. Likewise, decimating each specimen in a sample to an identical number of triangles results in a higher relative resolution (triangles per unit surface area) in smaller specimens than in larger ones, biasing both resultant patch counts and surfacing complexity indices. Future studies should consider the unique characteristics (e.g., size, resolution) of each surface model, rather than employing a single universal protocol. This study is supported by the Spanish Ministry of Science and Innovation (project DGI CGL2006-1352-C03; Juan de la Cierva research fellowship; and FPU grant), Fundación Atapuerca, and the Spanish Society of Periodontics and Osteointegration (SEPA).

Genetics and history reconstruction of Brazilian afroderived populations.

SILVIENE FABIANA DE OLIVEIRA¹, CARLOS EDUARDO GUERRA AMORIM^{1,2}, CAROLINA CARVALHO GONTIJO¹, GUILHERME GALVARROS BUENO LOBO RIBEIRO¹, MARIA ANGELICA FLORIANO PEDROSA¹, MARCELO RIZZATTI LUIZON³, LUCITANO BRANDAO FERREIRA⁴, AGUINALDO LUIZ SIMOES³, CELSO TEXEIRA MENDES JUNIOR³ and MARIA DE NAZARE KLAUTAU-GUIMARAES¹. ¹Laboratório de Genética, Universidade de Brasília, ²Programa de Pós-graduação em Genética e Biologia Molecular, UFRGS, Brazil, ³Universidade de São Paulo, Campus Ribeirão Preto, Brazil, ⁴Cátedra Unesco de Bioética, Universidade de Brasília.

Brazilian afroderived populations, also known as *quilombos remnants* (QR), are spread all over

the country. These populations were mainly founded by fugitive or freed slaves, generally 150 years ago. Here we present an overview of the studies developed with six of those populations regarding estimates of parental contribution, especially African, European and Amerindian, in the current genetic composition of these populations. Biparental genetic constitution based on AIMs was analyzed to all of them, while uniparental and autosomal STRs were studied for four of those populations. African parental autosomal contribution based on AIMs was the highest, although Amerindian and European contributions were also significant. For only one of those populations, Amerindian contribution was the highest. When four of those QRs were analyzed for autosomal STR, some differences were observed in comparison to AIMs, but there was no clear pattern. Y-chromosome haplogroup and STR data indicates very high European contribution and Amerindian haplotypes and/or haplogroups were virtually absent. Female profile (mtDNA) presented similar estimates for the three parental groups, with higher African contribution. The data presented here indicates that Africans and their descendants were the main responsible for these QRs formation, with significant proportions of Amerindian and European contributions. Men were the major responsible for the insertion of European alleles, while women for the insertion of Amerindian alleles. This study was funded by CNPq, CAPES and Finatec.

Nutritional composition of actual and potential insect prey for the Kasakela chimpanzees of Gombe Stream National Park, Tanzania.

ROBERT C. O'MALLEY¹, MICHAEL L. POWER² and CRAIG B. STANFORD¹.

¹Department of Anthropology, University of Southern California, ²Department of Zoological Research, National Zoological Park.

Insects (particularly termites, ants, and bees) are preyed upon by chimpanzees, gorillas, orangutans, and humans, and can provide nutritional benefits comparable to meat on a gram-for-gram basis. While palatable insects are abundant in many ape habitats, insectivory is not universal across populations of any ape species. Efforts to compare insectivory patterns across ape communities are complicated by a lack of comprehensive nutritional data. We collected samples of insects preyed upon by chimpanzees of the Kasakela community in Gombe National Park, Tanzania (as well as insects found within the community range and ignored by these chimpanzees, but known to be preyed upon by apes elsewhere) for nutritional assays. For termites and ants we collected separate samples of all castes for analyses when possible. Assays for gross energy (GE), ash, chitin (estimated by the acid detergent fiber procedure), and estimates for fat and protein followed standard methodologies. On a dry-weight basis the insect prey of Kasakela chimpanzees had lower values for ash ($z=2.74$, $p=.0061$) and higher GE ($z=-2.62$, $p=.0088$), but were not significantly different in chitin ($z=0.18$, $p=.8572$), estimated fat ($z=-1.39$,

$p=0.1645$) or protein ($z=0.09$, $p=.9283$) than the other insects assayed (all tests are 2-tailed). We conclude that Kasakela chimpanzees favor insect prey high in GE and low in ash. Choice of insect prey is also likely to be influenced by other factors such as prey abundance and distribution within the community range, fat and caloric content on a *per-unit* (i.e., per-insect) basis, differences in potential intake rates between species and castes. This research was supported by a USC Joint Initiative Merit Fellowship, a USC Summer Dissertation and Writing Award, a USC International Field Research Award, and the USC Jane Goodall Center.

Measurement of daily energy expenditure and time budgets in *Lemur catta*.

MATTHEW C. O'NEILL¹ and KATHLEEN M. MULDOON².

¹Department of Anatomical Sciences, Stony Brook University School of Medicine ²Department of Anatomy, Dartmouth Medical School and Department of Anthropology, Dartmouth College.

Understanding how energy and time are allocated among different activities can provide insights into how a population or species adapts to its environment. However, few direct measurements of matched daily energy expenditure (DEE) and time budgets have been made for nonhuman primates. Here, we present new data on DEE and time budgets for *Lemur catta*. These data are then combined with lab-based measurements of energy costs to gain insight into the main determinants of daily energy use in ringtailed lemurs. We measured DEE (kJ/day) in ringtailed lemurs free-ranging within a ~17 acre natural habitat enclosure at the Duke Lemur Center (DLC), Durham, NC. Doubly labeled water was administered to each lemur ($N=5$, Mass= 2.21 ± 0.08 kg), and concentrations of the labeled isotopes were monitored over a 10-day period in July 2009. Daily activity was recorded using focal animal sampling, and GPS was used to measure day travel distances of the group. The average DEE for the DLC ringtailed lemurs was less than the value predicted for a mammal of similar body mass, based on published regression equations. Within our data, there were correlations between the total DEE, resting and travel times. Calculations of time-energy budgets using lab-based measurements confirm that resting and walking costs account for much of the total DEE. Taken together, these data demonstrate that adaptive shifts in resting and/or traveling costs could substantially impact daily energy use and allow populations or species to occupy new ecological niches. The Claire Garber Goodman Fund, Dartmouth College (KMM); NSF (00525034) and Wenner-Gren (7380) (MCO).

Tracing Wakhi origins: An odontometric approach.

PATRICK O'NEILL and BRIAN E. HEMPHILL. Dept. of Sociology and Anthropology, California State University Bakersfield.

The Wakhi are an ethnolinguistic group who occupy a series of highly isolated valleys within the rugged Karakorum Highlands of northern Pakistan. Allocation of permanent tooth size among two geographically distinct samples of Wakhis from Gulmit (n= 156) and Sost (n= 170) were compared to test the accuracy of lumping such linguistic and geographically-based ethnic classifications commonly used in demographic studies. This comparison also seeks to determine whether rapid phenetic divergence has occurred between populations who likely share a common origin but have subsequently been isolated by harsh terrain and socio-political boundaries. The close similarity in the patterning of permanent tooth size allocation found in these two Wakhi samples suggests that such classificatory schemes can be applied effectively to groups located in the Hindu Kush Highlands. Affinities between these two Wakhi samples were placed into wider context by comparison to 20 additional prehistoric and living samples of ethnic groups from Northern Pakistan, Central Asia, and peninsular India. Odontometric data were scaled against the geometric mean by sample to eliminate the effects of overall size and pairwise differences in the patterning of tooth size allocation were assessed with simple Euclidean distances. The diagonal matrix of Euclidean distances was submitted to hierarchical and neighbor-joining cluster analyses, multidimensional scaling, and principal coordinates analysis. The results confirm evidence for a disturbance of the South Asian gene pool prior to the 5th millennium B.C. and support Wakhi claims of population origins in Central Asia accompanied by relatively recent immigration into the extreme northwestern periphery of South Asia.

Pseudoarthrosis of the acromion as possible indicator of biomechanical stress.

EDITH OPLESCH¹ and MICHAEL SCHULTZ¹. ¹Department of Anatomy, University of Goettingen, Germany.

Fracture of the acromion in association with trauma is regarded as an infrequent injury (Wilber et al. 1977). The resulting pain can be relatively tolerable, a continued, though restricted, use of the shoulder is, therefore, possible (Naested et al. 1995). Due to repetitive loading of the fracture, especially during the healing phase, nonunion can occur, leading to pseudoarthrosis.

In the skeletal population of the Iron Age cemetery at the Tell Kāmid el-Lōz (Lebanon), two cases of pseudoarthrosis of the acromion were found. This sample, dating from 500 BC, consists of a total of 88 specimens. Both affected individuals were young women. One displayed the injury on the left hand side, the other on the right hand side. The question of whether the condition was unilaterally or bilaterally present cannot be answered because of the poor preservation of the contralateral scapula. In both cases, the anterior portion of the acromion was separated showing sclerotic lesions on the surface of the broken ends. Since the pathological condition described above is considered to be relatively rare, the specific circumstances leading to the

type of stress causing the fracture in combination with pseudarthrosis remain to be discussed. In addition to common accidental events such as, for example, a fall or intentional violence, occupational stress resulting from biomechanical loading of the shoulder girdle within the context of a specific activity could be a plausible explanation. The congenital disorder called "Os acromiale" cannot be excluded, however, this is not very probable because of the morphology of the relevant bone surfaces.

Genetic diversity of the black crested gibbon (*Nomascus concolor*) from the Wuliang Mountains of Yunnan, China: preliminary results.

JOSEPH D. ORKIN¹, HE KAI^{2,3} and JIANG XUELONG². ¹Department of Anthropology, Washington University in St. Louis, ²State Key Laboratory of Genetic Resources and Evolution, Kunming Institute of Zoology, Chinese Academy of Sciences, Kunming, ³Graduate School of the Chinese Academy of Sciences, Beijing.

Anthropogenic effects have led to widespread fragmentation and extirpation of black crested gibbon (*Nomascus concolor*) populations. The largest, most stable population is endemic to the Wuliang Mountains of central Yunnan, China, where 98 groups (about 500 individuals) have been identified, but its natural population genetic diversity remains relatively unknown. Furthermore, numerous geographic boundaries—both anthropogenic and natural in origin—separate these groups of gibbons, and the effect of these boundaries on gene flow among groups has not been examined. A one month pilot study was carried during July 2009 to non-invasively collect fecal samples from black crested gibbons at two sites in the Wuliangshan National Nature Reserve in Yunnan, China. We collected 36 fecal samples from unhabituated black crested gibbons and Phayre's leaf monkeys (*Trachypithecus phayrei*). Individuals were not identified and fecal samples were collected from the forest floor using either the two step EtOH/Silica gel method or RNA later. Microsatellite and mitochondrial DNA from the D-loop and cytochrome B regions was sequenced to determine the preliminary genetic diversity from four groups of gibbons. Preliminary results indicate more modest genetic diversity within the Wuliangshan gibbons than when compared to those from neighboring populations.

Ancient DNA insights into American colonization.

DENNIS H. O'Rourke¹, JUSTIN TACKNEY¹ and JENNIFER RAFF¹. ¹Department of Anthropology, University of Utah, Salt Lake City.

Ancient DNA studies of the colonization of the Western Hemisphere have been limited, although the potential for novel insights is great. Despite methodological advances, diversity at the single mitochondrial locus remains the focus. aDNA results indicate that although the primary American mtDNA haplogroups were

present at founding, and had achieved substantial geographic structure prior to 3,000 years ago, genetic drift has resulted in some loss of haplotype diversity. Simulations, indicate that these drift effects need not have been associated with drastic population reduction or exceptionally small founding populations. As more full-sequence data become available, aDNA studies will provide more precise estimates of coalescent ages for multiple genetic lineages, enabling 1) direct comparisons of genetic and archaeological dates for prehistoric events, 2) more accurate estimates of demographic parameters (e.g., effective size) for modeling alternative colonization models, and 3) more robust testing of the effects of evolutionary forces on the structuring of modern genetic variation. Assessing the extent and pattern of prehistoric genetic variation relative to morphological variation will require greater access to nuclear genetic data in ancient samples than is currently routinely pursued. Expanding aDNA sampling to include archaeo-faunal collections, as well as the genomes of ancient human pathogens, will help to further clarify prehistoric population dynamics. More substantive contributions from aDNA studies will require larger and older ancient samples (>10,000 BP), especially from South America, areas of Beringia, and intervening coastal regions. This argues for greater coordination between geneticists and archaeologists to accumulate maximally informative samples for aDNA analyses.

Accuracy of the mandibular ramus as a sexual indicator.

ROSACELI ORTEGA. Department of Anthropology, New Mexico State University.

Many morphological and metric methods have been used to determine sex in the modern human skull. When only the mandible is obtained, the shape and size would determine its sex, allowing a 50% chance of being correctly sexed. In this current study, an effort is made to establish standards for sex determination by using the mandibular ramus to assess well-defined and replicable measurements for separating known adult males and females in skeletal samples from various populations, including Africa, Asia, Europe and North America. Metric measurements of the mandibular angle, minimum mandibular ramus breadth and the mandibular condyle depth were completed on each mandible. A morphological approach of the mandibular ramus angulation was determined using a similar scoring system as in Loth and Henneberg (1996). Both of these methods were used to clarify which process was more effective in determining the sex of individuals. These results highlight the significance of using metric and morphological methods combined to obtain a more effective determination of sex especially when in archaeological excavations or in forensic cases, only a mandible is discovered.

Carabelli's trait expression at the enamel-dentine junction (EDJ) and outer enamel surface (OES) of *Pan* maxillary molars.

ALEJANDRA ORTIZ¹, MATTHEW M. SKINNER², SHARA E. BAILEY^{1,2} and JEAN-JACQUES HUBLIN². ¹Department of Anthropology, New York University, Center for the Study of Human Origins, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig.

Cingulum morphology on upper and lower molars has long been of interest to dentists and paleoanthropologists, and has been implicated in alpha taxonomy and phylogenetic systematics of the hominoid clade. One expression, the Carabelli's trait, appears on the lingual aspect of the protocone of the upper molars. In modern humans, it ranges in expression from a pit/groove to a large free-standing cusp. While its frequency and degree of expression have proven useful in assessing biological relationships among major human populations, Carabelli's trait has received comparably little study in chimpanzees. This study examines the Carabelli's trait expression at the EDJ and OES of *Pan* maxillary molars in order to: 1) determine the developmental origin and relative contribution of the EDJ and the enamel cap to Carabelli's trait expression; 2) assess the applicability of current classifications of Carabelli's trait to capture variation in *Pan*; and 3) compare Carabelli's expression between *Pan paniscus* and *Pan troglodytes*. Upper molars of *P. paniscus* (n=9) and *P. troglodytes* (n=34) were subjected to micro-computed tomography, from which 3D digital models of the EDJ and OES were generated. Our results reveal that the Carabelli's trait originates at the EDJ, and that there is a high degree of correspondence between expression at the EDJ and OES. We suggest modifications to current scoring systems of Carabelli's in order to adequately describe the morphological complexity of this feature in *Pan*. Finally, species-specific differences in Carabelli's trait are evident, with *P. paniscus* exhibiting greater mean values in cingulum length and robusticity. This research is supported by the Max Planck Society and the New York Consortium in Evolutionary Primatology.

Food properties and implications for juvenile foraging in Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*).

KERRY OSSI-LUPO¹ and ANDREAS KOENIG². ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Department of Anthropology, Stony Brook University.

Skill learning has been proposed as one explanation for extended development among primates. In particular, achieving ecological competence may require time for gaining experience, but juveniles' smaller size and lesser strength may also limit foraging efficiency. These constraints have been difficult to disentangle for obvious reasons: as immature subjects age, they also get larger, stronger and presumably more experienced. Also, while certain foods are easily categorized as difficult to eat, comparing objectively across all foods in the diet can become problematic. As a step toward unraveling size-related constraints from

those of experience, we examined the influence of food toughness on diet and feeding rates for wild juvenile Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*) at Phu Khieo Wildlife Sanctuary, Thailand. Feeding data, including bites per minute, were collected on adults (N=14) and juveniles (N=15) from three groups. Food toughness was measured using a portable mechanical tester. As expected, younger juveniles had significantly lower intake rates across all food types (i.e., seeds, leaves, flowers) than did older juveniles, who had lower rates than adults. Bite rates and toughness values within food categories showed a significant negative relationship when controlling for age class. However, regression coefficients seem to suggest a greater impact of toughness on younger juveniles than on either older juveniles or adults. These results may demonstrate that size/strength differences no longer limit feeding efficiency for older juveniles. Future analyses will examine additional aspects of foraging to better assess the timing of competence and the role, if any, of experience. Supported by the Leakey Foundation, NSF DDIG (BCS-0647837), NSF (BCS-0542035), the Wenner-Gren Foundation, and the Office of the Vice President for Research and the Department of Anthropology, Stony Brook University.

Conjoining a neighborhood: Data structure and methodology for taphonomic analysis of the very large assemblage from Sacred Ridge.

ANNA J. OSTERHOLTZ and ANN L.W. STODDER. SWCA. Environmental Consultants, Inc., Phoenix.

This presentation describes the methodology employed in the analysis of the processed human remains of 33 individuals deposited in a Pueblo I pithouse at the Sacred Ridge Site (5LP0245) in Southwestern Colorado. The analysis includes 4 major components: 1) collection of standard taphonomic data to characterize and quantify the entire assemblage; 2) a comprehensive program of intra- and inter-feature conjoining through which 34% (5,016) of the 14,882 bone fragments were refit into conjoined units of two or more fragments; 3) collection of standard osteological data including nonmetric traits; 4) detailed documentation of bone modification including the presence of perimortem trauma suites documented in the forensics literature and clinically documented fracture types. Modifications were recorded by element specific location zones designated on the basis of morphological features. Together, the analyses go beyond quantitative taphonomy and provide a basis for reconstructing some of the behavior that created the assemblage: victims were hobbled by blows to the feet and ankles before execution-style decapitation, scalping, dismemberment, disembowelment, and possibly trophy taking of hands, ears and noses. All parts of the body were subject to destruction; deposition was random in terms of anatomical part, age or sex of the individuals represented. The results demonstrate the importance of extended conjoining efforts and the use of

clinical and forensic protocols. Individuals, not bone fragments, are the optimal unit of analysis if we want to comprehend processed human remains assemblages and the motives for the interpersonal violence they embody.

Assessing bone growth and development in modern American children.

STEPHEN OUSLEY, KATHRYN FRAZEE and KYRA STULL. Department of Applied Forensic Sciences, Mercyhurst College.

Much of what we know about human growth and development comes from large-scale longitudinal studies such as those conducted at the Fels Institute. Despite the clear pattern of secular trends in greater childhood growth, earlier maturity, and greater adult stature in the 20th century, standards for age estimation in forensic anthropology are currently derived from children born over 80 years ago. As a result, modern age estimates from unknown remains will be biased upwards. Additionally, growth data were collected previously to establish growth and development norms for known-age children, making the forensic application of the data, estimating age from growth and development, very difficult. In recognition of the need for up-to-date standards for estimating age in modern subadults, the National Institute of Justice awarded a grant in October 2008 for the creation of a digital radiographic database. Radiographs from clinical and especially medical examiner settings from around the country form a unique resource because large-scale collections of subadult skeletons are virtually unheard of. These data can also be used to study growth and development in modern children. To date, over 11,000 radiographs have been scanned. Preliminary results indicate that as expected, skeletal development in modern children, as seen in the appearance of ossification centers, proceeds at a faster rate than before. Additionally, the generation of age estimated with a specific confidence interval are possible, and 95% confidence intervals are narrower than the previously published textbook standards. This database will be available for research by forensic anthropologists and auxologists in 2010. This research is supported by National Institute of Justice grant 2008-DN-BX-K152.

Mother-infant interactions during moderate global maternal nutrient restriction in captive baboons (*Papio hamadryas anubis*).

LYDIA OVERBAUGH¹, MARK NIJLAND², KATE KEENAN³, PETER NATHANIELS², ANNICA POYAS¹ and THAD BARTLETT¹.

¹Department of Anthropology, University of Texas at San Antonio, ²Center for Pregnancy and Newborn Research, University of Texas Health Science Center, ³Department of Psychiatry, University of Chicago.

Both maternal style and maternal nutritional status have been shown independently to correlate with long-term behavioral and cognitive outcomes in offspring. To date, however, there has been little research into the relationship between maternal style and

nutritional status. Nevertheless, anecdotal evidence suggests that maternal nutrient restriction (NR) may disrupt normal mother-infant interactions. As part of ongoing research on moderate global maternal nutrient restriction in socially housed baboons, this study explores the nature of early mother-infant interactions among NR females. We predicted that nutritional stress would lead to increased time in contact, higher frequencies of restraining infants and lower frequencies of rejecting infants in NR mothers. Our study included six control females and four experimental females. Control females were fed *ad libitum* and experimental females were fed 30% less throughout pregnancy and lactation. Maternal behavior was recorded with handheld video for eight weeks following parturition (94 observations, 31 hours total) and subsequently coded by a single observer (LO). Coded behaviors included mother-infant proximity and infant restraint and rejection of infants. Though not statistically significant, time in contact was higher among experimental mothers than control mothers (88.59% vs. 77.26%, ANOVA: $F=2.196$, $df=9$, $P<0.177$). However, rates of infant restraint (per minute) were higher among controls than experiments (0.098 vs. 0.073, ANOVA: $F=0.180$, $df=9$, $P<0.68$). No females were observed rejecting infants during the study period. These results suggest that proximity and infant restraint and rejection may be mediated by separate factors. Alternatively, maternal style and nutrition may impact offspring development independently. Research supported by grants from National Institutes of Health, grant number R21HD057480, and San Antonio Life Sciences Institute.

First data on daily ranging behavior of simakobu monkeys (*Simias concolor concolor*) at Betumonga Research Station, Pagai Islands, Mentawai, West Sumatra, Indonesia.

L.M. PACIULLI, S.N. RENFROE and R.A. WASHINGTON. Department of Anthropology, University of West Georgia.

Ranging data can yield insight into aspects of an animal's activity patterns, energy expenditure, resource availability, predation threats, etc., and may ultimately affect social factors such as group size and structure. To date, no data have been published on the daily ranging behavior of the little-known simakobu monkey (*Simias concolor concolor*) inhabiting the Pagai, Mentawai Islands. In addition, data on unhabituated simakobu home ranges vary greatly from 2.5 – 30 ha (Rowe, 1996). Therefore, in this study, the daily ranging behavior of simakobu monkeys inhabiting the Betumonga Research Station forests was examined. During habituation, the animals were followed and a trail system of their travel paths was established using the angle (azimuth) and distance between two points along a trail. The points were flagged and coded with a letter (representing the trail name) and a number (representing different areas along the trail). These data were used to create a map of the forest and the monkey's trails using Geographic Information Systems (GIS). Five-minute

instantaneous focal animal sampling was employed to record the focal animal's location in the trail system during 60 full-day follows. GIS ranging functions then were used to calculate daily path lengths. This pilot study includes data on one group consisting of three simakobu monkeys who had a mean daily path length of 700 m. The simakobu daily path length is similar to its' closest living relative's daily path length, the proboscis monkey (*Nasalis larvatus*), who has a day range of 706 m.

Community violence and everyday life: Death at Arroyo Hondo.

ANN M PALKOVICH. Department of Sociology and Anthropology, George Mason University.

Traumatic skeletal injury, manipulated body parts and unusual contexts for human remains are among the primary evidence of violence in the past. Much of this evidence points to dramatic events, such as warfare, slavery and even cannibalism, with tragic consequences that altered individual lives and broadly affected the social fabric of communities. Such aggression experienced by communities may often be expressions of broad scale power relations, yet internal community violence can also be culturally embedded acts where aggressive responses to calamitous everyday events are framed by the group's beliefs and practices. In this paper, I discuss a series of unusual interments at Arroyo Hondo Pueblo to explore of the nature of community violence and the deadly consequences of aggressive acts in a village under stress.

Length of weaning, not gestation, predicts brain size in rodents.

J.D. PAMPUSH¹, LINDSAY BARONE² and BENJAMIN C. CAMPBELL¹. ¹University of Wisconsin-Milwaukee, ²A.T. Still University.

Studies of cross species variation in primate brain size have demonstrated links with both group size and maternal energetics. However, group size does not appear to play the same role in several other mammalian taxa, suggesting that primate brains are different in some important way. To provide additional comparative perspective on the determinants of primate brain size, we tested the relationship of brain size to life history variables among rodents. Data on adult brain size, adult body size, age at weaning, and length of gestation were taken from existing literature including 72 species. Phylogenetic corrections were done using the CIAC software package. Rodentia is a very diverse group with a large range of body sizes, therefore multiple methods of controlling for body size were explored. Our results indicate a strong link between age at weaning, but not length of gestation, and adult brain size. Based on studies of brain development in the laboratory rat, we interpret the relationship between age of weaning and adult brain size to reflect the co-incident timing of synaptogenesis, an energetically expensive process, and lactation among rodents. Our findings for rodents

contrast with previous results among primates and bats, in which length of gestation, but not weaning age is a significant predictor of brain size across species. Taken together, these results further suggest important pre- and postnatal developmental differences between primate brains and those of other mammals.

Assessing dental health predictors in a Swiss medieval population by a spatial probit model.

CHRISTINA PAPAGEORGOPOLOU^{1,2}, FRANK RÜIL¹, FRANK SIEGMUND² and ULRICH WOITEK³. ¹Institute of Anatomy, University of Zurich, ²Seminar für Ur- und Frühgeschichte, University of Basel, ³Institute for Empirical Research in Economics - Economic History Section, University of Zurich.

Body height can provide valuable information on socio-economic status and biological standards of living (e.g. Komlos, 1998, 2003; Woitek, 2003). Based on this we analyze the relationship between the dental health and the individual's height, specifically looking for the impact of the socio-economic environment (as reflected by height) on characteristics such as caries, ante mortem tooth loss (AMTL) and dental wear. We use a spatial probit model, appropriate because the dependent variable is categorical. Taking into consideration that the state of a tooth is not completely independent from the neighbouring teeth, we allow for spatial autocorrelation. The size for the data set makes it necessary to use a Bayesian simulation based method instead of the Maximum Likelihood approach. We applied the above model to a medieval population from the Swiss Alps (Tomils/Sogn Murezi, Graubünden, 11th-15th AD). Pathological data of the permanent teeth (7683 alveolae) and the length of the long bones from 280 adults have been used for the analysis. We found a strong spatial autocorrelation between the teeth (rho 0.88, st. dev. 0.02), and a strong relation between dental health and individual's height. The probability of AMTL decreases with femur length while for dental wear increases with femur length. Slight differences between sex and age groups as well as tooth groups were observed but the general pattern remained the same. The probit model is a useful tool for analysis of spatial data with biological background and offers a new approach on the reconstruction of living standards of past populations.

Event history analysis of Dengue Fever outbreaks in eight different endemic regions.

DANIEL PARKER^{1,2,3} and DARRYL HOLMAN^{3,4,5}. ¹Department of Anthropology, ²Population Research Institute, The Pennsylvania State University, ³Department of Anthropology, ⁴Center for Studies in Demography and Ecology, ⁵Center for Statistics in the Social Sciences, University of Washington.

Dengue fever, a tropical illness resulting from infection by one of four dengue viruses, is a major public health concern. An estimated 50 million people become infected each year,

making dengue the most common vector-borne infection in the world. Since there currently is no vaccine, public health measures are reliant on disease modeling, surveillance, and prevention. The aim of this project was to both determine significant factors in dengue fever epidemics and then to quantify the effects of those significant factors on the length of epidemics and on the time in between epidemics. Eight different endemic regions were chosen as study sites and region-specific data for all covariates were collected for all sites. Sites were selected according to the availability of historical data for all covariates. A piecewise logistic regression model with time-varying covariates was used to analyze the historical data. Mean monthly temperature was the most significant factor, increased temperature acted to hasten the onset of outbreaks during interepidemic spells and lengthen the duration of outbreaks during epidemic spells. Previous investigations have noted the influence of temperature on the geographic range and vector efficiency of dengue fever, this model describes the effects of temperature on epidemics in endemic regions.

Manual and pedal pressures during sloped quadrupedal locomotion in *Lemur catta* and *Varecia rubra*.

LESLIE R. PARKER¹, ROSHNA E. WUNDERLICH¹ and TRACY L. KIVELL².
¹Department of Biology, James Madison University, Harrisonburg, ²Dept. Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig.

Primates have long manual digits that facilitate a secure prehensile grip but are susceptible to high bending stress. During horizontal locomotion, primates experience higher peak loads on their hindlimbs than their forelimbs, possibly to moderate load on their forelimbs. During descent weight is shifted anteriorly and increase stress on manual digits. We predicted that animals with long digits would exhibit postural changes to unload these digits when stresses are high. We examined manual and pedal plantar pressure in a very terrestrial strepsirrhine, *L. catta* (N=2) with relatively short manual digits (fingers-hand ratio 34.5, toes-foot ratio 39.0), and the highly arboreal *V. rubra* (N=2; fingers-hand 56.1, toes-foot 21.1) walking on a pressure mat during horizontal, incline and decline (30°) walking. Maximum pressure, peak force, and contact time were analyzed for the palm, manual digits, sole, and pedal digits. Forelimb peak pressure of *V. rubra* was lower than that of *L. catta* on horizontal and incline substrates but higher than *L. catta* during decline walking. *V. rubra* placed more load on their manual digits relative to their pedal digits during horizontal and incline walking, while *L. catta* placed relatively more load on their manual digits during decline walking. In contrast, *V. rubra* did not put substantial pressure on their pedal digits on horizontal and decline substrates, but exhibited more load on their pedal digits during incline walking. Primates protect their long digits by altering gait mechanics, and highly terrestrial and arboreal strepsirrhines may cope with varied terrain in

different ways. This study was generously funded by NSF BCS-0452217 to DS

The postmortem interval: A systematic study of pig decomposition in west central Montana.

HILLARY PARSONS¹. ¹Department of Anthropology, University of Montana.

The postmortem interval (PMI) is an important piece of information used by forensic and criminal investigators to help investigate crimes and other unattended deaths. Time since death estimations assist law enforcement in providing a reference with which to compare a suspect's alibi, identify victims of crime, and solve cases. Studies of decomposition have been conducted at the University of Tennessee's Anthropological Research Facility in Knoxville, TN; however, decomposition at high altitude climates characterized by colder temperatures and arid conditions is poorly understood. Further, the lack of postmortem interval studies in west central Montana has hindered the investigation and identification of recovered individuals in this area. Using pigs as proxies for human cadavers, the rates of decomposition were observed to help estimate the postmortem interval. This research provides information on how the rate of decomposition of two pigs is affected by the climate and insect activity of west central Montana in August and October; late summer and early fall, respectively. The unique climate of west central Montana produces slower decomposition rates that differ significantly from those observed in Tennessee and elsewhere in the United States. The use of accumulated degree-days (ADD) to estimate the postmortem interval reveals inconsistent time since death estimations as compared to previous ADD studies. These inconsistencies can be attributed to significant differences in the climate and weather patterns specific to west central Montana. This study was partially funded by the University of Montana's President's Excellence Fund.

Basicranial shape variation and the developmental determinants of primate craniofacial evolution.

TRISH E. PARSONS¹ and BENEDIKT HALLGRÍMSSON². ¹Biological Anthropology Graduate Program, Faculty of Medicine, University of Calgary, ²Cell Biology and Anatomy, University of Calgary.

The integration pattern of the primate skull biases the direction of variation that is generated during development thereby directly affecting the skull's evolvability. We hypothesize that the integration pattern of the primate skull is such that alterations to the generation of one craniofacial morphogenetic unit will necessarily incite changes to the other units that comprise the skull. Specifically, we predict that the shape of the chondrocranium during development influences shape variation in the rest of the skull along specific morphological axes. We test this hypothesis using transgenic mice that exhibit altered gene expression only in tissues comprised of collagen II and all factors known

to cause shape change are kept constant. In the skull, mainly the chondrocranium is affected. The phenotypes of these mice include both over- (Pten mice) and under-growth (Sec-tRNA and Brachymorph mice) of cartilaginous tissues. A geometric morphometric singular warps analysis of covariation of the skulls of these mice indicates that shorter basicranial shapes tend to correspond with shorter and wider faces, high cranial vaults and more globular crania. These trends coincide with the three major axes of variation identified across primate and hominid evolution, specifically shortened faces, shortened basicrania and larger calvaria. These results enhance our understanding of the covariation structure of the primate skull as we have experimentally shown that the shape variation of the basicranium elicits evolutionarily relevant shape change in both the face and calvarium. This research elucidates the developmental determinants of these major axes of craniofacial phenotypic variation in primates. This study was funded by CIHR Skeletal Regenerative Medicine Team Grant, and NSERC.

Geometric morphometric analysis of the human sacrum and its utility in sex estimation.

NICHOLAS V. PASSALACQUA¹, JENNIFER M. VOLLNER¹ and CHRISTOPHER W. RAINWATER^{2,3,4}. ¹Department of Anthropology, Michigan State University, ²Department of Anthropology, Center for the Study of Human Origins, New York University, ³New York Consortium in Evolutionary Primatology, ⁴Office of Chief Medical Examiner, New York City.

Accurate estimation of sex from the human skeleton can be difficult when unidentified, incomplete remains are encountered. This research provides a novel technique of determining sex from the human sacrum using a discriminant function analysis of geometric morphometric data.

Non-metric methods of estimating sex from the sacrum are available, yet the utility of these methods is unclear and remain untested. Linear measurements of the human sacrum have also been previously implemented for sex estimation with limited success. This study initially conducted a two-dimensional geometric morphometric analysis of 18 landmarks on anterior human sacra of 146 individuals (70 males, 76 females) from the Hamann-Todd Collection yielded poor classification results (43.15% cross-validated percent correct). These results suggested that a three-dimensional (3D) analysis may be necessary to fully appreciate sexual dimorphism in the sacrum.

Accordingly, three-dimensional geometric morphometric analysis examined shape differences in the sacrum from a sample of 163 sacra (85 males, 78 females) from the Hamann-Todd Collection. Twenty-three 3D landmarks were developed and collected on each individual using a Microscribe digitizer. This 3D data was then subjected to a Procrustes' fit and Procrustes' coordinates were analyzed through a discriminant function analysis. Results indicate an 85.75% cross-validated accuracy on the

correct classification of sex (89.40% for males, 82.10% for females). These data suggest that the sacrum is quantifiably sexually dimorphic, however if an innominate is present, the innominate has a greater potential to correctly estimate sex using 3D data than the sacrum (Klales *et al.* 2009).

Anthropoid first metatarsal from the late Eocene of Egypt.

BIREN A. PATEL¹, D.M. BOYER², R.L. JACOBS³, E.R. SEIFFERT¹ and E.L. SIMONS⁴. ¹Department of Anatomical Sciences, Stony Brook University, ²Department of Ecology and Evolution, Stony Brook University, ³Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ⁴Duke Lemur Center and Department of Evolutionary Anthropology, Duke University.

The specialized grasping feet of primates, and in particular awareness of the nature of the hallux grasping capabilities of living prosimians, have played central roles in understanding the origins of primates. Prior comparative studies of first metatarsal (Mt1) morphology have documented specialized characters in living prosimians indicative of a more abducted hallux capable of strong grasping. These include a well-developed peroneal process and a greater physiological angle (i.e., the angle of proximal articular surface of Mt1 relative to the long axis of its shaft). Although known Mt1s of fossil prosimians share these characters with their living relatives, Mt1 morphology in the earliest crown-group anthropoids is unknown. Here we describe a Mt1 from the latest Eocene of Egypt (from the ~34 Ma Quarry L-41 in the Fayum Depression) and compare it with a sample of living anthropoids and prosimians, and fossil prosimians (*Notharctus*, *Adapis*, *Adapoides*). Multivariate analyses of Mt1 shape variables (total length, midshaft diameter, proximal articular surface width, peroneal process width and length), and comparisons of physiological angle, indicate that the Fayum specimen is most similar to those of crown-group anthropoids. The Fayum Mt1 presumably belongs to either *Catopithecus* or *Proteopithecus*, which are the most common anthropoid taxa at L-41. The anthropoid-like morphology of the Fayum specimen differs from that of a possible anthropoid (eosimiid) Mt1 from the middle Eocene of Asia, which appears to be more similar to those of fossil prosimians (e.g., adapoids). Implications for competing hypotheses surrounding the evolution of the primate grasping foot will be discussed.

Reconstructing the paleoecology of fossil primates from Taung using low-magnification dental microwear features.

JAMES W. PATTERSON¹ and FRANK L. WILLIAMS¹. ¹Department of Anthropology, Georgia State University.

Taung yielded the first Pliocene Hominini fossil, *Australopithecus africanus* recovered from a lime quarry in 1924. To identify whether the habitat of the site differed from present conditions, dietary preferences of fossil

papionins from Taung, including *Parapapio antiquus* (n = 8), *Papio izodi* (n = 12) and Indeterminate (n = 10) were examined under low-magnification to discern patterns of dental microwear. The comparative fossil sample from Sterkfontein Member 4 included *Parapapio broomi* (n = 10) and *Parapapio jonesi* (n = 5). Extant *Papio ursinus* (n = 20) from the Cape region and the Orange Free State, South Africa, provided a modern analogue. Six dental use-wear scars on the paracone of the second molar were recorded within a 0.4 mm² ocular reticle at 35x, using a moveable external light source. The data were analyzed using ANOVA with Tukey's Honestly Significant Differences to detect for differences between groups for each feature. Linear regression was included to identify significant covariation of microwear features. Principal Components Analysis and Discriminant Function Analysis using 95% confidence ellipses around group centroids are incorporated to identify species-specific dietary signals. Extant *Papio ursinus* is separated from the extinct taxa solely by a relatively greater number of fine scratches with respect to other microwear features. *Papio izodi* overlaps primarily with extant *Papio* and secondarily with *Parapapio* forming a more discrete grouping that includes *Parapapio antiquus* from Taung. A wetter more closed environment is suggested for Taung and Sterkfontein Member 4, compared to the habitat of present-day central South Africa. This study was supported by a Research Team Grant, a Research Professional Enhancement Grant and a Tech Fee Grant from the Vice President for Research at Georgia State University.

Investigating radiographs as a valid tool for anthropometric measurements. A comparative study using dry bone and radiographic maximum femoral length in research estimating living stature.

KATIE PAUL¹ and MARIE LOUISE JØRKOV^{2,3}. ¹University of Bournemouth, England, ²Copenhagen City Museum, ³Laboratory of Biological Anthropology, Copenhagen University.

It is well known that there is a relationship between stature and long bone lengths and that it is population specific. However, the methods are limited to only a few geographical/ancestral populations due to the lack of well documented contemporary skeletal collections. Consequently, anthropometric stature research has been completed using radiographs; and subsequently their accuracy needs to be ascertained. We here present a comparative study between the maximum long bone length measured from radiographs and corresponding length using a standard osteometric board. A magnification correction factor was calculated to the radiograph measurements using a known diameter stainless steel ball bearing. The non-parametric Wilcoxon signed-rank test produced an exact significance of $p \leq 0.05$, therefore concluding a significant difference between the two experimental conditions. The effect size was >0.5 , thus the experimental manipulation is considered to be large and an important factor of the variance. The mean measurements were

inputted into a White American male regression formula to assess the deviations in stature estimates obtained from the different methods. In conclusion radiographs are not accurate reflections of dry bone measurements. However, the effect this had on the stature estimates is relatively small (an average difference of 10.2mm). Therefore it is advised that radiographs are only used in research where no other method is available, completed with caution and all necessary procedures are taken to eliminate any limitation.

Diets of sympatric chimpanzees and elephants at Mainoro during an extended dry season.

CHARLOTTE L.R. PAYNE^{1,2} and GARY P. ARONSEN². ¹Leverhulme Centre for Human Evolutionary Studies, University of Cambridge, ²Department of Anthropology, Yale University.

In this study, we present preliminary data on the diets of sympatric chimpanzees and elephants at Mainoro, a new site in Kibale National Park, Uganda. Mainoro is located near to the park border and encompasses large areas of very young forest, planted since 1994. We collected and analysed fecal samples to estimate the importance of different fruit species in the diets of unhabituated chimpanzees and elephants during an extended dry season. Macroanalyses of 93 chimpanzee fecal samples and 49 elephant fecal samples show that, in areas of mixed mature forest, elephants and chimpanzees had some dietary overlap during a 1-month period. Notably, *Warburgia ugandensis* was found in the majority of both elephant (61%) and chimpanzee (79.5%) samples. However, samples collected close to the park border showed a marked difference in dietary habits: In this area, chimpanzee samples yielded far greater amounts of *Ficus spp.* seeds (present in 92% of samples) and *Warburgia* seeds were comparatively rare (15%). Elephant fecal samples collected in this area did not contain any *Warburgia*. Instead, the remains of human-cultivated plants were found in the feces, revealing evidence of crop-raiding, which is an ongoing problem in this area. Interviews with local villagers suggest that elephants frequently crop-raid in this area, but that these events are only rarely reported to the authorities. Further study will reveal whether these patterns are restricted to periods of fruit scarcity, or if this data is representative of year-round dietary overlap between chimpanzees, elephants, and human communities. Supported by YIBs.

Correlations between genetic ancestry and superficial traits indicate substantial admixture stratification in Brazil.

LAUREL N. PEARSON, DENISE K. LIBERTON, ELLEN E. QUILLEN, RALITZA L. ZIKATANOVA, RINALDO W. PEREIRA and MARK D. SHRIVER. ¹Department of Anthropology, Pennsylvania State University, ²Department of Genomics and Biotechnology, Catholic University of Brasilia.

Brazil is one of the most admixed countries in the world. How this admixture affected the

distribution of genetic ancestry across Brazilian ethnic ("Color") groups is a fundamental question which to date has only received minimal attention. In an effort to systematically study variation in genetic ancestry in Brazil, we collected DNA and various phenotypic measures from 596 volunteers in Brasília, Brazil. Participants were asked to provide their self-described "Color" as defined by the Brazilian census (Preta/Black, Parda/Brown, Branca/White, Indígena/Indigenous, Amarela/Yellow). Phenotype data was collected from each subject including hair texture, high-resolution eye photographs, skin and hair color by reflectometry, and three-dimensional facial photographs. To estimate genomic ancestry, DNA from each participant was genotyped using 176 ancestry informative markers (AIMs), autosomal SNPs with large frequency differences between parental populations known to contribute to Brazilian admixture (West African, East Asian, European and Indigenous American).

Although genomic ancestry shows significant overlap across "Color" groups, there are highly significant differences in average proportional ancestry. Additionally, analyses comparing trait values and genetic ancestry show significant correlations consistent with expectations of populations stratified with respect to genetic ancestry. Ethnographic research indicates that designations of "Color" are fluid and largely based on physical traits as opposed to known ancestry. This likely contributes to the observed ancestry overlap between ethnic groups and the strong association between phenotype and group. This study emphasizes the importance of genetic marker based estimates of ancestry as well as objective assessment of superficial traits in understanding the admixture process.

Appendicular morphology and ecogeographic adaptations of the early Holocene skeletons from Gobero, Niger.

OSBJORN M. PEARSON¹ and CHRISTOPHER M. STOJANOWSKI². ¹Department of Anthropology, University of New Mexico, ²School of Human Evolution & Social Change, Arizona State University.

Gobero is a series of Holocene cemeteries centered around an extinct paleolake in the Central Sahara Desert (Niger). Geochronological analysis indicates two occupation phases (9500-8200 and 7200-4500 BP) separated by an arid spike. The two populations exhibit dissimilar stature and craniofacial features but share dental similarities which recall Epipalolithic populations from the Maghreb. The present research focuses on the earlier population from Gobero associated locally with the Kiffian cultural tradition. To evaluate the appendicular morphology and ecogeographic adaptations of this population, we measured the length, midshaft diaphyseal dimensions, and epiphyseal breadths of the major long bones in adequately preserved skeletons ($n = 8$). We calculated a series of indices that capture ecogeographic variation (femoral head diameter vs. femoral length, crural and brachial index), and habitual activity

(pilastric, cnemic, and humeral midshaft shape) and compared these to 12 recent and 5 fossil populations. Twenty-three muscle insertion markers were coded following the Mariotti et al. system. The results show the early people from Gobero were very tall, with a very linear physique with elongated distal limb segments. They had strongly developed femoral pilaster and platycemic tibiae (129.3 ± 6.8 and 58.2 ± 5.3 , respectively, for males), but with rounded rather than flattened humeral midshafts. Most of the muscle marks were weakly developed. This set of postcranial features strongly resembles Skhul-Qafzeh and, less strikingly, Khosan. The Kiffian postcranial signature resembles Epipaleolithic populations of the Maghreb corroborating craniometric evidence for a Holocene dispersal of these peoples into the Sahara. This work was supported by the Wenner Gren Foundation for Anthropological Research (GR7747) and the National Science Foundation (0820805).

Tell me more about *Theropithecus*: an investigation of cranial morphology in African papionins.

TARA A. PEBURN. Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine; Department of Anthropology, CUNY Graduate School and University Center, NYCEP.

Due to its unique and highly derived cranial morphology as well as the limited available sample, *Theropithecus* is often excluded from analyses of the Papionini. However, *Theropithecus* is integral to further teasing apart the morphological differences between members of the molecular clades [i.e., *Cercopithecus/Mandrillus* (CM) vs. *Lophocebus/Papio/Theropithecus* (LPT)] and discerning the character polarity of papionin integrated form. Three-dimensional coordinates of 45 landmarks were digitized on 260 adult crania to better understand the intricacies of *Theropithecus* morphology in a phylogenetic context. Two species from each of the five African papionin genera were included, except for the monotypic *Theropithecus*. Analyses were performed on the entire cranium from three cranial subsets, the face, vault and basicranium. Landmarks were subjected to generalized Procrustes analysis, followed by PCA. Overall, the unique morphology of *Theropithecus* is highlighted, including its superiorly oriented nasal clivus, high zygomatics and upturned nuchal plane.

More importantly, *Theropithecus* consistently groups with *Papio* versus *Mandrillus* and with the LPT clade when the mangabeys are included in the analyses. The LPT clade exhibits a relatively shorter nuchal plane and anteriorly oriented zygomatics which are positioned more superiorly on the cranium along with the postglenoid processes. In addition, the LPT clade has a relatively more elongate and narrow "temporal fossa," with medially positioned lateral pterygoids. Midsagittally, the LPT clade is more elongate between the palate and nuchal plane, whereas the CM clade's elongation occurs anteriorly and posteriorly (i.e., within these two structures). Implications for these morphological patterns and the evolution of

papionin crania are discussed. This study was funded by LSB Leakey Foundation; Sigma Xi; Wenner-Gren Foundation (Grant 7172).

The biological impact of culture contact: a bioarchaeological study of Roman colonialism in Britain.

JOSHUA JAMES PECK. Department of Anthropology, California State University, Sacramento.

Social conflicts arising from interregional interaction are identified as vital and pervasive features of human societies. Colonial encounters represent an important tool in understanding this phenomenon, as they provide valuable information on a host of themes fundamental to understanding cultural interaction and the more encompassing aspects of culture change. This study contributes to our understanding of this phenomenon by addressing the biocultural impact of Roman expansionism in Britain. Specifically, this research tests the hypothesis that the sociocultural implications of urban development in Roman Britain had a detrimental effect on population health and well-being. Bioarchaeological data were collected from pre- and postcontact populations from northeast England, represented by skeletal remains from the middle Iron Age (450 – 120 BC) and Romano-British period (AD 43 - 457), respectively. Results indicate a significant increase in the frequency of nonspecific indicators of physiological stress during the postcontact period, suggesting greater exposure to the synergistic effects of malnutrition and disease. A decrease in dietary breadth and a less nutritious and more cariogenic diet is indicated by a marked decrease in oral health following the Roman conquest. Changes in activity and behavior are suggested by a general increase in osteoarthritis and traumatic injury in the postcontact population. These findings support the hypothesis that the disruption, inequalities, and ambiguity produced by Roman expansionism had a negative effect on postcontact population biology. As such, both cultural and biological responses to colonialism are suggested to play an important role in the process of identity creation and transformation following colonial encounters.

Morphological changes associated with tooth loss and alveolar resorption in male baboons.

CHRISTOPHER PERCIVAL¹, KATHERINE WILMORE¹, SATAMA SIRIVUNNABOOD², JEFFREY ROGERS^{3,4}, JAMES CHEVERUD⁵, ANNE BUCHANAN¹, KENNETH WEISS¹ and JOAN RICHTSMEIER¹. ¹Department of Anthropology, Penn State University, ²Department of Industrial and Manufacturing Engineering, Penn State University, ³Southwest National Primate Research Center, ⁴Baylor College of Medicine, ⁵Department of Anatomy and Neurobiology, Washington University Medical School.

Tooth loss and alveolar resorption during life can significantly change adult cranial morphology and affect morphometric studies. Some adult males within a skeletal population

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of baboons (*Papio hamadryas*) from the Southwest National Primate Research Center (San Antonio, TX) displayed tooth loss, alveolar resorption, ankylosis, and tooth root resorption. Alveolar resorption associated with canine and incisor tooth loss clearly changed local morphology. We hypothesized that this tooth loss and root resorption also influenced morphology at a distance from the alveolus, because chewing behaviors would change and the canine root extends deeply into the snout. Adult males (n=186) were classified first on the extent of right maxillary canine and nearby alveolar resorption, and secondly by the number of maxillary incisors present. Pairwise EDMA form analyses of a representative subset of right side linear distances were carried out between all classes within each classification scheme. These indicated that there were similar trends of morphological change (not associated with age) of the premaxilla and anterior maxilla within each classification scheme and significantly different local morphology between individuals with negligible resorption and those with complete tooth loss. While resorption was sometimes extensive, especially in individuals lacking upper incisors, there didn't appear to be systematic morphological effects at a distance from sites of resorption. These results imply that morphological changes due to tooth loss and resorption remain localized. Practically, they suggest that morphological studies of baboon populations that include individuals with anterior tooth loss need only exclude measurements near these sites of loss from analysis. The Genomics of Cranial Morphology Project is funded by NSF (BCS:0725227, BCS:0523637, BCS:0725031).

The taphonomy of violence: deconstructing social behavior through the paleopathology of trauma analysis.

VENTURA R. PEREZ. University of Massachusetts Amherst.

The identification of violence and trauma in an archaeological context requires a nuanced and detailed analysis of both material culture and human remains. This paper focuses on sharp-force trauma data from individual skeletal elements for two Ancestral Pueblo sites, Peñasco Blanco (n=1,301) and La Plata (n=3,542); the epiclassic site of La Quemada (n=800); and a historic Yaqui massacre (n=57), that illuminate the challenges of properly interpreting the kinds of violence present and the cultural factors that explain it. The material from these assemblages exhibits examples of a wide range of bone damage and modification including blunt and sharp force trauma, pre- and peri-mortem modification, breakage, chopping, burning, and dismemberment. Using a methodology that combines microscopy of cutmarks (Peñasco Blanco [n=29]; La Plata [n=10]; La Quemada [n=623]; and the Yaqui massacre [n=23]) with detailed taphonomic reconstruction of each category of bone damage, the combined empirical datasets suggest that several of the current explanatory hypotheses cannot be accepted (e.g., cannibalism for the Ancestral Pueblo, and violent trauma for all of the La Quemada remains). By examining the

maximum width and depth of each cutmark in cross-section along with tool use and pattern recognition of the trauma, I suggest a series of alternative hypotheses (postmortem processing for Peñasco Blanco and La Plata; ancestor veneration and mutilation at La Quemada; and trophy taking and maceration for the Yaqui remains) to illustrate the need to move beyond what I have termed checklist osteology (presence or absence) with regard to cutmark analysis.

A well evaluated preauricular groove on the coxal bone is a very reliable sexual trait but not an indicator of parity: Test in the Simon collection of identified skeletons (Switzerland).

GENEVIEVE PERREARD LOPRENO¹ and JAROSLAV BRUZEK^{2,3}. ¹Laboratory of prehistoric archaeology and peopling history, Department of anthropology and ecology, University of Geneva, ²PACEA – Laboratory of anthropology of past populations, UMR 5199 CNRS, University Bordeaux I, Talence, France, ³Department of anthropology and human genetic, Faculty of Science, Charles University, Prague.

The complexity of the structures in the preauricular area of the coxal bone has produced an abundance of publications for almost one and a half century since Zaaijer's first description of the preauricular groove as a "racial" feature in females (Zaaijer, 1866) and the paraglenoid groove being the result of the ligamentous stabilization of the sacroiliac articular capsule (Löhr, 1894). The results of the evaluation and the discernment of these morphologies depend on the method used.

The purpose of the present study is to test the degree of masculinity or femininity of the preauricular area by means of the method of Bruzek (2002) and to investigate the relationship between the preauricular groove presence and parity in a female sub-sample. Scoring was made by two observers.

The studied sample consists of 506 coxal bones (among which there are 237 pairs) belonging to 269 individuals (134 females and 135 males) from the Simon skeletal collection of documented age and sex (University of Geneva, Switzerland). The age-at-death of the subjects varies between 16 and 91 years. Parity, established from the register of families, is known for a sub-group of 99 females.

The results show that the distinctive feminine morphologies, described as having a true preauricular groove, are not linked to parity. Nevertheless, this distinctive feature is specific to females, and it is not possible to confuse it with a paraglenoid groove; we did not observe the specific feminine morphology in the male coxal bones. The correlation of the inter-observers results is strong and allows us to discuss the problems of definition, history and origin of the true preauricular groove as a sex-linked trait. This study was funded by the Swiss National Fund of Scientific Research (grant n° FNS 31-53681.98)

***De novo* sequencing and evolutionary analyses of liver-expressed genes in primates.**

GEORGE PERRY¹, YING WANG¹, JOHN MARIONI¹, YOAV GILAD¹, and JONATHAN PRITCHARD^{1,2}. ¹Department of Human Genetics, University of Chicago, ²Howard Hughes Medical Institute, University of Chicago.

We used oligo(dT)-conjugated magnetic beads and the Illumina Genome Analyzer to sequence the mRNA products of genes from the liver tissues of 4 unrelated individuals per species in a diversity of primates: humans, chimpanzees, vervets, rhesus macaques, common marmosets, mongoose lemurs, crowned lemurs, black & white ruffed lemurs, Coquerel's sifakas, and aye-ayes. Because we did not have the benefit of prior genome sequence information for most of these species, we used a paired-end design and relatively long sequencing reads to assist *de novo* gene transcript assemblies. The resulting dataset contains thousands of fully-sequenced genes with corresponding estimates of relative gene expression levels for each species, facilitating across-primate evolutionary analyses at the protein coding, gene structure, and gene regulatory levels. Furthermore, for hundreds of genes per species, we also have sufficient sequence coverage - for each individual - to identify single nucleotide polymorphisms (SNPs), which provides a species-level estimate of genetic diversity and the opportunity for additional evolutionary tests. This study was funded by the Howard Hughes Medical Institute.

Wild expectations: Evaluating the standards of care for chimpanzees in the federal sanctuary system.

REEMA PERSAD-CLEM¹, MEREDITH DORNER², LAUREN SARRINGHAUS³, GINGER STANLEY⁴ and WILLIAM MCGREW⁵. ¹Project Dragonfly, Miami University, Ohio, ²MiraCosta College, ³Department of Anthropology, University of Michigan, Ann Arbor, ⁴Department of Anthropology, Miami University, Ohio, ⁵Leverhulme Centre for Human Evolutionary Studies, University of Cambridge.

We did an empirical test of the Standards of Care for Chimpanzees Held in the Federally Supported Sanctuary System (SCCHFSCS), which encourages species-typical behaviors through mandates such as exposure to natural settings and wider ranging areas. We studied the pre-release and post-release behaviors of the first group of 18 captive chimpanzees (*Pan troglodytes*) to make the transition to an outdoor lifestyle in a 6-acre forest (Habitat) at Chimp Haven Inc. (CH), Louisiana. We used scan sampling to assess non-social behavior e.g. outdoor period, spatial use and social behavior e.g. grooming, proximity, territoriality and compared our results to data collected on wild chimpanzees. Post-release, quadrupedalism (89%) and climbing (11%) fell within the range of wild chimpanzee locomotion, as did the overall level of social behavior (11%). In the Habitat, associations resembled the social grouping of wild chimpanzees, with groups of 1-5 individuals (χ^2 (10) = 258.3; p = 0) being

the most common. However, CH individuals were more terrestrial (95%) than wild chimpanzees, spent less time foraging (13%) and did not use vegetation in a similar fashion to wild conspecifics. Dissimilarities in forest structure, advanced age, absence of resource competition and minimal influence of neighboring communities hindered comparisons to wild chimpanzee behavior. Nonetheless, the element of choice afforded to CH individuals by the SCCHFSCS is what distinguishes their current existence from their former research lives and to some extent, is what they have in common with wild counterparts. This study was funded by the Zoology and Anthropology Depts., Miami University.

Missing data and the taxonomy of *A. africanus*.

TIM PETERSEN. University of New Mexico.

The cranial base includes many features that appear to be useful in paleoanthropological analyses, including the taxonomy of *A. africanus*. Previous morphometric work has shown that the basicranial shapes of StW 505 and Sts 19 are the most distinct from the remainder of the attributed fossils, but also that they are unlikely to be both conspecific and taxonomically distinct from *A. africanus*. A total of 27 variable morphological characters were employed to expand upon this result and either support or contradict it. Some had been previously identified by others and some were developed for this project. As with the morphometric data, most specimens could not be scored for one or more traits due to lack of preservation. In order to overcome this difficulty and to permit simultaneous comparison of more specimens, groups of fossils with overlapping preservation were identified. For a given group, the matrix of resulting pairwise similarities on observable traits were ordinated with NMDS to identify specimens with unusual morphological patterns. When taken in concert with the morphometric analyses, these results indicate that Sts 19 is the specimen most likely to be distinct from *A. africanus*, but StW 505's apparent distinctiveness in the morphometric results is not supported by its morphological pattern. Two other specimens, however, the calvaria Sts 25 and the occipital fragment StW 580, also show consistent distinction. These analyses therefore indicate that the *A. africanus* cranial-base sample is likely polytaxic, but any different species is represented by only a few specimens. Supported by NSF grant no. BCS-0451969.

Metagenomic approaches to studying primate dietary ecology.

SARAH PICKETT¹ and ANTHONY DI FIORE^{1,2,3}. ¹Department of Anthropology, New York University, ²Center for the Study of Human Origins, New York University, ³New York Consortium in Evolutionary Primatology.

Description of primate diets is often based on direct observation of foraging behavior and morphological classification of food remains from feces. However, for some diet items (e.g.,

insect prey), it may be difficult or impossible for researchers to identify what is being consumed visually, and observation conditions may not always permit adequate sampling of feeding behavior. Moreover, taxonomically-informative morphology (e.g., seeds, insect exoskeletons) may be destroyed by the digestive process. Given these impediments, a metagenomic approach to studying diets provides a promising alternative. We used this approach in a preliminary study of interspecific and temporal variation in the insect diets of several sympatric New World monkeys that are known to differ in feeding ecology. From fecal DNA extractions of wild woolly, titi, saki, capuchin, and squirrel monkeys, we selectively amplified arthropod-specific mtDNA sequences using conserved primers. PCR products were then either sequenced directly or cloned and then sequenced and compared to existing arthropod sequences in the NCBI GenBank and Barcode of Life Data Systems (BOLD) databases to assign the order, family, and occasionally genus-level taxonomy of the insect DNA present in each sample. Our study is the first to successfully use molecular techniques to identify insect prey in primate diets, and our results suggest that a metagenomic approach may prove valuable for corroborating observational data and for expanding the resolution of primate diet studies. As comparative data become available for additional animal and plant taxa, the approach also holds promise for studying other components of primate diets. This research was supported by the Collegiate Research Scholar grant from New York University. Additional funding was provided by the New York University Molecular Primatology Laboratory.

The facial reconstruction of the Amud 1 fossil.

BRIAN E. PIERSON and TRENTON W. HOLLIDAY. Department of Anthropology, Tulane University.

Amud 1 is a Mousterian-associated skull of an adult male *Homo neanderthalensis* from Amud cave in northern Israel dating to ca. 50 kya. The specimen has been noted as one of the largest individual Neanderthals ever recovered. The cranial capacity of the Amud 1 skull is estimated at 1740 cc – larger than that of most modern humans. Here we detail a recently-realized facial reconstruction of the specimen. Facial reconstruction is a relatively new science, and has only been executed with competence in the last decade. The methods used in this reconstruction are based on the Manchester method, utilizing the most current measurements, techniques and materials. Most of the midface of Amud 1 is missing; however the base of the nasal aperture remains intact offering enough information to speculate the bi-alare margins. Also, since only a small proximal fraction of the left nasal is preserved, nasal bones for the specimen were reconstructed using comparisons with other Neanderthals and following the relationship of the position of rhinion to the bi-orbitale chord previously noted by us (Pierson and Holliday, 2008). The other skeletal features that are used for facial

reproduction are intact. The final appearance of the reconstruction is consistent with the geological age of the remains and *H. neanderthalensis* features. The specimen's large size and robust features are unique, and as a teaching tool this facial reproduction may help to reduce some of the stereotypes associated with earlier, less careful, reconstructions of Neandertals.

An assessment of health and lifestyle among pre-1521 Chamorro from Saipan, Commonwealth of the Northern Mariana Islands.

MICHAEL PIETRUSEWSKY¹, MICHELE TOOMAY DOUGLAS¹, MARILYN SWIFT², RANDY HARPER² and MICHAEL A. FLEMING². ¹Department of Anthropology, University of Hawaii at Manoa, ²Swift and Harper Archaeological Resource Consulting, Saipan.

An earlier investigation of health and disease in the Mariana Islands (Guam, Rota, Tinian, and Saipan) suggested that the prehistoric inhabitants of Saipan experienced more stress than the prehistoric Chamorro living on Guam. Utilizing general and specific indicators of stress recorded in skeletal remains from two recently excavated sites on Saipan, the Chalan Monsignor Guerrero Road Project (CGM) and the Beach Road Sewer System (BRSS) sites, this new study focuses on the health and lifestyle of pre-1521 Chamorro living on Saipan. Chamorro subsistence economies included reliance on cultivated tree and root crops, fishing, and possibly rice. The non-specific indicators of systemic stress investigated include cribra orbitalia (CO), LEH, and stature. The more specific stressors examined include trauma, infection, and dental disease (e.g., AMTL, caries, dental abscess, etc.). With the exception of significantly lower dental caries prevalence ($P = 0.0001$) in the new Saipan series, the frequencies of stress indicators are similar in the skeletal series from Saipan. Comparisons between Saipan and Guam reveal significantly higher frequencies of CO, AMTL, and dental attrition and lower frequencies of dental caries in the Saipan series. Although not significant, slightly higher frequencies of treponemal infection and limb bone fractures are observed in the Saipan series. The results of this new study provide partial support of the earlier assessment that the prehistoric inhabitants of Saipan were subjected to greater stress levels than those living on Guam. Cultural habits such as chewing betel-nut and other environmental and cultural differences are examined to explain these results. This research was funded in part by Capital Improvement Funds, Saipan, CNMI.

Evidence for ritual and trauma in 2nd to 6th century AD human skeletal remains from Samtavro in the Republic of Georgia.

VARSHA PILBROW¹, CHRIS BRIGGS¹, ANTONIO SAGONA², VAKHTANG NIKOLAISHVILI³, CLAUDIA SAGONA², CLIFF OGLEBY⁴, GELA GIUNASHVILI³ and

GIORG MANJGALASHVILI³. ¹Department of Anatomy and Cell Biology, University of Melbourne, ²School of Historical Studies, University of Melbourne, ³Georgian National Museum, ⁴Department of Geomatics, University of Melbourne.

Samtavro is a large cemetery site in the town of Mtskheta, the capital of the Caucasian Kingdom of Iberia, which covered the eastern half of the present day Republic of Georgia. Joint excavations by the University of Melbourne and the Georgian National Museum at Samtavro have revealed Persian, Roman and Byzantine influences from roughly the 2nd to 6th century AD -- a testimony to the chequered political and population history of the region during pre-Christian and early Christian times. The evidence for ritual and trauma is strong among the skeletal population. Of the 36 tombs excavated, 24 contained human remains substantial enough to be attributed to individuals. Sixty individuals were identified, of which only five presented complete articulated skeletons. Crammed remains of multiple burials, separation of cranial from postcranial elements and post-mortem re-arrangement of long bones into geometric patterns are some of the burial rituals encountered. A common social practice was the intentional modification of the cranium by antero-posterior or bilateral compression. Four of the six adult crania were intentionally modified, resulting in tall domed heads. The evidence for trauma was seen in pre-mortem bilateral cuts along the posterior side of the proximal tibia (two individuals), partially healed wounds in the parietal (two individuals) and possible case of hangman's fracture. The significance of the ritual and trauma is being investigated, but equal representation of both sexes and age groups in the burials, lack of militaristic grave goods, and prevalence of everyday luxury items precludes warfare, systematic conflict or pillaging. The Australian Research Council, the University of Melbourne and the Georgian National Museum funded this research.

Dental phenotypic variation at Neolithic Çatalhöyük, Turkey: Identifying kin relationships in an early farming society.

MARIN A. PILLOUD¹ and CLARK SPENCER LARSEN². ¹Department of Anthropology, San Jose State University, ²Department of Anthropology, The Ohio State University.

The Neolithic site of Çatalhöyük (7400 – 5600 cal BC) in Turkey is widely recognized for its role in understanding early farming societies. Since 1993, some 500 individuals have been recovered from house floors throughout the site. Using data collected on dental metrics and morphology, this study tests the hypothesis that houses and house groupings represent family units and the social structure of Çatalhöyük was largely kin-based. Data were collected ($n=266$) and subject to various univariate and multivariate statistical treatments to identify potential kin groups. Results indicate that inclusion for interment within a house or neighborhood was only minimally related to biological affinity. That is, biodistance appears

to have little to do with potential kin relationships. However, in a few cases where houses endured over time through rebuilding episodes, there appears to be a preference for inclusion of related individuals. Distinctive phenotypic variation was also found at a larger division of the site into northern and southern components. These findings suggest that Çatalhöyük social structure was centered on the house as the unifying social principle. Membership within a house cemetery transcended biological lines, creating a fluid definition of "kin." However, in rare instances, there is a suggestion of lineal descent groups in houses rebuilt over time. In addition, we argue that the northern and southern components represent two moieties important in defining social structure. These findings contribute to the understanding of the transition to settled life and inform the discussion on cultural evolution and biological infinity in this Neolithic setting. Funded by grants from the Ohio State University, American Research Institute in Turkey (Pilloud), and National Geographic Society (Larsen).

Metric and morphological sex differences in the ulna. Discriminant function for Mexican population.

MARTHA PIMENTA¹ and GALLARSO ALFONSO². ¹Centro Peninsular en Humanidades y Ciencias Sociales., UNAM, ²Centro INAH Yucatán.

With the aim to offer better options to sex determination for Mexican population in forensic and archaeological cases, this study was made. The analysis of ten variables in the ulna of 86 individuals of known sex from the Mexican skeletal collection housed at the Medical School of the National University of México. All of them came from cadavers used in the dissection room. All of them are from the Forensic Medical Service of Mexico City and several hospitals. The outcome that all of the 10 measurements were significant differences between females and males and nine side as well. Finally we obtain 36 discriminant function for sex determination with at least 80% of reliability.

Connated permanent dentition and the implications for interpreting mortuary practice at the site of Ancón, Peru.

CHRISTINE M. PINK. Department of Anthropology, University of Tennessee, Knoxville.

The present research describes the unilateral expression of connated, or double teeth, in two individuals interred at the Ancón necropolis. The mortuary component at the site of Ancón has been utilized for an extended period of time including the Pre-ceramic through at least the Late Intermediate Period (LIP) (2000 BC-1470 AD). This study focuses on one tomb context at Ancón thought to date to the Middle Horizon (600-1000 AD), possibly into the LIP (1000-1470 AD).

It has been suggested that the occurrence of double teeth has a genetic basis (Hitchin and

Morris, 1966). Three individuals from the same mortuary context were examined with the trait present for two females, but not in the male individual. The double teeth also did not have an identical expression in the affected females. Despite inconsistencies in the expression of this trait, it is proposed that the individuals in the tomb represent a familial or biologically closely related group. This may have been the pattern of burial at Ancón for later interments, with tombs being used by nuclear or extended families, possibly according to matrilineal descent. This case has important implications for understanding mortuary ritual at Ancón during this period and for coastal populations on the whole.

This study was funded by the William M. Bass Endowment.

Dental health and population stress at Ancón, an archaeological site on Peru's central coast.

MATTHEW JAMES PISCITELLI and SLOAN R. WILLIAMS. Department of Anthropology, University of Illinois at Chicago.

Bones and teeth are useful for testing hypotheses and making inferences about health and disease, nutrition and diet, demography, and ancient lifeways. This study compares male and female dental health across the lifetimes of individuals who were buried at the Necropolis of Ancón, located 40 km north of Lima on Peru's central coast. The Necropolis of Ancón was an ancient cemetery that contained burials dating from the Early Intermediate Period through the Late Horizon (200 BC-1550 AD). We analyzed 88 individuals from material originally collected by Dorsey for the Chicago World's Fair in 1893 and currently housed at the Field Museum of Natural History in Chicago. Like many other museum collections, postmortem anterior tooth loss prevented our investigation of linear enamel hypoplasia, a commonly used indicator of populational stress. Therefore, we compared molar wear patterns and carious lesion and abscess frequencies with long bone measurements and age-at-death estimates in order to understand the relationship between dental health, stature and age at death and gauge population health levels at Ancón. This investigation serves as a general study of health in an ancient cemetery population from coastal Peru and provides an opportunity to revisit the osteological paradox.

Analysis of Postcranial Remains from Sanjan, Valsad District, Gujarat State, India.

GAURI PITALE. Department of Anthropology, Southern Illinois University Carbondale.

The site of Sanjan located in state of Gujarat in India has yielded many osteological remains dating to the 15th century A.D. This site represents a large city that existed between the 8th and 13th centuries A.D. Sanjan is probably one of the earliest locations on the Indian subcontinent where the Zoroastrian population settled after fleeing from Iran due to Islamic persecution. This study has utilized approximately 12% of the post-cranial remains, which were randomly sampled from the entire

range of excavated osteological material. This collection is particularly notable because these skeletal remains are those belonging to a well-defined endogamous group, corresponding to a concise temporal span. The goal of this study was to determine whether the Sanjan remains have traits consistent with those known to characterize contemporary Zoroastrians. Analysis of the post-crania has revealed that by and large the populace at Sanjan was a healthy and well-nourished one. The pathologies that have been encountered are mainly confined to non-specific infections and neoplastic growths. Apart from that, one femur shows evidence of Osteopenia. It is important to determine whether the study of the remaining osteological collection will yield more evidences along these lines as the present day Zoroastrian population of India has high occurrences of Osteoporosis. Comparative study done in the future on remains from Sanjan and present day Zoroastrians will assist biological anthropologists in determining how these people adapted to their new environment.

3D geometric morphometric analysis of Miocene hominoid mandibular symphysis shape.

MARY K. PITIRRI¹, NANDINI SINGH², KATERNIA HARVATI³, DAVID R. BEGUN¹ and LÁSZLÓ KORDOS⁴. ¹Department of Anthropology, University of Toronto, Canada, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Germany, ³Department of Early Prehistory and Quaternary Ecology, Eberhard Karls University of Tübingen, Germany, ⁴The Geological Institute of Hungary.

The primate mandible contains important information regarding function, dietary adaptations, and phylogeny. Although Miocene hominoid mandibular specimens are often very fragmentary, the symphyseal aspect is frequently preserved and provides an opportunity to assess the variation among Miocene taxa, as well as the similarities of these taxa to extant hominoids. Here, 3D geometric morphometric methodology is applied to quantify and compare the shape of the mandibular symphysis of eight Miocene fossil taxa (*Rudapithecus hungaricus*, *Dryopithecus fontani*, *Griphopithecus alpani*, *Epipliopithecus vindobonensis*, *Proconsul heseloni*, *Proconsul nyanzae*, *Ouranopithecus macedoniensis*, *Sivapithecus sivalensis*), and a comparative sample of extant hominoids (*Hylobates*, *Pongo*, *Pan troglodytes*, *Pan paniscus*, *Gorilla*). The shape of the symphysis was captured using five landmark co-ordinates. Generalized Procrustes analysis was used to superimpose the specimen landmark configurations and the superimposed coordinates were analyzed using standard multivariate statistical techniques, including principal component analysis, and cluster analysis. Mandibular shape differences along principal components were visualized, and the effect of size-related shape variation was analyzed. Results highlight the uniqueness of *R. hungaricus* relative to the other Miocene taxa. *R. hungaricus* was separated from all other fossil taxa, grouping this specimen with the

majority of the extant hominoids. *R. hungaricus* displays a tall, narrow symphysis that lacks a superior transverse torus, while the remaining Miocene taxa exhibit short, wide symphyses with superior transverse tori. Multiple lines of evidence (dental morphology, microwear and mandibular morphology) reveal a unique functional pattern in *R. hungaricus*, including a combination of soft fruit frugivory and specialized anterior dental processing. Research supported by the University of Toronto, the Max Planck Society, the EU PF4 Marie Curie Actions grant MRTN-CT-2005-019564 'EVAN', the Alexandre von Humboldt Research Foundation, and the Natural Sciences and Engineering Research Council of Canada.

Gait acclimatization as a function of age and task demands in young children.

JOHN D. POLK¹ and KARL S. ROSENGREN².

¹Department of Anthropology, University of Illinois Urbana-Champaign, ² Department of Psychology, Northwestern University.

Bipedal gait is a hallmark human characteristic, yet the manner in which we acquire locomotor skill is dependent on the interaction between various physical and environmental components. We present recent data on young children's locomotor skill as a function of age and changing task demands. A number of researchers have suggested that (1) as infants begin to walk, gait asymmetries result from the competing task demands of maintaining balance and propelling oneself forward, and 2) as children acquire greater experience with walking, they modify their gait to fit the particular needs of the task. We evaluated the gait skill of children aged 2-5 in performing several common balance and propulsion tasks and assessed age- and task-related differences. Younger children demonstrate more variability in gait measures than older children, and both balancing and propulsive tasks influence the patterns of movements and variability. By demonstrating task and age-related changes in patterns of movement, we show that skilled movement emerges as a function of interacting organismic and environmental demands, and not due to either a predetermined mental representation of the task or genetic blueprint.

Hominoid daily energy expenditure and the Human Paradox.

HERMAN PONTZER¹, DAVID A. RAICHLEN² and BRIAN M. WOOD³.

¹Department of Anthropology, Washington University, ²School of Anthropology, University of Arizona, ³Department of Human Evolutionary Biology, Harvard University.

Among the living hominoids, human foragers use the longest daily travel distances and spend the greatest amount of time and energy gathering and preparing food. Yet despite these substantial daily energy costs, human foragers, even those in low-productivity habitats, reproduce at substantially higher rates than the other great apes. This Human Paradox – the ability to maintain high reproductive output despite high foraging costs – suggests that

human metabolic physiology is adapted to a high rate of energy throughput, requiring more mass-specific energy per day than other apes and consequently providing more energy for reproduction. Alternatively, daily energy expenditures may be similar in humans and other apes, and differences in reproductive rates may be caused by differences in energy allocation (e.g., repair versus reproduction). To test these hypotheses, we examine direct measurements of daily energy expenditure in humans and orangutans, as well as direct measurements of resting metabolic rates in humans, orangutans, and chimpanzees, to determine whether human daily energy expenditures (kCal/day) exceed those of other hominoids. Results suggest that the metabolic physiology of apes is evolutionarily labile, and that differences in life history strategies among living apes reflect differences in energy throughput and not simply energy allocation. Further, these results challenge "zero-sum game" models of hominid energetics, instead suggesting that increased energy expenditure in activities such as ranging can increase the energy available for other activities such as reproduction. This work was supported by the National Science Foundation.

Facial phenotypic differences in children with Autism spectrum disorders.

KIMBERLY K. POPE¹, IAN D. GEORGE¹, T. NICOLE TAKAHASHI², JUDITH H. MILES², YE DUAN^{2,3} and KRISTINA ALDRIDGE^{1,2}.

¹Department of Pathology & Anatomical Sciences, University of Missouri School of Medicine, ²Thompson Center for Autism and Neurodevelopmental Disorders, University of Missouri, ³Department of Computer Sciences, University of Missouri.

The brain develops in concert and in coordination with the developing facial tissues, with each influencing the development of the other. Autism spectrum disorders (ASD) result from alterations in the embryological brain, suggesting that the development of the face of children with ASD may show subtle facial differences compared to typically-developing children. We test this hypothesis by comparing three-dimensional photographic images acquired from children with ASD and age-matched, typically-developing children. The 3dMD Cranial system was used to acquire 3D stereophotogrammetric images for our study sample of 8-12 year old children diagnosed with ASD (N=60) and typically-developing children (N=69) following approved IRB protocols. Three-dimensional coordinates were recorded for 17 facial anthropometric landmarks from these images using 3dMD software. Age-matched comparisons of facial morphology in the two groups were completed using Euclidean Distance Matrix Analysis (EDMA). Results show that there are significant differences in facial morphology in children with ASD compared to typically-developing children. Children with ASD have significantly broader orbits, philtrums, and mouths, and higher foreheads relative to typically-developing children. Typically-developing children display more anteriorly prominent foreheads and nasal

bridges relative to children with ASD. We also find a subgroup of children with ASD with facial morphology that differs from the majority of the children with ASD and the typically-developing children; this subgroup is defined by a superoinferiorly longer midface. These results indicate that alterations in the developing brain may be associated with subtle, but distinct differences in facial phenotypes. Work supported in part by ASDRP W91ZSQ8006N604 and the Simons Foundation.

Diet and phylogeny in primate communities.

LEILA PORTER¹ and JOHN FLEAGLE². ¹Department of Anthropology, Northern Illinois University, ²Department of Anatomical Sciences, Stony Brook University.

Many aspects of primate biology are strongly associated with phylogeny, including such features as body size, life history, locomotion, and even social behavior. Closely related species tend to behave in similar ways. One aspect of primate ecology that has rarely been examined in a phylogenetic context is diet. There are many reasons to expect that primate diet is associated with phylogeny, including the fact that closely related taxa are widely known to share features of their dentition and digestive physiology. In order to examine the relationship between diet and phylogeny in primate communities, we have examined the diets of sympatric species of primates in communities from South America, Africa and Asia using Renkonen's Percentage Similarity Index, and subsequently used the indices to perform cluster analyses of the same data. For two communities in which dietary data on sympatric taxa were collected synchronously, dietary similarity corresponded almost exactly with phylogeny. The relationship between diet and phylogeny was less strong in other communities, possibly reflecting the effects of inter-annual dietary variation on the species' diets and/or adaptive diversity within clades. These results demonstrate that phylogeny is a key factor in shaping primate feeding and foraging behavior, and indicate that more detailed, synchronic studies of whole communities are needed to improve our understanding of primate diets.

Forensic anthropological and chemical contributions to the determination of cause of death: A case study.

WENDY E. POTTER. Department of Anthropology, University of New Mexico; New Mexico Office of the Medical Investigator.

Partial skeletal remains were recovered from a remote mountain campsite in New Mexico. As the cause and manner of death (COD/MOD) were not apparent, the forensic pathologist consulted an anthropologist. An atypical rib fracture was observed and perimortem trauma was suspected. If the fracture was the result of a ballistic injury, residue from the projectile may remain on the bone. The rib fragment was subjected to gross and microscopic examination, radiography, and chemical tests (to detect heavy metals and lead). These analyses revealed that

the splayed fracture had small radiopacities, which were visible as dark specks under a dissecting microscope. A team of ballistics experts (Albuquerque Police Department) conducted the chemical detection of metal residues. A control with known positive for lead was performed, and then the dark specks were scraped from the bone. These tested positive for metal/lead residues. In addition, the internal aspect of the rib was tested and also indicated the presence of heavy metal residue (not tested for lead to preserve a sample for independent lab tests). The anthropological analysis, microscopic examination, and radiography were suggestive of ballistic injury, and the chemical tests confirmed the presence of heavy metal and lead residue on the bone. Accordingly, the pathologist determined that the COD was a gunshot wound (manner: homicide). This case study illustrates the benefits of multidisciplinary collaboration in a medicolegal setting; through the efforts of the pathologist, anthropologist, and criminalists, a determination of COD/MOD was possible, providing closure for loved ones and evidence for legal proceedings.

Differential infant and child mortality and morbidity in Late Anglo-Saxon England.

RONIKA POWER¹ and HOLGER SCHUTKOWSKI². ¹Department of Ancient History, Macquarie University, Sidney, ²Archaeological Sciences, University of Bradford, Bradford, United Kingdom.

Distributions of mortality and morbidity during infancy and childhood provide meaningful proxies for ambient living conditions and the local socio-ecology of past societies. Whilst age-related trends have been extensively studied in this regard, the biological sex of juvenile individuals is largely excluded from demographic configurations despite suitable methods available for assessing sex from sub-adult skeletons. This study investigates whether the inclusion of sub-adult sex amongst Late Anglo-Saxon (10th-12th centuries AD) population data provides indications of differential child and infant mortality and morbidity, as well as inferences regarding biases in parental care.

Methods of morphological sex assessment were applied to the sub-adult components of the proto-urban St. Peter's Church, Barton-upon-Humber (N=108), and rural Raunds Furnells (N=152) assemblages. Osteological analysis indicates that differential child and infant mortality and morbidity were extant at both sites, with females predominating amongst the samples, in particular during early childhood. These results stand in opposition to the initial research hypothesis of higher male mortality due to inherent biological weakness and enhanced female vigour. Unbalanced mortality and morbidity sex ratios are synthesised with historical, archaeological and ethnographical evidence to infer that female offspring received diminished parental investment at both Barton-upon-Humber and Raunds Furnells under complex environmental and social conditions.

Substantial disparity in mortality sex ratios between the sites is suggestive of regional bio-

cultural variation in parental behaviour, with extremely low ratios at Raunds, inferring that gender discrimination against females was more severe in the rural population. RP was supported by an Australian Commonwealth Scholarship (UCR-2006-8).

Three-dimensional study of pulp chamber and radicular canal morphology in hominin premolars.

LEYRE PRADO-SIMON¹, ANTHONY J. OLEJNICZAK¹, JOSE MARIA BERMUDEZ DE CASTRO¹, AIDA GOMEZ-ROBLES¹, PILAR BACA GARCIA² and MARIA MARTINON-TORRES¹. ¹Dental Anthropology Group, National Centre of Human Evolutionary Studies (Spain), ²Department of Estomatology, University of Granada (Spain).

Although many studies have explored aspects of the hominin dentine-pulp complex, most are based on standard 2D radiography or histology, or even external observations of the tooth root. The 3D morphology of the pulp chamber has not been systematically studied, but could offer novel information regarding taphonomy and hominin biology, and it facilitates analysis of broken fossils, including teeth exhibiting substantial attrition or taphonomic weathering. Here we present 2D and 3D measurements of hominin tooth roots and pulp chambers obtained via microtomographic imaging. Our sample consists of permanent lower second premolars from *Homo sapiens* (recent), *Homo neanderthalensis* (Krapina), *Homo heidelbergensis* (Atapuerca; Sima de los Huesos), and *Homo antecessor* (Atapuerca; Sima del Elefante). Our results reveal differences in several aspects of root and pulp morphology between species when overall tooth size is accounted for. With the exception of *Homo neanderthalensis*, the pulp chamber and radicular canal approximately follow the contour of the external surface of the tooth; in *H. sapiens* and *H. heidelbergensis*, both surfaces evince a conical shape. In *H. neanderthalensis*, the shape of the pulp chamber and canal were similar to the other taxa (approximately conical), but the external surface of the root was cylindrical, demonstrating that the shapes of the internal and external root surfaces are not necessarily tightly correlated. This study demonstrates that microtomography is an important tool for the study of the dentine-pulp complex, and that species level differences among hominins can be identified even in cases where only partial roots fragments are available. Research supported by the Atapuerca Foundation, CENIEH, the University of Granada, the Spanish Ministry of Science and Innovation, NESPOS, and SEPA.

Morphometric analysis of MT 2 with *Pan*, *Gorilla*, *Homo* (recent and Holocene), and South African fossil hominins.

DANIEL J. PROCTOR. Department of Anthropology, University of Iowa.

This study examined MT 2 using linear measurements, to test the hypothesis that the

human metatarsal base and proximal articular surface is narrower than in apes (Susman, 1983). A sample of *Pan*, *Gorilla*, *Homo* (recent and Holocene) was used. The first analysis used eight measurements in a principal components analysis, and included Stw 89. Factor 1 is attributed to size. Factor 2 accounted for 11% of the variation and is attributed to differences in shape. Human and ape groups are distinguished primarily by *Homo* having a narrow articular surface, which accounted for 65% of factor 2. The metatarsal dorso-plantar base is relatively larger in apes, accounting for 45% of the variation. The fossil Stw 89 groups most with *Pan*, and is within the range of *Gorilla* but outside the range of *Homo*. The second PCA used four variables and included Stw 377, Stw 89, SKX 247, Stw 573d (Little Foot), and Stw 595c (previously unpublished). Factor 1 was attributed to size; factor 2 accounts for shape differences and 15% of the variation. Factor 2 reflected the largest difference, that *Homo* has a narrow articular surface relative to the apes, accounting for 48% of the variation. Specimens Stw 89 and Stw 595c show most similarity to apes and do not fall within the range of *Homo*. Specimens Stw 577 and Stw 573d fall more within ape ranges but overlap the extreme range of *Homo*, while SKX 247 falls within the lower range of *Homo* and upper range of *Gorilla*.

(Paleoanthropology) early hominin evolution, (Paleoanthropology) early *Homo* evolution, or (Human Skeletal Biology) functional skeletal biology of humans

The role of selection-nominated candidate genes in determining Indigenous American skin pigmentation.

ELLEN E QUILLEN¹, ABIGAIL W. BIGHAM², RUI MEI³ and MARK D. SHRIVER¹. ¹Dept. of Anthropology, The Pennsylvania State University, ²Dept. of Pediatrics, University of Washington, ³Affymetrix, Inc., Santa Clara, California

World-wide variability in skin pigmentation has been a subject of anthropological inquiry from the beginning of our discipline. Recent genomic studies indicate that skin pigmentation is one of the most rapidly evolving phenotypes in many human populations and that genes underlying skin pigmentation have been subject to some of the most extreme selective pressures of any genes in the human genome. Unlike previous research, this study both identifies pigmentation genes that have undergone selection in Indigenous American populations and tests the influences of these genes on skin color in admixed individuals. 906,600 single nucleotide polymorphisms (SNPs) were surveyed for signatures of selection in indigenous populations from Central and South America. Evidence of selection was identified by comparison to HapMap Phase I populations using reduction in heterozygosity (*InRH*), Locus-Specific Branch Length (LSBL), Tajima's *D*, and haplotype block structure. In the 12 pigmentation candidate genes that show the strongest evidence of selection (*ADAM17*, *POMC*, *AP3B1*, *OPRML*, *SILV*, *OCA2/HERC*, *PLDN*, *MYO5A*, *RAB27A*, *CYP1A2*, *ATRN*, and *ASIP*), 48 SNPs selected to represent the overall

variation in the selection nominated candidate genes were genotyped in individuals of admixed Indigenous American and European ancestry. These SNPs show substantial allele frequency differences between the parental populations. Using admixture based regression model analyses, genes contributing to darker skin pigmentation in Indigenous Americans were found. This study not only identified skin pigmentation genes contributing to skin color variation in previously understudied Indigenous American populations, it validated the usefulness of using population genetic tests of selection to identify functional genes. This study was generously funded by the National Science Foundation Dissertation Improvement Grant 0925976

The role of dietary toughness in the ontogeny of Nicaraguan mantled howler monkey (*Alouatta palliata*) feeding behavior.

MELISSA RAGUET-SCHOFIELD¹. ¹University of Illinois at Urbana-Champaign, Department of Anthropology.

This study investigates the ontogeny of feeding behavior in mantled howler monkeys (*Alouatta palliata*) living at La Isla de Ometepe, Nicaragua, in order to determine whether or not accelerated growth and maturation in folivorous primates enables these species to rapidly and efficiently meet the masticatory and digestive challenges of an adult-like, leaf-based diet. Two groups of howlers were followed for one year, and data were collected on the dietary patterns of juveniles (approximately 6-18 months, n=10), adult males (n=8) and adult females (n=20). Resource toughness was quantified using a portable field tester. A toughness profile was calculated for each age and sex class by multiplying the time spent feeding (TSF) times the average toughness for 7 species of commonly consumed mature leaves. Results indicate that howlers of all age and sex classes consumed similar diets, in terms of gross dietary category and plant species. Juveniles, however, had a toughness profile that was only 74% that of adults. This difference in adult/juvenile feeding behavior suggests that masticating and digesting an adult-like diet containing tough resources posed significant challenges to juveniles. The results of this research demonstrate that juveniles' dietary inefficiencies may have far-reaching consequences for the evolution of the mantled howler life history strategy, including patterns of growth and maternal investment tactics. This research was supported by the National Science Foundation (Dissertation Improvement Grant 0622411), the Graduate College at the University of Illinois, a Beckman Institute CS/AI Fellowship, Idea Wild, and Sigma Xi (Grant-in-Aid of Research).

Histological age at death estimation from the second metacarpal.

ÉMELINE RAGUIN¹, MARGARET A. STREETER², RICHARD LAZENBY³ and MICHELLE S.M. DRAPEAU¹. ¹Department of Anthropology, Université de Montréal, ²Department of Anthropology, Boise State

University, ³Anthropology Program, University of Northern British Columbia.

This preliminary study tests the hypothesis that evidence of bone remodeling in the second metacarpal (MC2) can be used to estimate age at death. The metacarpals used in this analysis originated from an historic European sample from Ontario, Canada (n=63, 33 males and 30 females). They range in age from 19 to 61 years (mean=41.1±11.6). Age was known or independently estimated from gross morphology. For each right and left MC2, Osteon Population Density (OPD; intact and fragmentary osteons/mm³) was recorded on four quadrants (anterior, posterior, medial, lateral), sampling two periosteal to endosteal columns separated by one column width.

When the sexes were combined, OPD correlated moderately but significantly with age (right r=0.559, left r= 0.606). However, when males and females were analyzed separately, the correlation between OPD and age in the female sample was improved (right r=0.669, left r=0.766) while that of males was reduced (right r=0.498, left r=0.501). It remains unclear why the correlation is better in females than males, but similar results have been obtained in other studies. These results also indicate that there is a better correlation between OPD and age in the left MC2 than in the right. Given that most humans are right handed, and in this population males are more likely to be engaged in heavy labor, the right hand and males in general may have experienced greater loading, which could have induced greater remodeling and "blur" the correlation of OPD with age. This hypothesis needs to be investigated further. This research was funded by the Fonds québécois de recherche sur la société et la culture (Grant 2008-NP-108312 to MSMD) and by the Natural Sciences and Engineering Research Council of Canada (Grant 183660-03 to RL).

Neurobiological rewards and the evolution of the runner's high in humans and cursorial mammals.

DAVID A. RAICHLEN¹, ANDREA GIUFFRIDA², GREGORY L. GERDEMAN³ and ADAM D. FOSTER¹. ¹School of Anthropology, University of Arizona, ²Department of Pharmacology, University of Texas, Health Science Center, ³Department of Biology, Eckerd College.

The incorporation of endurance running (ER) into the hominin locomotor repertoire may explain the many anatomical changes that occurred with the origins of the genus *Homo*. Testing the ER hypothesis is difficult, however, because bipedal running presents some unique biomechanical problems, limiting anatomical convergences with quadrupedal cursors. A possible solution to this hypothesis testing problem is to examine systems that aid running performance, but that are not directly tied to locomotor posture. Here, we tested the hypothesis that neurobiological rewards were affected by the evolution of ER. Human runners often report neurobiological rewards during and after running bouts (frequently termed the "runner's high") that play a major

role in their motivation to run, and increase their ability to sustain high aerobic intensities over long distances. Although endorphins are often associated with the runner's high, we examined the role played by endocannabinoids (eCBs), neurotransmitters linked to the runner's high in previous experiments. We predicted that humans and other mammals that evolved to run long distances (cursorial mammals) would have significant exercise-induced increases in eCBs, while non-cursors would not experience increased eCB production. We measured plasma levels of eCBs in a sample of humans, dogs, and ferrets before and after thirty minutes of ER. We found that both dogs and humans experience an increase in eCBs after running, while ferrets, a non-cursorial mammal, show no significant change ($p=0.33$) in eCBs after ER. These results suggest that exercise-induced eCB signaling is convergent in cursors and that selection has shaped human neurobiology for ER. Supported by NSF BCS-0820270.

Social drive and the coevolution of auditory sensitivity with group size in strepsirrhine primates.

MARISSA A. RAMSIER¹, ANDREW J. CUNNINGHAM^{1,2}, JAMES J. FINNERAN³, and NATHANIEL J. DOMINY^{1,4}. ¹Department of Anthropology, University of California, Santa Cruz, ²Department of Anthropology, The George Washington University, ³U.S. Navy Marine Mammal Program, SSC Pacific, San Diego, ⁴Department of Ecology and Evolutionary Biology, University of California, Santa Cruz.

The sensory drive and perceptual drive hypotheses postulate that animal sensory and signaling systems become adapted to environmental conditions via evolutionary modifications to the underlying nervous system, and that such adaptations drive communication and can lead to reproductive isolation and speciation. Here, we propose the reverse scenario, wherein social behavior and communication drive the auditory sensitivity of an adaptive radiation of primates. Utilizing the auditory brainstem response method, we gathered a large data set on auditory sensitivity in eleven strepsirrhine primate species at the Duke Lemur Center. We discovered a significant relationship between auditory sensitivity and group size, wherein auditory sensitivity increases (mean ABR threshold decreases) as group size increases ($r^2: 0.45$, ANOVA $F_{1,9}: 7.44$, $p<0.05$). Further, 60-dB high-frequency limit increases as group size increases ($r^2: 0.674$, $F_{1,9}: 26.26$, $P<0.01$), indicating better high-frequency sensitivity in larger groups. These relationships are supported by behaviorally-derived auditory data from strepsirrhines and primates as a whole.

Multiple studies suggest that primates form large groups to defend against predation. We suggest that increased auditory sensitivity allows larger groups, which often must forage over relatively large areas, to (1) maintain contact with group members that are out visual range, and (2) be receptive to complex alarm calls broadcast at a distance. This study represents the first documented case of social

drive on auditory sensitivity in primates and points to the need for additional data on auditory sensitivity in hominoids; such an expanded data set might provide interesting insights into the evolution of group size in hominids. This study was funded by the Department of Anthropology, University of California, Santa Cruz, CA, and by a grant to NJD by the David and Lucile Packard Foundation.

Temporomandibular joint disorders in archaeological populations: A pilot study examining the shifting prevalence of TMJ osteoarthritis between the medieval and post-medieval periods in London.

CAROLYN RANDO. Institute of Archaeology, University College London.

Temporomandibular joint disorders (TMD), an umbrella term referring to a group of orofacial pain disorders, including disc displacement and osteoarthritis, affect a significant portion of the general population, with prevalence of temporomandibular joint osteoarthritis (TMJ OA) at around 30%. Current clinical research into the epidemiology of TMD is extensive, however the distribution and pattern of TMD, specifically TMJ OA, in the transition to the modern era is still unknown, as previous archaeological investigations rarely focused on this shift. To determine if changes in prevalence of TMJ OA occurred in this transition to the modern period, a small pilot study was undertaken, comparing two skeletal assemblages, Medieval and Post-medieval Londoners, the latter considered contemporaneous to modern populations. A difference in the rate of TMJ OA is expected between these two time periods, potentially resulting from the distinct lifestyles of each. Using collections from the Museum of London, the TMJs of 67 specimens from the Medieval (n=31) and Post-medieval (n=36) periods were examined for TMJ OA, employing OA diagnostic criteria developed by Rogers and Waldron. TMJ OA was present in 12.9% of the Medieval sample (n=4) and 36.1% (n=13) of the Post-medieval sample. The observed increase in TMJ OA could suggest marked changes, either behaviorally or technologically, occurred in the transition to the modern period, affecting the prevalence of TMJ OA. Further research on this topic could elucidate the conditions that produced this shift and allow for better understanding of the nature of TMJ disorders in archaeological populations.

Primate evolution of antimicrobial high-density lipoprotein.

JAYNE RAPER¹, RUSSELL THOMSON¹ and MARK CARRINGTON². ¹New York University Medical Center, ²University of Cambridge, UK.

Trypanosome lytic factors (TLFs) are antimicrobial high-density lipoproteins that are only present in select primates, and are defined by their ability to kill extracellular protozoan parasites of the sub-genus *Trypanozoon*. Two subspecies of *Trypanosoma brucei* have evolved resistance to human TLFs and can consequently

infect humans, resulting in Human African Trypanosomiasis (sleeping sickness). TLFs have been detected in the blood of a subset of non-human primates including, baboons (*Papio cynocephalus*, *P. anubis*, *P. hamadryas* and *P. papio*), mangabeys (*Cercocebus*), mandrills (*Mandrillus sphinx*) in the subfamily *Cercopithecinae* and gorillas (*Gorilla gorilla*) in the family hominidae. No other primates or animals to date have detectable TLF activity. Unlike humans and gorillas, several of the primates within the *Cercopithecinae* are protected against all African trypanosomes. To determine if protection is due to TLF, we analyzed *Papio hamadryas* TLF. The unique protein components of all TLFs include a hemoglobin-binding protein, Haptoglobin-related protein (Hpr) and the killing component apolipoprotein L-I (apoL-I), which is a pore-forming protein. We find that the baboon and human Hpr protein have 96% identity, and enhance, but are not essential, for killing activity. In contrast, baboon apoL-I is 60 % identical to human apoL-I, and we have demonstrated *in vivo* that the capacity to kill all African trypanosomes resides in the C-terminus of apoL-I. We are currently analyzing the TLFs of the other *Cercopithecinae*.

Torsion and bending resistance provided by the mesial groove of maxillary canines in cercopithecoid monkeys.

ANDREW J. RAPOFF¹, W. SCOTT MCGRAW² and DAVID J. DAEGLING³.

¹Department of Mechanical Engineering, Union College, ²Department of Anthropology, Ohio State University, ³Department of Anthropology, University of Florida.

The function of the mesial groove in maxillary canines is unresolved. That the groove is expressed differently in males and females suggests a behaviorally-based explanation. Our previous results (*AJPA* S48:218) suggest canine tapers are not optimized for particular parasagittal loadings; rather, the taper limits stress gradients across a behavioral spectrum. Canine stress may be more severe with the superposition of twisting, especially within unpredictable loading environments. Here we evaluate the biomechanical effect of the mesial groove and assess its function from this explicit perspective. We determined the resistance provided by the groove to torsion and bending to understand if it functions to alleviate additional stress by making the canine more compliant with respect to twisting. We reconstructed crown geometry from apex to base using micro-computed tomography on permanent maxillary canines from males and females representing 8 West African cercopithecoid species. We determined torsion stiffness factors (e.g., the polar moment of inertia for circular cross-sections) about the centroid and bending stiffness factors about the buccolingual centroidal axis on a reconstructed cross-section near the base of each tooth. Factors were determined on cross-sections "as is" (including the mesial groove) and then after "filling in" the groove. The groove provides a significantly greater reduction in torsional stiffness compared to bending stiffness, and the

effect is significantly greater in males. These results may support the hypothesis that the mesial groove functions to alleviate the additional effect of twisting on canine stress and especially in males who more aggressively load their canines. Supported by National Science Foundation BCS-922429, BCS-60017683, BCS-0921770, BCS-0922414 and DUE-0511287.

Another roadside attraction: repercussions and responsibilities regarding human remains from the "Million Dollar Museum."

ANNA L. RAUTMAN¹, HEATHER J.H. EDGAR^{1,2}. ¹Maxwell Museum of Anthropology, ²Department of Anthropology, University of New Mexico.

The "Million Dollar Museum" near Carlsbad NM, was a roadside attraction for 80 years until 2008. The "Museum's" collection included the remains of at least 22 people (MNI and MLNI). These remains were transferred to the Maxwell Museum, University of New Mexico, in two assemblages in 2007 and 2009, with virtually no provenience information. The first assemblage represents nine individuals, including eight full and partial mummies. There are seven adults including three possible males and one female, and one infant and one fetus, both of which are male. The second assemblage includes commingled and partial remains of 13 individuals: six adults, two young adults, two older juveniles, two young juveniles, and one infant. Two individuals in the second assemblage are males and two are females. Three-dimensional reconstructions from computed tomography revealed the preservation of internal organs in several mummies, as well as an *Olivella* shell placed between one mummy's teeth and cheek. ¹⁴C dating, isotopic and biological analyses are being used to estimate provenience for the remains received in the first assemblage. This poster discusses what can be learned from collections of human remains such as these, by placing them in a larger Southwestern bioarchaeological context. In addition to the results of osteological and other analyses, legal and ethical responsibilities associated with the acceptance of such collections are described. As more roadside attractions close, legitimate museums will be faced repeatedly with the decision whether to accept such collections, requiring a carefully balanced consideration of legal and ethical responsibilities.

Allometry of masticatory loading parameters in primate and non-primate mammals.

MATTHEW J. RAVOSA¹, CALLUM F. ROSS², DESTINY B. COSTLEY¹, SUSAN H. WILLIAMS³, SUSAN W. HERRING⁴, ZI-JUN LIU⁴, KATHERINE L. RAFFERTY⁴ and WILLIAM L. HYLANDER⁵. ¹Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine, ²Department of Organismal Biology and Anatomy, University of Chicago, ³Department of Biomedical Sciences, Ohio University College of Osteopathic Medicine, ⁴Department of Orthodontics, School of Dentistry, University of

Washington, ⁵Department of Evolutionary Anthropology, Duke University.

There is considerable research on the scaling of locomotor loading patterns in vertebrates. However, a comprehensive analysis of interspecific variation in mammalian masticatory loading parameters is lacking. To address this gap, we analyzed mandibular corpus bone strain in 11 taxa varying in body size by over 2.5 orders of magnitude, including goats, horses, alpacas, pigs and seven primates. During alert chewing and biting of fracture resistant foods, *in vivo* bone strain was collected with rosette gages placed along the lateral aspect of the mandibular corpus below the molars or premolars. Bone-strain data were used to characterize relevant masticatory loading parameters, such as peak loading magnitudes, chewing cycle duration, chewing frequency, occlusal duty factor, loading rate and loading time. Interspecific analyses indicate that, much as observed in limb elements, corpus peak-strain magnitudes are similar across mammals of disparate body sizes. Chewing frequency is inversely correlated with size, much as with locomotor stride frequency. Some of this allometric variation in chewing frequency is due to a negative correlation with loading time, which in part increases with size. Similar to the locomotor apparatus, occlusal duty factor does not vary with body size. Peak principal-strain magnitudes are positively correlated with loading time and especially loading rate, with this complex relationship best described by a multiple regression equation with an interaction term between loading rate and loading time. In addition to informing interpretations of craniomandibular growth, form, function and allometry, these comparisons provide a skeleton-wide perspective on the patterning of osteogenic stimuli across body sizes. Supported by NIH, NSF, MU Express Program, Ford Foundation and Duke University.

Effectiveness of seed dispersal by an endangered lemur species.

ONJA H. RAZAFINDRATSIMA. Department of Ecology and Evolutionary Biology, Rice University.

This study was carried out within the humid tropical forest of Ambatolaidama corridor, in Masoala National Park, Madagascar, during the hot and humid season of November 2006 to January 2007. It aims in understanding the importance of an endangered endemic lemur species, the red-ruffed lemur (*Varecia rubra*) in the reforestation of the corridor, as a seed disperser. Three radio-collared adult females were followed daily for continuous observations to monitor their defecations. 268 fresh faeces samples were collected from dawn to dusk during 58 days of observations, and then analyzed in order to extract seeds. 906 seeds with more than 1mm size were extracted. Seed viability was studied through immersion test; and by planting viable defecated and non-passed seeds in a nursery adjacent to the corridor. The results showed that red-ruffed lemur disperse many tropical plant species throughout this corridor. Moreover, most of gut-passed-seeds

were viable and their germination rate was higher than those of seeds removed manually. Furthermore, seedlings from the defecated seeds grow faster. Thus, seed dispersal by the red-ruffed lemur in the rainforest of Ambatolaidama is successful and important for some tropical plant species. This lemur species plays an important role in the reforestation of the corridor. This study was conducted in collaboration with Barbara Martinez of the Graduate Program in Conservation Biology at the University of Minnesota.

Large mammal community evolution, modern human subsistence, and climate change through time in the Western Cape, South Africa

AMY L. RECTOR. Institute of Human Origins, School of Human Evolution and Social Change, Arizona State University, Tempe, Cenozoic Studies, Natural History Department, Iziko Museum, Cape Town, South Africa.

The archaeological record of the Western Cape (WC), South Africa, includes early examples of possible advanced human behaviors and also spans glacial cycles associated with dramatic climatic fluctuations. Paleoenvironmental contexts for WC modern human occupation are often reconstructed using mammals from archaeological assemblages, but are plagued by bias of subsistence strategies of humans who accumulated them. Therefore, this study seeks to create an unbiased reconstruction of environmental change over the last ~160,000 years to better understand the evolutionary context of WC modern humans. To avoid comparisons between unbiased modern communities and biased archaeological assemblages, this analysis uses the structures of archaeological large mammal communities to reconstruct WC paleoenvironments from Marine Isotope Stage (MIS) 6 through the Holocene through the lens of human "prey species." To do so, mammalian community structures including only families regularly found preyed upon in the WC archaeological record were constructed for 52 modern African sites in defined habitats. This variation was used to compare the assemblages of 100 levels from 14 WC sites spanning MIS 5 – MIS 1 to reconstruct changing paleoenvironments and human subsistence strategies. Results indicate that while a general paleoecological trend can be identified for each MIS, paleohabitats are not consistently reconstructed according to the commonly cited dichotomy that glacial periods were characterized by grasslands while interglacials were not. Therefore, changing the strategy for reconstructing WC paleoenvironments results in novel paleoecological interpretations that have consequences for how we interpret the evolutionary contexts of some complex human behaviors.

Bioarchaeological evidence for violence in Roman London.

REBECCA REDFERN. Centre for Human Bioarchaeology, Museum of London.

London, following its foundation in the mid 1st century A.D., quickly established itself as the foremost trading centre in the new province, Britannia, and developed into the largest urban settlement in Britain, being home to people from across the Empire. Although evidence for interpersonal violence has been identified in the City's large extra-mural cemeteries, rare intramural samples have provided new insights into the range and type of violence occurring within London. One 2nd century A.D. sample of skulls and worked leather was buried close to the City's walls in an industrial pit and drainage gully, and located adjacent to the Walbrook stream tributary. This sample was recorded using the standards employed by the Museum of London (2008). A total of 39 skulls were identified: 35 male, 2 intermediate sex and 2 undetermined sex. Where age could be determined, the majority of individuals (28.2%) were between 26–35 years old. The majority of the sample had evidence for peri- and/or antemortem trauma (59%) and wide a range of traumas were identified: peri-mortem depressed fractures, projectile and sharp-force weapon injuries and blunt-force trauma; and antemortem facial fractures and depressed cranial fractures. The greatest range of traumas was identified in the 26–35 year old age-group and those over 18 years old. The presence of these lethal traumas and the context of the sample may suggest that these remains might reflect ritualised violence or a hitherto under-known episode of insurgency.

Modulation of jaw kinematics to food material properties in *Cebus*.

DAVID A. REED¹ and CALLUM F. ROSS¹.
¹Department of Organismal Biology and Anatomy, University of Chicago.

Food material properties (FMP) impact both temporal and spatial aspects of chewing kinematics. These temporal and spatial effects were quantified in complete chewing sequences in two *Cebus*. Seven foods were assigned to two food groups based on their material properties, foods of high and low stiffness. Foods of high stiffness were found to have significantly lower mean cycle durations for the first 15 chews. Spatially, these foods elicited a significantly lower vertical displacement of the mandible for the first twenty chews. These foods also elicited a greater lateral displacement of the mandible throughout the chewing sequence, but this relationship was only significant for 17/40 total chews. Spatial variables at the level of the cycle had very little effect on the variance in cycle duration. Variance in the constitutive phase durations was a better predictor of cycle duration. In particular, lower slow close (SC) durations in high stiffness foods for chews two through fifteen explained the majority of variance in chew cycle duration. In the first chew, the duration of SC was found to be statistically indistinguishable in the two foods groups. The temporal variance in this phase duration throughout the sequence was explained primarily by the spatial variable vertical displacement. We hypothesize from these data that the lower SC durations and vertical

displacements in foods of high stiffness after the first chew reflect a passive response of the mandible to a faster reduction in bolus particle size, a phenomenon resulting from the intrinsic fracture properties of the food item.

Biogeographic patterns in the mid-Pliocene: the effects of time-averaging and site deposition.

KAYE E. REED and ELIZABETH H. HARMON. Institute of Human Origins, School of Evolution and Social Change, Arizona State University, Tempe.

Biogeographic patterns of mammals across Pliocene Africa are used to identify possible hominin dispersal patterns and centers of endemism. Previous research examined taxonomic similarity among hominin sites to understand differences in mammal species present. Resulting variation among species is often attributed to geographic distances and/or habitat differences, which create barriers to dispersal. We propose that time-averaging and the mode of deposition of fossil assemblages may influence biogeographic patterns as well. We analyzed taxonomic dissimilarity among African hominin sites dated from ~4.2 to ~3.0 Ma with Dice Similarity Indices, cluster analyses, and minimum spanning trees. Results indicate that fossil assemblages from the same regions group more closely no matter how much time was represented, e.g., Hadar members are more similar to each other than any one member is to another hominin locality. We examined differences in ecological similarity using trophic and substrate adaptations of mammals in each assemblage with the same techniques. In this case, localities grouped by reconstructed habitats suggesting that although there are ecological vicars at hominin sites from this time period, there are barriers to dispersal for many mammals.

Finally, we addressed site deposition by comparing assemblages from the Kada Hadar 2 Member of the Hadar Formation (~3.0 Ma; fluvially deposited) and Makapansgat, South Africa (~3.0 Ma; carnivore accumulated). While abundances of each species differ greatly between sites as expected, the number of species is quite similar. Thus, time averaging and deposition do not appear to influence greatly biogeographic patterns of the Pliocene.

The evolution of sexual dimorphism in the petrous bone. A comparative analysis between modern humans and the great apes using the lateral angle method.

SARAH REEDY. Department of Anthropology, University of Massachusetts, Amherst.

Recent research has shown that the cranial base, specifically the petrous portion, is sexually dimorphic in humans. The objective of this project is to determine if the lateral angle in chimpanzees, gorillas, and orangutans is sexually dimorphic as it is in humans. The lateral angle refers to the angle at which the inner auditory canal opens in relation to the endocranum. This method has shown to be 83% accurate in determining the sex of adult

humans. If this angle proves to be dimorphic in the other great apes it would indicate that this angle is probably dimorphic in fossil hominins. If non-human ape lateral angles are not dimorphic, it would indicate that sexual dimorphism of this angle occurred after the great ape-human split. The lateral angle was measured in a sample of 101 chimpanzees, 62 gorillas, and 66 orangutans. Results indicate that there is no significant difference between males and females of these species. This is noteworthy because it means that this sexually dimorphic trait evolved after the human/chimpanzee split. It is important now to understand why this trait evolved. It could be due to habitual bipedal stance, the evolution of increased cranial capacity, or maybe both. Future research in areas of the morphology and integration of the human cranial base should also include research of the evolution of sexual dimorphism of the cranium. This study was funded by Sigma Xi, grant number G200810150575.

What predicts day range length and group size in gibbons?

ULRICH H. REICHARD and MATTHEW G. NOWAK. Department of Anthropology, Southern Illinois University, Carbondale.

Primate ranging behavior is thought to be limited by the distribution and availability of food resources. The ecological constraints model predicts that day range length should increase with increasing group size to facilitate the energetic requirements of more individuals. Support for this hypothesis comes from within-group studies of fission-fusion primate communities, with far less evidence from primates living in stable groups. Besides ecological correlates, fewer studies have considered social factors such as inter-group interactions or infanticide risks which may alternatively or likewise constrain group size and travel patterns. We tested ecological and social effects on day range length in a large community of wild white-handed gibbons at Khao Yai National Park, Thailand. Group location was marked on a trail map every ten minutes and day range length was calculated cumulatively as the distance traveled between recorded locations. Our data did not strongly conform to the predictions of the ecological constraints model, because we found no relationship between day range length and either adult group size, total group size or social system (i.e. multimale or single-male), although a significant monthly seasonal effect was detected. Interestingly, the occurrence of intergroup encounters also lead to increased day range length. We interpret our data to indicate that group travel is still influenced by ecological factors, regardless of group size variation, because 'season' had a significant effect, suggesting that seasonal fluctuations in food availability influence day range length across groups. Additionally, social factors such as intergroup encounters may also constrain day range length in gibbons. This study was funded by Southern Illinois University Carbondale.

Patterns of habitat use and ranging behavior of squirrel monkeys (*Saimiri sciureus*) in the Yasuni National Park, Ecuador.

MAURA C. REILLY and SCOTT A. SUAREZ.
Department of Anthropology, Miami University

Spider monkeys and woolly monkeys in Yasuni, Ecuador navigate their habitats using a series of repeated-routes that follow naturally occurring ridge tops (Di Fiore and Suarez, 2006). Several hypotheses may account for the ridge-top travel, including food-finding, predator-monitoring, reducing cognitive load, and minimizing travel costs. This project considers the last hypothesis by examining the ranging behavior of sympatric squirrel monkeys. Because squirrel monkey body mass is one eighth that of atelines, energetic costs for traveling perpendicular to ridges should not be much. Therefore, the use of ridge tops for travel by squirrel monkeys would reject the energetic constraints hypothesis. We studied two groups of squirrel monkeys at the Proyecto Primates site in the Yasuni National Park, Ecuador, from July to August of 2009 (n=13 follow days). At five-minute intervals, we recorded the location and altitude of the group using a Garmin 76CSx GPS (n=357 points), as well as the forest height, aspect, habitat density, and feeding behavior of group individuals. In contrast to the travel patterns of the spider monkeys, squirrel monkeys are not constrained to ridge-top travel, preferring the low dense trees characteristic of lower ridge slopes. We found no significant difference between spider (264 m) and squirrel monkeys (294 m) in altitude preferred. Unlike the direct routes of atelines, squirrel monkey travel is tortuous, and is more often perpendicular to, rather than parallel to, the ridge tops. The lack of constrained ridge travel in squirrel monkeys supports the energetic model for the ateline route system in Yasuni. This study was funded by Miami University Undergraduate Summer Scholars, Rebecca Jeanne Andrew Memorial Award, and the University of Cambridge Junior Fellows In Biological Anthropology Study Abroad Fund.

The interplay between function and phylogeny in the manifestation of phalangeal morphology.

THOMAS REIN. Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

Phalanges are considered highly informative in the reconstruction of locomotor repertoires of extinct primate taxa since these skeletal elements directly interact with the substrate during locomotion and are less developmentally constrained than more proximal limb segments. Variation in traits, such as shaft curvature and orientation of the proximal articular surface, has been linked to differences in locomotion based on comparative, ontogenetic, and biomechanical analyses. Building on previous work, this study investigates phalangeal morphology in a wider comparative context in order to analyze the interplay between phylogeny and function. This study examines phylogenetic signal and the relative correspondence between shape variation

of seven phalangeal characters and the percentage of locomotor behaviors performed in twenty primate taxa.

Three-dimensional landmarks were collected on the third proximal manual phalanx using a Microscribe G2X digitizer. Measurements were extracted using Pythagorean formula and analytic geometry. Mean values of these measurements were regressed against published percentages of locomotor behavior and body mass. Phylogenetic signal was estimated using Pagel's lambda. Results indicate that phalangeal curvature and the angle of the orientation of the proximal articular surface correspond relatively well with the degree of observed suspensory behavior and substrate usage. The degree of phylogenetic signal, however, is relatively lower in phalangeal curvature, and this trait may be more useful in predicting locomotor behavior across taxa. These results provide a better understanding of the relative degree to which functional and phylogenetic constraints impact upon phalangeal morphology, thereby allowing a more refined assessment of locomotor behavior in the fossil record. This research was funded by the National Science Foundation, BCS-0849204, the L.S.B. Leakey Foundation, the Wenner-Gren Foundation, the New York Consortium in Evolutionary Primatology, and New York University.

Robusticity, architecture and asymmetry in the upper limb: An investigation into the division of labor and soldier status in the ancient Middle East.

JILL A. RHODES. Department of Anthropology, Bryn Mawr College.

The investigation of activity-related change may identify differences in sexual division of labor, social and economic status and more specifically, weapon-use. This project aims to investigate activity differences through external humeral measurements to quantify articular and diaphyseal robusticity, humeral retroversion and directional asymmetry among males and females from the Iron II (1000-800 BCE) occupation of Hasanlu, NW Iran. At this time, Hasanlu comprised both a fortified citadel and lower town with an associated cemetery. The citadel was sacked and burned in 800 BCE and the site abandoned, allowing *in situ* preservation of the victims.

Specific aims are multiple: first to investigate variation between those individuals who fell in the sacking of the citadel and those interred in the cemetery. Do activity (status) differences exist between the two locations? Was a trained army present in the citadel and did those individuals differ from the rest of the populous? Comparison is also made between males from the citadel and males from other weapon-related contexts to examine for evidence of training and weapon-related pattern differences in robusticity, architecture and asymmetry.

Results show homogenous activity patterns for the males from both contexts while significant differences exist between the females. The levels of directional asymmetry are generally similar between males from weapon contexts, differing primarily in the proximal humerus and maximum humeral length. These differences

relate to unimanual activity focused at the shoulder. Results thus indicate the lack of a specifically trained soldier class at Hasanlu; rather all men likely participated in similar activities.

The anatomy of footprints from Koobi Fora, Kenya.

BRIAN G. RICHMOND^{1,2}, MATTHEW R. BENNETT³, JOHN W.K. HARRIS⁴, ANNA K. BEHRENSMEYER⁵, DAVID R. BRAUN⁶, STEVIE CARNATION⁷, HABIBA CHIRCHIR⁸, DAVID J. GREEN⁸, PURITY KIURA⁹ and EMMA MBUA¹⁰. ¹Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ²Human Origins Program, National Museum of Natural History, Smithsonian Institution, ³School of Conservation Sciences, Bournemouth University, ⁴Anthropology Department, Rutgers University, ⁵Paleobiology Department, National Museum of Natural History, Smithsonian Institution, ⁶Archaeology Department, University of Cape Town, South Africa, ⁷Interdepartmental Doctoral Program in Anthropological Science, Stony Brook University, ⁸Hominid Paleobiology Doctoral Program, Department of Anthropology, The George Washington University, ⁹Archaeology Department, National Museum of Kenya, ¹⁰Paleontology Department, National Museums of Kenya.

The scarcity of relevant fossils and footprints hampers our understanding of the evolution of human gait. Researchers continue to debate the taxonomic attribution and functional significance of the few available late Pliocene-early Pleistocene pedal fossils (e.g., OH 8), and disagree over whether or not the primitive and unique aspects of pedal morphology are consistent with a modern human-like gait. Our recent discovery of hominin footprints in the Koobi Fora Formation, Kenya (FwJ14E, 1.51-1.53 Ma, Area 1A; and Gaji10, 1.4 Ma, Area 103) offers unique evidence about early Pleistocene hominin gait and foot shape. Here we report on the anatomy and functional significance of these footprints, including several newly discovered (2009 field season) prints preserving fine anatomical detail.

After excavating the prints, we photographed, measured, and laser-scanned the prints to preserve their 3D morphology. We compared the prints with a sample of modern human prints from the Dassenach (Ileret, Kenya) and a cast of Laetoli (3.7 Ma) prints using conventional and geometric morphometric methods.

Our analyses found no evidence that the prints from different sites and event layers were made by different foot morphologies or gait. However, the prints differ significantly from modern human and Laetoli prints in some aspects of shape. Moreover, footprints found at FwJ14E in 2009 show particularly strong evidence of an adducted hallux, short toes, longitudinal arch, and a deeper impression in the medial than lateral forefoot. These features show that, by 1.5 Ma, hominins had acquired the key hallmarks of a modern human walking gait. Grant Sponsorship: NSF DGE-0801634; NSF BCS-0924476; GWU UFF fund.

Brain white matter asymmetries in humans and non-human primates: A comparative Diffusion Tensor Imaging (DTI) study.

JAMES K. RILLING^{1,2,3,4}, BHARGAV K. ERRANGI⁵, LONGCHUAN LI⁶, MATTHEW GLASSER^{1,10}, XIAODONG ZHANG⁷, HELEN MAYBERG^{2,8}, XIAOPING HU^{5,6} and TODD M. PREUSS^{4,7,9}. ¹Department of Anthropology, Emory University, ²Department of Psychiatry and Behavioral Sciences, Emory University School of Medicine, ³Division of Psychobiology, Yerkes National Primate Research Center, ⁴Center for Behavioral Neuroscience, Emory University, ⁵Department of Biomedical Engineering, Georgia Institute of Technology/Emory University, ⁶Biomedical Imaging Technology Center, Emory University School of Medicine, ⁷Division of Neuroscience, Yerkes National Primate Research Center, ⁸Department of Neurology, Emory University School of Medicine, ⁹Department of Pathology, Emory University School of Medicine, ¹⁰Department of Neurobiology and Anatomy of Washington University School of Medicine.

Human brain organization is characterized by significant functional laterality and neuro-anatomical asymmetry. Comparing the nature and magnitude of these asymmetries in humans and other primates is an active area of research that may shed light on the evolution of the human mind and brain. In this study, we compared asymmetries in white matter fractional anisotropy (FA), a presumed correlate of white matter myelination or fiber density, in humans, chimpanzees and macaque monkeys. Diffusion-weighted images were acquired from 9 human females, 36 chimpanzee females and 23 macaque females. Tract-based spatial statistics (TBSS, FSL, <http://www.fmrib.ox.ac.uk/fsl/>) was used for voxel-wise asymmetry analyses of FA. The original images and their left-right flipped versions were non-linearly registered to a symmetrical template, and a permutation-based paired t-test was used to determine left-right differences in the registered images ($p_{\text{FWE}} < 0.01$, corrected for multiple comparisons). In humans, TBSS revealed widespread leftward (left>right) asymmetries in white matter FA, with minimal rightward asymmetries. By contrast to humans, both chimpanzees and macaques had similar amounts of leftward and rightward asymmetries. For example, the arcuate fasciculus, a putative language pathway, was strongly leftward asymmetric in humans, but of mixed asymmetry in chimpanzees and macaques. Our results show that leftward asymmetries in white matter FA are more pronounced in humans. These differences in FA presumably reflect differences in the amount of myelination or the density of fibers in white matter tracks, and may therefore be relevant to explaining the evolution of human cognitive and behavioral specializations. This study was funded by NIH P01 1580566256A1 and NIH RR-00165.

Correlation between measures of the lateral and midline basicranium: Implications for understanding facial positioning in anthropoid primates.

TERRENCE B. RITZMAN^{1,2}, LYNN E. COPES^{1,2} and KRISTI L. LEWTON^{1,2}: ¹School of Human Evolution and Social Change, Arizona State University, ²Institute of Human Origins.

The anatomy of the basicranium is an important factor underlying cranial variation in primates and, specifically, plays a role in modulating the position of the facial skeleton relative to the braincase. Recent studies have demonstrated that the lateral and midline basicranium in *Homo sapiens* are not tightly integrated and the lateral basicranium is more critical in determining the morphology of the facial skeleton. It is unknown, however, if this relationship holds for other primates. Authors have also suggested that the morphology of the lateral basicranium—specifically the middle cranial fossa (MCF)—may track changes in temporal lobe morphology. Evolutionary changes in the size and shape of the temporal lobes, then, may influence the morphology of lateral (but not midline) aspects of the MCF, which, consequently, affects facial positioning. Using a radiographic sample of anthropoid primates (N=214), the present study addresses two questions: (1) Are midline and lateral measures of the MCF correlated?; and (2) Is temporal lobe size correlated to midline and/or lateral measures of the MCF? Results indicate that midline and lateral measures are not tightly correlated and the lateral measures predict temporal lobe size better than midline measures. These results suggest that studies of the relationship between basicranial morphology (especially that which is associated with the anatomy of the temporal lobes) and facial positioning should focus on lateral measures of the MCF. These findings also imply that the morphology of the temporal lobes may be an important determinant of facial position in extant and extinct primates, including hominins.

Hierarchical analysis of dental variation using geometric morphometrics.

OLIVER T. RIZK¹, THERESA M. GRIECO¹, and LESLEA J. HLUSKO¹. ¹Department of Integrative Biology, University of California Berkeley.

Geometric morphometrics (GM) is widely employed to study taxonomic variation and functional morphology. This technique quantifies shape variation that is difficult to detect using traditional measurements. Here, we present a GM analysis of maxillary dental arcade variation in *Macaca fascicularis* (n=54) and *Cebus guereza* (n=52) as part of a larger project investigating patterns of dental variation in Old World Monkeys. From a set of 45 two-dimensional occlusal landmarks we took a hierarchical approach and analyzed subsets representing the total tooth row, the postcanine dentition, and the molar series. At all levels the proportion and direction of the variation are similar within both species as represented by principal components. For example, PC1 for the tooth row accounts for approximately 43% of the variation and primarily describes sexual dimorphism driven by the anterior dentition, as

would be predicted. However, PC2 for the tooth row accounts for 20% and describes arch shape. This PC is interesting in that it varies similarly within both species and is the primary dimension discriminating the two. The within-taxon similarities continue for the postcanine and molar row analyses, suggesting that their variation results from similar function and/or development. We also find that at various levels we are able to discriminate between taxa, possibly providing new methods for taxonomic identification from fragmentary remains. We will describe these results in more detail and discuss the implications for paleontology, morphological integration, and neontology. This research is supported by National Science Foundation grant number BCS-0616308.

Monkeys in the mountains versus the plains: Geography drives genetic variation.

UMA RMAMAKRISHNAN. National Center for Biological Sciences.

Macaques are the most wide spread among all non-human primates. Adaptation to such environmental variation has not only resulted in a huge morphological diversification but also given rise to a varied repertoire of behaviour among only 22 species. We study two Indian species namely the Arunachal macaque (*Macaca munzala*) and the bonnet macaque (*M. radiata*). Although phylogenetically closest among all other macaque species, they inhabit very dissimilar habitats. While the Arunachal macaque lives in a mostly unexplored, high altitude, cold and humid mountainous terrain of north-eastern India, its sister species is an endemic but common primate of the hot and dry plains of peninsular India. Using 23 microsatellite loci and mitochondrial DNA, we investigated patterns of genetic diversity for these species, and our results further suggest that while Arunachal macaque lineages show considerable genetic differentiation across short distances, bonnet macaque populations are very similar across their much larger geographic distribution. Arunachal macaque populations also reveal signatures of significant, recent population bottleneck potentially induced by anthropogenic influences. In summary, our results reveal that differences in ecology and geography drive patterns of genetic differentiation in two macaques. We discuss the consequences of such differences and their consequences for species evolution.

High-speed throwing in humans requires elastic energy storage at the shoulder.

NEIL THOMAS ROACH¹ and MADHUSUDHAN VENKADESAN^{1,2}. Department of Human Evolutionary Biology, Harvard University, ²School of Engineering and Applied Sciences, Harvard University.

Humans are unique among primates in our ability to throw objects accurately at high speeds, an ability presumably selected during hominin evolution for hunting. Previous work on the biomechanics of throwing has shown that high projectile velocities are achieved through rapid, sequential rotations occurring at

numerous joints throughout the body resulting in a "whip-like" accumulation of kinetic energy. This kinetic energy is then transmitted to the projectile at release. Previous studies also show that action at the shoulder makes the largest contribution to projectile velocity. This study proposes and tests the hypothesis that humans use an elastic energy storage mechanism in the shoulder during overarm throwing. Published angular velocities and torques at the shoulder, estimated using inverse dynamics analysis, are used to calculate actual, instantaneous and average power output at the shoulder. These actual power values are compared to modeled, theoretically maximum possible muscular power output. Results show that active muscle power generation cannot account for measured power output, and therefore elastic energy storage at the shoulder significantly increases power production. Using mathematical optimization, we predict arm kinematics during the elastic energy storage phase to maximize the shoulder's contribution to projectile translational velocity. The predicted kinematics is compared to actual kinematic patterns seen in human throwers. The effects of humeral torsion, brachial index and projectile mass on the proposed mechanism will be discussed.

Human versus Non-human: the burned, fragmentary osseous assemblage from the Donner party campsite.

GWEN ROBBINS. Department of Anthropology, Appalachian State University.

In spring of 1846, the George and Jacob Donner families along with some 80 traveling companions began their overland trek to California. By the time the party ascended the eastern Sierras in late October, a snowstorm forced the group to bivouac. The migrants were separated into two contingents; the larger party camped near Donner Lake and the smaller group—including the Donner family—settled seven miles away at Alder Creek. Though written accounts from the Lake site imply that many would eventually resort to cannibalism, no such records exist for Alder Creek. Over sixteen-thousand bone fragments were recovered during excavation at the Donner family campsite hearth but identification of these bones was hampered by extensive dietary processing, burning, and diagenesis. Here we present the results of our osteological analysis to determine whether any of the fragments were human and what other kinds of mammals were present in the assemblage. We analyzed eighty-five of the largest mammalian long bone fragments. In this poster, we present the rubric we developed to discriminate human and other large mammals using both quantitative and qualitative methods in histology. We also present the results of our analysis, which indicate a diverse starvation diet sustained the population at Alder Creek before they ultimately resorted to cannibalism. Finally, we suggest future directions for developing quantitative methods to discriminate mammalian bones in fragmentary, burned archaeological assemblages.

Health, diet and mobility at the medieval Bowl-Hole cemetery, Bamburgh, Northumberland, England: A contextual study of skeletal and isotopic data.

CHARLOTTE ROBERTS¹, SARAH GROVES¹, GRAHAM PEARSON², GEOFF NOWELL² and COLIN MACPHERSON²

¹Department of Archaeology, Durham University, ²Department of Earth Sciences, Durham University.

One hundred burials have been excavated at the 7th-8th century AD Bowl-Hole cemetery Bamburgh, north-east England. Historical data indicate a time of migration to England from the Continent and displacement of the native population. Some bioarchaeological studies have challenged this idea. A current study (2006-10) aims to elucidate health, dietary status and mobility. The question addressed was can 'non-locals' be distinguished from 'locals' through their biological profile, isotopic signature, and burial treatment. This study extends recent research on mobility in the early medieval period from England using isotope analysis. Skeletal analysis documented normal and abnormal variation. Dental enamel and bone samples were analysed for oxygen, strontium, carbon and nitrogen isotope levels to assess diet and mobility. Preliminary data suggested one person derived from east Yorkshire/Lincolnshire (YL-south of the site), one from central Scotland, 37 from southern Scotland/Cumbria (SC - north and west), and 23 are local (N-Northumberland). Locals had lower rates of dental calculus/antemortem tooth loss compared to those from SC (60% V 78% and 8% V 16%, respectively). Cribriform orbitalia, maxillary sinusitis and tibial periostitis, respectively, were also less frequent in locals than in people from SC (33% V 14%, 4% V 22% and 6% V 21%). The data suggests that no people originated on the continent, burial context did not suggest a continental origin, but that locals had less evidence of health problems. These data are discussed in relation to the "osteological paradox" and the challenges of interpreting palaeopathological data in the context of mobility and diet.

Revisiting shrinkage: a test of the long-term integrity of dental molds.

CHRIS ROBINSON¹ and ZACHARY KLUKKERT^{2,3}. ¹Department of Biology, Bronx Community College, City University of New York, ²Department of Anthropology, City University of New York, ³New York Consortium in Evolutionary Primatology.

Due to both the expense of traveling to museums and the worries of many curators that the specimens under their care may be damaged during the molding process, molds of extant or fossil dental specimens are often used multiple times, sometimes years apart, to create casts for researchers from different institutions to study. Previous analyses found that under the proper environmental conditions, mold-material shrinkage over a 12 week period yielded no significant shape differences in the casts produced. In our study we made casts of *Pan-*

paniscus mandibular first and second molars (n=19) from a single set of molds approximately 10 years apart to determine whether this result held for longer time periods. Both sets of casts were prepared using epoxy (Epotek 301 and F-82 epoxy resin, respectively). We measured the MD length, BL breadth and crown height of each cast twice and tested for significant differences between the two sets of casts. Our results show that the two sets of casts were not significantly different for length or height but that the newer casts were significantly broader bucco-lingually. We hypothesize that the molds lost some of their volume as they dried up over time. This may have caused the space between the walls of the mold to increase, leading to the wider bucco-lingual breadth of the newer casts. This result has important implications for researchers intending to study dental casts made from molds that are many years old, even if those molds are kept under proper conditions.

Twining in humans as a measure of maternal heterogeneity.

SHANNEN L. ROBSON¹ and KEN R. SMITH^{2,3}. ¹Department of Anthropology, University of Utah, ²Department of Family and Consumer Studies, University of Utah, ³Huntsman Cancer Institute, University of Utah.

Successful twin pregnancies are more costly than singletons. Nevertheless twinning persists at low levels in all human populations. We propose that twinning is a marker of heterogeneity, identifying those women who possess an enhanced phenotypic quality that allows them to bear these elevated reproductive costs. If so, we expect that these women will outperform mothers of singletons on other life history measures as well. We examined whether mothers of twins are more robust by comparing the reproductive and survival events of mothers who bore at least one set of twins to those women who did not in the Utah Population Database (UPDB). The UPDB is a vast historical database allowing us to capture a sizable number of women who bore twins in a natural fertility population. We further restricted our sample to women who were born after 1860 but prior to 1900, lived to age 50, and married once to men who were alive when their wives were 50, resulting in about 5,000 women who had even borne multiples and over 60,000 mothers of only singletons pregnancies. Using survival analyses we found that, as expected, mothers of twins exhibit additional features of phenotypic robusticity including lower mortality, shorter interbirth intervals, and higher lifetime fertility than their singleton-only bearing counterparts. We conclude that bearing twins may be a useful measure of maternal heterogeneity.

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Lack of regional continuity in the Alabama-Coushatta tribe: Mitochondrial DNA analysis in the Southeastern United States.

ALYSON R. RODE¹, MOSES C. SCHANFIELD² and RIPAN S. MALHI¹. ¹Department of Anthropology, University of Illinois, Urbana-Champaign, ²Department of Forensic Sciences, George Washington University.

Fifty-nine previously unreported blood serum samples from the Alabama-Coushatta tribe of Texas and Louisiana were analyzed for mitochondrial DNA (mtDNA) Hypervariable Sequence I (HVS1). Using these data we tested whether the Alabama-Coushatta resemble other tribes in the Southeastern United States. Ancestors of the Alabama-Coushatta lived along the Coosa River along with other Muskogean-speaking tribes prior to the Indian Removal Act of 1830, and are believed to be the 'Coosa' tribe encountered by Hernando de Soto in 1540. As reported by Bolnick and Smith (2003), the haplogroup frequencies of populations in the Southeast exhibit a lack of regional continuity as compared to other geographic regions in North America such as the Northeast.

We found that the Alabama-Coushatta were statistically different from other Muskogean-speaking tribes such as the Choctaw, Chickasaw, Muskogee (Creek) and Seminole populations and more similar to other non-Muskogean-speaking tribes in Eastern North America. This supports Bolnick and Smith's assertion that the discontinuous trend among Southeastern tribes is most likely the result of a genetic bottleneck following the rapid population decline associated with European contact.

In addition, representative mitochondrial subhaplotypes were successfully genotyped following Tamm et al. (2007), providing the first set of subhaplogroup data for a tribe in Eastern North America.

Grooming, group size, and feeding priority in female Rhesus macaques.

M.A. RODRIGUES¹ and D.L. HANNIBAL². ¹Department of Anthropology, The Ohio State University, ²Department of Anthropology, University of Oregon.

The social brain hypothesis predicts that larger groups require greater investment in allogrooming for social cohesion. It has been suggested that low-ranking individuals allogroom to gain tolerance from high-ranking individuals for access to food resources. Here, we report on data collected from twenty-eight adult female rhesus macaques on Cayo Santiago, Puerto Rico. Contrary to the social brain hypothesis predictions, we found that individuals in large groups (10.3%) do not invest more time in grooming than individuals in small groups (13.6%) ($F=1.302$, $p=0.263$). Furthermore, time spent allogrooming does not explain access to food resources among middle- and low-ranking females ($F=0.403$; $p=0.533$), nor does the interaction of group size and grooming ($F=0.032$; $p=0.859$), the interaction of rank and grooming ($F=0.005$, $p=0.943$), or the interaction of group size, rank, and grooming ($F=2.684$; $p=0.118$). The interaction of group size and rank was significant ($F=6.123$, $p=0.022$). Removing grooming from the model,

however, negates the significance of the group size and rank interaction. The benefits of membership in a large group outweigh the disadvantages of increased intragroup competition for low-ranking individuals. In smaller groups, however, low-ranking individuals are constrained by both intergroup and intragroup competition. Furthermore, grooming does not appear to offset the disadvantages of low rank or small group size. While increasing group size and rank improve access to food resources, and the contribution of grooming for tolerance was not significant in this study, further investigation on the role of grooming in the complex dynamics of intergroup and intragroup competition for food resource is warranted. Funding from University of Oregon Fellowships and Awards and NCRR-NIH CM-5 P40 RR003640-20.

Calcaneal proportions in the small adapid *Anchomomys* from the Middle Eocene Spain.

IMMA ROIG¹, S. MOYA-SOLA², M. KOHLER² and D. M. ALBA¹. ¹Institut Català de Paleontologia, Universitat Autònoma de Barcelona, ²ICREA at Institut Català de Paleontologia and Unitat d'Antropologia Biòlgica (Dept. BABVE), Universitat Autònoma de Barcelona.

We perform an allometric analysis of the calcaneal proportions of the small-bodied primate *Anchomomys* Stehlin, 1916 (Primates: Adapidae) from the Middle Eocene Spanish localities of Sant Jaume de Frontanyà 3C (Catalonia) and Cañes (Castilla y León), in order to make locomotor inferences for this taxon. The analysis shows that primates as a whole display a longer distal calcaneus relative to both total calcaneal length and body mass as compared to other mammals. This moderate degree of distal calcaneal elongation is interpreted as a grasping adaptation: the more proximal position of the fulcrum on the distal tarsus instead of the metatarsus requires an elongation of the distal portion of the calcaneus in order to preserve a sufficiently long load arm. Due to their higher emphasis on grasping and their tarsi-fulcrumating foot, prosimians display a higher degree of distal calcaneal elongation than the more cursorial and metatarsi-fulcrumating anthropoids. However, only the extreme degree of distal calcaneal elongation displayed by small vertical-clingers-and-leapers (tarsiers and galagos) can be interpreted as a leaping adaptation, where foot elongation must involve the tarsal region because of grasping; although this reduces the foot's mechanical advantage, distal calcaneal elongation in these small-bodied leapers has been favored in order to enhance take-off velocity. When biomechanical considerations and scaling effects are properly considered, the calcaneal proportions of *Anchomomys* (both relative to calcaneal length and body mass) emerge as those expected for a small-bodied (140 g), generalized prosimian with a tarsi-fulcrumating foot adapted to vertical clinging but not specialized for leaping.

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Hand biomechanics during simulated Oldowan tool use

CAMPBELL ROLIAN¹, DANIEL E. LIEBERMAN², JOHN PAUL ZERMENO².

¹Department of Cell Biology and Anatomy, University of Calgary, ²Department of Human Evolutionary Biology, Harvard University.

Human radial digits show derived features compared with apes, including longer, more robust thumbs and hypertrophic thenar muscles. These traits are thought to be adaptations evolved in the context of lithic technology. This idea rests on the previously untested hypothesis that Oldowan manipulative tasks require large gripping forces, and produce large joint contact stresses that are beyond the functional capabilities of ape-like digits. We used portable force plates simulating Oldowan tools to (i) document the magnitude of external/internal forces and joint stresses in the radial digits during hardhammer percussion and flake use, and (ii) examine how variation in digit morphology affects muscle and joint mechanics during Oldowan tasks. Force and kinematic data were collected from a sample representing normal variation in digit morphology (n=25). The effect of digit size/shape on digit biomechanics was evaluated using partial correlations, controlling for the effects of tool reaction forces and impact velocities. Results show that individuals with longer digits actually require relatively less muscle force to stabilize digital joints, and are exposed to relatively lower joint contact stresses during Oldowan tasks, because digital joint size increases with positive allometry relative to digit length in humans. Analyses further suggest that *Pan-* or *australopithecine*-like pollical anatomy presents serious performance challenges to habitual tool use. Our data support the hypothesis that evolutionary increases in thumb length, robusticity and thenar muscle mass enabled hands in *Homo* to produce more force and tolerate higher joint stresses during tool use than ape-like hands. This study was funded by the American School for Prehistoric Research and a Canadian Natural Sciences and Engineering Research Council Postgraduate Scholarship to CR.

Buccal dental-microwear analysis among Pygmy hunter-gatherers from Western Central Africa.

ALEJANDRO ROMERO¹, FERNANDO V. RAMIREZ-ROZZI², ALAIN FROMENT³, JOAQUÍN DE JUAN¹, ALEJANDRO PÉREZ-PÉREZ⁴. ¹Department of Biotechnology, University of Alicante (Spain), ²UPR 2147 CNRS, Dynamique de l'évolution humaine, Paris (France), ³IRD UMR 208, Musée de l'Homme, Paris (France), ⁴Department of Animal Biology, University of Barcelona (Spain).

Buccal-tooth surface microwear is highly correlated with abrasive particles in foodstuffs during chewing. However, human microwear-dietary models related to ecological and cultural factors are still scarce. African pygmies are foragers' societies living in the tropical forest. The analysis of enamel microwear in these populations should provide a good model for societies living in similar environmental conditions. Replicas of left-lower M1 were obtained in a sample of *in vivo* Baka pygmies from southeastern Cameroon (n=42), BaBinga (n=5) and BaBongo (n=6) museum pygmies from Central African, Congo and Gabon, and a control group of Spanish volunteers (n=36). Buccal-microwear was examined with a Scanning Electron Microscope (SEM) at 100 \times . Microstriation density and length by orientation (in 45° intervals) from 0° to 180° were measured. Significant differences (ANOVA and Tukey's HSD tests; p<0.05) were found in the microwear density (p<0.000) and length (p<0.000) between Pygmy and control group, indicating that different enamel microwear can reflect distinct diets. The low density and longer microstriations in pygmies indicates a diet that contains few abrasives probably related to higher amount of meat and non-abrasive plant materials in dietary. When enamel microwear is compared among pygmies groups, results of discriminant analyses indicate that microstriation density by orientations is higher in BaBongo pygmies than in the Baka and BaBinga populations, probably due to the fact that BaBongo economy is more based on agricultural resources than other pygmies groups, BaBongo lived much sedentarily and in closer relation with Bantu populations, as suggested by ethnographic and genetic data. This study was funded by Spanish GV and MEC, grant numbers BEST/2009/258, CGL2007-60802 and Wenner-Gren Foundation, grant number Gr.7819.

Evolved dependence of the human immune system on microbial Old Friends.

GRAHAM A.W. ROOK. Windeyer Institute for Medical Sciences, University College London, UK.

Man has moved rapidly from the hunter-gatherer environment to the living conditions of the rich industrialised countries. The hygiene hypothesis suggests that the modern increases in chronic inflammatory disorders are a consequence of reduced exposure to micro-organisms that have a role in setting up regulation of the immune system. The concept began with the allergic disorders, but is now extended to autoimmunity, inflammatory bowel disease, atherosclerosis, & depression associated with raised inflammatory cytokines. Epidemiology that targets the identifiable, clinically apparent infections of childhood consistently fails to find associations with protection from these disorders, but these organisms are recent acquisitions, dating back only to the late Neolithic. The organisms shown to be relevant (by epidemiology, animal experiment and clinical trials) have had very long associations with the mammalian immune system, usually traceable back to the Paleolithic

or earlier. Often these organisms have been present as commensals (particularly gut microbiota), environmental "pseudocommensals", subclinical infections or asymptomatic carrier states, and the mammalian immune system is in a state of "evolved dependence" on their continued presence. Some of these "Old Friends" modulate dendritic cells and T cells in such a way that immunoregulatory circuits are established. This understanding can simplify the quest for clinical solutions to the problem posed by the increasing incidence of inflammatory disorders in rich countries. Clinical trials are in progress. We can anticipate rapid increases in the use of these organisms or their components in novel types of prophylactic with applications in several branches of medicine.

The evolution of rotational birth: inferences from a three-dimensional virtual reconstruction of the pelvic girdle of Jinniushan.

KAREN R. ROSENBERG¹, MARCIA PONCE DE LEÓN², LÜ ZUNÉ³ and CHRISTOPH ZOLLIKOFER². ¹Department of Anthropology, University of Delaware, ²Anthropological Institute and Museum, University of Zurich, ³Department of Archaeology, Beijing University.

Rotational birth is a hallmark of human obstetrics which has important implications for the social context within which birth takes place. Here we test the hypothesis that rotational birth evolved recently in human evolution coincident with the origin of modern humans. The Mid-Pleistocene archaic fossil human from Jinniushan (dated to approximately 260 kya) is unique for this time period as it is represented by associated cranial and postcranial remains permitting estimates of body size and proportions, encephalization and pelvic dimensions. Jinniushan is the largest currently known female in the human fossil record and comparable in overall pelvic size to the male specimens Atapuerca-SH1 and Kebara-2. This sample provides an opportunity to test hypotheses about the evolutionary timing of rotational birth. Although the Jinniushan specimen is missing the sacrum, the os coxae is essentially complete. We present a new computer-assisted three-dimensional reconstruction of the entire pelvic girdle of Jinniushan. Using reconstructions of archaic and recent human neonates, we infer obstetric constraints by computer-based simulation of the birth process. Our analyses show that while birth canal size is somewhat larger than in modern humans, birth canal shape as well as cephalopelvic proportions are indicative of a rotational birth mechanism. This is consistent with what we see in the recently described female *Homo erectus* pelvis from Gona, Ethiopia (1.8 mya), suggesting that a rotational birth mechanism preceded the evolution of anatomically modern humans.

The skull of *Tarsius*: functional morphology, eyeballs, and the non-pursuit predatory lifestyle.

ALFRED L. ROSENBERGER. Department of Anthropology and Archaeology, Brooklyn College (CUNY), New York.

Little is known about the impact of enormous eyeballs on the tarsier's head. A biomechanical analysis compares the cranium of *Tarsius* with the Eocene fossil *Necrolemur*, a moderately large-eyed surrogate for ancestral tarsiid cranial morphology. Eyeball hypertrophy has radically influenced the neurocranium and basicranium, driving the evolution of such derived features as: recession of orbital fossae; ectopically located eyeballs; uplifted brain and rounded braincase; antero-ventrally shifted foramen magnum; enlarged and horizontally leveled nuchal plane; laterally displaced and narrowed tympanic cavities; and, shortened external auditory tubes. The gestalt is an adaptation to efficient orthograde head carriage, balanced head-turning movements, and spatial packaging of cranial components, responses to an extreme loading regime in which the eyes, with a mass approximating twice the bulk of the brain, profoundly eccentrically loads the skull. Specializations of the retina and cortex suggest tarsiers have an acutely developed spatial sense, adept at detecting and mapping motion. Spanning several anatomical systems, this configuration contributes to an extreme form of vertical clinging and leaping (XVCL) geared for noiseless, non-pursuit predation, an energy-minimizing procurement strategy that may be a trade-off for relying on metabolically expensive, outsized eyeballs, maintained by a highly nutritious, super-specialized animalivorous diet. A more varied galago-like locomotor profile and foraging habit was common among fossil tarsiiforms and preadaptive to this lifestyle. Tarsier ecomorphology evolved to minimize the costs of being extraordinarily "top heavy," carrying a heavy load that is roughly equivalent to three brains.

Lumbar spine spondylolysis: using computed tomography to evaluate the possibility of adult onset lumbar spondylosis as a cause of back pain.

MATTHEW C. ROSETT¹, BENJAMIN K. BROOKS², SAMUEL L. SOUTHAM², GARY W. MLADY² and JEREMY LOGAN².

¹Department of Anthropology, University of New Mexico, ²Department of Radiology, University of New Mexico School of Medicine.

The objective of this study was to determine if adult new onset low back pain could be secondary to lumbar spondylolysis by establishing the age related prevalence in the general population using patients undergoing CT imaging for reasons unrelated to back pain. Abdominal and pelvic CT scans from 2,552 patients were retrospectively reviewed by radiologists for lumbar spondylolysis, including unilateral and bilateral defects. In order to determine an accurate representation of the general population, all indications for CT imaging were reviewed with the exception of patients with a primary complaint of low back pain as the primary indication for imaging. Individuals were grouped together by age into equally distributed categories.

Results indicated that lumbar pars interarticularis defects were observed in 203 cases with an overall prevalence of 8.0%. Additionally, prevalence per decade varied and ranged from 7.0% (ages 30-39) to 9.2% (ages 70+), prevalence of ages 20-49 was 7.9% and ages 50+ was 8.0%, and the male to female ratio was 1.5:1. Logistic regression analysis showed no statistically significant increase in spondylolysis based on age. No significant increase in the prevalence of lumbar spondylolysis was demonstrated in patients greater than age 20. This suggests that the development of symptomatic lumbar pars defects do not occur in this population and should not be considered as a rare but potentially treatable cause of new onset low back pain in adults. As demonstrated in previous studies, the male-female ratio of 1.5:1 is statistically significant.

Bone strain and finite element modeling of the *Cebus* mandible during hard object feeding.

CALLUM ROSS, LAURA PORRO and DAVID REED, Organismal Biology & Anatomy, University of Chicago.

The relationship between mandible morphology and material properties of the diet is poorly understood. This relationship, if it exists, might be revealed by studies of hard object feeding which presumably entails generation of high force magnitudes. Peak mandibular corpus bone strain magnitudes during the power stroke of mastication vary across food types that differ in qualitative descriptors such as "toughness" or "hardness". However, measures of strain have not been made while the animals eat foods of known material properties. We hypothesized that the nature of the loading regime would vary according to the direction of movement of the mandible during mastication which would in turn be related to food material properties. Hard-object feeding was studied in *Cebus* monkeys using *in vivo* bone strain, finite-element modeling, EMG and 3-d jaw kinematic techniques. Three rosette gages placed around the cross-section of the mandible were used to collect strain data during powerful incision, premolar biting and mastication. Strains measured *in vivo* were compared with surface strains from a finite-element model of the capuchin mandible. These data suggest that the mandible is bent, twisted and sheared during premolar biting on hard objects. The data suggest that variation in ER^{0.5} affects mean orientation of the neutral axis of bending in a chewing sequence. These data suggest that differences in food material properties can affect loading regimes in the primate mandible.

Reassessment of the late Neandertals from Spy (Belgium).

HELENE ROUGIER^{1,3}, ISABELLE CREVECOEUR^{2,3}, ANTOINE BALZEAU⁴, GILLES BERILLON⁵, ANNE HAMBÜCKEN³, BRUNO MAUREILLE², ARNAUD MAZURIER⁶, VIRGINIE VOLPATO⁷ and PATRICK SEMAL³. ¹Department of Anthropology, California State University Northridge,

²PACEA-UMR 5199 CNRS, Université de Bordeaux, ³Service Anthropologie et Préhistoire, Institut royal des Sciences naturelles de Belgique, ⁴UMR 7194 CNRS, Département de Préhistoire du Muséum National d'Histoire Naturelle, ⁵Dynamique de l'Évolution Humaine, UPR 2147 CNRS, ⁶Études Recherches Matériaux, ⁷Forschungsinstitut Senckenberg.

In 1886, the cave of Spy yielded the remains of two adult Neandertals. For the first time, Neandertal fossils were discovered *in situ* and in association with ice age artifacts and fauna, thus confirming their antiquity. The Neandertals from Spy have been subsequently studied by each generation of paleoanthropologists given their good state of preservation and presence of cranial and infra-cranial remains. Recent direct dating of the Spy Neandertals has further reinforced their importance in the fossil record by showing that they are among the most recent representatives of this fossil group and that they may be associated to a transitional middle-to-upper Paleolithic techno-complex.

However, there has not been a synthetic study of the Spy skeletons since the 1887 monograph, nor a complete study of the Spy archeological and fauna collections.

We will present how our multidisciplinary approach has allowed us to reassess the Neandertal skeletons from Spy. We will show that there may have been a mix of material after the excavations resulting in 1) the incorrect attribution of some of the bones to either Spy I or II, and 2) the inclusion of Neolithic remains to the Neandertal collection. We will also present new Neandertal remains that we discovered among the fauna collections from Spy, and that belong to Spy I and II.

Our re-assessment of the adult Neandertal skeletons from Spy is key to paleoanthropologists who want to include these fossils as reference material, and raises questions about the necessity to re-evaluate the validity of old collections. This study was funded by the European Union, The Neanderthal Tools project - IST 6th framework programme; Belgian Science Policy, Research project MO/36/012 and IST project I2/2F/212; FRS-FNRS, grant number 2005-2006/1.5.287.

Community repositories for voxel datasets and derivative 3D visualizations: Opportunities and obstacles identified by the DigiMorph.org Project.

TIMOTHY ROWE. Jackson School of Geosciences, The University of Texas at Austin.

Short of destructive sampling, previous generations had to be content studying only external surfaces of fossils. Today, computed tomography is just one of a growing armament of non-destructive scanning techniques that enable non-destructive and quantitative visualization of entire object volumes. These novel 3D datasets enable derivative visualizations such as endocasts of spaces housing the inner ear and brain, and novel visualizations of the nasal capsule that are fostering a renaissance in morphology. Volumetric datasets are becoming as

fundamental to morphology as the specimens themselves. To the extent that these datasets and derivative visualizations are the sources of discovery, then they should be archived as vouchers and potential sources for discovery cascades. Like collections of physical specimens, our experience suggests that the impact of individual datasets and endocasts can be expanded enormously by arranging them into organized collections or digital libraries. Economic efficiencies also follow the pooling of resources into communal digital collections. Technological hurdles do stand in the way, but these are surmountable with planning and comparatively modest funding. More problematic are societal issues. These range from editorial matters, to intellectual property concerns of museums stewarding the original specimens, that volumetric datasets can be transformed into physical objects and sold as commodities. While commercialization of such property seems desirable, so far our community has performed poorly. Also unresolved are the relative merits of distributed versus centralized repositories. DigiMorph.org, now 10 years old, offers a vantage point for community discussion on how to plan ahead for the exploitation of digital volumetric data on the massive scale that looms ahead.

Heritability of serological measures of common infections: a family-based study of Mexican Americans.

ROHINA RUBICZ¹, ROBERT YOLKEN², ELLEN KRAIG³, CHARLES T. LEACH⁴ and HARALD H. H. GÖRING¹. ¹Department of Genetics, Southwest Foundation for Biomedical Research, ²Department of Pediatrics, Johns Hopkins School of Medicine, ³Department of Cellular and Structural Biology, University of Texas Health Science Center at San Antonio, ⁴Department of Pediatrics, University of Texas Health Science Center at San Antonio.

Differences in susceptibility to infectious disease are attributable to many factors, including genetic differences between individuals and populations. Here we test the hypothesis that variation in antibody titer, which reflects infection history, is partly due to genetics. Participants included >1300 Mexican Americans in the San Antonio Family Heart Study. Antibody titers and seroprevalence were determined by ELISA for 12 common infections: Chlamydia pneumoniae; Helicobacter pylori; Toxoplasma gondii; hepatitis A; influenza A; influenza B; Cytomegalovirus; Epstein-Barr virus; herpes simplex I virus (HSV-1); herpes simplex II virus (HSV-2); human herpesvirus 6; and varicella zoster virus. Both quantitative antibody titers and discrete serostatus phenotypes (seropositivity/seronegativity) were analyzed. Additive genetic heritability (h^2) was calculated using variance component (VC) pedigree analysis with the computer program SOLAR. To assess influence of shared environmental factors, a household component was included in the VC model. All pathogens (except the discrete trait for HSV-2, which is sexually transmitted) were found to have a significant heritable component at $p \leq 0.05$, with h^2 ranging

from 15.5% (HSV-2) to 45.7% (hepatitis A) for quantitative titers, and 32.6% (HSV-1) to 70.4% (C. pneumoniae) for seropositive/seronegative status. However, fewer pathogens were significantly heritable when simultaneously accounting for household. Household was significant for approximately half the pathogens, the largest contribution being 31.5% ($p=8.6 \times 10^{-03}$) for influenza A, likely due to the infection being passed among relatives. These results demonstrate individual genetic differences do contribute to serological phenotypes, and identifying the underlying genetic factors may help shed light on how the immune system functions, disease susceptibility and treatment. This study was funded in part by NIH, HL080149.

The evolutionary roots of human social norms in chimpanzees: an experimental study.

CLAUDIA RUDOLF VON ROHR, JUDITH BURKART and CAREL VAN SCHAIK. Anthropological Institute & Museum, University of Zurich.

All human social life is guided by social norms whose violation may provoke strong reactions not only in victims but, most importantly, also in unaffected bystanders. Chimpanzees also protest when their "personal" expectations are violated (e.g. stolen food). Hence, chimpanzees seem to possess a form of "egoistic norms" (i.e. the individual's selfish preferences). However, to establish the presence of social norms in chimpanzees, we have to investigate whether they, like humans, also show reactions when they are unaffected bystanders. We hypothesize that a possible violation of a social norm in chimpanzees is the killing of infants by adults. We therefore conducted video experiments with captive chimpanzees housed in Gossau (N=11) and Basel (N=8), Switzerland. In the habituation phase, we showed the whole group video clips of unfamiliar conspecifics performing socially neutral behaviors (largely tool use). In the experimental phase, the chimpanzees watched unfamiliar conspecifics performing infanticide (treatment), performing hunts or showing excitement in other contexts (controls). We predicted that when killing infants violates chimpanzees' social expectation, they should show the strongest reactions towards infanticide compared to the other stimuli. Preliminary analyses show that the chimpanzees looked significantly longer at scenes of infanticide than of other stimuli, and also showed more distress behaviors. Furthermore, video clips were controlled for the amount of stimuli they provided. Thus, our experiments suggest that chimpanzees differentially evaluate infanticide from other social events even as completely unaffected bystanders. This differentiated response satisfies a basic precondition for the existence of social norms. This study was funded by the University Research Priority Program in Ethics, University of Zurich.

Body size and body shape in early *Homo* – implications of the Gona pelvis.

CHRISTOPHER RUFF. Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, Baltimore.

Discovery of the Early Pleistocene Gona (BSN49/P27) pelvis, attributed to *Homo erectus* (Simpson et al., 2008), raises a number of interesting issues regarding variation in early hominin body size and shape. The Gona pelvis is mediolaterally wide (288 mm), but has very small articular surfaces (acetabular breadth of 41 mm), suggesting a very small body size. Both of these characteristics run counter to traditional reconstructions of Early Pleistocene *H. erectus*. Here, femoral head breadth (estimated from acetabular breadth if necessary) is used to estimate body mass in 37 early hominin specimens ranging in age from 6.0 to .26 Ma. Estimated body mass averages 36.4 kg (range 28–52 kg) in non-*Homo* specimens (*Orrorin*, *Australopithecus*, *Paranthropus*) and 62 kg (range 52–77 kg) in Early Pleistocene *Homo* specimens (except Gona). Gona has an estimated body mass of 36.8 kg. Including the Gona specimen within *H. erectus* increases sexual dimorphism in body mass from 1.18 to 1.44, larger than that observed or inferred here in any other hominin taxa, while size dispersion within female *H. erectus* rises to a level above that observed in any modern primate. This raises questions about the taxonomic attribution of the Gona specimen. The M-L wide breadth of the Gona pelvis must be viewed within the context of overall variation in body breadth among Early-Middle Pleistocene hominins, which exhibits ecogeographic variation overlain by generally wider pelvis at all latitudes compared to modern humans, related to an M-L wider birth canal and possible non-rotational birth mechanism.

Comparison of limb bone biomechanical properties among primates, bats, gliders, and squirrels.

JACQUELINE RUNESTAD CONNOUR. Department of Natural Sciences, University of Findlay, Findlay, Ohio.

Humeral and femoral biomechanical properties in small primate generalists are compared to those properties in non-gliding arboreal sciurids, placental gliders, and megachiropterans. Primates and sciurids are expected to be the most similar as they are relatively generalized, while bats and gliders are expected to differ corresponding to locomotory behavior. The sample includes 13 platyrhine, 7 prosimian, 13 sciurid, 11 glider, and 7 bat species from museum collections. Properties analyzed are humeral and femoral lengths and midshaft cross-sectional properties calculated from biplanar radiographs. Data are fitted using least squares regression for ANCOVA slope and elevation comparisons. Further analyses will be conducted. Results place primates intermediate between the other groups in most of the properties considered. Prosimians and sciurids are similar in humeral length. Sciurids, however, have shorter femora than both primate groups, and larger cross-sectional properties, and are not as similar as expected. Bats have longer humeri and larger humeral

cross-sectional properties, as expected for fliers. Bats have shorter and narrower femora than gliders and primates. However, bats do not differ in femoral cross-sectional cortical area from the other groups, and are high in proportion of femoral cortical area compared to femoral total cross-sectional area. The narrowness of bat femora has been previously noted by Swartz et al. (2003) and Riskin et al. (2009), who also report that bat landings seem to be high impact. This combination of external femoral reduction and high landing reaction forces may result in relatively thick femoral cortices as observed in this study.

A population genetics approach to studying Egyptian state formation.

ADAM RUSSELL¹, and KANYA GODDE^{1,2}.

¹Department of Anthropology, University of Tennessee, Knoxville, ²Department of Science, South College, Knoxville.

The process of state formation has many key archaeological signatures. Territorial states, for example Egypt, have defining characteristics such as elaborate art and architecture due to greater surplus from economical control (Trigger 2003). However, territorial state predecessors were less densely populated cities, consisting mostly of elites with agricultural production of necessary items (Trigger 2003). While archaeologically it may be somewhat apparent how populations reacted to state formation, biological changes can be much more obscure. In order to detect biological changes in population structure in Egyptians during state formation, a population genetics approach was applied, using RMET. Craniometrics of five Egyptian samples from the sites of Badari, Naqada, Gizeh, Lisht and one dating to the Coptic Monk period were obtained from Dr. Tsunehiko Hanihara (personal communication). Taken together, the statistics indicate a pattern consistent with state formation in Egypt; the Predynastic samples are differentiated from later groups and extraregional gene flow was low. The skeletal analysis agrees with the mortuary evidence; social complexity evolved from somewhat egalitarian behaviors in early Predynastic (Badari), with stratification gradually becoming more apparent in by the end of the Predynastic period (Naqada) (cf. Bard 1989 Castillos, 1983; Midant-Reynes, 2000a,b). Consequently, from an archaeological perspective, social complexity most likely arose due to changes in procurement of goods and creation of surplus, resulting in individual families becoming more influential and powerful, causing an internal structural change. Therefore, the skeletal and archaeological data presented in this study agree with Zakrzewski (2007) that state formation occurred internally in the Egyptians.

Human fetal and postnatal rates of cranial bone growth and patterns of vault curvature.

DANA J. RUSSELL¹ and FRANK L. WILLIAMS¹. ¹Department of Anthropology, Georgia State University.

AAPA ABSTRACTS

Selection for a larger cranial capacity in the genus *Homo* necessitated extensive brain growth after birth so that the efficiency of bipedalism would not be compromised by an increasingly larger pelvis. The brain grows rapidly after birth in humans in contrast to nonhuman primates which experience rapid prenatal brain growth, but much slower postnatal expansion of brain tissue. The marked increase in cranial capacity of humans postnatally has been explained as an extension of fetal rates of brain growth into the first year of life. To ascertain the extent to which fetal rates of brain growth are maintained during the first six postnatal months, cranial linear distances from 80 individuals represented by fetal remains and 44 infants younger than six months were obtained from the Fetal Osteology Collection at the Smithsonian Institution. Rates of growth in chord and arc measurements for the frontal, parietal and occipital bones between fetuses and neonates were compared using linear regression of logged-transformed variables followed by an ANCOVA. Curvature of cranial bone lengths and widths was estimated by chord/arc indices, and differences assessed using t-tests. Rates of cranial growth were significantly slower for neonates, suggesting that while human brains increase substantially in size during the first six postnatal months, fetal rates of brain growth are not continued past birth. Except for parietal anterior-posterior eminence where bossing of the bone is the most pronounced, fetal cranial bones are significantly more curved than those of neonates suggesting a remodeling of the cranium occurs shortly after birth.

Comparative sacrocaudal anatomy in catarrhines.

GABRIELLE A. RUSSO¹ and LIZA J. SHAPIRO¹. ¹Department of Anthropology, The University of Texas at Austin, Austin.

The functional morphology of the primate tail is poorly understood compared to other aspects of the postcranial skeleton. Previous research demonstrates that arboreal primates have longer tails compared to closely-related terrestrial forms, reflecting their use of the tail as a balancing aid during arboreal locomotion. Morphological correlates related to this, however, have not yet been investigated. We test the utility of three quantitative approaches for determining tail length and mobility from the morphology of the sacrum's caudal end in extant cercopithecines and hominoids. We quantify the sacrum's caudal articular surface and postzygapophyseal shape using geometric morphometrics, dorsoventral angle of the caudal articular surface from digital photographs, and trabecular morphology of the caudalmost sacral element using high resolution x-ray CT. Long-tailed catarrhines (LTC) are distinguished from non-tailed catarrhines (NTC) by all three methods and, short-tailed catarrhines (STC) are sometimes distinguished from LTC. Geometric morphometric analyses show the caudal articular surface is mediolaterally expanded in NTC, circular in LTC, and STC have an intermediate shape. Among tailed catarrhines, LTC have more obliquely oriented sacral

postzygapophyses than STC, allowing for a greater range of movement at the tail base. Analysis of digital photographs reveals that LTC exhibit the greatest dorsoventral angle, followed by STC and NTC, respectively, permitting greater dorsal extension at the tail base. Trabeculae are more anisotropic in LTC than NTC. Our findings indicate that the morphology of the sacrum's caudal end may reflect differences in tail length and mobility. These results have implications for reconstructing tail length from fossil sacra.

Foramen magnum position is influenced by neocortex size but not posture.

AIDAN RUTH, MARY ANN RAGHANTI, RICHARD MEINDL and C. OWEN LOVEJOY. Department of Anthropology, Kent State University, Kent, Ohio.

An anterior position of the foramen magnum is often cited as a correlate of bipedal posture in hominids. Other investigators (e.g. Biegert 1967) contend that it more accurately reflects increased encephalization. The present study examines this problem in Phyllostomid bats, which most commonly employ an inverted but orthograde posture during rest although all participate in active flight.

The position of the foramen magnum was evaluated using Bolk's Basal Index (1909). A mean Basal Index was obtained for six species of bats. Neocortex volume for each species was obtained from Baron (1996) and divided by telencephalon volume to reflect relative neocortical expansion. A substantial negative correlation ($r = -.80$, $P = .027$) was found between the two values, as predicted by Biegert's hypothesis. As a further test of the possible influence of size, the Basal Index was compared to a Gnathic Index. This correlation ($r = .50$, $P = .153$) was moderate but not significant. Since there is little variation in locomotor pattern and/or posture within this group of bats, this confounding variable can also be excluded. These data provide strong evidence that the position of the foramen magnum may be used as a potential indicator of neural reorganization (in particular, expansion of the neocortex), but not as a covariate of posture.

Interlimb variation in trabecular bone architecture in primates.

TIMOTHY M. RYAN¹, ALAN WALKER¹, ANIA SWIATONIOWSKI¹ and BERT VAN RIETBERGEN². ¹Department of Anthropology, Pennsylvania State University; ²Department of Biomedical Engineering, Eindhoven University of Technology.

The utility of trabecular bone architecture for reconstructing locomotor and masticatory behaviors in the fossil record depends on establishing clear functional relationships between trabecular bone form and function. To this end, a significant amount of research has been focused on trabecular bone structure of the primate proximal femur with conflicting results. The goal of this study is to analyze the effects of differential limb usage on the trabecular bone

architecture of the proximal femur and humerus across primate taxa with diverse locomotor behaviors including brachiation, quadrupedalism, climbing, and leaping. High-resolution x-ray computed tomography scans were collected from the proximal femur and humerus of over 100 individuals from fifteen primate species representing a range of body masses and locomotor behaviors. Bone volume fraction, anisotropy, trabecular thickness, and trabecular number were quantified in multiple volumes of interest within each specimen. Trabecular bone volume fraction is consistently and significantly higher in the femoral head than in the humeral head in nearly all taxa independent of locomotor behavior. Humeral trabecular bone is generally more isotropic than femoral trabecular bone in all species sampled and trabecular thickness appears to scale with body mass. The more robust trabecular bone of the proximal femur possibly reflects the general hindlimb dominance of primate locomotion. These results indicate broad similarity in bone structure of the hip and shoulder across all primates no matter locomotor behavior, calling into question the utility of trabecular bone structure in these regions for locomotor reconstructions in the fossil record. Research supported by NSF BCS-0617097.

Isotope evidence for human diets in the Mesolithic and Neolithic periods of eastern coastal Iberia (Valencia).

DOMINGO C. SALAZAR GARCÍA^{1,2} and MICHAEL RICHARDS^{1,3}. ¹Department of Human Evolution, Max-Planck Institute for Evolutionary Anthropology, ²Departamento de Prehistoria y Arqueología, Universitat de València, ³Anthropology Department, University of British Columbia.

We report here on the results of carbon and nitrogen stable isotope analysis of humans and fauna from twelve Mesolithic and Neolithic sites from the Valencia region of Iberia. In other parts of Europe there is isotopic evidence for an abrupt change in diet between these periods, especially in coastal regions of Northern Europe. To date, there are few isotopic studies for these periods from the Mediterranean. This communication reports new isotopic data from the eastern Iberian Peninsula, from sites dating to the Mesolithic, and early, middle and late Neolithic. The results show no major diet shift between these two periods, and confirms the consumption of marine protein resources during the Neolithic. This study was funded by the Science Ministry of Spain and the Max-Planck Society.

Sex determination using discriminant function analysis of lower limb measurements from a Late Horizon Andean population.

ELLEN SALTER-PEDERSEN. Department of Anthropology, Indiana University, Bloomington.

The purpose of this study is to develop new standards for the estimation of sex of human skeletal remains from the Andean region.

Previous studies have shown that metric assessment of sex can yield a high level of accuracy. Unfortunately, the standards developed with this method are population specific. This study uses a collection of adult skeletons from the Late Horizon (AD 1450-1535) cemetery of Rinconada Alta, located on the outskirts of Lima, Peru. Ninety-nine skeletons were examined of which 49 were male and 50 were female. The skeletons were initially sexed using morphological features of the pelvis and skull. Eighteen standard measurements were collected from the femur, tibia, fibula and calcaneus and the data were analysed with discriminant function analysis in SPSS 16.0. Classification using univariate functions ranged in accuracy from 65.5% to 96.3% while multivariate functions ranged in accuracy from 84.6% to 97.2%. Discriminant functions using measurements of the femur and tibia were overall more accurate than those of the fibula and calcaneus. Further, classifications based on epiphyseal measurements were more accurate than those using measurements of the diaphysis. This study indicates that formulae developed from lower limb measurements can be used for accurate sex determination of skeletons from the Andean region. Moreover, this method can be applied to complete, incomplete and fragmentary skeletal remains.

Assessing changes in stature and body size scaling from *Australopithecus* to *Homo* using femoral length/iliac breadth ratios.

AARON SAMS¹ and JOHN HAWKS¹.
¹Department of Anthropology, University of Wisconsin-Madison.

Following the discovery of KNM-WT 15000, many researchers (Ruff, 1991; Wheeler, 1992, 1993; Aiello & Wells, 2002) attempted to explain the differences in body size proportions between australopithecines such as A.L. 288-1 and early *Homo*. However, the primary assumption of these papers, that there was a change in the scaling of body size to stature from *Australopithecus* to *Homo* has yet to be directly tested. Whereas Ruff's (1991) study examined the relationship between estimated stature versus bi-iliac breadth in *Australopithecus* and early *Homo*, this study compares the ratio between maximum femur length and maximum iliac breadth as a relevant developmental system reflecting stature and pelvic size in modern human, australopithecine, and early *Homo* samples. Utilizing resampling methods, three hypotheses are tested. These are that there is no change in femur/iliac breadth ratio between: 1)all hominids; 2)australopithecines and early *Homo*; 3) early *Homo* and modern humans.

As expected, the first hypothesis, that stature to body size ratio has not changed from australopithecines to modern humans, is rejected. The second and third hypotheses are more difficult to explore, given the limited complete sets of femora and pelvises. However, resampling tests effectively reject hypotheses 2 and 3, suggesting that three grades of stature/body size ratios exist. Mathematical calculations imply probable overlap in the distribution of ratios between all three groups,

which may suggest that there are structural and/or genetic constraints on the relative growth of the pelvis relative to stature.

Representational play in wild chimpanzees (*Pan troglodytes*).

AARON A. SANDEL. Department of Evolutionary Anthropology, Duke University.

Representational, or imaginary play is a hallmark of human behavior, but its presence in nonhuman animals remains controversial. Wild and captive chimpanzees engage in social and solitary play, continuing even into adulthood, but representational play has not been specifically described in the wild. Language-trained chimpanzees (*Pan troglodytes*) and bonobos (*P. paniscus*) have been observed to engage in varying levels of representational play, such as attributing animate qualities to inanimate objects (e.g. dolls). Reports of wild chimpanzees grooming and playing with dead animals also indicate at least a basic level of representational play. In this study, I describe two novel instances of play with inanimate objects in chimpanzees from Kanyawara, Kibale National Park, Uganda. A juvenile male was observed playing with a dead African palm civet (*Nandinia binotata*) and a young adolescent female was observed playing with a rock. Behaviors directed toward the objects included grooming, cradling, carrying, and copulating, which mirror adult behavior, although in the detached context of solitary play. These observations, when considered with other instances of object play in wild chimpanzees suggest that humans' imaginative abilities are shared with chimpanzees, thus providing further insight into the cognitive faculties of apes.

A new Oligocene catarrhine primate from Saudi Arabia and ancestry of Old World monkeys and apes.

WILLIAM J. SANDERS^{1, 2}, IYAD S. ZALMOUT¹, LAURA M. MACLATCHY^{1, 2}, GREGG F. GUNNELL¹, YAHYA AL-MUFARREH³, MOHAMMED A. ALI³, ABDUL-AZZIZ H. NASSER³, ABDU M. AL-MASARY³, JEFFREY A. WILSON^{1, 4} and PHILIP D. GINGERICH^{1, 2, 4}. ¹Museum of Paleontology, University of Michigan, ²Department of Anthropology, University of Michigan, ³Saudi Geological Survey, Paleontological Unit, ⁴Department of Geological Sciences, University of Michigan.

The temporal interval (ca. 30-23 Ma) between propliopithecoid occurrences and diversification of cercopithecoids (OWM) and proconsuloids, dendropithecoids, and/or hominoids in Afro-Arabia during the early Miocene has yielded little direct evidence about the timing of origin or ancestral morphological condition of hominoids and cercopithecoids. We report here the recovery of a partial cranium of a new catarrhine from the Shumaysi Fm. in western Saudi Arabia, dated to ca. 29-28 Ma. The new cranium predominantly resembles male crania of the propliopithecoid *Aegyptopithecus*, with low hafting of the face on the neurocranium, snout-like midfacial projection, relatively broad,

low molars, relatively small canine crowns, and a frontal trigon, and lacks obvious ape and OWM synapomorphies. However, it shares possession of a tubular ectotympanic with apes and OWM. The most parsimonious interpretation of these features is that the new catarrhine is an advanced stem catarrhine close to the ancestry of apes and OWM. The age and apparent phylogenetic position of the new catarrhine provide an opportunity to test competing hypotheses about the ancestral morphotype of OWM and apes, the phylogenetic connection between propliopithecoids and crown catarrhines, and the timing of the OWM-ape divergence. Our results indicate that the last common ancestor of these catarrhines had a long, projecting *Aegyptopithecus*-like, rather than short, flat gibbon-like face, that propliopithecoids played an important role in the evolution of later catarrhines, and that the OWM-ape split could have occurred as early as the beginning of the late Oligocene, but likely not earlier. This study was funded in part by financial support from the Saudi Geological Survey, Jeddah, Saudi Arabia.

Interactions among tooth wear, plant fracture mechanics and tooth function.

GORDON SANSON. School of Biological Sciences, Monash University, Australia.

Tooth wear affects shape and has been linked to efficiency of tooth function, with subsequent implications for longevity and fecundity through predator-prey and social interactions. However, fine scale interactions operating when opposing teeth fracture plant tissue that carry an abrasive load, and that might influence diet selection, are less well understood. Steel models replicating the enamel ridges of horse teeth must occlude to 15-30 µm to sever a single blade of *Pennisetum* grass and require a load of 29 N. Maintaining this clearance ensures that up to 10 stacked leaves can be fractured. Allowing the clearance gap to increase under a load of 1,500 N was insufficient to completely sever all 10 leaves in a stack. Most phytoliths are larger than the gap, while most wind blown dust is smaller. In this model, if silica phytoliths are harder than enamel, teeth should be worn faster than seems to occur naturally. The large size of silica phytoliths combined with their apparent softness compared to enamel suggests they cannot be a major source of tooth wear. Decreasing tooth sharpness using kangaroo facsimiles requires increasing forces to successfully sever grass blades. Perpendicular forces of 1,500 N on *Phyllostachys* bamboo leaves between Giant Panda molar facsimiles caused less than 5% leaf area damage, suggesting that enamel ridges must be close to the height of the leaf stack or shearing will be prevented. Higher forces required by worn teeth will increase wear in a feedback loop, which will be exacerbated if tougher plants are ingested.

Hypertrophic osteoarthropathy: Dry-bone evidence from the Coimbra Skeletal Identified Collection (Portugal).

ANA LUÍSA SANTOS¹, SANDRA ASSIS¹ and CHARLOTTE ROBERTS². ¹CIAS – Research

Centre for Anthropology and Health, University of Coimbra, Portugal; Department of Archaeology, Durham University, England.

Hypertrophic osteoarthropathy (HOA), is characterized by digital clubbing, bone deposition on the long bones and joint inflammation. Symmetrical periosteal lesions in paleopathology is considered the hallmark of HOA. Besides its unknown aetiology, it has been associated with cardiovascular, gastrointestinal and pulmonary disorders (e.g lung cancer, pneumonia, pulmonary fibrosis, emphysema and tuberculosis). The aim of this work was to assess whether the presence of a relationship between the presence of HOA and pulmonary conditions, especially tuberculosis. A sample of 329 individuals were selected from the Coimbra Skeletal Identified Collection (66 non-adults, and 263 adults: 143 females and 186 males). The sample comprises individuals recorded with tuberculosis ($n=125$) and pulmonary non-tuberculosis ($n = 62$) as causes of death, and a control group ($n=142$) selected randomly from the individuals with a non-tuberculosis/ non-pulmonary cause of death. Macroscopic, radiological and documentary evidence about the individuals enabled assessment of the relationship between lung disorders and HOA. Lesions compatible with HOA were found in the three groups, being more frequent and statistically significantly present in the individuals who died from pulmonary conditions (11.8%, 22 of 187, $X^2 = 7.281$, $p<0.005$). Individuals with TB as a cause of death revealed an association with the presence of HOA (OR=4.6; IC95%:0.081-0.255) This work, based on identified skeletons of people who died before the development of antibiotics, agrees with clinical studies that have established a possible correlation between pulmonary conditions and HOA; the data may help in differentially diagnosing the many instances of periosteal new bone formation found in archaeological samples.

The Y chromosome history of Native Americans.

FABRÍCIO R. SANTOS¹, DANIELA R. LACERDA¹, MARILZA S.A. JOTA¹, MARILIA SCLiar¹, EDUARDO TARAZONA-SANTOS¹, VANESSA RODRIGUES PAIXÃO-CORTES², SANDRO L. BONATTO³ and MARIA CATIRA BORTOLINI². ¹Department of General Biology, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil, ²Department of Genetics, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, ³Faculty of Biology, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, Brazil.

The human Y chromosome history reveals a counterpart of the mtDNA reconstruction of the pre-Columbian colonization of America. Although in the beginning this chromosome revealed a paucity of polymorphisms, large SNP surveys have identified in the last decade many point mutations and small indels that were used to reconstruct a patrilineal phylogeny. The Y chromosome phylogeny and distribution in current native populations reveal the

unequivocal existence of only two major haplogroups, namely the Q and C, but the former is much more abundant among present day Native Americans all over the continent. Thus, the paternal history of the settling of the New World is monotonous when compared to the five major mtDNA lineages observed in this continent. However, the combined use of Y chromosome SNPs and microsatellites, as well as the identification of new informative SNPs to the American prehistory is portraying a more detailed scenario of this last epic in the peopling of the world continents. A moderate bottleneck followed by population expansion explains most of the observed distribution, but the discovery of some new sublineages, particularly in South America, indicates the existence of a more complex founder population than previously supposed. Furthermore, the heterogeneous intra-continental pattern of gene-flow and drift is well correlated with present and past cultural aspects, indicating social networks, besides geography and linguistics, as an important driving force in shaping the present Y chromosome diversity in Native Americans. This study was funded by FAPEMIG, CNPq, and CAPES.

Locomotor development of wild chimpanzees.

LAUREN SARRINGHAUS. Department of Anthropology, University of Michigan.

As a first step in determining whether changes in positional behavior affect the development of bones, I investigated the ontogeny of locomotion in wild chimpanzees. Locomotor frequency data on kinematically distinctive behaviors were collected on wild chimpanzees at Ngogo, Kibale National Park, Uganda over 9 months during 2007 and 2009. One hour focal follows were conducted on adult, adolescent, juvenile, and infant chimpanzees. Infants were subdivided into early, middle, and late age categories. The large sample of chimpanzees at Ngogo enabled me to make strong statistical inferences about how their locomotion changes during ontogeny. Analysis of variance revealed two significant developmental changes in locomotion: (1) a shift from predominant reliance on the upper limbs for movement during infancy to increasing reliance on the lower limbs in subsequent age categories and (2) a shift from grasping supports during arboreal quadrupedalism by middle infants to knuckle-walking by late infants and juveniles. A grasping stage had not been previously reported in wild infants.

Results of this study indicate that loading patterns on the hand change drastically during infancy, leading to the prediction that significant changes in bone development may be occurring at this time. These results set the stage for ongoing Museum and laboratory research examining whether changes in locomotor behavior have measurable effects on anatomy. This study was funded by the Leakey Foundation and the University of Michigan International Institute.

Does the effect of body mass on energy expenditure scale allometrically in walking children?

ISABELLE SARTON MILLER¹ and PATRICIA KRAMER². ¹Bellevue College, Bellevue, ²University Washington, Seattle.

In the past, VO_2 was divided by the body mass of the subject in an attempt to standardize VO_2 across individuals of different sizes (or body masses). As has been much discussed, this procedure is not acceptable, because the use of ratios often leads to spurious, misleading correlations, especially for subjects far from the mean values, like children. The use of allometric modeling and power functions to remediate the problem of ratios has been proposed as a solution, but this approach assumes that the power function does not vary with the kind or intensity of exercise. Recently, it was shown in adults that the mass exponent increases as the intensity of exercise increases and we wondered if this might also be the case in children. Using the walking VO_2 of 73 prepubescent children (7-10 years), who each walked at their self-selected slow, normal and fast velocities while their VO_2 was measured, we found that the exponent for body mass is not constant across the three levels of exercises, but rather, as the speed increases the mass coefficient increases from 0.51 to 0.82. This effect is also seen when net VO_2 (walking VO_2 minus standing resting metabolic rate) is used, with the exponent increasing from 0.68 to 1.02. (All p's were > 0.001 and the 95% confidence intervals did not overlap among the three exercise intensities.) We conclude from these results that the effect of body mass on walking VO_2 is complex and no simple panacea exists for controlling for size effects. This research was supported by NSF dissertation enhancement grant #0236406.

An application of the crisis index to the 19th century cholera epidemics in Gibraltar.

LARRY SAWCHUK¹ and LIANNE TRIPP¹. ¹Department of Anthropology, University of Toronto.

During the 19th century thousands of prisoners served out their sentences in convict stations under deplorable conditions throughout the British Empire. Scant information on the health of these unique communities exists. Using Gibraltar's convict station as a case study, the reconstructed profile of the prisoners from 1860 to 1873 is compared to that of the civilians and the military. We hypothesize that the convicts' health status was jeopardized by the cholera 1860 and 1865 epidemics because their lifestyle heightened the risk of coming in contact with the deadly cholera *vibrio*. The impact of the cholera epidemics on the three communities was evaluated using standard epidemiological measures; these include: the attack rate, cause-specific crude mortality rate, fatality rate and the crisis index. The crisis index is unique in that it assesses the intensity of the epidemic as it incorporates the deaths attributed to the epidemic weighted by the duration of the epidemic. Our results suggest that the convict overall state of health was similar to that of the military. During the cholera epidemic in 1865, the well-being of the convicts was severely compromised with

significantly higher attack, mortality rates and crisis index. The crisis index for the military was only 6.59 but much higher at 21.61 for the convicts. Factors responsible for the higher index can be attributed to a cluster of vulnerabilities that were intrinsic to the prisoners' way of life where exposure to host of risk factors played out during a highly compressed period of time.

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Optimal foraging in the mind: chimpanzee long-term spatial memory and food profitability characteristics.

KEN SAYERS and CHARLES R. MENZEL. Language Research Center, Georgia State University, Decatur,

While classical models from foraging theory assume that animals encounter resources randomly, evidence suggests that primates, in some cases, possess knowledge concerning the locations of distant patches. In addition, various details of these foods may be retained, hypothetically allowing for the rank-ordering, by profitability characteristics, of items beyond the range of an animal's perception. A simulation of this problem was conducted with two lexigram-trained chimpanzees housed at the Language Research Center, Georgia State University. Ten bags of almonds, varying in quantity and presence/absence of shells, were hidden randomly in the organic layer of the forest outside the chimpanzees' outdoor enclosure ($n = 20$ trials for each subject). After delays from 15 minutes to over 23 hours, subjects interacted with a person who did not know the locations or contents of the hidden bags. The chimpanzees were successful in directing the uninformed persons, largely by manual pointing, to the locations of these non-visible foods. The order of bag recovery for both subjects was highly ordered, and involved the concurrent use of information relating to quantity, handling time, and the distance of items from the subject. There was a strong ($p < 0.001$) negative correlation between the 1-2-3...10 order of recovery and the profitability (kilocalories/handling time) of each bag. This is consistent with instantaneous rate maximization, and suggests that nonrandom and distant "encounter" could be incorporated into optimal diet models, as well as investigations into the evolution of primate, including hominid, foraging strategies. Supported by National Institute of Child Health and Human Development, HD-38051, R01 HD-056352.

Cranio-metric variation in prehistoric central and southern Florida.

WILLIAM C. SCHAFFER. School of Human Evolution and Social Change, Arizona State University.

Stepwise discriminant function analysis and Mahalanobis' generalized distances were performed on selected cranial measurements documented by Hrdlicka (1940:324-357) in a total of 92 crania representing nine cranial series

from prehistoric archaeological sites located in central and southern Florida. The main objective of this study was to investigate historical-biological affinities between groups, and compare them to the available archaeological, ethnohistoric, and historical linguistic record. Statistical analyses were able to demonstrate historical-biological affinities between skeletal groups isolated on the eastern and western coasts. Results of this investigation suggest that historical linguistic and political affiliations interpreted at or around the time of contact (i.e., Timucuan and Muskogee Divisions) may not have been representative of historical-biological affinities during Woodland and Mississippian periods prior to Spanish exploration.

Comparison of SNPs, STR and InDels to measure local differentiation in SW Chinese populations.

MOSES S. SCHANFIELD^{1,2}, S. MILLER², K. LABATO^{2,3} and SHEN BIN^{2,4}. ¹George Washington University, ²Analytical Genetic Testing Center, Denver, ³Colorado Bureau of Investigation, Denver, ⁴University of British Columbia, Vancouver.

In Yunnan Province, Southwest China, there is a high concentration of minority populations along with the majority Han population. These populations represent the major linguistic diversity in East Asia including branches of Sino-Tibetan family that represents largely northern languages and Tai-Kadai and Hmong-Miao languages which represent Southeast Asian languages. To investigate the ability to differentiate these linguistically dissimilar populations, in a relatively restricted geographic area, data from 6 STR loci, 6 electrophoresis loci, 2 IG allotype loci, mtDNA 9 bp deletion and Y YAP insertion were analyzed in 8 populations living in Yunnan, China (Han, Hani, Bai, Kachin, Lisu, Lahu, Dai and Miao). Missing data was filled in from the literature. F analysis was used to look at within, and between region variation at each locus (F_R , F_{WR} , F_{RT} and F_{ST}) and averaged over all loci. Within Yunnan only the IG loci indicated greater differentiation between languages than within languages, but it was not significant $F_{RT} = 0.029$, for all others within variation was higher than between languages. Within region variation was only significant for the 9 bp deletion ($F_{WR} = 0.066$). Thus, at the regional level there appears to be little genetic differentiation between different language groups. The STR loci had the lowest differentiation among the loci tested suggesting that these loci may not be very useful at looking at microdifferentiation in regional populations. In contrast, for the IG loci and 9 bp deletion NE and SE Asians are highly differentiated ($F_{RT} = 0.184$ and 0.110 respectively).

Morphological differences in humeral cancellous bone of Neanderthals and extant hominids.

HEIKE SCHERF and JEAN-JACQUES HUBLIN. Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology (Leipzig, Germany).

The shoulder is the most mobile joint in the primate body. Analyses of the external morphology of the shoulder in fossils have been conducted on various taxa as they give information about habitual forelimb activity. However, conclusive interpretations of fossils are hindered by the many degrees of freedom of this joint and the variety of habits in extant and fossil species. Cancellous bone offers an additional source of information about the loading conditions of the shoulder as it adapts functionally. We collected high-resolution computed tomography (HrCT) scans of proximal humeri of adult Neanderthals (3) and adult extant hominids with different shoulder loadings (*Pongo pygmaeus* (14), *Pan troglodytes* (15), *Homo sapiens* (21)). Subsequently, we quantified the trabecular architectures, measuring nine standard 3D-morphometric parameters. The voxel sizes of the HrCT scans ranged from 22 to 31 μm . By visual inspection, no definite differences in the trabecular architectures of the different species were definable. However, we were able to discriminate the different species by principle component analysis of the 3D-morphometrics of the trabecular geometry. The distinct trabecular patterns map the different climbing styles in *Pongo* and *Pan* and contrast them with the relatively low humeral loading conditions in *Homo*, which are caused by manipulatory activities. The Neanderthals make up a separate group and results indicate that they displayed high levels of "hands-above-shoulder-activity", which could be linked to the importance of specific activities. The results of this study suggest that more detailed analysis might give even more information about Neanderthal activity in the future. This study was supported by the Max Planck Society.

Juvenile growth in Prehistoric-early historic Pueblo Indians.

MICHAEL A. SCHILLACI^{1,2}, DEJANA NIKITOVIC² and LIANNE TRIPP². ¹Department of Social Sciences, University of Toronto Scarborough, Toronto, Ontario, Canada, ²Department of Anthropology, University of Toronto.

The present study examines patterns of juvenile growth in a diachronic and heterogeneous sample of ancestral Pueblo Indians (AD 800-1680) from the American Southwest. The assessment of growth is accompanied by an evaluation of pathological conditions often considered to be indicators of nonspecific stress in a population. Together these biological markers reflect in a general way the overall health of our sample of Pueblo Indian juveniles which can be interpreted within a culturally relevant context. The results of our analysis of growth revealed a high degree of stunting beginning just after birth to about 4.5 years of age. Stunting was accompanied by a high incidence of porotic hyperostosis and cribra orbitalia during the first two years of life. Our sample exhibited high infant mortality between birth and 1 year of age. Juveniles exhibiting evidence of porotic hyperostosis experienced lower, though statistically nonsignificant, cumulative survivorship ($P=0.070$) than those

who did not. Our study is consistent with previous research reporting poor health and high mortality for Pueblo Indian juveniles. Through use of a culturally relevant context defining childhood in modern Pueblo Indians, we show that the observed poor health and high mortality occurs before the important transition from young to older child, and their concomitant initial incorporation into tribal ritual organization. This research was conducted in collaboration with A. Palkovich and N. Akins. We thank A. Stodder for her comments and advice. This research was funded by a standard research grant from the Social Sciences and Humanities Research Council of Canada.

Midfacial and dental factors that constrain maxillary sinus expansion in anthropoids: The perinatal period.

ROBIN M. SCHMIEG¹, GREGORY M. COOPER², JAMES B. ROSSIE³, CHRISTOPHER J. BONAR⁴, MARK P. MOONEY⁵, MICHAEL I. SIEGEL⁵ and TIMOTHY D. SMITH^{1,5}. ¹School of Physical Therapy, Slippery Rock University; ²Departments of Surgery and Oral Biology, University of Pittsburgh; ³Department of Anthropology, SUNY Stony Brook; ⁴Cleveland Metroparks Zoo; ⁵Department of Anthropology, University of Pittsburgh.

Paranasal sinuses are thought by some to expand opportunistically during growth. In anthropoid primates, for example, it has been hypothesized that the magnitude of maxillary sinus growth is influenced by adjacent structures such as deciduous premolars. In the present study, dental and midfacial variables were studied in a perinatal sample of four anthropoid primates, including three callithrichines and *Saimiri boliviensis*. In the latter species, no maxillary sinus (MS) forms postnatally; the natal recess of the MS fails to expand beyond the level of the last premolar. Using histological and microCT methods, we measured palatonasal indices (PNI, interdental width/nasal width), relative tooth size (tooth volume/palatal length ratio) and radiographic hydroxyapatite (HA) density at different levels of maxillary dentition. Kruskall-Wallis tests indicated significant ($p < 0.05$) differences among species for all variables. At the level of the first two premolars, results suggested considerable variability. However, in *Saimiri* development of posterior maxillary dentition appears to be advanced compared to the callithrichines. HA density of dp4 in *Saimiri* is 17% greater or more compared to the callithrichines; this disparity appears to be far greater at the level of M1. Also at M1, *Saimiri* has the lowest palatonasal index, indicating potential space for sinus expansion is limited by adjacent dentition. In accord with this, relative M1 size was greater by more than 20% in *Saimiri* compared to each of the callithrichines. These results suggest that pneumatization of the primordial MS of *Saimiri* is constrained by relatively large, well mineralized posterior maxillary teeth. This study was funded by the National Science Foundation, # BCS-0820751.

The interaction of social organization and juvenile risk aversion: A case study in atelin primates.

CHRISTOPHER A. SCHMITT^{1,2,3} and ANTHONY DI FIORE^{1,2,3}. ¹Department of Anthropology, New York University, ²New York Consortium in Evolutionary Primatology, ³Center for the Study of Human Origins, New York University.

The Ecological Risk Aversion (ERA) hypothesis proposes that the extended pre-reproductive period characteristic of anthropoid primates results from strategies that juveniles adopt to mitigate ecological risks, particularly those arising from within-group feeding competition and predation. These risks are expected to vary with aspects of social organization, perhaps most importantly with the size of foraging parties. We explored how differences in social organization might influence food competition and predation avoidance in two sympatric atelin taxa in Amazonian Ecuador: woolly monkeys (*Lagothrix*), which live in large, socially-cohesive groups, and spider monkeys (*Ateles*), which live in comparably-sized fission-fusion groups. We recorded measures related to food competition and predation avoidance during 323 hours of focal animal observation on 4 groups (3 *Lagothrix*, 1 *Ateles*). Despite the hypothesized benefits of fission-fusion versus cohesive social structures for reducing food competition, we found no significant difference in neighbor density while foraging between comparable juvenile age-sex classes in the two taxa, and rates of aggression were extremely low. *Ateles* juveniles maintained a higher density of close neighbors while foraging but also had a higher frequency of beneficial interactions (food sharing, food inspection), while *Lagothrix* juveniles maintained a comparatively low density of close neighbors but nonetheless experienced a higher frequency of food-related aggression. Counter to expectations, we found no relationship between foraging party size and nearest neighbor distance or neighbor density in either taxon. Our results suggest that the ERA hypothesis could benefit from a more nuanced consideration of the influence of social organization on juvenile social behavior. This study was funded by NSF DDIG (BCS-0824372), New York University, the LSB Leakey Foundation, and the Wenner-Gren Foundation for Anthropological Research.

The impact of physical activity on dietary choices of a western population and its correspondence to hunter-gatherer macronutrient profiles.

STEPHANIE SCHNORR and KERRIE P. LEWIS. Department of Anthropology, Texas State University – San Marcos.

Modern societies experience diminished amounts of physical activity in the daily lives of westernized populations and an emphasis on refined agricultural foods in the diet. This study investigates the interplay between diet and activity in terms of everyday food choice. We predicted that strenuous physical activity, with

total energy expenditure (TEE) over resting metabolic rate (RMR) ≥ 1.8 , should impact the dietary needs of a body, and that as such, athletic individuals would maintain macronutrient profiles closely aligned with that of modern hunter-gatherers: 19-35% protein, 28-58% fat, and 22-40% carbohydrate. If the macronutrient percentage of modern athletic diets corresponds closely with that of modern hunter-gatherer diets, then perhaps an active lifestyle induces natural preferences for the same type and quantity of macronutrients that our Paleolithic ancestors ate.

We conducted an online survey of university students to obtain 24 hour dietary recall and daily physical activity logs for each individual. Our data show that 78% of subjects exhibited an athletic profile (TEE/RMR ≥ 1.8), while only 4.3% matched the hunter-gatherer macronutrient profile. Only 3.2% met hunter-gatherer values for both diet and physical activity. Ancestral human diets were restricted to nutritionally dense foods to accommodate a small gut, large brain, and active metabolism. However, 96% of athletic subjects matched a modern dietary profile associated with sedentary populations; one that emphasizes refined carbohydrates ($> 40\%$ total calories). We discuss important health implications related to this dietary shift over time and how current nutritional guidelines influence the dietary decisions of modern western athletic individuals.

Creating statistical atlases of modern primate endocranial morphology using non-rigid deformation analysis of high-resolution CT images.

P. THOMAS SCHOENEMANN^{1,2}, JANET MONGE^{2,3}, RALPH L. HOLLOWAY⁴, BRIAN B. AVANTS⁵ and JAMES C. GEE⁵. ¹Department of Anthropology, Indiana University, ²Museum of Archaeology and Anthropology, University of Pennsylvania, ³Department of Anthropology, University of Pennsylvania, ⁴Department of Anthropology, Columbia University, ⁵Department of Radiology, University of Pennsylvania.

Fossil endocranial surfaces provide the most direct evidence of the time course of brain evolution, but they are complicated morphological shapes that are not trivial to characterize and measure. In order to interpret changes in the fossil record, comparisons must be made both among fossils and between fossil and modern forms. It is easy to be misled by comparisons made to a limited sample, and/or samples that have unrecognized biases. While such problems are sometimes unavoidable in fossil comparisons, they are not unavoidable for comparisons to modern forms. Pilot studies using data from the Open Research Scan Archive (ORSA) have demonstrated the effectiveness of creating atlases for overall cranial form using non-rigid deformation analysis of high-resolution CT images. These studies also result in detailed information regarding within-population variability at each point, thereby allowing for statistical tests of morphological differences on a point-by-point basis across the objects of interest. We

demonstrate here that these methods can also be applied to endocranial form, using a sample of modern human and ape endocranial from both ORSA and Ralph Holloway's endocast collection. The technique involves iteratively morphing endocranial surface images into successive approximations of the average shape. The process is repeated until subsequent iterations do not change. The atlases can be downloaded and used for comparative studies by any researcher. This will facilitate the standardization of comparative work in paleoneurology. This study was made possible by funding from NSF, grant number 0447271.

Resource availability and social structure in wild hamadryas baboons.

AMY L. SCHREIER¹ and LARISSA SWEDELL². ¹Department of Evolutionary Anthropology, Duke University, ²Department of Anthropology, Queens College, City University of New York.

Hamadryas baboons are known for their multi-level social structure in which large groups (bands) break into smaller foraging parties (one-male units (OMUs) and clans) during daily travel. The evolution of this social structure has been attributed to the sparse distribution of resources in hamadryas habitats enabling the baboons to break into individual OMUs when resource availability is lowest, but this idea has never been tested. Here we test this relationship in a band of ~200 hamadryas baboons at the Filoha site in central Ethiopia. In addition to *Acacia* scrublands typical of hamadryas habitats, palm forests exist at Filoha, providing a high availability of doum palm fruit, a preferred food resource. As food availability is higher in palm forests than *Acacia* scrublands, we expected the baboons to be more cohesive when foraging in the former. Data on social cohesion were collected during focal samples of individual OMUs from March 2005 - February 2006. The relationship between cohesion and the distribution of resources was inconsistent at the OMU level. At the clan level, by contrast, the baboons were more cohesive when foraging in palm forests than in *Acacia* scrublands: there were significantly fewer OMUs within a 10 m radius in *Acacia* scrublands than in palm forests, and leader males remained in proximity to one another on average in palm forests more so than in *Acacia* scrublands. These results suggest that, overall, the baboons were more likely to break up into individual OMUs in *Acacia* scrublands and forage as clans in palm forests.

Geographic structure of genetic variation in North America: Population fissions and European admixture.

KARI BRITT SCHROEDER¹, RIPAN MALHI², BRIAN KEMP³, ANJELICA GONZÁLEZ-OLIVER⁴ and DAVID GLENN SMITH¹. ¹Department of Anthropology, University of California, Davis, ²Department of Anthropology, University of Illinois, Urbana-Champaign, ³Department of Anthropology, Washington State University, ⁴Departamento de Biología, Universidad Nacional Autónoma de México.

A satisfactory understanding of how modern Native North America populations are biologically related to each other requires increased sampling of populations and/or genetic markers and testing of the fit of different models of population structure. To this end, we combine new autosomal microsatellite data from Native North American populations with previously published data. Using J.C. Long's *Generalized Hierarchical Modeling* software, we evaluate the fit of different trees to the data. Although we observe a correlation between population pairwise genetic and geographic distances, as expected with a long-term process of isolation by distance, we show that this correlation likely results from geographically-structured population fissions. This pattern could result from the initial peopling of North America or from a later process. The magnitude of European ancestry in the sampled populations, as estimated with the software *structure*, varies drastically among geographic regions, and may limit our ability to use modern genetic variation to investigate Native North American prehistory.

This study was funded by the Wenner-Gren Foundation for Anthropological Research, grant number 7580 to K.B. Schroeder and D.G. Smith, and by the National Science Foundation, grant BCS-0422144 to R.S. Malhi, B.M. Kemp, and D.G. Smith.

Mandibular variation in southern African early *Homo*.

LAUREN SCHROEDER¹ and REBECCA R. ACKERMANN¹. ¹Department of Archaeology, University of Cape Town, South Africa.

Phylogenetic relationships among specimens attributed to the rather ambiguous and exceptionally diverse Plio-Pleistocene early *Homo* record continue to be debated. Affiliations of southern African specimens are especially poorly understood. This debate is complicated by the fact that our understanding of the cause and effect of inter- and intra-specific variation in this lineage is limited. One particularly enigmatic specimen – UR 501 from Uraha, Malawi – falls at the temporal and morphological extremes of the hypodigm, and although it has been classified as *Homo* (specifically *Homo rudolfensis*), it has not been well-evaluated in terms of our understanding of variation within the complete southern Africa sample. In this study we assess the affinities of UR 501. 3-D scanner and conventional morphometric data are collected from samples including possible early *Homo* specimens from Swartkrans and Sterkfontein, as well as UR 501, and numerous robust australopith mandibles, incorporated because of their temporal/spatial correspondence. Extant variance/covariance matrices from hominoids are used to calculate inter-individual scaled Mahalanobis' Distances between these specimens to determine their morphological relationships. These data are also analyzed using quantitative genetic statistical tests developed from neutral evolutionary theory in order to estimate the causal factors behind morphological divergence – i.e. whether divergence was likely to result

from selection versus drift. Results show that the Uraha mandible is unusual relative to other southern African early *Homo* material, and that genetic drift is unlikely to be responsible for the divergence of this specimen, implying that this specimen is adapted to a different diet/environment and possibly warranting taxonomic separation. This study was funded by the L.S.B. Leakey Foundation Baldwin Fellowship

How long were australopithecine toes?

KATHERINE E. SCHROER^{1,2}, ADAM D. GORDON³ and BRIAN G. RICHMOND^{2,4}.

¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Department of Anthropology, University at Albany – SUNY,

⁴Human Origins Program, National Museum of Natural History, Smithsonian Institution.

The locomotion of *Australopithecus* is central to understanding the origin and evolution of human gait. Disagreements over whether *Australopithecus* had short, human-like toes or long, chimpanzee-like toes figure prominently in debates over how australopithecines walked and the extent to which arboreality was an important part of their locomotor repertoire. The shortness of human toes provides a decreased range of flexion, creating a mechanical lever during the toe-off portion of bipedal gait. Conversely, long toes provide greater flexion and assist in climbing. Pedal proximal phalanges, metatarsals, and tarsals were measured on a large extant sample including modern humans (n=50), chimpanzees (n=50), gorillas (n=50), and orangutans (n=24). *A. afarensis* pedal measurements were taken from the literature. A Monte Carlo resampling approach was used to 1) assess statistically the relative length of *A. afarensis* proximal pedal phalanges compared to other bones in the foot complex, and 2) compare *A. afarensis* and extant hominoid relative toe lengths. The resampling method accurately predicted the relative level of arboreality of extant hominoids based on toe length and established statistically distinct means of relative toe length for each hominoid species. A comparison between *A. afarensis* and extant hominoid toe lengths demonstrated that *A. afarensis* toes are significantly longer than human phalanges and significantly shorter than chimpanzee phalanges. This study demonstrates that *A. afarensis*'s toes were intermediate in length and adds support to other anatomical evidence that *A. afarensis* was adapted to bipedalism. The results also have implications for reconstructing forefoot function and gait. This study was funded by NSF-IGERT DGE-0801634.

Incisor curvature and diet in cercopithecoids.

ROBERT SCHUBERT, DEBBIE GUATELLI-STEINBERG, PAUL SCIULLI and SCOTT MCGRAW. Department of Anthropology, The Ohio State University, Columbus.

Based on a large sample of hominoids and a smaller combined sample of ceboids and

cercopithecoids, Deane showed that incisor surface curvature, along both mesio-distal and cusp-cervix dimensions, is associated with broad dietary categories. Frugivores tend to have more curved incisors than folivores, and within frugivores, hard-object feeders have more curved incisors than soft-object feeders. In the present study, we extend Deane's work in two ways. First, we investigate the relationship between incisor surface curvature and diet specifically within the superfamily Cercopithecoidea in a large sample ($n=87$) of folivores and frugivores, including the hard object feeders *Lophocebus* and *Cercocebus*. Second, we determine the extent to which incisor curvature can be used to correctly assign individuals to the dietary categories of "frugivore" or "folivore". Using a measuring microscope, we recorded points at regular intervals along the labial surfaces of upper central and lateral incisors. We then fit polynomials to the data and determined the first derivative of the curve at each point. Using logistic regression analysis on the first derivatives, it was possible to correctly assign individuals to dietary categories 77% of the time. These results indicate that incisor surface curvature carries a strong dietary signal within the Cercopithecoidea, providing a basis for inferring diet from the incisor curvature of fossil cercopithecoids. Testing the hypothesis that incisor curvature is a response to high bending moments generated during obdurate food processing will require data on the direction and magnitude of forces during mastication as well as the material processes of foods themselves. Supported by NSF Grant BCS-0607520 to DGS.

The current status of the three-wave migration model.

THEODORE G. SCHURR. Department of Anthropology, University of Pennsylvania.

Ever since the publication of the tripartite migration model by Greenberg et al. (1986), in which independent expansions into the New World gave rise to Amerind, Na-Dene and Eskimo-Aleut populations, respectively, there has been considerable debate about the number of migrations that contributed to the genetic diversity of ancestral Native American populations. Studies of gene blood group antigens, serum proteins, erythrocyte enzymes, immunoglobulins, and leukocyte antigens generally supported this model, although the linguistic classification of Native American languages on which it was based has been heavily criticized. Similarly, HLA data sets favor three Siberian sources of diversity in Native Americans. Initial mtDNA and Y-chromosome studies were also viewed as supporting multiple migrations into the New World, although subsequent work has pointed to a single major expansion during the last glacial maximum as generating much of the haplogroup diversity in the Americas. However, the distribution of certain maternal and paternal haplogroups in Native American groups still remains to be fully explained. Autosomal DNA studies have further suggested that ancestral Native American groups derived largely from a single major expansion into the New World,

although some suggest an Asian source area different from that indicated by the haploid genomes. Given these complexities, this study reassesses the consistency of current and unpublished genetic data sets with the predictions of the original tripartite migration model, i.e., the emergence of distinct ethnolinguistic groups from separate demographic events, and evaluates the findings in the context of climatic conditions influencing human entry into the New World.

Two-rooted lower canines: A defining characteristic of the Eurodont dentition.

G. RICHARD SCOTT and LINDSAY DORIO. Department of Anthropology, University of Nevada Reno, Reno NV.

With the exception of Carabelli's trait, the European dentition is better known for the morphological traits that it does not exhibit rather than the ones that it does. Europeans show little or no incisor shoveling and double shoveling, incisor winging is rare, accessory cusps of the upper and lower molars are uncommon, as are the protostyli and deflecting wrinkle. Even a major hallmark of the European dentition, 4-cusped lower molars, is defined by the absence rather than the presence of a particular cusp (i.e., the hypoconulid). One root trait, however, runs counter to the characterization of reduced and simplified European crowns and roots. Although a rare trait in general, two-rooted lower canines are far more common in Europeans than in any other regional grouping. In Sub-Saharan Africans, the trait is virtually unknown. In Asian and Asian-derived populations, it varies between 0.0 and 1.0 percent. Europeans, by contrast, consistently exhibit frequencies from 5-8% and in a recent study of skeletons from northern Spain, the trait attained a frequency of 10%. Given adequate sample sizes, this trait is extremely useful in evaluating gene flow between Europeans and neighboring groups. In South Siberia for example, a frequency of 3% places these populations almost exactly between Europeans and Asians, a position supported on genetic grounds. In any dental analysis of European skeletal remains, this important variable should be evaluated.

Correlated evolution in the anthropoid dentition: Is canine size influenced by changes in incisor and postcanine size?

JEREMIAH E. SCOTT. School of Human Evolution and Social Change, Institute of Human Origins, Arizona State University.

Several authors have hypothesized that canine reduction in the hominin clade is a pleiotropic or developmental by-product of changes in the size of other components of the dentition. These hypotheses posit (1) a positive relationship between incisor size and canine size (i.e., canine size decreases as incisor size decreases), and (2) a negative relationship between canine size and postcanine size (i.e., canine size decreases as postcanine size increases). The goal of this study was to test these hypotheses in extant anthropoids. Data for thirty anthropoid species

were analyzed using phylogenetic comparative methods. Dental measurements (canine basal crown area, canine height, incisor-row area, and postcanine-row area, excluding the anteriormost premolar) were size-adjusted using shape ratios and regression residuals, with a geometric mean of seven skull dimensions acting as the size variable. Males and females were examined separately. Results indicate that relative canine size is generally uncorrelated with relative incisor and postcanine size in anthropoids. The few significant correlations that were obtained are confined to females: relative canine basal crown area is positively correlated with relative incisor area in female anthropoids, and with relative postcanine area in female catarrhines. The latter result is in the opposite of the predicted direction. Notably, in no case was relative canine height correlated with relative incisor or postcanine size. Thus, although there is some evidence for correlated evolution among different components of the anthropoid dentition, there is no comparative support for the idea that hominin canine reduction resulted from incisor reduction or postcanine enlargement. This study was funded by grants from the Leakey Foundation, the Wenner-Gren Foundation (grant number 7861), and the Graduate and Professional Student Association of Arizona State University. Further support was provided by the Institute of Human Origins.

Premolar microwear texture analysis of *Australopithecus africanus*.

JESSICA R. SCOTT¹, PETER S. UNGAR², FREDERICK E. GRINE³ and MARK F. TEAFORD⁴. ¹Doctoral Program in Environmental Dynamics, University of Arkansas, ²Department of Anthropology, University of Arkansas ³Departments of Anthropology and Anatomical Sciences, Stony Brook University, ⁴Center for Functional Anatomy and Evolution, Johns Hopkins University.

Molar microwear studies have suggested that some Pliocene hominins, e.g., *Paranthropus robustus*, relied on hard, brittle foods as "fallback" resources rather than preferred items, whereas others, e.g., *Australopithecus africanus*, relied on tough foods. A recent biomechanical study, however, has argued that the craniofacial morphology of *A. africanus* evolved as an adaptation to hard-object feeding. According to this model, *A. africanus* processed hard foods like nuts and seeds using the premolars rather than the molars, explaining the lack of molar microwear evidence for hard-object feeding. Here we present premolar microwear texture data for *A. africanus* and compare them with molar data for the same individuals to look for evidence of differences in function along the tooth row. Thirteen specimens from Sterkfontein that preserve both molar and premolar microwear were included in the study. Point clouds were generated from "Phase II" premolar facets using white-light confocal profilometry, and data were collected at a lateral sampling interval of 0.18 μm (vertical resolution = 0.005 μm) over an area of 276 x 204 μm . Scale-sensitive fractal analysis attributes that separate extant taxa with differing diets were calculated. Statistical analyses reveal no

differences between molar and premolar microwear textures in any of the variables examined. Premolar and molar data for individuals were similar, suggesting no differences in the fracture properties of foods processed by these teeth. The results indicate that neither the premolars nor the molars of *A. africanus* individuals examined were used to process large quantities of hard, brittle foods in the days before death. This study was funded by the US National Science Foundation.

Spatial determinants of chin prominence in extant humans.

JILL E. SCOTT¹, NATHAN E. HOLTON^{2,1}, MYRA F. LAIRD¹, ROBERT G. FRANCISCUS^{1,2}, STEVEN D. MARSHALL², THOMAS E. SOUTHARD². ¹Dept. of Anthropology, University of Iowa, ²Dept. of Orthodontics, University of Iowa.

The mentum osseum, or chin, is considered a derived feature of *Homo sapiens* and has been causally linked to linguistics, biomechanics, and spatial dynamics. In a study of Euro-Americans and African-Americans, Durand and Hunt (2008) demonstrated a moderate inverse relationship between chin prominence and facial prognathism. Further, in a longitudinal growth study of Euro-Americans, Marshall et al. (in press) found that chin prominence is tied to differential growth of the mandibular corpus and the dentoalveolar complex which is integrated with the maxilla through occlusal interlocking. Differential maxillary-mandibular spatial position and occlusal interlocking similarly account for variation in chin prominence in adult comparisons of Euro-Americans (Scott et al., 2009).

This study tests whether alveolar prognathism can account for variation in chin prominence in adults across a wide geographic range (total n=458) consisting of adult Euro-Americans, African-Americans, and several indigenous populations (Europeans, sub-Saharan Africans, Australians, Melanesians, and Asians). We predicted that chin prominence should be associated with the relative anterior-posterior placement of the maxilla and dentoalveolar complex and tested this hypothesis with 3-D coordinate landmark data from mixed-sex samples (all exhibiting normal occlusion) subjected to principal components analysis of Procrustes shape variables, and thin plate spline analyses. As predicted, chin prominence was positively associated with the anterior-posterior position of the dentoalveolar complex and maxilla. This suggests that chin development in extant *Homo sapiens* is, in part, a function of lower anterior maxillary growth reduction, and we posit that this relationship may influence chin presence/absence across the wider range of genus *Homo*.

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The effects of ancestry models and ascertainment on methods of detecting population structure.

NICOLE M. SCOTT¹ and J.C. LONG².

¹Department of Human Genetics, University of Michigan, Ann Arbor, ²Department of Anthropology, University of New Mexico, Albuquerque.

Here we investigate the effects of population relationships and marker ascertainment on methods designed to detect population structure. Specifically, we use the rejection sampling from Kimura's diffusion approximation to simulate genetic drift in different populations. We evaluate two types of phylogenetic structure 1) a high divergence tree: patterned after indigenous populations from Africa, Europe, Asia and the Americas; and 2) a low divergence tree: patterned after Europeans, and East Asians. We mimic ascertained data by choosing polymorphic loci from the simulations 1) based on the European population, or 2) across all populations. Then we analyzed our simulated data using two population structure-detecting methods: hierarchical modeling as implemented in the program generalized hierarchical modeling (GHM), and K-means cluster analysis as implemented in the program STRUCTURE. We found that for the low divergence tree, the results from GHM were always consistent with the simulation model. With the divergence tree, GHM consistently provided the best fit to the true model, although the parameters were often inconsistent with the simulation model with ascertained SNPs. The STRUCTURE program identified the correct number of populations for both simulated models; however, it did not find the higher levels of structure, or show how the simulated populations were related to each other. This study highlights the importance of knowing the correct SNP ascertainment for studying population relationships. Moreover, it shows that neither statistical approach is guaranteed to find all levels of population structure.

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An assessment of human variation among prehistoric Florida populations through the analysis of craniometric data.

SAMANTHA M. SEASONS. Department of Anthropology, University of South Florida

The analysis of craniometric data collected from skeletal remains can provide very valuable information pertaining to the amount of variation among prehistoric populations. When combined with contextual archaeological data, craniometric analyses can support differences between populations including, but not limited to; biological distance and cultural isolation. To examine homogeneity among precontact populations, methods for data collection will explore variation in shape and size of crania by using a Microscribe 3-DX digitizer to collect coordinate data using the full protocol of cranial landmarks. It is crucial to recognize that cranial variation among these populations will be

directly related to their temporal and geographic relationships. Craniometric data for 157 skulls from six Florida sites: Captiva Island (8LL57), Perico Island (8MA6), Belle Glade (8PB40 and 8PB41), Safety Harbor (8PI2), Horr's Island (8CR41 and 8CR42) and Artesia (Fuller Mound A 8BR90, Fuller Mound B 8BR91, and Fuller Mound D 8BR93) were analyzed using Cluster Analysis, ANOVA and Tukey's Pairwise Comparison (post-hoc test) in SPSS 17.0. Preliminary results suggest that there are no distinct differences in cranial size between the populations. Based on the small amount of cranial variation, it can be suggested that cultural isolation among prehistoric populations in Florida may have been limited. Further examination of archaeological reports and published literature is needed to interpret these findings.

Population history and substructure of Anatolia and Turkey as evidenced by craniofacial diversity.

NORIKO SEGUCHI¹, SERPIL EROGLU², RYAN W. SCHMIDT¹ and C. LORING BRACE³. ¹Department of Anthropology, The University of Montana, Missoula, Department of Anthropology, ²Mustafa Kemal University, Hatay, Turkey, ³Museum of Anthropology, The University of Michigan, Ann Arbor.

Anatolia, the Asian segment of Turkey, is an area of evolutionary importance for human groups who used this corridor as a bridge for migration between the Caucasus, Western Asia and Europe since Lower Paleolithic times. Historically, Anatolia has been occupied by diverse civilizations, including the Byzantine and Ottoman Empires. This study is an attempt to understand Turkish population substructure and history by examining craniofacial diversity through several temporal periods framed within a population genetic model. If the region of Anatolia has been used as a migratory corridor for peoples spanning disparate geographic areas (Balkans, Central Asia, and East Asia), then gradual craniofacial change is expected due to these migrations coupled with extensive admixture. Studies using mtDNA indicate a pre-Neolithic expansion resulting in extensive migration, while Y chromosome studies reveal haplogroup clustering and gene flow from the Caucus with less admixture from Central and East Asia. Overall, our results indicate minimal Turkish population substructure. When crania were separated into sex, our results are consistent with uniparental marker population history. Female crania show a distinctness with modern groups and are actually more similar to Neolithic European and Near Eastern populations. This would indicate a relatively stable female population in Anatolia since Neolithic times. Male crania are more heterogeneous and cluster within a larger geographic zone of Eurasia and the Near East consistent with greater male migration. There is little support for admixture from Central or East Asian groups. These results support the hypothesis for a Turkic language displacement with insignificant genetic exchange.

Looking for genetic adaptations to diet from a comparative study of herders and agriculturalists in Central Asia.

LAURE SEGUREL¹, PATRICK PASQUET¹, MYRIAM GEORGE¹, TANYA HEGAY², ALMAZ ALDASHEV³, RENAUD VITALIS¹ and EVELYNE HEYER¹. ¹Eco-Anthropologie, UMR 7206 CNRS - MNHN- Université Paris Diderot, Paris, ²Uzbek Academy of Sciences, Institute of Immunology, Tashkent, Uzbekistan, ³Institute of Biology and Medicine, National Center of Cardiology and Internal Medicine, Bishkek, Kyrgyzstan.

During the vast majority of their past, humans have been hunter-gatherers, with a diet poor in carbohydrates and a variable availability of food. This dietary pattern could have led to strong selective pressure for insulin resistance, a phenotype saving the precious glucose. Nowadays, in industrialized conditions (a high quantity and density of food with less physical activity), these past adaptations might have become an important genetic burden, leading for example to type II diabetes or other "civilization diseases". However, at the Neolithic transition, nearly 10.000 BCE, while hunter-gatherers and herders would still need to select for insulin resistance, agriculturalists could have seen this selective constraint released, thanks to high levels of carbohydrates in their new diet. According to these hypothesis, i.e. the thrifty genotype (Neel, 1962) and the carnivore connection (Colaguri & Miller, 2002), past genetic adaptations to lifestyle are therefore responsible of important health disparities between ethnic groups. To test these hypothesis, we have collected phenotypic and genetic data in Central Asia, for Tajiks and Kyrgyz, known to be respectively long-term agriculturalists and herders populations. We have found that herders have nearly twice more risk to be insulin resistant than farmers, which is consistent with the previous evolutionary hypothesis. Among the 11 studied genes (known to be associated with type II diabetes), no causative mutation has been found in higher frequency in herders so far. However, tests of neutrality have revealed signals of balancing and local selection on some genes, which could be involved in past adaptations to diet. Further analyzes based on haplotypic data will certainly provide us more information on when these selection events have occurred.

Morphology and relationships of the large-bodied adapiform *Afradapis* from the late Eocene of Egypt.

ERIK R. SEIFFERT¹, JONATHAN M.G. PERRY², ELWYN L. SIMONS³ and DOUG M. BOYER⁴. ¹Department of Anatomical Sciences, Stony Brook University, ²Department of Anatomy, Midwestern University, ³Division of Fossil Primates, Duke Lemur Center, ⁴Department of Ecology and Evolution, Stony Brook University.

Birket Qarun Locality 2 (BQ-2) is a near-coastal fluvial deposit of earliest Priabonian or earliest late Eocene age (~37 Ma) in the Fayum Depression of northern Egypt. The locality has

produced a diverse mammalian fauna that includes the parapithecoid anthropoid *Biretia* and crown strepsirrhine primates such as *Karanisia* and *Saharagalago*. One of the most common primates at BQ-2 is the adapiform *Afradapis*, the largest 'prosimian' primate ever documented in Afro-Arabia. The dental morphology of *Afradapis* is similar to that of the enigmatic middle Eocene adapiform *Caenopithecus* from Europe, but *Afradapis* is further specialized in having lost P_2^2 and having an enlarged and obliquely implanted P_3 that develops a wear facet from contact with the upper canine. The latter features evolved convergently in stem Catarrhini, along with other gnathic features seen in *Afradapis* such as a deep and robust mandibular corpus, a fused mandibular symphysis, and distinct superior and inferior transverse tori. *Afradapis* also possesses long molar shearing crests and a relatively low mandibular condyle, an unusual combination that suggests a diet of large but tough foods. Phylogenetic analysis places *Afradapis*, the younger African genus *Aframomius*, European *Caenopithecus* and *Darwinius*, and North American *Mahgarita* in a stem strepsirrhine clade, Caenopithecinae. *Afradapis* provides surprising new evidence for primate diversity in the Eocene of Africa, and reveals that caenopithecines were the first primates to occupy anthropoid-like feeding niches in Afro-Arabia. This study was funded by The Research Foundation of S.U.N.Y., the U.S. National Science Foundation, and The Leakey Foundation.

Scapular spine orientation determines the relative proportions of the supraspinous and infraspinous fossae.

MICHAEL S. SELBY and C. OWEN LOVEJOY. Department of Anthropology and School of Biomedical Sciences, Kent State University.

The shape of the anthropoid scapula corresponds with locomotor behavior but likely in complex ways. Substantial craniocaudal length, large supraspinous, infraspinous, and subscapular fossae, and a cranially oriented acromion appear to positively correlate with an arboreal habitus. However, given their complex developmental basis, these scapular features are unlikely to be independent. We assessed their potential interactions using principal components. The first separated hominoids and *Ateles* from other anthropoids. Loadings indicate that their narrow mediolateral breadth and more cranially oriented acromion relative to the vertebral border were the basis of this distinction. Components two and three differentiate hylobatids based on their large supraspinous/infraspinous fossae ratio. Orangutans show an opposite pattern. A ratio of supraspinous fossa size to vertebral border length correlates moderately with acromion angle among anthropoids ($r = 0.450$, $p < 0.001$), but more strongly when orangutans are excluded ($r = 0.744$, $p < 0.001$). In most anthropoids, the angle of the acromion corresponds to the orientation of the scapular spine, however, in orangutans, it curves distally at an angle distinct from that of the spine. The supraspinatus/infraspinatus ratio may therefore be

poorly related to locomotor pattern and may instead be a simple consequence of scapular spine orientation. If so, the relative proportions of rotator cuff muscles may be of little importance for suspensory behavior. Selection may have favored a more cranially oriented acromion, which is likely achieved by reorientation of the scapular spine.

Frequency of hyperostosis frontalis interna in a modern population from Rhode Island.

DOMINIQUE SEMERARO¹ and LUIS CABO-PÉREZ². ¹Office of State Medical Examiners, Rhode Island Department of Health, ²Departments of Anthropology and Applied Forensic Sciences, Mercyhurst College.

Hyperostosis Frontalis Interna (HFI) is characterized by marked thickening of the internal surface of the frontal bone that may extend to the parietals and can include ossific nodules. While the exact etiology of the condition is up for debate, it is a long held belief that it is almost exclusively a postmenopausal female trait, with the ratio of male to female incidence being roughly 1:10. However, a recent study incorporating cadaveric and several 20th and pre 19th century skeletal samples (Hershkovitz *et al.*, 1999) suggests a greater incidence in males than previously believed. The current study examines an autopsy sample of 452 males and 185 females analyzed at the Rhode Island Office of State Medical Examiners during 2008, and 39 of these individuals exhibited signs of HFI. This sample resulted in a comparatively low 1:3 male to female ratio before sample size correction. The study compares the observed relative frequencies with those traditionally proposed for the sexual distribution of this trait, as well as with the ones obtained from similar samples in recent studies (Devriendt *et al.*, 2005). Best fit estimates for both the sexual distribution and overall frequency of HIF in the population under investigation are provided, with a discussion of their relevance for the interpretation of the etiology of this trait.

Covariation between facial and mandibular shape in *Hylobates* and *Pongo* with respect to facial orientation

SASCHA SENCK, MICHAEL COQUERELLE, GERHARD W. WEBER. Department of Anthropology, University of Vienna, Austria.

Pongo and *Hylobates* are characterized by a structural condition known as airorhynchia, an upwardly deflected face relative to the basicranium. The degree of deflection varies considerably between and within species. A change in the orientation of the maxilla would impact on the mandibular shape to maintain functions such as mastication and mechanical protection of hyo-laryngeal structures. In this study we investigate the multivariate relationship between mandibular shape and the variation in maxillary orientation in airorhynchous species. We quantify shape covariation between face and mandible using 210 facial and 415 mandibular 3D landmarks

and semilandmarks digitized on CT scans of 40 adult *Pongo pygmaeus* and 40 adult *Hylobates muelleri* specimens. Landmark configurations were superimposed using generalized Procrustes analysis. Morphological integration of the viscerocranum and the mandible within each species was studied using singular warps (SW), a special case of symmetrical 2-block partial least squares. Despite the general craniomandibular differences between *Hylobates* and *Pongo*, in both species a downward deflection of the premaxilla is highly correlated ($r > 0.82$) with an increase of the angle between mandibular corpus and ramus, and a relatively higher symphysis. On the contrary, a dorsal flexion of the midface covaries with a more vertical ramus orientation and lower symphysis. We find that SW1 scores correlate ($r > 0.77$) with size in both species, larger individuals showing a longer and more ventrally flexed viscerocranum. We further speculate about the functional aspects in terms of accommodations maintaining both bite force and hyo-laryngeal protection in case of ventrally inclined viscerocranum.

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Conditional independence of dental and skeletal ontogeny relative to chronological age in modern and fossil humans?

MAJA ŠEŠELJ. Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology.

Modern humans are characterized by a very slow pattern of growth and development compared to the great apes. In hard tissues this trend is evident in late dental eruption and late attainment of skeletal maturity, but it is uncertain when this pattern arose during hominin evolution. Most studies of modern and fossil human ontogeny focus on either dental or skeletal development and use the other as an age proxy. However, it is critical to consider the relationship between dental and skeletal growth and the timing of developmental events. This study uses chronological age as the standard against which age-related variables are evaluated, and investigates skeletal and dental growth indicators simultaneously. These include dental formation and eruption, several cranial metric and nonmetric growth indicators, union of ossification centers and epiphyses, and long bone lengths and diameters. Results from two known-age collections (Hamann-Todd, n=62 and Luis Lopes, n=89) suggest that dental and skeletal growth may be conditionally independent given age. This means that both dental and skeletal growth indicators are correlated with age, but not to each other when age is controlled. When dental and skeletal development of several Pleistocene fossils is compared simultaneously to that of recent modern humans of similar chronological age (as estimated from dental microstructure), the Nariokotome *H. erectus* is skeletally greatly advanced over its modern human peers, but the overall rates of growth and development of two Neanderthals and an Upper Paleolithic *H. sapiens* generally fall within the modern human

range of variation. This study was funded by the Center for the Study of Human Origins, Department of Anthropology, New York University, the Graduate School of Arts and Science, New York University, the Wenner-Gren Foundation Dissertation Fieldwork Grant, and the NSF Doctoral Dissertation Improvement Grant number 0925861.

Opposites attract: MHC and mate choice in mandrills.

JOANNA M SETCHELL¹, MARIE J E CHARPENTIER², KRISTIN M ABBOTT³, E JEAN WICKINGS⁴ and LESLIE A KNAPP³. ¹Evolutionary Anthropology Research Group, Department of Anthropology, Durham University, UK, ²Centre d'Ecologie Fonctionnelle et Evolutive UMR 5175, CNRS, 1919 Route de Mende, 34293 Montpellier Cedex 5, FRANCE, ³Department of Biological Anthropology, University of Cambridge, UK, ⁴Centre International de Recherches Médicales, Franceville, GABON.

Major histocompatibility complex (MHC) associated mate preferences have been reported for a variety of organisms, but relatively little is known concerning the relationship between MHC genes and mate choice in primates. It has also been suggested that such mate preferences do not play a role in species in which male-male competition is strong. We investigated patterns of reproduction in a semi-free-ranging population of mandrills in relation to genetic relatedness and male genetic characteristics, using both neutral microsatellite and MHC genotyping. We compared genetic characteristics of the sire and his genetic dissimilarity to the mother with all other potential sires present at the conception of each offspring (n=193 offspring for microsatellite genetics, 180 for MHC). The probability that a given male sired increased as pedigree relatedness with the mother decreased, and as overall genetic dissimilarity and MHC dissimilarity with the mother increased. Reproductive success also increased with male microsatellite heterozygosity and MHC diversity. These effects were apparent despite the strong influence of male dominance rank on reproductive success. The closed nature of our study population is comparable to human populations for which MHC-associated mate choice has been reported, suggesting that such mate choice may be particularly important in relatively small or isolated populations with little or no migration to introduce genetic variation. CIRMF is financed by the Gabonese government, Total Gabon and the Ministère Français des Affaires Etrangères. The work presented here was funded by a Leverhulme Trust UK project grant (No. F/01576/B). MJEC was financed by a Marie Curie Outgoing Fellowship.

Using locomotor ontogeny to understand the interaction between small body size and arboreal locomotion: a case study using sugar gliders (*Petaurus breviceps*).

LIZA J. SHAPIRO¹ and JESSE W. YOUNG². ¹Department of Anthropology, University of

Texas at Austin, ²Department of Anatomy and Neurobiology, Northeastern Ohio Universities College of Medicine.

Locomotor features shared by arboreal marsupials and primates are frequently cited as a complex that evolved in a small branch habitat. Adaptations to a small branch niche can only be understood in the context of body size, and ancestral primates were presumably very small. Therefore, understanding primate origins necessitates a consideration of how small animals navigate arboreal substrates. Juvenile arboreal mammals navigate the same habitat as adults, but at reduced body sizes. Ontogeny thus provides a unique opportunity to assess the effects of body size on locomotion while controlling for phylogeny.

This study used locomotor ontogeny to test the effects of body size, substrate diameter, and age on quadrupedal kinematics. Kinematic data were collected longitudinally from a juvenile sugar glider (1-4 months; 40 to 74g) and on four adults. Subjects walked across a flat surface or horizontal poles of varying diameter. Sugar glider gait was influenced more strongly by age than by relative body to substrate size. The juvenile did not shift its gait in response to substrate size, but used lower limb phases and more flexed limbs than adults, even at similar relative body sizes. Lateral sequence (LS) gaits predominated. With age, the juvenile decreased limb contact times and shifted from lateral to diagonal couplets. The gliders' frequent use of LS gaits demonstrates that primate-like gait is sufficient, but not necessary, for navigating a small branch habitat. Additionally, the lack of clear size effects shows that the challenges of a small branch habitat may differ for small and large mammals.

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Temporal Changes in Prehistoric Trophy Taking in the Ohio River Valley.

RACHEL A. LOCKHART SHARKEY and CHRISTOPHER W. SCHMIDT. Indiana Prehistory Laboratory, University of Indianapolis.

Skeletal and soft tissue trophies were taken throughout prehistory along the lower Ohio River. Trophies were usually heads and limbs and were taken from men, women, and children. The objective of the current study was to determine if patterns in trophy taking remained constant through time. Comparisons were made between Middle/Late Archaic (4000-1000 BC) and Late Prehistoric skeletons (AD 1000-contact) from Indiana and Kentucky (total sample size, 5960). Sites were included only if they had at least one trophy victim. The data were categorical in nature and tested via chi-square. It was determined that more trophies were taken during the Middle and Late Archaic ($\chi^2 = 21.759, p = 0.000$) and the type of trophy appears to change over time with heads and limbs being more common in the Middle/Late Archaic ($\chi^2 = 3.994, p = 0.046$). Scalping, which is present during the Archaic and Late Prehistoric, becomes far more common during the latter period ($\chi^2 = 9.186, p = 0.005$). Moreover, the treatment of trophy victims changes as multiple victim

burials are more common during the Late Prehistoric. Overall, the differences indicate that trophy taking was not a static enterprise and that the underlying circumstances surrounding trophy taking events changed through time.

The evolution of the serotonin system in macaques.

MILENA R. SHATTUCK and RIPAN S. MALHI. Department of Anthropology, University of Illinois Urbana-Champaign.

The serotonin system has been the subject of intense study for its association with behavior. Across many taxa, variation in serotonin levels has been associated with increases in aggression and impulsivity and many psychiatric drugs work by manipulating the serotonin system. Moreover, numerous genetic studies have shown that polymorphisms in genes associated with the serotonin system correlate with variation in aggressive and impulsive behavior. Therefore, an understanding of how this hormonal system evolved is critical for understanding the evolution of behavior. The macaque genus is comprised of behaviorally and geographically diverse species, making it a useful model for studying the evolution of genes and behavior. It has been suggested that the presence of polymorphisms in genes associated with the serotonin system are maintained through selection and may be what allow macaques to thrive in such a wide range of habitats. We address this hypothesis by sequencing three genes – SLC6A5, TPH2, and 5HT1B – related to serotonin functioning in rhesus macaques (N=27), longtail macaques (N=12), and Japanese macaques (N=10), as well as in seven other macaque species and a vervet. We apply a variety of tests designed to estimate which evolutionary forces acted on these genes, including tests to detect and distinguish different types of selection. We also use coalescent simulations, incorporating what is known about the demographic history of macaques, to model the evolution of these genes and thus gain insight into how the serotonin system evolved. These results help to explain how and why behavioral diversity evolved in macaques. This study was funded by the National Science Foundation, grant BCS-0925458.

'Putting flesh back onto the bones?' Can we predict soft tissue properties from skeletal and fossil remains?

COLIN SHAW^{1,2}. ¹Leverhulme Centre for Human Evolutionary Studies, Cambridge University, ²Department of Anthropology, Pennsylvania State University.

Estimates of muscle and soft tissue properties derived from hominin skeletal and fossil remains would greatly enhance descriptions of body size and shape, and prior physical capabilities. Presently, the utility of this approach remains uncertain given the complex nature of the relationship between muscle and bone. To address numerous principal issues pQCT imaging was employed to quantify the muscle-bone relationship in the arm, forearm and lower leg of modern human athletes

(runners, field hockey players, swimmers, cricketers) and controls. Given the presumed behavior patterns of prehistoric hominins, the assessment of highly active participants was required. In all locations the strongest relationships exist between muscle area (MscA) and bone area (BA), and MscA and multi-plane diaphyseal bending strength (J). Greater morphological variation, in both muscle and bone, was found in the arm than the forearm or lower leg. Habitual biomechanical loading appears to increase the strength of the muscle-bone relationship in the arm, while causing it to weaken in the forearm and the lower leg, and may reflect tissue economics required for efficient biomechanical movement. Using single slice (50% segment length) measurements employed here, the most accurate soft tissue predictions would be derived from the arm. The ability to estimate soft tissue properties from osseous tissue or fossil remains will improve through the assessment of complete limb segments, and the entire body. Full body CT scanning will allow for evaluation of the correspondence between soft and hard tissue along the limb, providing more accurate soft tissue predictions. This study was funded by The Royal Anthropological Institute, UK.

Sex scoring using area and volume measurements of the supraorbital region – a pilot study based on digital 3D models of human crania.

BRIAN M. SHEARER, SABRINA B. SHOLTS, MICHAEL GLASSOW and SEBASTIAN K.T.S. WÄRMLÄNDER. Department of Anthropology, University of California, Santa Barbara.

Glabellar prominence is one of the most sexually dimorphic traits of the human skull, as this trait tends to be expressed more strongly in males than in females. Although levels of expression can vary greatly within and among populations, traditional sex trait scoring systems define only five levels of expression based on visual assessment alone. In this pilot study, we used digital 3D-models of human crania to measure the volume and surface area of the supraorbital region and quantify variation in glabellar prominence on a continuous scale. The observed correlation between area/volume values and trait scores suggests that it may be possible to develop a protocol for sex scoring based solely on area/volume measurements obtained from 3D models of crania. Such methods would allow researchers to quantify cranial sex traits with greater objectivity and specificity, therefore producing more accurate and reliable sex determinations from the human skull.

Molecular phylogenetics and chronometries of Tarsiidae based on 12s mtDNA haplotypes: Evidence for Miocene origins, numerous diversifications within the Sulawesian clade.

MYRON SHEKELLE¹, RUDOLF MEIER², IAN WAHYU², WIRDATETI³ and NELSON TING⁴. ¹*tarsier.org*, ²Department of Biological Sciences, National University of Singapore,

³Museum Zoologicum Bogoriense, Indonesian Institute of Sciences, ⁴Department of Anthropology and Roy J. Carver Center for Comparative Genomics, University of Iowa.

It has been more than 20 years since a molecular study first included more than one tarsier species, but only relatively recently have the molecular genetic differences among tarsiers been closely studied. When this has happened, the results have challenged previous assumptions about extant tarsiers as being closely related species. We report the first ever study of DNA sequence data from wild-caught tarsier populations that includes samples from the extreme northern and southern limits of the distribution of the *T. tarsier* species complex (=Eastern Tarsiers), and use these data to test hypotheses about the age of crown tarsiers and to examine the hypothesis of numerous diversifications among Eastern Tarsiers. DNA sequence data were obtained from tissue samples representing each of the three major *Tarsius* clades, including multiple wild-caught individuals from the Eastern Tarsier group. *Tarsius syrichta*, *T. bancanus*, and outgroup taxa were downloaded from Genbank. Sequences were aligned and trimmed, leaving a data matrix with 726bp. Bayesian phylogenetic analyses were conducted in the program BEAST. Tarsiers form a monophyletic group whose extant mitochondrial lineages split between 10.1 – 32.3 Ma into an Eastern Tarsier clade and a Western-Philippine Tarsier clade. The Western and Philippine Tarsiers diverged from one another between 4.4 – 18.5 Ma, and the Eastern Tarsiers form a monophyletic group whose initial diversification of mitochondrial lineages into northern and southern clades occurred between 3.2 – 10.4 Ma. Five robustly supported clades were recovered within the Eastern Tarsiers, but the relations among these were unresolved. Evolutionary and conservation implications are discussed. This material is based on work supported by the National Science Foundation under Grant No. INT 0107277 and grants from the Margot Marsh Biodiversity Foundation, the Gibbon Foundation, and Primate Conservation, Inc. to MS. Sponsorship for MS in Indonesia was provided by Noviar Andayani of the Center for Biodiversity and Conservation Studies, University of Indonesia, and by the Indonesian Institute for Science. Permits for conducting research in conservation areas and for trapping tarsiers were provided by the Indonesian Department of Forestry.

The prevalence of axial developmental defects among Florida Archaic hunter-gatherers from Gautier (8BR193).

KATY SHEPHERD¹, HEATHER WALSH-HANEY¹ and CHRISTEN HERRICK¹.

¹Division of Justice Studies, Florida Gulf Coast University.

The frequency and severity of axial developmental defects (i.e., *spina bifida occulta*, *pars interarticularis*, cranial/caudal vertebral border shifting, irregular vertebra/rib segmentation, and abnormal sternabrae fusion) shed light upon the ability of humans to alter

development, growth, morphology, and behavior in response to environmental conditions. While previous osteological studies of Florida's early and late Archaic hunter-gatherers indicate little dietary or disease stress, there is a dearth of published research examining the health status of Florida's middle Archaic hunter-gatherers. As such, we analyzed the prevalence of axial developmental defects in this Florida Archaic skeletal sample in order to determine the general health status of these hunter-gatherers.

The Gautier skeletal sample comprises 83 adult and 12 juvenile individuals. Our macroscopic analysis revealed that 8 individuals evidenced at least one axial developmental defect (8.4%). Nearly 4% of the sample presented with vertebral border shifts ($n = 3$) while just over 2% ($n=2$) exhibited *pars interarticularis* defects. Upon chi square analysis of variance, the prevalence of individual axial developmental defects within this Archaic hunter-gatherer sample were not statistically different from expected values ($X^2 = 2.341$; $df = 1$; $p = 0.126$). Our findings suggest that the overall health status of the Gautier skeletal sample was in keeping with previous studies examining early and late Florida Archaic skeletal samples.

Population structure by isonymy of 19th century Tioga County, New York.

KEVIN ERIC SHERIDAN^{1,2}. ¹Department of Anthropology, Binghamton University-SUNY, Binghamton, ²Public Archaeology Facility, Binghamton University-SUNY, Binghamton.

Surname information from an 1887-1888 directory was utilized to study relationships by isonymy among 9 towns within Tioga County, New York. Individual surnames served as the unit of analysis for this study. Internal and between group differentiation was calculated via random isonymy in order to determine regional and between group kinship, F_{st} , R_{st} and biological distance (d^2). Biological distance was compared to spatial distance between towns via a Mantel test. Regional kinship was calculated as 0.00039, while F_{st} and R_{st} were calculated as 0.00077 and 0.00068 respectively. These values are indicative of either recent common ancestry or high levels of recent migration. Since Tioga County had been established for nearly 100 years and had been undergoing significant development following the Reconstruction era, the regional kinship data is more consistent with the latter interpretation. A priori and conditional kinship levels did not significantly differ. Both a priori and conditional kinship levels appeared to correspond to geographic distance, with adjacent town displaying greater kinship levels (with the exception of the town of Spencer). However, the Mantel test revealed that biological distance measures did not significantly correspond to geographic distance. Since distance is a more important influence on isolated populations, lack of correlation between geographic and biological distance is consistent with the level of development of late 19th century Tioga County.

The Misadventures of Huck Finn: the costs and benefits of being orphaned for juvenile male chimpanzees.

HOGAN M. SHERROW, Department of Sociology & Anthropology, Ohio University, Athens.

Chimpanzees have very long periods of juvenility, during which they most commonly associate, travel and interact with their mothers, learning important ecological and social information from them. Upon reaching adolescence, males become independent from their mothers and begin to invest heavily in social relationships with adult males. However, not all males move through this normal developmental trajectory. Instead, some males are orphaned as juveniles, and are forced to become ecologically and socially independent earlier than what is typical. Orphans are not uncommon among wild primate populations and most previous reports indicate that orphaned individuals are "adopted" by adult females (Thierry & Anderson, 1986). However, at Ngogo, orphaned juvenile males most commonly joined adult male social groups and seemed to develop particularly close relationships with individual males. The result is that it is unclear what costs and benefits juvenile male chimpanzees face, if they are orphaned. I conducted research at Ngogo, Kibale National Park, Uganda. In 1995 Watts and Mitani initiated the Ngogo Chimpanzee Project. Research has been uninterrupted and is ongoing. All adult and adolescent male chimpanzees of the community are well habituated and are observable within 3 – 5 meters on the ground. The Ngogo chimpanzee community is the largest on record, with a total of about 140 animals. During my study there were 15 adolescent males and 23 adult males in the community. Here I report on two adolescent and three juvenile males who all were, apparently, orphaned as juveniles. I used focal, scan and *ad libitum* methods to collect data on social interactions with other group members. I recorded the most common associates of these males, who they received support, or aggression from, their most common grooming partners and their relative dominance ranks (if any). The data were then analyzed to address whether or not orphaned males received preferential treatment from older males equally, or if they had special relationships with particular males. Further, I tested whether or not those special relationships, if they existed, translated into agonistic support for the orphan males, resulting in higher than expected dominance rank. Finally, I give a qualitative report of the activities, adventures and misadventures of juvenile male chimpanzees, especially orphans, putting them in a larger life history framework. This study was funded by the L.S.B. Leakey Foundation and the Mellon Foundation.

Seasonal changes in dietary composition for Hadza foragers of Tanzania: implications for hominin evolution.

DIANA S. SHERRY¹ and FRANK W. MARLOWE². ¹Department of Human Evolutionary Biology, Harvard University,

²Department of Anthropology, Florida State University.

Identifying keystone resources that enabled early hominins to survive periods of low fruit availability, and simultaneously to increase dietary quality relative to the phylogenetic baseline, has sparked a lively debate in the anthropological literature about the relative importance of meat versus tubers. Hadza foragers of Tanzania provide an instructive case study for evaluating leading hypotheses and broad principles of dietary ecology theoretically operative in the ancestral past. We measured changes in dietary composition for the Hadza throughout the year to determine: 1) whether tubers versus meat functioned as a key resource during the dry season, and 2) the extent to which dietary quality fluctuated seasonally. Our findings showed that the Hadza achieve a fairly stable level of dietary quality by utilizing a diverse set of high-quality foods. Tubers functioned primarily as a fallback food in direct relation to the availability of fruit (berries) rather than as a major fallback food during the dry season. Small to medium-sized game showed a distinct association with the mid-dry season. Large game was relatively rare and showed no seasonal pattern. Somewhat surprisingly, baobab emerged as the most prominent resource associated with the dry season. These results led us to draw a number of inferences about the dietary ecology of early hominins. We conclude that an investigative framework focused on identifying keystone resources, or centered on the relative importance of meat versus tubers, tends to eclipse recognition of "specialized omnivory" itself as the main dietary adaptation responsible for the early trajectory of hominin evolution. This study was funded by The National Science Foundation, grant number 0242455.

The reality of aging virtually: A test of transition analysis on pelvic laser scans.

NATALIE R. SHIRLEY¹, BRIDGET FB ALGEE-HEWITT² and REBECCA J. WILSON¹. ¹Department of Anthropology, University of Tennessee, Knoxville, ²Department of Biomedical Sciences, Grand Valley State University.

Age-progressive morphological signatures are translated into age-informative phases or scores to produce skeletal age-at-death estimates. This methodology requires the practitioner to physically examine the skeletal elements in order to determine age. Accordingly, any skeletal-based aging research conducted for the purpose of advancing methodology, or for education and training, requires access to skeletal collections. Inevitably, the breadth of an individual's experience is limited by access to resources. Moreover, a forensic anthropologist's ability to make a positive identification is affected by location, accessibility, and retention of pertinent skeletal elements. Recent advances in data acquisition and geometric modeling can improve age estimation procedures by changing the way in which skeletal material is accessed and evaluated. This study uses three-dimensional models from high resolution laser

scans of the pubic symphysis and auricular surface to test the feasibility of using scanned models as surrogates for bony material. Results from laser scans and from bony material from 58 positively identified cases from the University of Tennessee's William M. Bass Forensic Collection were compared. The scans and bones were scored following Milner and Boldsen's (2008) transition analysis (TA) guidelines and the associated ADBOU software was used to obtain age estimates. The comparability of TA ages between the personally inspected bones and the computer-generated virtual scans are discussed, and observer error rates are provided. In addition, the advantages of virtual skeletal collections are discussed, including easy access to reference and study materials, data preservation in the event of accidental loss, and convenient forensic consultation and evidentiary archiving capabilities.

Evolutionary and functional analysis of a developmental enhancer with human-specific expression.

SAMUEL J. SHOLTIS¹, HEATHER BRESLAWSKI¹, LAURA DEMARE¹, CAROLE PEASE², JAMES MCGRATH² and JAMES P. NOONAN¹. Departments of Genetics¹ and Comparative Medicine², Yale University School of Medicine.

Sequence change that altered developmental gene regulation played an important role in human evolution. Comparative genomic analyses have identified a subset of conserved noncoding sequences (CNSs) that show accelerated evolution along the human lineage ("human accelerated" CNSs, or HACNSs). CNSs are enriched in developmental regulatory elements, suggesting that HACNSs may include individual molecular components of human-specific developmental regulatory architecture. Here we focus on the detailed characterization of the most rapidly evolving element, *HACNS1*. Using a transgenic reporter assay we show that *HACNS1* drives gene expression in the branchial arches, otic vesicle, and primordial limbs between mouse embryonic day (E) 10.5 and E16.5. The chimpanzee ortholog also functions as an enhancer, but fails to drive expression in the limbs. 13 human-specific nucleotide changes in an 81bp region are sufficient to confer the gain-of-function, which may have contributed to human-specific aspects of limb development. We show that the mouse ortholog of *HACNS1* does not function as an enhancer and a "humanized" mouse sequence only partially recapitulates the *HACNS1* expression pattern. This suggests either that rodent specific changes have caused a loss of function in the mouse or that *HACNS1* function evolved during primate evolution and was further refined in humans. To address this question we analyze *HACNS1* ortholog enhancer function in a broad phylogenetic sample of mammals, establishing the ancestral state of *HACNS1* function and characterizing its evolution. These studies serve as the framework for ongoing efforts to identify and characterize the evolutionary molecular mechanisms of human-specific gene regulatory architecture *in vivo*.

An investigation of European skeletal remains buried on San Nicolas Island, California: new insights into early European contact with native Californian populations

SABRINA B. SHOLTS¹, ANNA CLEMENT² and MARGARET CLEGG³. ¹Anthropology Department, University of California, Santa Barbara, ²Institute of Archaeology, University College London, ³Natural History Museum, London.

Recent analysis of a collection of human skeletal remains from San Nicolas Island in southern California, housed at the Natural History Museum in London, has provided new insights into the history of this ancient population. Within the collection of skulls, all but one possessed the classic suite of prehistoric Nicoleño features, such as heavy tooth wear, robust morphological features and the presence of upper incisor shoveling. The skull of one adult male, however, lacked all of the key Nicoleño features, exhibiting some strong indicators of European ancestral affinity, such as the presence of Carabelli's cusps. This dental assessment was supported by the results of a craniometric analysis of the skull using CRANID discriminant analysis program. Although European maritime explorations of the Santa Barbara Channel Islands began in the 16th century, there has been no evidence that these early voyagers ever set foot on the small and remote San Nicolas Island. As a result, it is commonly believed that Europeans did not engage in direct contact with the native Nicoleños during prehistoric and protohistoric times. Given that the excavator of the skull described it as being that of a 'prehistoric Shoshonean' found in a traditional mortuary context on San Nicolas Island in 1929, the possible origins of this individual were investigated further using historical, archaeological, and radiometric evidence. Our findings challenge traditional assumptions about the nature of European-native Californian interactions in the Santa Barbara Channel Islands area and provide new insight into this poorly understood aspect of its human history.

Osteological Indicators of Health and Nutritional along the Central Tombigbee River in Eastern Mississippi.

KRISTRINA SHULER, ¹CHRISTINA BREEDEN, ²DANIELLE COOK. ¹Auburn University, ²University of Southern Mississippi.

The numerous hamlets and farmsteads of the North American southeast likely played key roles in formation of modular societies commonly referred to as chiefdoms. Yet, we know relatively little of the quality of life within peripheral communities to larger ceremonial centers such as Moundville. In this study, we explore regional health and nutritional status in five skeletal series from the central Tombigbee River area of eastern Mississippi, including: Mississippian period interments from Kellogg (22CI527) and Late Woodland burials from Coferdam (22Lo599), Shell Bluff (22Lo530), Tibbee Creek (22Lo600), and White Springs

(22It537). Porotic hyperostosis was scored for 95 individuals, revealing no significant differences in dietary iron by sex, age, or site. Mississippians, however, displayed significantly higher rates ($\chi^2=5.337$, $P<0.05$) than their Late Woodland counterparts. Similarly, the 68 individuals scored for enamel hypoplasias (growth arrest) did not differ in prevalence by sex or site, but age at onset was nearly 6 months earlier for Mississippian than Late Woodland series. Likewise, infectious disease sequelae (periostitis and osteomyelitis) from 132 tibiae demonstrated few differences by sex. Woodland prevalence was well below 30% but increased to 35% in the Mississippian. Together, this suggests that life at the margins of the Moundville chiefdom was not especially stressful. The advantage of relatively low population density, access to diverse natural resources, and lower reliance on horticulture, when coupled with connections to Mississippian political economy, may have conferred some advantage at rural sites. Small community studies such as this are vital to presenting a fuller view of region's past.

Swiss Mummy Project: Experimental mummification of fresh human limbs.

NATALIA SHVED, CHRISTINA PAPAGEORGOPOLOU, JOHANN WANEK, GIOVANNI COLACICCO and FRANK RUEHLI. Institute of Anatomy, University of Zurich.

Mummified human tissues are of foremost interest in forensics and paleopathology. The goal of this study is to apply evidence-based diagnostic criteria and state-of-the-art methodology to analyze mummified human tissues to improve knowledge on post-mortem alterations in ancient and modern settings. Two human lower limbs (LL) were amputated from a female donor (intra vitam body donation declaration; ethics committee approval) 24h post-mortem and "naturally" mummified by heat (ca. 40°C, 10-20% humidity (H)) and by "ancient Egyptian-style artificial" mummification (20-26°C, 35-70% H) by natron (54% NaCl, 16% Na₂SO₄, 18% Na₂CO₃, 12% NaHCO₃). At days 1, 3, 5, 7, 11, 14, 19, 25, 32, 38, 45, 52, 60, 70 and 84 post-mortem, magnetic resonance imaging (MRI; a.o. T1-, T2-weighted, ultra-short-echo time sequences), computed tomography, histological analysis (skin, muscle biopsies; HE, Goldner, van Giesen stainings) and x-ray tomographic microscope were performed. A steady increase of pH and humidity from 35% to 70% H and no changes of average temperature were observable in the naturally mummified LL. Weight of the LL decreased during the first two months by about 30%. According to MRI, the remaining pockets of humidity were particularly visible along anatomical compartments and more towards the interior regions of the limb. Histological examination revealed a good preservation of the mummified tissue (esp. stratum corneum). The initial study outcome shows a surprisingly low rate of mummification-related tissue alteration. However, based on this pilot study, future research will enlighten the enigmatic process of human tissue mummification, particularly at a

microscopic, radiological and molecular level. Grant support: Swiss National Science Foundation (Nr. 325130_120662)

Stature estimation in central Europe (5000 BC–7th c. AD): methodological considerations and diachronic trends.

FRANK SIEGMUND¹ and CHRISTINA PAPAGEORGOPOLOU^{1,2}. ¹Seminar für Ur- und Frühgeschichte, University of Basel, Switzerland, ²Archaeological Service Graubünden, Switzerland.

Stature estimation from skeletal remains is of great importance in anthropology and related disciplines. A large number of regression formulae exist, but intra- and interpopulation variability in long bone proportions is high and an optimal formula suitable for all populations is difficult to find. This study proposes suitable regression equations for stature estimation in archaeological skeletal material of central Europe, and records the diachronic changes considering factors such as social status and biological welfare. Traditional (Pearson, 1899; Breitinger, 1938; Bach, 1965; Trotter and Gleser, 1952, 1958, 1977; Olivier et al., 1978) and new equations (Sjovold, 1990; Feldesman et al., 1990; Formicola and Franceschi, 1996; Raxter et al., 2008; Vercellotti et al., 2009) were applied to long bone measurements of 1010 individuals (529 males, 581 females) from 13 archaeological sites (France, Germany, Switzerland; 4th–7th c. AD) and to means of long bone measurements of 3500 individuals, from 68 geographically close sites (5000 BC–7th c. AD). Pearson's equations gave good results whereas still frequently used formulae did not prove reliable. A combined method of Pearson (1899) and Trotter and Gleser (1952) provided the most accurate estimations. There were no significant small time-scale changes and no social status differences –as depicted on gravegoods-, whereas on long term scale an increase in body height of 4 cm from Neolithic (5000 BC) to Early Medieval period (7th c. AD) was recorded. This study offers valuable insights on stature fluctuation from Neolithic to medieval times in central Europe estimated with the best applicable methodology.

Are cross-population differences in hot flash frequency due to variation in women's awareness of hot flashes?

LYNNETTE L. SIEVERT¹, KHURSHIDA BEGUM², TANIYA SHARMEEN², LORNA MURPHY¹, SHANTHI MUTTUKRISHNA³, and GILLIAN R. BENTLEY⁴. ¹Dept Anthropology, Mass Amherst, ²Dept Anthropology, University College London, ³Dept Obstetrics/Gynecology, University College Cork, Ireland, ⁴Dept Anthropology, Durham University, UK.

Population variation in frequency of hot flashes (HFs) at midlife has been established through survey research. One explanation for this variation may be cultural differences in how women interpret or report HFs. To test this explanation, HFs can be objectively measured and compared with subjective experience. The

purpose of this study was to compare subjective and objective HFs among Bangladeshi women aged 35–59 living in Sylhet, Bangladesh, Bangladeshi immigrants living in London, and white British neighbors. In face to face interviews, women living in Bangladesh were most likely to report HFs ($n=157$, 45.5%) compared to London migrants ($n=180$, 42.5%) and white London neighbors ($n=153$, 31.6%; $p<0.05$). In each group, a subset wore an ambulatory Biolog monitor from late morning to early evening to measure changes in sternal skin conductance due to HFs. Subjective HFs were recorded by buttons on the monitor. Each woman was treated as an independent sampling unit and the percentage of subjectively reported HFs measured by a monitor (true positives) was calculated. False negatives and false positives were also calculated. In Bangladesh, women reported the most subjective HFs (mean 3.0) compared to Bangladeshi immigrants (mean 1.3) and their white neighbors (mean 1.3, $p<0.05$). There were no significant differences in the frequency of objective HFs across the groups. Mean percentages of true positives, false negatives, and false positives did not differ across groups. Differences in the cultural interpretation of experience, or differences in climate, could explain population variation in subjective but not objective experience. Supported by NSF grant #0548393, Commonwealth Scholarship and Fellowship Plan (CSFP, UK), and the Wolfson Research Institute, Durham University.

Evaluation of CT-derived data from a large sample of modern Americans using Fordisc 3.0.

TERRIE L. SIMMONS, MELISSA A. TORPEY and PHILIP N. WILLIAMS. Counterterrorism and Forensic Science Research Unit, FBI Laboratory, Quantico, VA.

Routine computed tomography (CT) scans allow access to the craniofacial morphology of living individuals and provide a unique opportunity to evaluate Fordisc's effectiveness at classifying modern, rather than archaeological, samples. In this study, CT scans of 303 living male and female North Americans from three descent groups (African, Asian, and European) were compared to the Forensic Data Bank (FDB). The aim of this study was to determine if CT-based measurements could approximate standard caliper measurements well enough to successfully classify individuals using the discriminant functions in Fordisc 3.0. Three-dimensional (3D) bone models were rendered and measured with standard craniometric landmarks using 3D visualization software. Individuals were subjected to two classification schemes, one against all 12 FDB populations and one against those of the same sex (4 female, 8 male). When compared to all FDB populations, 61% of individuals were correctly assigned ancestry, 79% sex, 79% into the correct sex, and 50% sex and ancestry. Although females achieved a greater proportion of correct ancestry assignments (66%), males were more frequently assigned to the correct sex (91%) and sex/ancestry group (51%). When same-sex comparisons were made, the overall correct classification frequency improved

significantly to 63% (67.5% females, 59% males). European-descent females were classified correctly most often in both analyses, (76% all, 92% same-sex). Only six individuals had classifications below statistical significance (typicality probability $\leq .048$), in either analysis. This study shows that CT-derived measurements are accurate enough to achieve statistically significant, above-chance sex/ancestry classifications for modern North Americans using Fordisc 3.0. This research is supported in part through the FBI's Visiting Scientist Program, an educational opportunity administered by the Oak Ridge Institute for Science and Education (ORISE).

A new reconstruction of the KNM-WT 15000 juvenile male pelvis.

SCOTT W. SIMPSON^{1, 2}, LINDA B. SPURLOCK³, C. OWEN LOVEJOY⁴, and BRUCE LATIMER^{1,2}. ¹Department of Anatomy, Case Western Reserve University School of Medicine, ²Institute for Science of Origins, Case Western Reserve University, ³Cleveland Museum of Natural History, ⁴Department of Anthropology, Kent State University.

Few postcranial elements are known from *Homo erectus* despite a lengthy history of discovery that includes many cranial specimens spanning three continents and well over one million years. The discovery of the remarkably complete KNM-WT 15000 juvenile male partial skeleton allowed the first systemic descriptions of *Homo erectus* postcranial anatomy, including some basic observations like patterns of growth, intermembral indices, and stature, among others. Figuring prominently in these studies is the individual's pelvis. Reconstruction of the pelvis led to assessments of *Homo erectus* body form, locomotor ability, and even estimations of female obstetric capacity and maximum neonatal brain size.

Here, we present a revised reconstruction of the juvenile pelvis. Using plaster casts of the original fossil sacral and os coxae fragments, we repositioned the elements and reconstructed the missing portions based on comparisons with known early *Homo*, *Australopithecus*, and modern human pelvis. This resulted in a revised anatomical reconstruction that includes a slightly wider sacrum, more laterally flaring and transversely oriented ilia, shorter ischia, and longer pubes. The anatomical consequences of this reconstruction present wider biiliac and interacetabular breadths – both of which have implications for body form and locomotion thus requiring reassessment of the adaptive history of African *Homo erectus*.

Who's your Daddy? Developmental simulation yields insights into the hybrid origin of *Rungwecebus kipunji*.

MICHELLE SINGLETON¹, KIERAN P. MCNULTY², STEPHEN R. FROST³, JOHN SODERBERG² and EMILY H. GUTHRIE³.

¹Department of Anatomy, Midwestern University, ²Department of Anthropology and Evolutionary Anthropology Laboratory, Uni-

versity of Minnesota, ³Department of Anthropology, University of Oregon.

Rungwecebus kipunji is a critically endangered papionin primate endemic to southern Tanzania. Although phenetically similar to mangabeys, kipunji mtDNA sequences nest within *Papio hamadryas cynocephalus*, suggesting that *Rungwecebus* originated through ancient hybridization between female yellow baboons and males of an unknown mangabey species. Nuclear sequences have failed to identify this paternal lineage, and the juvenile status of the sole available voucher specimen (FMNH 187122) complicates evaluation of the kipunji's morphological affinities. To identify the kipunji's likeliest paternal ancestor, we used developmental simulation to estimate adult kipunji cranial morphology and determined the phenetic affinities of simulated kipunji adults (SKAs). Our dataset comprised 153 landmarks and semi-landmarks collected on 205 juvenile and adult-male cercopithecine crania. Following generalized Procrustes analysis, the male developmental trajectory for each model species was approximated by regression of aligned coordinates on dental stage. Adult landmark configurations were simulated by addition of the resulting developmental vectors to the juvenile kipunji's landmark coordinates. Simulated adult morphologies were visualized by morphing a surface model of the juvenile cranium to each adult landmark configuration; phenetic affinities were assessed using several Procrustes-distance-based metrics. SKAs generated using different species vectors were extremely similar to each other and distinct from other papionins. Procrustes distances between SKAs were comparable to papionin within-species distances, suggesting our estimate of adult kipunji morphology is robust. SKAs were consistently most similar to *Lophocebus aterrimus* under all metrics. Based on these findings, *Lophocebus* is the most likely source of the kipunji's hypothesized paternal lineage. This research was supported by National Science Foundation Grant IIS-0513660 (to SRF).

Trabecular eccentricity: This new characteristic reveals relative influences of tension and compression stress in adapting metaphyses/epiphyses for habitual bending.

JOHN G. SKEDROS, CASEY J. KISER¹ and KENDRA E. KEENAN. Dept. of Orthopaedics, Univ. of Utah School of Medicine, Salt Lake City.

'Trabecular eccentricity' (TE), a new characteristic for considering potential interactions between cortical and cancellous bone adaptation, helps reveal synergism in cortical/cancellous distributions that may not be intuitive. TE is the placement of the cancellous envelope within the entire bone cross-section; greater TE increases non-central placement of the cancellous envelope and increases asymmetry in cortical thickness of opposing cortices. In a computational study of modern human femoral necks, Fox and Keaveny (J. Theoretical Biology, 2001; erratum 2003) show how the superior ("tension") and inferior

("compression") cortical thicknesses can be adjusted via TE to achieve an overall protective effect during bending. If opposing "tension" and "compression" cortical thicknesses are considered in terms of conventional understanding of local adaptation, and not TE, then cortical asymmetry (e.g., thinner "tension" cortex where bone is most prone to fracture) would not be recognized as having an overall protective effect. We explored implications and limitations of using TE for understanding potential synergism between cortical/cancellous bone envelopes in human and chimpanzee femoral necks, and sheep and deer calcanei—all have arched trabecular patterns consistent with habitual bending. Results reject the hypothesis that TEs are consistent in all the bone types. Marked differences in TEs between humans and chimpanzees possibly reflect species differences in relative cross-sectional robusticity (greater cortical robusticity in chimpanzees); hence, TE analyses may not be valid above some robusticity threshold. Results in the calcanei illustrate that when ligaments/tendons are considered that TE values can dramatically change interpretations of potential synergism between opposing tension- and compression-loaded cortices.

Environmental change during Bed II deposition at Olduvai Gorge.

REBECCA SLEPKOV¹, KRIS FIRE KOVAROVIC². ¹Department of Anthropology, University of Minnesota, ²Department of Anthropology, Durham University, UK.

Olduvai Gorge is one of the most important African Pleistocene hominin sites and, while Bed I (2.0 -1.78mya) has been the focus of numerous studies, Bed II (1.78-1.2 mya) has garnered less attention. This is particularly true of paleoenvironmental reconstructions; few have been conducted and the results have often disagreed. In addition, Bed II is separated geologically by the Lemuta Member, so analyzing it as a composite unit may not be appropriate. An ecological diversity analysis was conducted to compare the mammalian community structures of Lower Bed II (1.78 mya) and Upper Bed II (1.6 to 1.2 mya). A comparative sample of modern and fossil faunal communities provide context for our paleoenvironmental assessment of Bed II and principal components analyses are used to evaluate the differences in community structure with respect to the body size, feeding preferences and locomotor repertoires of the fauna. Lower Bed II is reconstructed as more wooded and Upper Bed II a more open grassland environment. Fossil communities similar to Lower Bed II include Bed I of Olduvai Gorge and Makapansgat. Upper Bed II has a community structure similar to Swartkrans, the Upper Ndolanya Beds at Laetoli, and Kanapoi. It was also shown that this form of analysis is useful in assessing the taphonomical biases of a fossil assemblage. The reconstruction of Upper Bed II as a grassland adds to the evidence that *Homo erectus* evolved in response to or contemporaneously with the emergence of open environments in East Africa.

Representing the geometry of organisms: Precision and accuracy in finite element modeling.

AMANDA L. SMITH¹, IAN R. GROSSE².

PAUL C. DECHOW³ and DAVID S. STRAIT¹

¹Department of Anthropology, University at Albany, ²Department of Mechanical & Industrial Engineering, University of Massachusetts at Amherst, ³Department of Biomedical Sciences, Baylor College of Dentistry.

Finite element analysis (FEA), a method used to explain how objects of complex design respond to load, has emerged as a powerful tool in evolutionary functional anatomy. However, the manner in which the method has been applied in anthropology and biology differs subtly from how it has been applied in engineering. Engineers use FEA as a tool to predict the mechanical behavior of, and optimize the design of, manufactured products. Engineers must do this as efficiently and as quickly as possible in order for engineered products to be competitive in the marketplace. As a result engineers understand and value modeling abstractions, such as geometry idealizations, which dramatically reduce the complexity of finite element models and yet still produce models with sufficient accuracy to serve the goals of the analysis. In contrast, natural scientists (trained to quantify shape with remarkable precision) tend to model incredibly complex organismal geometries with high levels of realism. Rarely asked, however, is the question of whether or not such effort-intensive modeling is necessary in order to obtain reasonably accurate mechanical results. Prior work on macaques indicates that certain coarse modeling assumptions can nonetheless produce models that are mechanically realistic. This study examines this question by performing a series of modeling experiments in which a geometrically precise FE model of a chimpanzee skull is made progressively more abstract (reducing mesh density, smoothing surface contours, removal of teeth, filling of sinuses, removal of neurocranium, halving skull). Results are compared to data obtained from *ex vivo* bone strain experiments. This study was funded by the National Science Foundation Physical Anthropology HOMINID program (NSF BCS 0725126).

Assessing the dental microwear of *Oreopithecus* using low-magnification stereomicroscopy.

APRIL K. SMITH¹ and FRANK L. WILLIAMS¹. ¹Department of Anthropology, Georgia State University.

Oreopithecus has been described as a folivore based on its dental morphology. SEM studies help to confirm this dietary signal. Low-magnification (35x) of dental microwear features is utilized to interpret two specimens attributed to upper Miocene *Oreopithecus*, IGF 11778 and IGF 10886 to examine whether it is positioned closer to extant primate folivores (*Colobus polykomos* and *Procolobus badius*), hard-object feeders (*Cebus apella*), frugivores (*Pan paniscus* and *P. troglodytes*), frugivore-

folivores (*Gorilla gorilla*) or folivore-frugivores (*Papio ursinus*). Microwear scars were counted twice (and averaged) on the paracone of the second molar within a 0.4 mm by 0.4 mm ocular reticle using an external light source to manifest refractive small pits and fine scratches, non-refractive large pits and coarse scratches, trench-like hypercoarse scratches and crater-like puncture pits. ANOVA show that taxa can be differentiated on the basis of small pits and fine scratches. Although *Papio ursinus* and *Pan troglodytes* show moderate to high frequencies of fine scratches, these taxa are distinct in number of small pits with the former showing relatively fewer and the latter exhibiting a relatively greater frequency. *Oreopithecus* lies between these extremes and in this way is similar to *Cebus apella*, although differences between *Oreopithecus* and *Cebus* occur in relative frequency of fine scratches; *Cebus* exhibits relatively few and *Oreopithecus* exhibits moderate numbers. Principal components analysis of small pits, fine scratches, hypercoarse scratches and puncture pits separates *Oreopithecus* and *Papio* from *Gorilla*. Of the species sampled, the dental microwear of *Oreopithecus* most closely approximates the dietary signal derived from *Papio ursinus*.

Magnitude of the “wild effect” in tooth emergence in chimpanzees of the Taï and Gombe forests.

B. HOLLY SMITH¹ and CHRISTOPHE BOESCH². ¹Museum of Anthropology, The University of Michigan, Ann Arbor, ²Department of Primatology, The Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany.

Our primary tool for reading the fossil record of human life history is to compare dental maturation between extinct species and the living chimpanzee. Whereas previous comparisons depend on captive data, Zihlman, Bolter, and Boesch (PNAS 2004) recently conclude that wild chimpanzees erupt teeth much later than captives, bringing into question comparisons within the hominin fossil record. Here we reassess the magnitude of the “wild effect” in chimpanzee tooth emergence with the following approach: We add ten new cases to previous data (total N=30), standardize how age is counted, correct two field identification errors and analyze the data using logistic regression. We then examine sample morbidity and mortality. Results second the key finding of Zihlman et al. (2004) that teeth emerged late in these wild individuals, although at a more moderate level, with means shifted approximately -1 SD compared to captive distributions. A critical point, however, is that the sample is largely natural deaths, merging the effect of being wild with the effect of being dead. Three findings suggest that maturational delays are partly attributable to the latter: younger deaths (1) were more delayed than the older in tooth emergence, (2) were more often accompanied by disease or debilitation, and (3) have a higher occurrence of dental anomalies. Definitive ages of tooth emergence times in living wild chimpanzees must be established

from the study of living animals. The fossil record, of course, does consist of many dead juveniles; present findings have implications for how we evaluate them. Supported by the MPI-EVA.

The peopling of Easter Island: A test of the single-wave vs. two-wave migration models using three-dimensional cranial morphology.

HEATHER F. SMITH. Department of Anatomy, Arizona College of Osteopathic Medicine, Midwestern University.

The geographic origins of the native human inhabitants of Easter Island, the Rapanui, have been heavily debated. The single-wave migration model postulates that the first colonizers sailed directly to Easter Island from Polynesia. An alternative hypothesis, the two-wave migration model, argues that the earliest migrants initially detoured and stopped along the western coast of South America before continuing to Easter Island. In order to address the hypothesis of gene flow between indigenous South American populations and native Rapanui, the present study evaluated in the Rapanui the three-dimensional aspects of human cranial morphology that have been determined previously to reflect population history accurately. Specifically, in samples of skulls belonging to Rapanui, native Polynesians and South Americans, 37 landmarks were digitized, and craniometric data from 57 standard linear dimensions were compared.

In Mahalanobis distances and on Multidimensional scaling plots, the three-dimensional cranial morphology and linear craniometric dimensions of Rapanui skulls were found to cluster closely with native Polynesians and were distinct from those of all other populations, including those from South America. In a Discriminant Function Analysis, the Rapanui crania were mostly likely to be classified as deriving from other Polynesian islands, but rarely as South Americans. These findings indicate that negligible gene flow has occurred between the indigenous populations of South America and Easter Island, supporting a single-wave migration model of Polynesian origin for the peopling of Easter Island. This finding also contributes broadly to a general understanding of the peopling of the Pacific. This study was funded by a collections study grant from the American Museum of Natural History, the National Science Foundation (BCS-0622570), the Wenner-Gren Foundation (Grant #7499), and Arizona State University's Graduate and Professional Students' Association.

Trabecular structure in the craniofacial skeleton of select anthropoid primates.

LESLIE C. SMITH¹ and P.C. DECHOW². ¹Department of Sociology and Anthropology, University of Texas at Arlington, ²Department of Biomedical Sciences.

Studies have shown that trabecular bone structure often corresponds with patterns of mechanical loading associated with the functional use of the skeleton. Most studies of primate trabecular function have focused on the mid-shaft and head of the femur, the calcaneous,

and the vertebrae. Analyses of the mechanical properties of the cortical bone of primate faces suggest functional adaptations in properties, such as material orientations and elastic moduli, but comparable investigations of the trabecular regions of the craniofacial skeleton have yet to be explored. This study analyses mechanical characteristics of trabecular bone in the faces of a sample of four anthropoid genera, *Homo*, *Pan*, *Gorilla*, and *Papio*. We hypothesize that patterns in trabecular bone structure will most strongly reflect functional adaptations in regions of the craniofacial that experience the greatest amounts of mechanical loading. Browridge, zygomatic, and alveolar trabecular structure was studied by means of microCT scans of craniofacial skeletal segments of 16 individuals. The results suggests that statistically significant differences exist between and within regions, and between taxa in a variety of measures of trabecular structure. Assessments of the data do not show lesser amounts of trabecular anisotropy in low strain regions, such as the browridges, compared to high strained regions such as the alveolus, contrary to our initial hypothesis. This suggests the importance of a careful appraisal of loading patterns by specific craniofacial region using advanced modeling techniques to understand the importance of such variation. This study was funded by the National Science Foundation Physical Anthropology HOMINID program (NSF BCS 0725126).

The canary in the coal mine: Treponemal disease across subsistence, settlement patterning and sociopolitical changes in southern Appalachia.

MARIA OSTENDORF SMITH¹, TRACY K. BETSINGER², LESLIE LEA WILLIAMS³ and ANTONIA M. ROBBINS⁴. ¹Department of Sociology and Anthropology, Illinois State University, ²Department of Anthropology, State University of New York, Oneonta, ³Department of Anthropology, The Ohio State University, ⁴Evanston Police Department, Evanston, Illinois.

Treponemal disease is known to be ubiquitous in Late Prehistoric (after AD 1000) North America. This visibility co-associates with aggregate village settlement and the consequential poor community health. Much of the literature considering the pattern of treponematosis in the riverine interior Southeastern U.S. is case driven, affirming the presence of the disease. However, some recent literature suggests population density may influence disease visibility suggesting farmstead/hamlet settlement frequencies may differ from palisaded village frequencies. Taking this a step further, morbidity differences may also differ by status if that subgroup is socio-culturally isolated. To examine these scenarios in a specific regional context, eleven sites in lower East Tennessee from two different subsistence/settlement patterns across two time periods (Late Woodland/Early Mississippian, AD 900-1100, N = 268) and Late Mississippian AD 1300-1600, N = 770) were surveyed for evidence of treponemal disease. The results indicate a statistically significant higher

frequency of treponematosis in the large aggregate village agriculturalist Late Mississippian sample (indicative cases: 9.7%) than the hamlet/dispersed farmstead horticulturalist Late Woodland/Early Mississippian sample (indicative cases: 4.5%). Status differences were statistically significant in the chiefdom-level Mississippian sample. There were no sex differences within either sample, which is consistent with all of the comparative literature.

Enamel thickness and tooth development in a subadult *Dryopithecus brancoi* (*Rudapithecus hungaricus*) individual.

TANYA M. SMITH^{1,2}, JOHN P. ZERMENO¹, JOANE POUECH^{2,3}, PAUL TAFFOREAU³, ANTHONY J. OLEJNICZAK^{2,4}, DONALD J. REID⁵, LAURA EASTHAM⁶, JEAN-JACQUES HUBLIN², LASZLO KORDOS⁷ and DAVID BEGUN⁶. ¹Department of Human Evolutionary Biology, Harvard University, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ³European Synchrotron Radiation Facility, Grenoble, ⁴Centro Nacional de Investigación sobre la Evolución Humana, Burgos, ⁵Department of Oral Biology, Newcastle University, ⁶Department of Anthropology, University of Toronto, ⁷Geological Institute of Hungary, Budapest.

The late-middle Miocene (ca. 9-10 mya) site of Rudabánya, Hungary has yielded a large collection of primate craniodental remains over the past four decades, including a cranium and associated mandible (RUD 200 & 212) with a fully-erupted dentition. We employed conventional microtomography to characterize enamel thickness in virtual planes of section (voxel sizes of 33-36 microns), and high-resolution dental impressions to quantify perikymata on the lightly-worn posterior molars. Phase contrast X-ray synchrotron microtomography (0.7 micron voxel size) revealed the long-period line periodicity, facilitating precise calculation of crown formation times non-destructively. The relative enamel thickness (RET) values of the anterior teeth and premolars are similar to those of chimpanzees, and thinner than orangutans. Molars are of intermediate RET (~11-17), closer to orangutans and several Miocene hominoids than to recent African apes. Perikymata numbers are more similar to chimpanzees than to orangutans, as is the long-period line periodicity of 7 days. Linear enamel thickness values and crown formation times of molar cusps are intermediate between chimpanzees and orangutans. The pattern of these data suggests that dental tissue structure and development in this individual is unlike that of any living great ape. Attrition on the first molars and the well developed canine and third molar roots prohibit precise determination of age at death. Assuming broad parallels to great ape developmental schedules, death is likely to have occurred after 10-12 years of age. Supported by the Max Planck Society, Natural Sciences and Engineering Research Council of Canada, Harvard University, and the European Synchrotron Radiation Facility.

Paranasal maxillary spaces in Old World monkeys: The perinatal period.

TIMOTHY D. SMITH¹, JAMES B. ROSSIE², GREGORY M. COOPER³, ROBIN M. SCHMIEG¹, CHRISTOPHER J. BONAR⁴, MICHAEL P. ZUMPANO⁵, ANNE M. BURROWS⁶ and VALERIE B. DELEON⁷. ¹School of Physical Therapy, Slippery Rock University, ²Department of Anthropology, SUNY Stony Brook, ³Departments of Surgery and Oral Biology, University of Pittsburgh, ⁴Cleveland Metroparks Zoo, ⁵Department of Basic Sciences, New York Chiropractic College, ⁶Department of Physical Therapy, Duquesne University, ⁷Johns Hopkins University School of Medicine.

Extant cercopithecoids, except for the genus *Macaca*, lack evidence of postnatal pneumatization of the maxillary recess (MR). This distribution is poorly understood, in part, because no studies have compared macaques to other cercopithecoids in the perinatal period, a time when secondary pneumatization is underway in many other anthropoids. In the present study, dental and midfacial variables were examined in a perinatal sample of four cercopithecoid genera: *Macaca*, *Trachypithecus*, *Allenopithecus*, and *Colobus*. Using microCT, skeletal relationships in the region of the MR were studied in three specimens. Selected specimens were studied by serially sectioning and staining to describe mucosal distribution in the maxillary paranasal spaces. In all species, the MR is an evagination of the middle meatus. In *Allenopithecus*, *Trachypithecus* and *Colobus* the MR is limited, barely expanding beyond the contour of the middle meatus. In contrast, in *Macaca* the MR is mostly an enclosed space outside and parallel to the middle meatus. However, its medial wall is formed by a soft-tissue reflection of mucosa rather than bone, and the osseous borders show little evidence of osteoclastic activity. Thus, secondary pneumatization of the MR is delayed in *Macaca* relative to other anthropoids that form a maxillary sinus. MicroCT reconstructions indicate that the MR is limited laterally by deciduous premolars in all species. However, orbits are proportionately larger in *Allenopithecus* and *Trachypithecus*, which may explain the less extensive MR in those species when compared to *Macaca*. This study was funded by the National Science Foundation, # BCS-0820751.

Rapid changes in cardiovascular risk factors associated with economic development and lifestyle change in an indigenous circumpolar population from Siberia.

J. JOSH SNODGRASS¹, WILLIAM R. LEONARD², LARISSA A. TARSKAIA^{3,4}, TARA J. CEPON¹, TATIANA M. KLIMOVA⁵ and VADIM G. KRIVOSHAPKIN⁵. ¹Department of Anthropology, University of Oregon, ²Department of Anthropology, Northwestern University, ³Department of Anthropology, University of Kansas, ⁴Institute for Molecular Genetics, Russian Academy of Medical

Sciences, ⁵FSRI Institute of Health, Republic of Sakha/Yakutia, Russia.

Lifestyle changes that occur with the transition from traditional subsistence-oriented economies have been linked to various negative health consequences (e.g., obesity and cardiovascular disease), including among circumpolar groups in North America. However, our understanding of the health effects of market integration among indigenous Siberians is complicated by the social transformations brought about by Soviet collectivization and the catastrophic changes initiated by the collapse of the Soviet Union. Previous research documents a pattern of cardiovascular risk factors among native Siberians that contrasts with that seen in other populations undergoing market integration (i.e., extremely high blood pressure levels but relatively favorable blood lipid profiles), yet numerous questions remain about the specific lifestyle (e.g., diet and physical activity) and genetic factors that structure these distinctive health changes.

In the present study, we investigate lifestyle determinants of cardiovascular risk among the Yakut (Sakha), an indigenous circumpolar group from northeastern Siberia that is currently experiencing rapid lifestyle change. We collected anthropometric, health (lipids, fasting glucose, blood pressure), dietary, and sociodemographic/lifestyle data among 300 Yakut adults (≥ 18 years; 150 females, 150 males) from Berdystiakh, Russia, which we compare with other Sakha Republic communities and other circumpolar populations. Results demonstrate high rates of hypertension (males: 34%, females: 30%), and moderate levels of obesity (males: 13%, females: 21%), impaired fasting glucose/diabetes (males: 14%, females: 13%), and dyslipidemia (e.g., low HDL cholesterol [males: 22%, females: 7%]). Cardiovascular and metabolic health in this community is rapidly deteriorating, which appears to reflect declining fitness and the growing consumption of market foods. This study was supported by NSF (ARC-0802390), FSRI Institute of Health, Northwestern University, and the University of Oregon.

The diet of the Dani: Isotopic analysis of a low-protein consuming human population from the highlands of Western New Guinea, Indonesia.

ANDREW D. SOMERVILLE¹, MARGARET J. SCHÖENINGER¹ and PHILLIP L. WALKER². ¹Department of Anthropology, University of California, San Diego, ²Department of Anthropology, University of California, Santa Barbara.

For decades anthropologists and nutritionists have studied the unusually low-protein diet of New Guinea highlanders. Certain communities regularly obtain 85-90% of their calories from starchy, low-protein foods, such as sweet potatoes and taro. The present study investigates the dietary patterns of the Mulia Dani of the central highlands of Western New Guinea, Indonesia through stable isotope analysis of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) in hair keratin

and evaluates the results in tandem with collected ethnographic data. We analyze sixty individuals of differing statuses, ages, and sexes with differing preferences for available food items. In total, individuals from nine villages are represented. The $\delta^{13}\text{C}$ results demonstrate that the average diet was composed of C3 plant resources, which is unsurprising as the sweet potato, their staple crop, utilizes the C3 photosynthetic pathway. The $\delta^{15}\text{N}$ results are some of the lowest ever recorded for a human population. If one village is excluded due to its outlying $\delta^{15}\text{N}$ values, the remaining Dani exhibit a mean nitrogen ratio of $\delta^{15}\text{N}=3.5\%$ ($n=43$), which is lower than the hair values of measured modern vegans (O'Connell and Hedges 1999). Isotopic analysis of carbon and nitrogen are commonly used for paleodiet reconstructions of archaic human populations and the isotopic investigation of a modern, low-protein-consuming human group adds to the world database of ecological niches and their expected isotope ratios in organic human tissue. The Mulia Dani results will be useful for interpreting dietary data from past societies and for understanding the range of human adaptive strategies.

Growing up in the Gravettian: ontogeny of cross-sectional geometry in the lower limb.

VITALE S. SPARACELLO¹, O.M. PEARSON¹, L. COWGILL². ¹Department of Anthropology, University of New Mexico, ²Department of Anthropology, University of Central Florida.

Gravettian adults are remarkable for the shapes of their lower limb bone diaphyses, including well-developed femoral pilasters, platymeric proximal femora, low neck-shaft angles, and platycnemic tibiae. These features suggest a very mobile lifestyle, yet comparatively little is known about how and when these traits developed during childhood. To gain insights into their ontogeny, we collected data on femoral and tibial midshaft cross-sectional geometry and external shaft measurements from original fossils and the literature for 9 Gravettian juveniles aged 4-15 years and 20 adults. We calculated second moments of area from external dimensions to augment available data and also ran analyses on external measurements alone; the results are largely similar. Juvenile shape indices (I_{\max}/I_{\min} , etc.) were transformed into a percentage of the adult mean. The results show that an adult level of platymeria could be obtained early, by 7-8 years of age, but with considerable individual variation. Femoral midshafts began to resemble adult patterns of exaggerated antero-posterior dimensions later. All juveniles older than 11.5 years had reached ~100% of the adult femoral midshaft shape and have a low neck-shaft angle, but only obtained 80-90% of adult flattening of the tibial shaft by 14-16 years of age. These results suggest that Gravettian children likely became very mobile in late childhood and began adult subsistence activities by their early teens. The results also hint that tibial cross-sectional shape develops more gradually than femoral shape. Supported by the National Science Foundation and Wenner-Gren Foundation

Growth and health status of Holocene occupants of Gobero, Central Sahara Desert: an analysis of linear enamel hypoplasias.

JENNIFER E. SPENCE¹, DEBBIE GUATELLI-STEINBERG¹, GARY T. SCHWARTZ^{2,3} and CHRISTOPHER M. STOJANOWSKI³. ¹Department of Anthropology, The Ohio State University, ²Institute of Human Origins & ³School of Human Evolution and Social Change, Arizona State University.

Recently a record of human occupation of the Holocene has been recovered from the Sahara. The Gobero site contains evidence of two anatomically and culturally distinct groups present during two humid periods and separated by a long period of severe aridity. The Kiffian (7700-6200 BCE) relied on hunting, gathering and fishing. The more diverse Tenerean (5200-2500 BCE) diet included small fish, shellfish, savanna vertebrates and herded animals. We predicted that the Tenerean, with a diverse subsistence strategy, would experience low levels of systemic stress and would thus exhibit few linear enamel hypoplasias (LEHs), dental defects chronicling growth disruption. We examined 78 anterior teeth that preserved visible perikymata and which were estimated to be $\geq 80\%$ complete. In addition, only individuals with ≥ 2 anterior teeth were retained in the sample. We conducted macro- and microscopic analyses of tooth replicas, including a count of LEH frequency, as well as a count of perikymata (growth increments) within defects to estimate stress duration. Although Kiffian and Tenerean samples did not differ in duration of LEH, we found a high frequency of LEH among the Tenerean, contrary to our expectation. Of 11 Tenerean individuals, 10 were affected by LEHs that could be matched to simultaneously forming anterior teeth. Tenerean individuals experienced, on average, two stress episodes during the period of anterior tooth formation. Despite the common finding that low levels of stress accompany diverse subsistence strategies, our results suggest that dietary diversity may not be sufficient to buffer against significant growth disruption.

This work was supported by the Wenner Gren Foundation for Anthropological Research (GR7747) and the National Science Foundation (0820805).

Dental isotope ecology in primate paleobiology.

MATT SPONHEIMER¹. ¹Department of Anthropology, University of Colorado at Boulder

Stable isotope analysis has become a common tool for investigating animal autecology and synecology. Yet, despite this trend in the broader ecological literature, and to some extent in the study of ancient human populations, there have been few stable isotope studies of primate neoeontology. Even more striking is the dearth of stable isotope studies of fossil primates, as such studies are likely to prove rewarding given the few paleodietary tools currently available. This paper will review the present state of primate biogeochemical studies, with a particular focus

on the use of dental tissues to recover information about primate diet, life history, landscape use, and possibly even social structure. It will focus particularly on the limitations of available techniques, but with an eye towards increasing their paleobiological utility. Especially promising areas of research will also be discussed. This study was funded by: National Science Foundation, Leakey Foundation, University of Colorado at Boulder

Home range overlap between adjacent troops of Japanese macaques in Yakushima, Japan.

DAVID S. SPRAGUE. Nat Inst Agro-Environmental Sci, Japan.

Home ranges often overlap between adjacent social groups of primates. In the Yakushima study site of Japanese macaques (*Macaca fuscata yakui*), a large number of social groups are packed closely together with considerable overlap between their home ranges. I analyzed travel route data for four groups, including one in the process of fission, arrayed along a north-south axis in the Yakushima study site to assess the degree of overlap among these groups based on home ranges calculated using minimum convex polygons (MCP) and kernel density estimators. The overall ranges could be partitioned into zones with different numbers and combinations of groups. A zone where ranges of all four groups overlapped existed for both MCP and kernel density home ranges. Although less overlap existed among core areas defined by the 50% kernel density contour, no group possessed a completely exclusive central core area. The exclusive zones in this data set were on the outer edges of the home ranges where no records of other groups existed because of the coastline or lack of data on neighboring, unstudied groups. Groups in the center had very little exclusive range. The large overlap among home ranges implies that strong inter-group competition exists among the study groups. However, the distance between travel routes recorded for each group on the same day suggest that the groups usually traveled at some distance from each other, with different pairs of groups tending to show significantly different distances among their routes.

The evolution of molar shape diversity in primates and euarchontan mammals: a geometric morphometric approach.

ELIZABETH M ST. CLAIR¹, DOUG M BOYER² and JONATHAN M G PERRY³.

¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University,

²Department of Ecology and Evolution, Stony

Brook University, ³Department of Anatomy, Midwestern University, Downers Grove.

Molar morphology has played a central role in hypotheses regarding primate evolutionary origins. We reassess the phylogenetic and ecological significance of molar shape using 3D geometric morphometrics on a sample of extant prosimian genera, Eocene basal euprimates, Paleocene plesiadipiforms, extant euarchontans *Tupaia* and *Cynocephalus*, and a proposed stem euarchontan, *Leptacodon*. Sixteen landmarks

were placed on µCT scan surface renderings of lower m2s (n=103). Data were subjected to generalized Procrustes analysis, followed by principal components (PC) analysis to identify factors summarizing shape variation. PC1 and 2 account for over 45% of the sample variance. PC1 is associated with variation in the presence/size of the paraconid, mesiodistal length, and talonid proportions; PC1 separates strepsirrhines and *Adapis*, with positive scores on this axis, from other taxa including basal adapids *Cantius* and *Dorruellia*. *Leptacodon* and *Purgatorius* differ from all other fossil taxa and *Tarsius* on PC2, and approach or overlap the distribution of *Cynocephalus* and *Tupaia*. More derived plesiadapiforms score lower on PC2 and overlap with tarsiids, *Teilhardina*, *Cantius* and *Dorruellia*. General linear model multivariate regression indicates that PC2 is significantly associated with broad dietary differences in extant taxa; shape changes along PC2 include variation in cusp height and crest length. These results are congruent with traditional phylogenetic and dietary hypotheses regarding the evolution of euprimates, suggesting that 3D geometric morphometric methods hold considerable promise to further elucidate changes in molar morphology and diet in the early radiations of euprimates, plesiadapiforms, and other euarchontan mammals. This study was funded by American Society of Mammalogists and Geological Society of America grants to EMSC, National Science Foundation dissertation improvement grant to DMB (BCS-0622544) and Evolving Earth Foundation grant to DMB, Duke University Dissertation Travel Grant to JMG.

Life after collapse: the impact of political fragmentation on resource availability and nutritional deficiency in southern Peru.

JENNIFER S. STARBIRD¹, MARTHA R. PALMA MÁLAGA², NICOLA O. SHARRATT¹, and MARIA KOLP-GODOY³.
¹Department of Anthropology, University of Illinois at Chicago, ²Pontificia Universidad Católica del Perú, ³University of Zurich.

Previous studies of osteological lesions associated with nutritional deficiency, particularly cribra orbitalia and porotic hyperostosis, have focused on the health consequences of the transition from foraging to agriculture. However, less well understood is the impact of the collapse of centralized trade networks in established agricultural societies on resource availability and subsequent health disparities. Since children represent the most vulnerable portion of the population, they may be used as sensitive indicators of total population health.

The present study examines changes in lesion frequency in subadults from three maize agricultural populations in southern Peru. The sites of Chen Chen, Tumilaca la Chimba, and Estuquía are characterized by decreasing levels of centralized control and increasing evidence of site isolation and defense. Chen Chen, a Tiwanaku V (AD 750-1000) site was a peripheral colony during the height of Tiwanaku state rule. The Tumilaca culture (AD 950-1150) represents an immediate post-collapse

component in the valley, incorporating Tiwanaku motifs and potentially maintaining some trade relations. The later Estuquía (AD 1200-1500) sites are smaller and more fortified than their predecessors. An analysis of mortuary samples from these sites shows a trend of increasing prevalence of malnutrition-related lesions from Chen Chen to Estuquía. Coincident with this is an increase in mortality in the youngest age groups (under one year). This suggests increasing resource scarcity, consistent with "balkanization" through the Late Intermediate Period after the collapse of the Tiwanaku state. This study was funded by Dumbarton Oaks and IIE Fulbright.

Juvenile scurvy in the valley of Stymphalos, Greece: A radiographic and macroscopic assessment.

ROBERT STARK¹ and SANDRA GARVIELOK¹. ¹Department of Anthropology, University of Alberta.

In recent years the prospect of identifying cases of juvenile scurvy (vitamin C deficiency) among archaeological populations has been increasingly debated. Research has largely focused on the macroscopic assessment of cranial porosity, particularly along the greater wing of the sphenoid and in the orbital roof. However, there is a lack of consensus as to the association of these porous lesions with scurvy, necessitating further investigation and the exploration of alternative means of assessment. As part of this exploration, a sample of fourteen sub-adult individuals from the late Roman-Byzantine site of Stymphalos (4th-6th c. CE) and the Cistercian monastery of Zaraka (14th-15th c. CE) in the valley of Stymphalos, Greece were examined for macroscopic porosity as well as clinically employed radiographic indicators of juvenile scurvy. The combination of macroscopic and radiographic indicators resulted in the identification of 29% (4/14) of individuals examined as exhibiting strong evidence for the presence of juvenile scurvy. The use of radiography in this study provided a means of connecting the proposed macroscopic lesions of juvenile scurvy with clinically documented radiographic signs of this disorder, allowing for a more clinically based diagnosis.

Such findings suggest that radiography, in combination with the currently employed suite of macroscopic lesions, can play an important role in the identification of juvenile scurvy in archaeological populations. This study was funded by the Social Sciences and Humanities Research Council of Canada (SSHRC), The University of Alberta and the Wiener Laboratory of the American School of Classical Studies at Athens.

Identifying Spanish Civil War victims: Multidisciplinary efforts to recover historic memory in Spain.

DAWNIE WOLFE STEADMAN¹, CAMILA OLJART², ELENA GARCIA-GUIXÉ³, MARÍA INÉS FREGEIRO², AIMEE HUARD¹, ANA HOOGEWERFF-GERGELI⁴, CARME BOIX⁵, ERMENGOL GASSIOT², and JORGE JIMENEZ². ¹Department of Anthropology,

Binghamton University, SUNY, ²Department of Prehistoria, Universitat Autònoma de Barcelona, Spain, ³Laboratori de Paleoantropologia i Paleopatología, Museu d'Arqueologia de Catalunya, Barcelona, Spain, ⁴Chemical Sciences and Pharmacy, University of East Anglia, Norwich, United Kingdom, ⁵Badley Ashton & Associates Ltd, Lincolnshire, United Kingdom.

The three-year Spanish Civil War ended in 1939 yet the repression of human rights and due process continued for nearly four decades. Little social change occurred even after Franco's death in 1975 given the "Pact of Silence" maintained by subsequent democratic governments concerning past atrocities. Recently, social movements have demanded accountability for past atrocities and seek to recover historic memory of the war. One very important avenue in reconstructing historical memory is the identification and contextualization of the thousands of victims of extrajudicial execution. Social groups, such as El Foro por la Memoria, have joined forces with historians, archaeologists, forensic anthropologists, geneticists, pathologists, and other scientists to locate and exhume mass graves, identify victims, and provide an objective account of the circumstances of death. This paper provides one example of multidisciplinary collaboration to locate and identify 11 men who were executed in 1936 near Malaga. Historians, conservators, and other researchers reconstructed the facts surrounding the event, determined who might be in the grave, contacted living family members who provided personal information about the missing and DNA samples, and analyzed personal effects and bullets recovered from the grave. Archaeologists documented the grave and contents, forensic anthropologists interpreted trauma and provided putative identifications, and geneticists established positive identifications. All 11 men were killed by multiple gunshots from at least two firearms. The personal, social and political ramifications of recovered historic memory are multifold. Unfortunately, future investigations are endangered by the lack of judicial cooperation and a volatile political climate concerning exhumations.

Stable isotope analysis of Shelter Island, NY Native American remains.

VINCENT H. STEFAN. Department of Anthropology, Herbert H. Lehman College, CUNY.

Significant effort has been given to the task of identifying the intensity level of maize utilization in coastal New England and New York during the Late Woodland period (about cal A.D. 1000 to 1600) (Little and Schoeninger 1995). The majority of the effort has been in the search for archaeological evidence of the presence and cultivation of maize in the Northeast (Hart 1999; Little 2002). Little and Schoeninger's analysis of stable carbon and nitrogen isotopes of Late Woodland human skeletal remains from Nantucket Island provided a "firm base for future studies of human diets on the East Coast" (1995:364). However, a search of the scientific literature has

revealed very few published reports of stable isotope analysis of Northeastern prehistoric Native American skeletal remains. The inadvertent discovery of prehistoric Native American skeletal remains on Shelter Island, NY provided a rare opportunity for dietary reconstruction using carbon and nitrogen stable isotope analyses. The conventional radiocarbon age obtained on bone collagen from the Shelter Island human skeletal remains was 420 ± 60 BP (Beta-184998), with a calibrated age range of AD 1430-1500 (1 sigma, 68% probability) and AD 1410-1640 (2 sigma, 95% probability) (Stuiver et al. 1998). These age ranges clearly indicate these human skeletal remains were buried during the Late Woodland or Final Woodland period. The stable isotope analyses provided the following values: $\delta^{13}\text{C} = -9.7\text{\textperthousand}$ and $\delta^{15}\text{N} = 11.7\text{\textperthousand}$. This presentation will discuss the interpretation of these values with regards to extent or lack thereof of maize consumption of prehistoric Native Americans of Shelter Island.

Phylogenetic analysis of two malaria-resistance loci.

MICHAEL E. STEIPER^{1,2,3,4}, JULIA M. ZICHELLO^{2,4} and FIONA WALSH¹. ¹Department of Anthropology, Hunter College of the City University of New York (CUNY), ²Program in Anthropology, The Graduate Center, CUNY, ³Program in Biology, the Graduate Center, CUNY, ⁴New York Consortium in Evolutionary Primatology (NYCEP).

In humans, malaria is a long-standing selective agent caused by parasites of the genus *Plasmodium*. This selective force has led to numerous genetic adaptations to combat malaria in humans, such as the sickle cell allele of the beta globin gene. Non-human primates harbor relatives of the human malaria parasites, suggesting that they may also be responding to these parasites with genetic adaptations. A diverse set of primates were phylogenetically analyzed at two of these loci: Glycophorin A and SLC4A1. These genes display signals of positive natural selection across primates, in lineages that harbor different species *Plasmodium* parasites and also those that do not harbor these parasites. These results have a number of potential explanations. The adaptive evolution at these genes could reflect a general involvement in adaptation to a range of parasites, not only *Plasmodium*. Or, the adaptive evolution could reflect former *Plasmodium* infection. In either case, these results imply that the links between candidate genes and selective agents need more direct testing, even among related species. This study was funded by Grant Number RR003037 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of NCRR or NIH.

Functional genomic signatures of human brain growth and development.

KIRSTIN N. STERNER¹, AMY M. BODDY¹, CHRISTOPHER W. KUZAWA², CHET C. SHERWOOD³, PATRIC R. HOF⁴, LEONARD LIPOVICH¹, LAWRENCE I. GROSSMAN¹, MONICA UDDIN⁵, DEREK E. WILDMAN^{1,6}, MORRIS GOODMAN^{1,7}, HENRIETTE E. MAIR-MEIJERS¹, AMY L. WECKLE¹, LUCIE GREGOIRE¹, and HARRY T. CHUGANI⁸. ¹Center for Molecular Medicine and Genetics, Wayne State University School of Medicine, ²Department of Anthropology, Northwestern University, ³Department of Anthropology, The George Washington University, ⁴Department of Neuroscience, Mount Sinai School of Medicine, ⁵Center for Social Epidemiology and Population Health, University of Michigan School of Public Health, ⁶Department of Obstetrics & Gynecology, Wayne State University School of Medicine, ⁷Department of Anatomy and Cell Biology, Wayne State University School of Medicine, ⁸Department of Neurology, Wayne State University School of Medicine.

Deciphering the genetic underpinnings of human learning and neurodevelopment is a major goal of biological anthropology. In the current study, we examined gene expression patterns in surgical samples derived from 37 human brains; spanning ages from infancy (0.9yrs) to adulthood (47yrs). This sampling strategy utilized living rather than postmortem tissue, and enabled us to test whether gene expression correlated with changes in the metabolic requirements of the brain during ontogeny. Data derived from positron emission tomography (PET) scans have demonstrated that glucose uptake in the neocortex changes as a function of age, reaching a peak metabolic cost at approximately 7yrs. We hypothesized that genes involved in neuroplasticity, synaptic function, and aerobic energy metabolism would show coordinated patterns of expression that tracked the glucose consumption patterns derived from the PET data. Using microarrays, we examined gene expression patterns, and analyzed the expression data using a quadratic regression approach. We found that genes were significantly differentially expressed as a function of both age and sex. Among genes whose expression changes as a function of age we found a significant overrepresentation of genes involved in gene ontology categories including nervous system development ($P=0.007$) and dendrite development ($P=0.03$). These findings demonstrate that gene expression is correlated with neurological development during human ontogeny. Moreover, candidate genes that show differential expression during human development include genes involved in ATP synthetase activity and neurogenesis. Understanding the evolution of these differentially expressed genes may provide clues to the origin and refinement of uniquely human cognitive abilities.

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Late children and increased female longevity in migrating Mennonites.

JOAN C. STEVENSON¹, PHILLIP M. EVERSON¹ and R. WARD EVERSON². ¹Departments of Anthropology¹ and Sociology²,

Western Washington University, Bellingham, WA.

The expectation from life history theory is that stressful settings can lead to excessive energetic demands during reproduction with negative health consequences e.g., reduced maternal post reproductive lifespan. This is assessed in a natural fertility population from church records for a Mennonite congregation during their times in Russia and after migration to the USA in the 1800s. Marriages were relatively late only after individuals were full members. Teen pregnancy and illegitimacy were rare. There were 377 mothers, 242 with complete data and 135 missing death dates. Survival analysis was performed to assess the effects of covariates with mother's age at death. For the total sample, parity ranged from 2 to 14 children with an average of 6.36 ± 0.17 ; average ages at first and last births were 23.74 ± 0.24 and 37.76 ± 0.32 years, respectively. The only significant covariate in this model was mother's age at last birth ($\chi^2 = 12.86$, d.f. = 4, $P=0.012$). Two categorical variables, loss of a child, and a multiple birth, separately increase the risk of dying five years earlier post reproduction. Positive correlations with maternal age at death among covariates were significant but weak for parity ($r=0.168$, $P<0.01$) and stronger for age at last birth ($r=0.262$, $P<0.001$). The former correlation may reflect the higher status and social support of many of the reproducing Mennonite women. The latter is consistent with recent analyses of frontier populations. As expected, there is a highly significant negative correlation between parity and proportion of male children ($r=-0.477$, $P<0.001$).

Variation in NMB and ATF3 protein expression in Von Economo neurons of hominoids: Implications for evolution of social cognition.

CHERYL D. STIMPSON¹, JOHN M. ALLMAN², NICOLE A. TETREAULT², CAMILLA BUTTI³, PATRICK R. HOF³ and CHET C. SHERWOOD¹. ¹The George Washington University, ²Caltech University, ³Mt. Sinai School of Medicine.

Von Economo neurons (VENs) are a type of neuron defined by their thin, elongated cell body and long dendrites projecting from apical and basal poles. They are mostly present in anterior cingulate cortex (ACC) and fronto-insular (FI), with particularly high densities in cetaceans, elephants and hominoids. VENs contribute to specializations of neural circuits in species that share both large brain size and complex social cognition and may represent an adaptation to rapidly relay socially-relevant information over long distances across the brain. Here, we examined the expression of neuropeptide B (NMB) and activating transcription factor 3 (ATF3) – both play a role in autonomic functions – in different morphological classes of ACC layer V neurons of apes using immunohistochemistry [hylobatids (n=2), *Pongo* (n=5), *Gorilla* (n=5), *Pan* (n=6)]. A Kruskal-Wallis test demonstrated that out of the total number of cells that expressed these proteins, *Pan* showed a greater percentage of

VENs that were stained for both ATF3 ($p=0.02$) and NMB ($p=0.01$) as compared to the other apes. Specifically, *Pan* showed an average of $7.73 \pm 1.08\%$ of VENs that stained for ATF3 and $12.09 \pm 1.86\%$ that stained for NMB. This suggests that in addition to variation among species in the distribution of VENs, there may also be phylogenetic variation in the protein expression profile of these cells. Relative to other apes, *Pan* might have VENs that are further specialized for enhanced interoceptive sensitivity. Future examination of protein expression by VENs in humans will increase understanding on the evolutionary functional roles of these neurons. This work was supported by the James S. McDonnell Foundation (22002078).

Is the age at onset of menopause adaptive? Putting the “adaptive onset” hypothesis to the test.

ASHLEY E. STINESPRING HARRIS¹, ROBIN M. BERNSTEIN² and BARRY X. KUHLE³. ¹Department of Anthropology, University of Illinois, Urbana-Champaign, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Department of Psychology, University of Scranton.

Researchers have yet to determine the adaptive origin of menopause. Some argue that menopause has been uniquely shaped by selection in humans. Others argue that the timing of reproductive senescence is ancestral and that it is a byproduct of selection for post-reproductive longevity. The goals of this study were to test an adaptationist perspective, specifically the “adaptive onset” hypothesis (AOH) (Kuhle 2007), and to further our understanding of the potential adaptive origins of menopause.

The AOII posits that both menopause and the timing of its onset are adaptive. According to this hypothesis, timing is mediated by a psychological mechanism that adjusts age at onset according to the likelihood of successful continued reproduction. Twelve factors were hypothesized to predict whether continued reproduction would be successful. If these factors were found to predict relative age at onset of menopause, this would imply support for the adaptive origin of menopause. Eight of the twelve predictive factors were tested using data extracted from the NLS Mature Women cohort. This dataset comprises a large sample of women for whom demographic information is known, including age at onset of menopause. Cox regression analysis and independent t-tests were conducted to test the predictions of the AOH. Results did not display the directional variation in age at onset proposed by the AOH. In fact, a majority of the tests display variation in the opposite direction than predicted. Therefore, these results of this study do not provide support for this adaptationist perspective on the evolutionary origins of menopause.

Humero-femoral strength indices, locomotion and foraging strategies among hunter-gatherers, primates and fossil hominins.

JAY T. STOCK. Leverhulme Centre for Human Evolutionary Studies, University of Cambridge.

Numerous studies have documented the complex relationships among mobility, biomechanical loading, physique and long bone robusticity in human populations and primates. Some of the most fundamental characteristics of the foraging strategy of a population or species relate to mobility: the type of locomotion practiced and the intensity of mechanical loading resulting from this mobility. This study investigates patterns of humeral and femoral robusticity among human foragers, primates and fossil hominins, to test whether characteristics of humerus and femur strength can be used to characterize the pattern and intensity of locomotion both between species and among modern humans. The comparative sample includes hunter-gatherers from both historic and archaeological contexts, representing a broad spectrum of foraging strategies in South, East and North Africa, the Levant, the Danube, northwestern Europe, the Cis-Baikal region of Siberia, the Andaman Islands, Australia, Japan, the great-Lakes and Arctic regions of Canada, Coastal California and the Tierra del Fuego. Comparative primate and fossil data include: *Pan*, *Pongo*, *Hylobates* and fossil hominins derived from original measurements and the literature. The results suggest that humero-femoral strength ratios differentiate broad patterns of mobility between species, and in particular, the degree of arboreality and upper limb loading among primates. Within modern humans, humero-femoral indices provide a morphological signature of watercraft dependent versus terrestrial foraging strategies. These contrasts provide a means of interpreting mobility patterns between species, and among human populations. Among fossil hominins, they suggest considerable upper-limb loading of AL288, and greater terrestrial mobility among Upper Palaeolithic foragers than Neandertals. This research is supported by funding from Natural Environment Research Council, U.K.

The bioarchaeology of genocide: The mass grave at Sacred Ridge, Site 5LP0245.

ANN L.W. STODDER¹, ANNA J. OSTERHOLTZ¹ and KATHY MOWRER¹. ¹SWCA Environmental Consultants, Inc., Phoenix.

This paper examines the context and social implications of processed human remains from Sacred Ridge, a 22 acre Ancestral Puebloan site in Southwestern Colorado where the fragmentary remains of 33 individuals of all ages and sexes were found in a house dating to 780-810 AD. Taphonomic analysis of the nearly 15,000 bone fragments reveals extensive patterned destruction of all parts of the bodies. Human remains and protein residue on stone and ceramic artifacts indicate that processing took place in at least two (probably several) areas at the site. Deposition of the already fragmentary remains was random in terms age, sex, and body part. Isotopic analysis does not identify the victims as immigrants, but

nonmetric traits confirm that they were biologically distinct from those buried in normative mortuary features at the site, consistent with an extended kin group. The distinct identity of the victims, the systematic destruction of their bodies, and the depositional context suggest that this was the execution of a targeted group of individuals, perhaps those in control of this regionally prominent site which has unique high visibility architectural features and enclosed, limited access, ritual structures. This is consistent with the legal concept of genocide, albeit at a small scale compared to modern campaigns, and suggests that these were early Pueblo I people with ritual-associated power. They were dispatched, with their dogs, in a spectacle of violence centuries after the incidents at Basketmaker sites, and before those at Pueblo II-III sites like Cowboy Wash, Castle Rock, and Mancos Canyon.

Technological advances in biomolecular analysis of ancient disease.

ANNE C. STONE¹, ALICIA K. WILBUR¹, TESSA CAMPBELL² and JANE E. BUIKSTRA¹. ¹School of Human Evolution and Social Change, Arizona State University, Tempe, ²Department of Archaeology, University of Capetown.

Technological breakthroughs in nucleic acid amplification and sequencing present new opportunities in ancient DNA research. In particular, these technologies may allow us to identify the causative agent of an infectious disease and investigate the evolution of this agent over space and time. To date, we have extracted DNA from over 115 samples exhibiting classic tuberculosis lesions. These were obtained from both the New and Old Worlds and from contexts dating before and after the Age of Exploration. We first used absolute quantitative PCR to assess the preservation of host and pathogen DNA. Human nuclear and mitochondrial, and mycobacterial repetitive and single copy loci were analyzed. These results indicate that while approximately half of the samples contain human nuclear and/or mitochondrial DNA, only 10% were positive for mycobacterial DNA. Mycobacterial DNA was typically recovered in the presence of human DNA (82%). These results support those of a previous study that concluded that initial assessment of host mtDNA preservation is advisable to avoid needless destruction of ancient remains. From the samples that tested positive for host and mycobacterial DNA, we selected two from Peru and one from Canada, for subsequent analyses using high-throughput pyrosequencing. Preliminary bioinformatic analyses show that both slow-growing (pathogenic) and fast-growing (environmental) species of mycobacteria are present in the samples. These analyses also suggest that new methods for targeting specific pathogens of interest are necessary to obtain sufficient genome coverage for evolutionary analyses. We will discuss ways for doing this and our progress in this effort. This study was funded by the National Science Foundation grant #BCS-0612222.

Fluctuating asymmetry in the protohistoric Arikara.

NATASCHA STORMS. Department of Anthropology, California State University, Sacramento.

Fluctuating asymmetry has been used by bioarchaeologists as a measure of the effect of underlying environmental stress on growth and development. Previous paleopathological research on the Arikara of North Dakota detected significant differences in levels of environmental stress and health in pre-contact, contact and post-contact Arikara populations. In an effort to test developmental stability across these time periods in the Arikara, juvenile individuals from three Arikara cemeteries, Mobridge, Larson, and Leavenworth, were examined for fluctuating asymmetry in post-cranial epiphyseal union. Data were collected on 170 individuals between the ages 11-30 years housed at the Department of Anthropology at The University of Tennessee, Knoxville: 41 individuals from the Leavenworth cemetery, 96 individuals from the Larson cemetery, and 35 individuals from the Mobridge cemetery. Eighteen sites of epiphyseal union were scored on a scale of 1-4, representing no fusion to complete fusion. Data were analyzed using paired T-tests and an alpha level of 0.5. Results indicate that only 9 individuals, 3 from each cemetery, exhibited fluctuating asymmetry between right and left side epiphyseal fusion. However, these results were not statistically significant. Considering that these results are at odds with the previously reported findings that health and stress differed significantly over time at Arikara sites, other explanations for these results are sought and discussed. While sample sizes are sufficient, it is believed that epiphyseal fusion may not be an indicator that is sensitive to developmental stress in this population and may instead be the result of population level differences in our ability to canalize development. Additional research on fluctuating asymmetry in the crania and dentition of these individuals is suggested.

A tough nut to crack: Reconstructing diet and interpreting feeding adaptations in early hominins.

DAVID S. STRAIT. Department of Anthropology, University at Albany.

Key questions in paleoanthropology include "What were the diets of early hominins?" and "Why did early hominin feeding adaptations evolve?" Although these questions appear to be redundant, they are different in important ways. This poster reviews the types of data used to address these questions (microwear, isotopes, functional anatomy). It is observed that: 1) australopith facial form is well adapted to withstand loads associated with premolar bites on large objects, 2) australopith postcanine occlusal morphology is well adapted for fracturing "hard" stress-limited foods, but poorly adapted for fracturing tough, displacement limited foods, 3) most early hominins do not preserve microwear evidence

of hard-object feeding, but neither microwear nor isotopic analyses are capable of falsifying the hypothesis that hard objects were selectively important components of their diets, 4) tough foods may have been frequently consumed by some early hominins, and 5) australopith species that appear to be functionally similar may have differed substantially with respect to the foods that they most frequently consumed. A synthesis of these data yields conclusions that, in certain cases, are unexpected, including: 1) early hominins were dietary generalists capable of shifting their diets to fit local ecological conditions, 2) large, hard-object feeding may have been a rare behavior, but remains the best explanation for the evolution of australopith craniodental form, 3) some hominins were poorly adapted to consume foods that were routinely eaten by them, and 4) hominins that regularly relied on tough foods may have been living in habitats that they would have considered marginal. This study was funded by the National Science Foundation Physical Anthropology HOMINID program (NSF BCS 0725126).

Was the high morphological diversity of recent Native South Americans present among the first inhabitants of the continent?

ANDRÉ STRAUSS¹, MARK HUBBE², TATIANA NUNES¹ and WALTER A. NEVES¹. ¹Laboratory for Human Evolutionary Studies, Department of Genetics and Evolutionary Biology, Universidade de São Paulo, ²Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica Del Norte.

Recent South Americans have been described as presenting high regional morphological diversity. Distinct hypothesis have been proposed to explain the origin of this high diversity of Native South Americans, among which: 1) the observed diversity is the result of distinct human dispersion waves coming into the continent during the Holocene; 2) the diversity was already present in the ancestral population of Early Americans located in East Asia or Beringia; or 3) local microevolutionary processes during the Holocene are the main source of origin of recent diversity. To decide among those alternatives is crucial to investigate if this high diversity can be found among Early South American samples. Regional diversity was measured through Fst estimates and mean within-group variance of Early population samples from Central Brazil (n=29) and Colombia (n=14) dated to Late Pleistocene/Early Holocene. The results were compared to results obtained for Howells series representing recent populations of six regions of the planet, including Americans. They show that, although recent Americans present high diversity, as previously described, Early Americans present much lower regional diversity, comparable to what is observed in Australo-Melanesia and Sub-Saharan Africa. This favors the idea that the observed recent diversity of Americans was not present in the first South-Americans and must have been originated after the settlement of the continent, either due to subsequent waves of human

dispersion into the continent or through local microevolutionary processes. This study was funded by FAPESP (04/01253-0; 07/51947-7; 08/51747-0) and FONDECYT (11070091).

A preliminary biocultural analysis of hereditary tooth decay among isolate populations in the northeastern Missouri Ozarks.

DAWN C. STRICKLIN¹, ROBERT S. CORRUCCINI¹ and SUSAN M. FORD¹. ¹Department of Anthropology, Southern Illinois University-Carbondale.

The purpose of this research was to determine whether or not excessive inbreeding is responsible for the disproportionate dental decay within the Northeastern Missouri Ozarks. Inbreeding can lead to higher frequencies of certain traits. The term, "inbreeding" is often used to describe isolate populations, and is a description often heard in reference to people of the Missouri Ozarks. The residents in the area display an unusual amount of dental caries, and a large percentage of the population wears dentures. This region was largely isolated from the rest of the United States until the mid-1950s. Locals suggest that excessive lead pollution may be the reason for the poor dental health that persists in the area.

A holistic approach was attempted that examined both biological and cultural factors in an effort to determine possible causes of tooth decay and premature dental loss in the area. An assessment of a sample of the population's dentition was made using ethnographic interviews, dental genograms, dental formulas, genealogy, and historical and archival research. A combination of these methodologies reveals that the cause of the declining dental health in the region is not due solely to excessive intermarriage. Rather, the reasons for dental decay are conflated by a variety of interrelated forces of independent agency, including possible lead contamination of water sources, geographic isolation, and lack of dental services. These results suggest that dental anthropology can be enhanced by the use of an interdisciplinary approach to research.

New research on the Iwo Eleru cranium from Nigeria.

CHRIS STRINGER¹, KATERINA HARVATI², PHILIP ALLSWORTH-JONES³, RAINER GRÜN⁴ and CALEB ADEBAYO FOLORUNSO⁵. ¹Dept of Palaeontology, The Natural History Museum London, UK, ²Dept of Early Prehistory and Quaternary Ecology, Eberhard Karls Universität Tübingen, Germany, ³Dept of Archaeology, Sheffield, UK, ⁴Research School of Earth Sciences, Australian National University Canberra, Australia, ⁵Department of Archaeology & Anthropology, University of Ibadan, Nigeria.

The Iwo Eleru skeleton was excavated from the Iwo Eleru rock shelter in 1965 by Thurstan Shaw and his team. This contracted burial was found in a level with Late Stone Age artefacts, and a radiocarbon determination on associated charcoal gave an age of $11,200 \pm 200$ BP. The

poorly preserved skeleton was of an adult and probably male individual, and the skull was reconstructed and studied by Brothwell (Brothwell and Shaw, 1971, *Man* 6: 221-227). He linked the skull to recent West African populations, but recognized that its lower vault and frontal profile were unusual. He also supplied cranial data for a Principal Components Analysis performed by Peter Andrews, and noted that this placed the specimen apart from recent African samples. Stringer included the Iwo Eleru cranium in univariate and multivariate (Canonical Variates, Generalised Distance) analyses for his doctoral thesis, completed in 1974. His results highlighted apparent archaic aspects in the specimen in its long and rather low cranial shape, and although modern overall, it also resembled fossils such as Omo Kibish 2 and Ngandong in certain respects. New studies using a primary replica of Brothwell's reconstruction have now been carried out by Harvati, employing geometric morphometrics to generate PCA, CVA, Procrustes Distance and Minimum Spanning Tree analyses of the specimen, and further dating of the skeleton is also underway. The new morphometric studies confirm the relatively archaic shape of the vault, suggesting that this Late Stone Age West African was markedly different from succeeding populations. This research is supported by the Max Planck Gesellschaft and the "EVAN" Marie Curie Research Training Network MRTN-CT-019564.

Stature estimation from cranial measurements in archaeological and modern populations of Switzerland.

CATHERINE STUDER¹, FRANK SIEGMUND², GERALDINE D' EYRAMES¹, VIVIANE ROTH¹, ALEXANDRA WENK¹ and CHRISTINA PAPAGEORGOPOLOU¹.
¹Archaeological Service Graubünden, Switzerland, ²Seminar für Ur- und Frühgeschichte, University of Basel, Switzerland.

Stature estimation from skeletal remains is of primary interest to a broad field of scientists e.g. anthropologists, forensics. However many of the existing stature estimation formulas are not applicable to poorly or partially preserved skeletal material. The aim of the present study was to investigate the possibility of estimating stature from craniometric data of 637 skulls found on a Swiss alpine ossuary (Poschiavo, 17th-19th c. AD). For this purpose we applied existing regression equations for stature estimation from craniometrics (Chiba and Terazawa, 1998; Ryan and Bidmos, 2007; Krishan, 2008; Kalja et.al., 2008) to completely preserved skeletal material geographically and chronologically similar to the investigated skulls. The results were poor and they mostly reflected the mean stature of the reference samples, significantly reducing the intrapopulation variability. A better approach was developed by systematically selecting similar reference series to the target sample by the sum of Euclidean distance of the cranial measurements. The individual stature is then estimated as a mean based on the ratios between stature and cranial measurements (seven

variables) of the reference sample. The results show less attraction to the mean of the reference population and plausible intrapopulation variability. We tested the specific method on a large scale of complete preserved skeletal remains (ca. 1500 individuals) with positive outcomes. Although stature estimation from cranial measurements cannot be so accurate to that obtained from intact long bones, we propose a new method applicable on partially preserved skeletal material useful within a bioarchaeological or a medico-legal context.

Comparative primate vaginal microbial ecology.

REBECCA M. STUMPF¹, SULEYMAN YILDIRIM¹, STEVE LEIGH¹, ABIGAIL SALYERS¹, BRYAN A. WHITE¹, MITCH IRWIN², TONY GOLDBERG³, SUSAN ALBERTS⁴, JEANNE ALTMANN⁵ and BRENDA A. WILSON¹. ¹Institute for Genomic Biology, University of Illinois, Urbana-Champaign, ²McGill University, ³University of Wisconsin, Madison, ⁴Duke University, ⁵Princeton University.

Host-microbe interactions profoundly affect primate physiology, reproduction, health, survival and ultimately, evolution. Because females are central to population viability and because the reproductive tract microbiome has the potential to influence female health, fecundity and pregnancy outcomes, understanding of both the variation in primate vaginal microbial ecologies and the factors (e.g. socio-ecological, sexual, morphological, or genetic) which influence microbial variation is crucial to understanding patterns of primate host-microbe relations.

To gain a preliminary understanding of vaginal microbial community compositions, we analyzed vaginal swab samples from four primate species: yellow baboons (*Papio cynocephalus*), olive baboons (*P. anubis*), sifakas (*Propithecus diadema*), and red colobus monkeys (*Piliocolobus badius*), using direct sequencing analysis of 16S rDNA clone libraries. Sample pyrosequencing outputs

were run through RDP classifier (70% bootstrap threshold) to assess the distribution of phylotypes across primates and obtain an initial picture of microbial community structure and diversity. Results indicate that *Firmicutes* and *Bacteroidetes* are the most common genera across all four species, though a substantially greater proportion of unclassified microbes (36% vs 0-13%) and a more diverse microbial community composition were found among the sifakas than any of the Old World monkeys. The inclusion of additional species will help to test hypotheses for the significance of phylogenetic, reproductive and morphological factors in explaining patterns of microbial community composition and interactions with their primate hosts. The authors wish to thank the University of Illinois, the UIUC Institute for Genomic Biology, and the National Science Foundation.

Quantitative analysis and functional significance of subchondral and cancellous bone micro-architecture in the hominid hind foot.

ANNE SU. Interdepartmental Doctoral Program

in Anthropological Sciences, Stony Brook University, Department of Biomedical Sciences, Ohio University College of Osteopathic Medicine.

Differences in patterns of subchondral bone density and in cancellous bone architecture quantified from computed tomography images have been independently hypothesized to reflect differences in habitual joint loading among animals. This study assesses the mutual consistency of these two morphological indicators of bone strength in the hominid hind foot and their potential utility in inferring locomotor behavior from isolated skeletal elements. Associated sets of distal tibia, talus, and calcaneus from museum specimens of modern *Homo*, *Gorilla*, *Pan*, *Pongo*, and *Papio* were µCT scanned at 46µm isometric resolution. The subchondral bone layer of each articular surface was isolated from the cancellous bone, segmented into anatomical regions, and the distribution of high-attenuating (radiodense) voxels within each region was quantified using *Amira* software. The bone volume fraction and trabecular structure of the cancellous bone underlying each articular region were quantified using *Quant3D* software. The results from the modern human sample show high subchondral bone radiodensity in articular regions that are consistent with those found by experimental studies to have high contact stress during bipedal walking. The cancellous bone underlying these regions are also found to display high bone volume fraction and trabecular thickness, supporting the hypothesis that both subchondral bone density and cancellous bone morphology are congruent indicators of compressive bone strength. Comparisons among the extant hominid samples reveal species-specific patterns of subchondral and cancellous bone properties consistent with differences in locomotor behavior. This study is supported by NSF DDIG (BCS-0824571), the Wenner-Gren Foundation, and the Leakey Foundation.

3D automatic methods to segment "virtual" endocasts: state of the art and future directions.

GERARD SUBSOL¹, GILLES GESQUIERE², JOSE BRAGA³ and FRANCIS THACKERY⁴. ¹Lab. of Computer Science LIRMM, CNRS/University Montpellier 2, France, ²Lab. of Computer Science LSIS, Aix-Marseille University, France, ³Lab. of Anthropobiology AMIS, University Paul Sabatier, Toulouse, France, ⁴Institute for Human Evolution, University of the Witwatersrand, South Africa.

Computer Tomography (CT) is now widely used to analyze the cranial inner features. A crucial step consists in delineating precisely the endocranial surface in 3D images. This procedure, called segmentation, can be performed manually but it is tedious in the case of accurate CT acquisitions (hundreds of slices) and it remains very dependent to the operator's experience and expertise. Several image processing methods as thresholding or region-growing (Schoenemann et al., 2006) have been proposed to assist the operator but they require a

manual interaction to be initialized or to tune parameters. Biomedical software as Mimics (Falk et al., 2007) or Amira (Specht et al., 2007) is currently used but it is not well adapted to fossil images where the contrast of the fossilized bone or the filling matrix may be low or variable. Recently, some researchers (Neubauer et al., 2004) propose to “warp” a reference endocranum surface to fossil data but this requires locating landmarks which is a complex and operator-dependent task. We propose a new method which is also based on such a template. The reference endocranum surface is automatically deformed to fit the interface of the bony parts in the 3D image, while keeping its initial and smooth shape. We performed preliminary experiments on 3D images of chimpanzee and Modern Man skulls and compared the results with segmentations obtained under the supervision of an anatomist. We also applied the method on STS5 (*Australopithecus africanus*) and analyzed the accuracy of the result. Research supported by the French Center for Scientific Research (PEPS-ODENT Project), the French Institute for Research in Computer Science and Control (3D-MORPHINE Concerted Research Action) and the HOPE (Human Origins and Past Environments) International Programme funded by the French Embassy in South Africa and the National Research Foundation (South Africa).

The lumbar vertebrae of the Middle Miocene stem great ape *Pierolapithecus catalaunicus* (Primates: Hominidae).

IVETTE SUSANNA¹, DAVID M. ALBA¹, SERGIO ALMECIJA¹ and SALVADOR MOYA-SOLA². ¹Institut Català de Paleontologia, Universitat Autònoma de Barcelona. Edifici ICP, Campus de Bellaterra s/n, 08193 Cerdanyola del Vallès, Barcelona, ²ICREA at Institut Català de Paleontologia and Unitat d'Antropologia Biológica (Dept. BABVE), Universitat Autònoma de Barcelona. Edifici ICP, Campus de Bellaterra s/n, 08193 Cerdanyola del Vallès, Barcelona.

We provide a description and functional interpretation of the two lumbar vertebrae of the stem hominid *Pierolapithecus catalaunicus* from Barranc de Can Vila 1 (BCV1; Catalonia, Spain; ca. 11.9 Ma), which belong to the holotype (a partial skeleton) of this taxon. The most complete specimen (IPS21350-64) is a lower middle vertebra, while the other one (more incompletely preserved; IPS 21350-65) corresponds to a last lumbar vertebra. A body mass of ca. 30 kg can be estimated for this individual on the basis of published allometric equations and several measurements taken in IPS21350-64. The morphological and morphometric study of these vertebral specimens shows that, despite the retention of some plesiomorphic features (shared with stem hominoids from the Early and Middle Miocene), *Pierolapithecus* shares a set of derived features with extant great apes: neural process caudally oriented; robust pedicle; dorso- and ventromedially oriented zygapophyses; lack of styloid processes (at least, functional ones); lack of vertebral wedging; lack of ventral keel; vertebral body relatively wide mediolaterally

and shallow dorsoventrally; quite dorsal origin of the root of transverse processes; and coplanar and dorsal orientation of the transverse processes. Preliminary allometric studies further suggest quite modern vertebral proportions. To sum up, the lumbar vertebral morphology of *Pierolapithecus* agrees with other skeletal elements, indicating that it is one of the earliest orthograde hominoids. Further research is required in order to decipher whether orthograde is a crown-group hominoid synapomorphy or a convergent bodyplan independently acquired by lesser and great apes. This work has been supported by the Spanish Ministerio de Ciencia e Innovación (CGI.2008-00325/BTE), the Generalitat de Catalunya (Grup de Paleoprimatología i Paleontología Humana, 2009 SGR 754, GRC; predoctoral fellowship 2006 FI 00065), and the National Science Foundation (NSF Award #BCS-0321893).

Asymmetry in *Saguinus oedipus* limb bone dimensions.

ADAM D. SYLVESTER. Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology.

Human limb bone articulation sizes are thought to be more symmetric between sides than bone lengths or diaphyseal breadths. It remains unclear, however, if this pattern is unique to humans or if it characterizes primates in general. Here the non-directional asymmetry of articular dimensions, maximum lengths and diaphyseal breadths are assessed in a sample of cotton-top tamarins (*Saguinus oedipus*) upper and lower limb bones. Twenty-four dimensions were measured on the left and right femora, tibiae, humeri and radii of 20 *S. oedipus* skeletons curated at the University of Tennessee, Department of Anthropology. All dimensions were measured a second time to estimate measurement error. A mixed-model ANOVA (with ‘individual’ as the random effect and ‘side’ as the fixed effect) was used to partition out the contribution of measurement error to the total non-directional asymmetry for each measurement. Only those dimensions with significant ANOVA for the interaction of ‘side’ and ‘individual’ were retained for further analysis.

Variance attributed to measurement error was subtracted from total asymmetry variance for each dimension. The square root of the remaining variance was then divided by the sample mean of that dimension to create a coefficient of variation of asymmetry. A consistent ranking of dimension types was found within each of the four limb bones. Lengths had the lowest coefficient of variation of asymmetry, followed by articulations and diaphyseal breadths. These results suggest that lengths, not articular dimensions, may be the most symmetric in non-human primate limb bones, which is distinct from the human pattern.

Shape correlation within and across Plio-Pleistocene hominin lower limb elements.

MELISSA TALLMAN^{1,2} ¹City University of New York; ²New York Consortium in Evolutionary Anthropology.

Inferences about locomotor patterns of Plio-Pleistocene early hominins rely entirely upon evidence collected from postcranial fossils. Many of these fossils are fragmentary and unassociated and are therefore excluded from analyses. Additionally, there are sometimes conflicting results from studies using different postcranial elements to make inferences about locomotor patterns. This study uses three dimensional geometric morphometrics to investigate how inferences about locomotor patterns can change based on the bone(s) analyzed, by examining the femur and tibia. Additionally, when possible, data from the femur and tibia are combined to look at patterns of covariance in the hindlimb. Three dimensional data were collected on a modern sample consisting of 78 *Gorilla*, 16 *Pongo*, 88 *Pan*, and 86 *Homo* specimens and a fossil sample consisting of 17 proximal femora, 17 distal femora, 17 proximal tibiae and 14 distal tibiae spanning the interval from 3.8-1.0 Ma. These data were subjected to a generalized procrustes analysis and standard multivariate analyses. The different anatomical areas analyzed yielded markedly different results. The proximal tibia was the least useful in these functional analyses and was only moderately able to recover the differences between modern taxa. The distal tibia and proximal femur both show a fully bipedal pattern emerging very early in the hominin lineage, whereas some of these fossils retain a more primitive pattern for the distal femur. A two-block partial least squares analysis indicates that some of the earliest fossils have a unique pattern of shape covariation in the lower limb.

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Jaw-muscle fiber architecture in tufted capuchins favors generating relatively large muscle forces without compromising jaw gape.

ANDREA B. TAYLOR^{1,2} and CHRISTOPHER J. VINYARD³. ¹Department of Community and Family Medicine, Duke University School of Medicine, ²Evolutionary Anthropology, Duke University, ³Department of Anatomy and Neurobiology, NEUCOM.

Cebus apella differs from other capuchins in displaying craniodental features that have been functionally and adaptively linked to their dietary flexibility and capacity to exploit hard and tough foods. We compared masseter and temporalis fiber architecture between *C. apella* (n=12) and two “untufted” capuchin species (*C. capucinus*, n=3; *C. albifrons*, n=5). We tested the hypothesis that tufted capuchins exhibit architectural properties of their jaw muscles, including relatively greater physiologic cross-sectional areas (PCSA) and more pinnate fibers, that facilitate relatively large muscle forces. *C. apella* has relatively greater superficial masseter and temporalis PCSAs, significantly so only for the temporalis. Capuchins do not differ significantly in pinnation angle. As an architectural trade-off between maximizing muscle force and excursion, we also predicted that *C. apella* exhibits relatively shorter muscle

fibers. Contrary to our prediction, capuchins do not differ in relative fiber lengths. Therefore, we attribute relatively greater PCSAs in tufted capuchins primarily to their larger muscle masses. By enlarging jaw-muscle mass to increase PCSA, rather than reducing fiber lengths and increasing pinnation, tufted capuchins increase jaw-muscle and presumably bite forces without markedly compromising muscle excursion. One performance advantage of this morphology is that it promotes relatively large bite forces at wider jaw gapes, which may be useful for processing large and potentially hard/tough foods, along the posterior dentition. We argue that in addition to material properties, the size of primate foods will play a role in determining how fiber lengths, pinnation and/or muscle mass change to increase PCSA for breaking down hard objects. This study was funded by the NIH (R24 HD050837-01) and NSF (BCS-0452160 and BCS-0552285).

Cross-cultural cognition and reasoning strategies in a group of Tibetan Buddhist monks.

NICOLE D. TAYLOR. Department of Anthropology, Emory University.

Ascertaining whether human perception and cognition is variable across cultures has important implications for theories of human cognitive evolution, studies of non-human primates and anthropological theory. Much of the current understanding of human cognition has been based on studies of American college students and most cross-cultural research employs an east/west dichotomy usually comparing Americans with East Asians. Differences between these two groups have largely been ascribed to differences in social systems. Eastern collectivist societies are said to yield holistic cognitive styles whereas Western individualist societies are said to yield analytic cognitive styles.

This study aims to determine whether Tibetan Buddhist monks fit into the established east/west dichotomy in terms of cross-cultural cognition. The Tibetan Buddhist monastic community constitutes a unique population that may have the social elements of East Asian populations and the intellectual elements of Western populations, which should result in a combination of cognitive strategies.

Reasoning strategies were evaluated using two tasks originally developed by Norenzayan and colleagues (2002), a categorization task and a deductive reasoning task. As hypothesized, Tibetan Buddhist monks demonstrate a combination of strategies that incorporates some aspects of western analytic reasoning and some aspects of eastern holistic reasoning. This study helps to further our understanding of the variation and/or conservation of human cognition across human populations, a necessary step for developing theories of human cognitive evolution. The complete array of human cognitive strategies must be considered in order to determine our evolutionary past and understand our current similarities and differences.

The dental microwear of hard-object feeding in laboratory primates.

MARK F. TEAFORD¹, PETER S. UNGAR², CALLUM F. ROSS³ and CHRISTOPHER J. VINYARD⁴. ¹Center for Functional Anatomy & Evolution, Johns Hopkins University School of Medicine, ²Department of Anthropology, University of Arkansas, ³Department of Organismal Biology & Anatomy, University of Chicago, ⁴Department of Anatomy and Neurobiology, NEUOCOM.

Dental microwear analyses have grown to become a standard part of paleobiological research, given the proper preservation of decent samples of fossil teeth. However, many interpretations are ultimately based on correlations between observed patterns of microwear variation and published differences in diet. In other words, there have been very few longitudinal studies of dental microwear formation. Recently, Strait et al. (2009) suggested that some molar microwear dietary inferences may be limited because some stages of food-processing take place more anteriorly along the tooth row, leaving much of the microwear of interest on the premolars. To begin to test this hypothesis, dental impressions were taken from captive capuchin monkeys (*Cebus apella* and *Cebus* sp.) at the University of Chicago and the Northeastern Ohio Universities College of Medicine. Baseline impressions were taken using the techniques of Teaford and Oyen (1989). All animals were then fed one of their standard research food items, brazil-nuts, *ad libitum* before follow-up impressions were immediately taken.

Initial results indicate that the brazil nuts left a complex microwear signature on the teeth, with microscopic pits and scratches formed all along the dental arcade, including incisors, premolars, and molars. This was not surprising, as the sound of cracking of hard pieces could be heard during chewing in the molar region. This is another indication that, while hard objects may indeed be ingested at the front of the mouth, hard and abrasive pieces still reach the molars during mastication.

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Wimpy males and formidable females: Testosterone levels in *Propithecus edwardsi*.

STACEY TECOT^{1,3}, SARAH ZOHDY^{3,4}, STEPHEN J. KING⁵, JUKKA JERNVALL^{1,4} and PATRICIA C. WRIGHT^{2,5}. ¹Department of Ecology and Evolution, Stony Brook University, ²Centre ValBio, Ranomafana, Madagascar, ³Institute for the Conservation of Tropical Environments, Stony Brook, New York, ⁴Institute of Biotechnology, University of Helsinki, Finland, ⁵Department of Anthropology, Stony Brook University.

Malagasy primates are monomorphic and females have a host of traits typically considered male. For instance, Milne Edwards' sifakas (*Propithecus edwardsi*) are female dominant, lack sexual size and color dimorphism, and females have masculinized

genitalia. To determine whether testosterone plays a role in female lemur development, we compared testosterone levels in wild male and female *P. edwardsi*. We predicted that monthly testosterone levels would not differ between males and females. We collected 416 fresh fecal samples (249 male, 167 female) from 5 groups in the rainforest of Ranomafana National Park, Madagascar between September, 2007 and January, 2009 ($n_{months}=14$, March and August, 2008 and February, 2009 excluded due to small sample sizes). Ethanol:water extractions were followed by solvolysis and celite chromatography, and testosterone levels were measured in 50 microliters of sample by enzyme immunoassay. Because individual baseline levels may vary, and steroids may fluctuate seasonally, we averaged monthly testosterone levels for each individual and used Mann Whitney-U tests to compare male and female testosterone levels each month (≥ 5 females, 6 males per month). As predicted, testosterone levels did not differ between males and females, except in December, 2007 ($z=-2.452$, $p<0.01$) and October, 2008 ($z=-2.298$, $p<0.05$), when male testosterone levels were higher. These results differ from those for ringtailed lemurs (*Lemur catta*), where males had higher testosterone levels (Drea, 2007), and suggest that (1) testosterone is likely involved in *P. edwardsi* female masculinization and social dominance, and (2) masculinization occurs through different pathways than that in *L. catta*. This research was funded in part by the NSF BCS 721233.

Spondylolysis in Late Byzantine Priene (Turkey).

WOLF-RUDIGER TEEGEN¹. ¹Institute of Prehistory, University of Leipzig (Germany).

The ancient city Priene (Turkey) was excavated by German archaeologists between 1895 and 1898 (Wiegand & Schrader 1904). Since 1998, a team from the University of Frankfurt and the German Archaeological Institute at Istanbul is continuing the excavations (Raack 2008). Several late Byzantine burials were discovered: in the temple of the Egyptian Gods (AEG), the Agora chapel (AK) and the south complex (SK). Totally, a MNI of 30 individuals (17 adults and 13 subadults) from the AEG, AK and SK sites were studied from a paleopathological point of view. Two cases of spondylolysis of the fifth lumbar vertebra (L5) from the AEG area and one from the SK area were discovered. Totally, 3 out of 12 individuals with a preserved L5 are showing spondylolysis; they are belonging to males between 20 and 50 years of age. Only in one case, the vertebral arch is still preserved. In one individual the L5 has been slipped approx. 5 mm ventrally. This indicates a slight spondylolisthesis. All individuals with spondylolysis are showing severe degenerative joint disease (DJD) of the lumbar vertebral bodies, indicating heavy physical load and – probably – lower back pain. It is striking that the individuals buried inside the Agora chapel which probably belonged to a higher social class, are showing neither spondylolysis nor severe DJD. Due to severe DJD in the present cases, it seems more likely that spondylolysis

originated in physical stress of the lumbar and sacral vertebrae. A genetic origin, can, however, not fully be excluded.

The study was funded by the German Archaeological Institute.

Allometric and ecogeographic limb growth among Late to Final Jomon period foragers from Japan.

DANIEL H. TEMPLE¹ and KENJI OKAZAKI².

¹Department of Anthropology, University of Missouri, Columbia, ²Graduate Institute of Anatomy and Cell Biology, National Taiwan University.

This study reconstructs the relative growth of limbs among prehistoric foragers from the Late to Final Jomon period (4000 – 2300 BP) using bi- and multivariate analyses. Relative growth of intralimb indices and principal components analysis (PCA) of log size/shape and log shape data were applied to Jomon limb lengths to reveal developmental patterning. Allometric growth coefficients were calculated for log size/shape data. Jomon samples (.807) have significantly greater slopes for the brachial index when compared to warm (.759) and cold (.700) adapted foragers. Intermediate slopes for crural indices are observed among Jomon samples (.833) when compared to warm (.864) and cold (.778) adapted foragers. Jomon brachial indices decline significantly following birth, remain consistent through childhood/juvenility, and increase before adolescence. Jomon crural indices decline significantly after birth, remain consistent through childhood/juvenility, and increase between adolescence/adulthood. Allometric coefficients calculated from PCA of log size/shape data indicate negative allometry for arm length (humerus = .86, radial = .698) and positive allometry for leg length (femur = 1.28, tibia = 1.05), with proximal limbs growing faster than distal. The first principal component of the log shape data is a growth vector ($r = .88$), with the second principal component contrasting brachial/crural indices. These indices decline following infancy and increase in adolescence similar to the bivariate analyses. Declines in brachial and crural indices following infancy are associated with increased growth rate of proximal limbs following birth. Increases in intralimb indices during adolescence reflect exposure to warm environments during the Holocene megathermal.

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Dietary influences over temporomandibular joint shape.

CLAIRE E. TERHUNE. Department of Community and Family Medicine, Duke University School of Medicine, School of Human Evolution and Social Change, Arizona State University.

Previous analyses of the masticatory apparatus have demonstrated that the shape of the temporomandibular (TMJ) is functionally and adaptively linked to variation in feeding

behavior and diet in primates. The research presented here further hypothesizes that TMJ morphology covaries with documented differences in food material properties, use of the anterior or posterior dentition during ingestion and mastication, and jaw gape. To evaluate this hypothesis, I used 2D and 3D morphometric methods to quantify TMJ shape across a broad sample of 48 anthropoid primates, and more narrowly among small groups of closely related taxa with documented dietary differences. Nonparametric methods were used to test for significant differences in TMJ shape between comparative groups, and correlations among variables were examined across the entire sample. Results indicate that some aspects of TMJ shape covary with documented differences in masticatory function. In most of the comparative groups examined, taxa with more mechanically demanding diets separated in morphospace from taxa with less demanding diets, indicating an association between TMJ form and diet. Features that varied most consistently among taxa were joint surface area, condylar width, and entoglenoid process height. Strong correlations were found between anteroposterior glenoid length and measures of gape, which is consistent with previous studies suggesting that gape increases can be achieved via increased translation at the TMJ. While results suggest that TMJ shape can be associated with known variation in food material properties and gape, the association between features of the TMJ and use of the anterior vs. posterior dentition remains unclear.

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Cross-cultural comparison of upper limb asymmetry in adults and juveniles from the Archaic period of the American Southeast.

GEOFFREY THOMAS. Department of Anthropology, Florida State University.

According to Wolff's law, bones alter their internal and external structures in response to mechanical loads from the environment. The types of bone remodeling and subsequent expression of robusticity and asymmetry, constantly change throughout an individual's lifetime. The nature of these biological changes depend on multiple variables, including the stage of the life course, the habitual usage of the limb, the type of remodeling (micro/macro structural) being examined, and the location on the body. Each of these factors has a dramatic influence, not only on the amount of robusticity and asymmetry expressed, but also on the process of remodeling. The upper limbs are the focus of many studies due to their non-weight bearing nature and their often dramatic responses to mechanical loads, particularly during prepubertal stages. This preliminary study examines upper limb dimensions of adults and juveniles from the Pickwick Basin ($N = 146$), Indian Knoll ($N = 302$), and Windover ($N = 83$) Archaic populations. These samples are known to be atlatl hunter-gatherers that exploited marine resources. In the absence of

marked nutritional or activity differences, it is expected that these populations would exhibit little to no differences in asymmetry across age cohorts. However, initial findings document more differences in direct asymmetry, particularly in diaphyseal dimensions, than expected. Further study of cross-sectional geometries is needed to elucidate the character of differences within and between these populations.

Monogamous and non-monogamous mating behavior in white-faced saki monkeys (*Pithecia pithecia*).

CYNTHIA L. THOMPSON. Department of Anthropology, Kent State University.

White-faced sakis display varying social arrangements from one-male one-female units to small multi-male multi-female groups. Whether these groups actually represent monogamous or small polygamous mating systems has heretofore remained unclear. Grouping and sexual behavior from three white-faced saki groups at Brownsberg Naturepark, Suriname over 17 months of data collection are presented. All occurrence sampling of copulations ($n=72$) and behaviors preceding copulation (most often genital sniffing, $n=120$) was conducted. All observed mating occurred within groups, and ranged from monogamous to polygamous, depending on the group. In the group in which polygamous mating occurred, females ($n=2$) mated with sexually active males ($n=2$) equally. The majority of copulations in all groups were peaceful (88.8%), however 9.7% of copulations were interrupted (by a male ($n=3$), female ($n=1$) or an infant ($n=3$)), as well as one additionally attempted, but unsuccessful interruption by a male. 3 cases were observed in which copulation was prevented entirely via interruption from an infant. Furthermore, one instance of male-male aggression directly related to copulation was observed, as well as two cases of male to female aggression (possibly sexual coercion). This represents the most complete study of white-faced saki mating behavior yet published. Given these data white-faced sakis, as has been shown for other species, display variation in mating systems which may depend upon mating opportunities available within a group. It is also suggested that individuals in polygamous groups may attempt to behaviorally influence mating behavior of other group members.

Looking for life in Lost City: limits and latitudes of working with small samples.

JENNIFER THOMPSON and DEBRA MARTIN. Department of Anthropology, University of Nevada, Las Vegas.

Lost City represents a conglomerate of Virgin Anasazi sites located along the eastern side of the Muddy River in S. Nevada (AD 500-1250). Interpretation of these sites is complicated because artifacts, documentation, and human remains were split among a variety of repositories and individuals over several decades, making them difficult to access. For example, of 200 human burials initially

recovered only 37 could be located for study and repatriation. When working with small and biased museum samples, individuals become the focus. Limited but important data can be obtained from small sub-sets of larger populations. By careful examination of the biases (i.e., in what ways is this population not representative of a real community?) and comparisons with other less biased collections, broad statements about health and lifestyle can be inferred. For example, analysis of pathologies and musculo-skeletal markers indicate that all adults were working at full capacity and sustaining wear-and-tear degeneration on their joint systems. Sixteen percent of the sample sustained non-lethal but significant trauma. Dental wear patterns did not conform to a single subsistence strategy – a finding supported by archeological data indicating a mixed economy. As part of NAGPRA compliance, it is useful to attempt synthesis and interpretation to the extent that is possible. Although the study is limited by small sample size, and old and incomplete excavation data, these human remains provide important insights into ongoing research questions regarding the Virgin Anasazi. Research funded by the National Park Service's Lake Mead National Recreation Area.

Trochanteric geometry as a subadult activity marker.

TRACEY TICHNELL. Department of Anthropology, Michigan State University.

Activity studies rely primarily on nonmetric traits, such as enthesopathies, with only cross-sectional geometry to provide a metric counterpart. Traction epiphyses offer an alternative as they do not bear weight and act primarily as attachment points for tendons. As bones grow, muscles can elongate these tuberosities, such as in the extreme case of Osgood-Schlatter disease. Size differences, that may result from performing a habitual activity during growth, can be detected by measuring these tuberosities in relation to a fixed point on their associated diaphysis and comparing this to a baseline. This study uses the greater and lesser trochanters, both traction epiphyses with limited muscle attachments, on two Mongolian test samples (a Xiongnu and a Mongol sample) to determine if differences are detectable. These two test samples were used as their populations lived in the same terrain, ate the same diet and all evidence points to the Mongol sample being directly descended from the Xiongnu sample, limiting genetic differences between them. Measurements were taken between three points on the proximal femur to form a triangle: the most proximal tip of the greater trochanter, the base where it transitions into the diaphysis, and the tip of the lesser trochanter. Trigonometry was used to determine the angles in these triangles. As angles do not change regardless of scaling, these angles were then compared to a baseline directly to determine if they differed. The geometry of the trochanters changes over time for both males and females, suggesting differing subadult activities in these two cultures.

Where are the warriors? Cranial trauma patterns and conflict in the Maya realm.

VERA TIESLER¹ and ANDREA CUCINA¹.

¹Facultad de Ciencias Antropológicas, Universidad Autónoma de Yucatán, Mérida, Yucatán, México.

This paper explores cranial trauma patterns in skeletal series recovered from 34 well documented Classic and Postclassic period Maya sites. We pose that different forms of organized inter-personal violence and weaponry use should leave distinctive traces and distribution patterns in the skeletal population and their archaeological contexts from which they derive. We confront urban vs. rural settings and different chronological and contextual situations (high vs. low vs. non-funerary status). We explore specifically the possibility of prior warrior/ captive status of the worked “trophy skulls” placed in caches, ritual trash areas and tomb burials and those recovered from ritual depositories in sink holes believed to be post-sacrificial. Our general results reveal similar frequencies (around 7%) and anatomical distributions of blunt force trauma in women and men from common burial contexts. These frequencies are lower than those encountered in pre-Columbian Andean world. However, within the overall Maya cohort, significant differences in the type of lesions are evident when high status burials are compared to low status burials and those from non-funerary contexts, like those assemblages pertaining to worked “trophy-heads” and others, recovered from the Sacred Cenote of Chichen Itzá. These differences point to the presence of warriors mostly in the latter contexts and provide clues as to the degree and form of organization of violent conflicts. Differences are evident also when time periods are confronted, showing a slight peak during the Terminal Classic period, which well reflects the well-known historical situation which the Maya experienced during times of political and social breakdown.

A possible cause of incongruence between molecular and morphological hypotheses of primate phylogeny.

MATTHEW A. TORNOW¹ and RANDALL R. SKELTON².

¹Saint Cloud State University, St. Cloud, MN, ²University of Montana.

When molecules and morphology produce incongruent hypotheses of primate relationships, the data are typically viewed as incompatible. Under these circumstances, molecular hypotheses are often retained as better indicators of phylogenetic history, particularly when multiple lines of molecular evidence support the same tree, and the utility of morphological characters may be rejected. However, it has been demonstrated that including fossil taxa in morphological analyses alters interpretations of character order and polarity and positively influences tree topology so that relationships between extant taxa are consistent with those found using molecular data. Thus, the source of incongruence between morphological and molecular trees may lie not in the morphological data themselves but in

assumptions surrounding character behavior and their impact on cladistic analysis.

In this study, we investigate the role that assumptions about character polarity and transformation order play in creating incongruence between primate phylogenies based on morphological data and those supported by multiple lines of molecular data. By releasing constraints imposed on published, morphological analyses of primates from disparate clades and subjecting those data to parsimony analysis in PAUP* 4.0b10, we test the hypothesis that incongruence between morphology and molecules results from inherent flaws in morphological data. We find that releasing *a priori* constraints on character behavior often produces trees that are consistent with molecular trees. Case studies are presented that illustrate how congruence between molecules and unconstrained morphological data may provide insight into issues of polarity, transformation order, homology, and homoplasy – considerations that may prove valuable in analyses of extinct primate relationships.

The isotopic identification of pre-Hispanic sacrificial victims from Huaca de la Luna, Peru, using paleodiet.

J. MARLA TOYNE¹, CHRISTINE D. WHITE¹,

JOHN W. VERANO², FRED J.

LONGSTAFFE³ and SANTIAGO UCEDA

CASTILLO⁴. ¹Department of Anthropology,

The University of Western Ontario,²Department

of Anthropology, Tulane University,³Depart-

ment of Earth Sciences, The University of

Western Ontario, ⁴Universidad Nacional de

Trujillo, Trujillo, Peru.

Rituals of sacrifice were important to the legitimizing ideology and power in ancient Moche society. Evidence for the execution and physical mutilation of young adult males has been documented archaeologically in Plaza 3C at Huaca de la Luna, but there is still much debate as to whether the victims were the products of elite Moche ritual battles or external conflicts with either Moche or non-Moche neighboring groups. We use stable carbon and nitrogen isotopic compositions of bone and tooth collagen (col) and structural carbonate (sc) to reconstruct the diets of a sample of these sacrificial victims ($n=16$) and compare them with burials from nearby residential complexes ($n=18$). Preliminary data suggest there is a significant difference in the types and range of food resources between the two samples. Most of the sacrificed individuals had more variable $\Delta^{13}\text{C}_{\text{sc}-\text{col}}$ spacings, and lower $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values than the site inhabitants, providing evidence for a diet based on terrestrial protein and C_3 plant resources, which is typical of highland food webs. Those interred in the urban center had diets more typical of Andean coastal agricultural populations, with significant contributions of C_4 plant (such as maize) and higher trophic level marine resources. We explore the hypotheses that the victims were captives from battles with highland groups, or that Moche warriors were dietarily distinct from other occupational specialists.

This research was supported by a Canadian SSHRC grant to C.D. White (no. 332337).

New evidence on headshaping from the Early Byzantine Maroneia in Thrace, Greece.

PARASKEVI TRITSAROLI. Greek Ministry of Culture.

The first case of headshaping from Early Byzantine Greece was identified in 2006 at the cemetery of Maroneia (5th-6th c. A.D.). Biocultural evidence suggested the presence of a female individual culturally linked to Hunic traditions. This paper analyzes the second case of headshaping on a female skeleton uncovered in 2009 and allows for the wider discussion of the presence of a larger group related to the Huns in the city of Maroneia. The skull was examined by combining macroscopic observation and x-ray. Points of pressure are recorded in the frontal, post-coronal and occipital regions resulting in an undulation of diploic bone. Possible bilateral pressure on the frontal bone has produced an artificially narrowed frontal. The skull extends posterosuperiorly. These features suggest the application of bandaging producing circular modification. Both headshaped skulls exhibit the same type of modification. Similarly, both women were buried in a supine position, without offerings, just like the remaining 36 deceased individuals in the cemetery of Maroneia. Headshaping was unknown among Byzantine customs. On the contrary, the Huns who attacked the Balkans twice and who unsuccessfully threatened Maroneia in 411 practiced a pronounced form of circular headshaping. Consequently, biocultural evidence strongly supports the hypothesis that a group linked to the Huns was installed at the city and was assimilated into this Early Byzantine society. Future biogeochimical analysis needs to be undertaken in order to investigate migration patterns. However, headshaping reflects the cosmopolitan character of Maroneia, an important urban center in a province of the Byzantine Empire.

The hazard of death on Mount Everest: Individual success and death over time.

BENJAMIN TRUMBLE^{1,2}, DARRYL HOLMAN^{1,2} and RICHARD SALISBURY³.
¹Department of Anthropology, University of Washington, Seattle. ²Center for Studies in Demography and Ecology, University of Washington, Seattle. ³Information Technology Division (retired), University of Michigan, Ann Arbor.

The success of commercial climbing expeditions on Mount Everest draws a large number of inexperienced climbers, including many that are ill prepared for the rigors of the high altitude. Previous examinations of associations between age, gender, success, and death on Mount Everest, have been based on independent excursions above base camp and do not account for individuals making repeated expeditions (Firth, et al. 2008; Huey and Eguskitza 2000; Huey, et al. 2007). This study

uses Cox proportional hazards models to investigate factors that increase the risk of death, and linear mixed effects models to examine covariates associated with sumitting. The first climb by an individual on Everest is hypothesized to be the most dangerous, due to novel exposure to altitude related illness. We examined records in the Himalayan Database of 8,538 individual expeditions above Everest Base Camp made by 6,435 different people. Of the 6,435 expedition members who climbed above base camp between 1921 and 2008, 133 died on Everest. The hazard of death while climbing was relatively stable over multiple seasons of exposure. Factors associated with an increase hazard of death were being over sixty and sumitting without supplemental oxygen. Linear mixed effects models revealed that experience and using oxygen were associated with increased chances of sumitting, while being older and climbing during the off season were negatively associated with sumitting. This project is funded in part by a NICHD/NIH Predoctoral Fellowship, Grant# 5T32HD007543-07.

Evolution of functional genetic variation at immune loci in wild baboons.

JENNY TUNG², S.C. ALBERTS^{1,2,3,4} and G.A. WRAY^{1,2,3}. ¹Department of Biology, Duke University, ²Institute for Genome Sciences & Policy, Duke University, ³Department of Evolutionary Anthropology, Duke University, ⁴Institute of Primate Research, National Museums of Kenya.

Individuals vary in their susceptibility and response to pathogens, and some of this variability can often be accounted for by genetic variation. Genetic variation of this type is an important subject of study in nonhuman primates: nonhuman primates serve as common models for human disease, and selective pressures on pathogen resistance may be evolutionarily important in these species. However, genotype-phenotype studies in primates have been hampered by practical considerations and by a lack of genetic resources. Here, we outline a method to investigate the effect of genetic variation on a molecular phenotype, gene expression, which may in turn influence organism-level phenotypic variation. This method uses allele-specific gene expression (the relative expression of one allele of a gene to the alternative allele of the same gene) to identify cases in which expression is influenced by linked genetic variation. We used samples from wild baboons in the Amboseli basin of Kenya to survey allele-specific expression in eleven immune-related genes. For four of these genes, we found strong evidence linking regulatory genetic variation and gene expression variation. One of these genes, the Duffy antigen receptor for chemokines (*FY*), was also associated with variation in susceptibility to the malaria-like parasite *Hepatocystis*. Follow-up experiments in a cell line confirmed that genetic variation at *FY* directly influences gene expression. Given that regulatory variation at *FY* also influences human malaria susceptibility, this case highlights a remarkable parallel between humans and

baboons and supports the utility of this method for investigating additional loci in nonhuman primates. This study was funded by NSF BCS-0725502 to S.C.A. and J.T., the American Society of Primatologists (to J.T.), and the Duke Institute of Genome Sciences & Policy (to G.A.W.).

A bioarchaeological reconstruction of cultural perspectives of violence in the ancient Andes.

TIFFINY A TUNG¹. ¹Department of Anthropology, Vanderbilt University.

The analysis of violence related skeletal trauma can reveal how and perhaps why violence was used against particular persons to kill or injure, and when examined for larger, archaeologically contextualized samples, these data may provide broader insights into cultural perspectives on violence for prehistoric populations. This paper provides a case study from the ancient Andes showing how data on bodily patterns of injury, lethality of wounds, and the demographic distribution of trauma, in conjunction with archaeological evidence, can be used to reconstruct cultural perspectives on violence.

The skeletal data derive from samples associated with Wari state rule (AD 600–1000) and collapse (AD 1000–1400). Preliminary results on adult antemortem and perimortem cranial wounds show a significant increase through time: antemortem cranial trauma goes from 23% (N=44) to 63% (N=60) and perimortem head wounds increase from 0% to 35% (both Fisher's exact, p<0.001). Although left ulnar parry fractures increase through time, the difference is not significant: 0% (N=33) to 6% (N=128). The data on trauma and age-at-death shows that while Wari military agents captured children for use as sacrifices, in later post-Wari times, children were killed with severe blows to the skull, much like adults. This suggests a change in attitude towards child-directed lethal violence that apparently went from ritual contexts (where it may not have been perceived as violence at all), to brutal blunt force trauma against children. These changing perspectives may be related to the larger shifts in socio-political organization that accompanied the collapse of the Wari state. This study was funded by a Vanderbilt Discovery Grant and the Council of American Overseas Research Center.

Astragalar shape: Differences and similarities in articular morphology among diverse catarrhine taxa.

KEVIN TURLEY, ERICA MIDTTVEIT, EMILY H. GUTHRIE and STEPHEN FROST. Department of Anthropology, University of Oregon.

The tibia, proximal element of the talo-crural joint, in primates has been previously examined using geometric morphometric techniques. It was highly conserved within taxa, but mass and substrate preference influence both presentation and articular morphology. The current study explores astragalar articular shape. Astragali from 170 specimens from *Homo*, *Gorilla*, *Pan*, *Pongo*, *Hylobates*, *Papio*, *Nasalis*, and *Macaca*

formed the study group. Laser surface scans were performed using a Minolta 910 and edited in Geomagic. Thirty landmarks were placed on the articular surfaces of the edited specimens using Landmark Editor software. Landmark configurations were then superimposed in Morphologika 2.0 and statistically analyzed with SAS using principal component analysis and multivariate regression to examine differences in shape and their relationship to talar size, body mass, substrate preference and phylogeny. Shape differences were visualized in specimen space by comparison of taxon means and estimated landmark configurations. An exemplar surface was then warped to fit these. Results demonstrated marked clustering of astragalar shape by taxon and were consistent with prior scans of tibial distal articular morphology. Larger taxa showed a more trapezoidal trochlear shape. Arboreal taxa had increased trochlear plane, oval posterior and lateral trochlear margins, and lateral facet concavity. Terrestrial taxa had a trapezoidal trochlear shape with straight posterior and lateral margins, decreased lateral facet concavity, and both the apex and medial facet were anteriorly displaced. Shape variations may provide stability and flexibility in mobile medial curvilinear surfaces in the former and irregular planar surfaces in the latter. Astragalar shapes across taxa reflect substrate. NSF (BCS-042539) and UO provided financial support.

Stress, dental health, and demographic transition in medieval France.

ERICA TYLER¹. ¹Department of Anthropology, The Ohio State University.

The reemergence of western civilization from the “Dark Ages” (5th to 9th centuries) and a concomitant decline in human health is frequently attributed to the major demographic transition to urban life in the Middle Ages (10th to 16th centuries). In France, this transition is associated with major changes in land use and social structure that have traditionally been interpreted as the causal factors in an unprecedented population explosion. This research tests the hypothesis that an earlier population increase, associated with significant increases in biological stress and deprivation, predated the agrarian and social reforms of the 10th century.

This hypothesis is tested through the bioarchaeological analysis of human skeletal remains from late Roman and early medieval (4th-9th centuries) northern France. The results indicate that a significant increase in population size and a shift in the cemetery population distribution had occurred by the mid to late 7th century AD. This shift is associated with significantly elevated frequencies of linear enamel hypoplasia, carious lesions, and antemortem tooth loss. These indicators, along with archaeological and historical evidence, imply a highly biologically stressed group suffering from decreasing dietary diversity and greater population pressure well before the 10th century. This analysis provides preliminary evidence for a closer examination of the medieval demographic transition. 10th C populations actually (Tyler, 2008) have lower

frequencies of stress so they may have already been adjusting by the end of the early medieval period. This study was funded by The National Science Foundation, The Sigma Xi Scientific Research Society, and The Coca Cola Corporation.

Dental microwear texture analysis of newly discovered hominins from Olduvai Gorge.

PETER S. UNGAR¹, KRISTIN L. KRUEGER¹, ROBERT J. BLUMENSCHINE², ROBERT S. SCOTT² and JACKSON K. NJAU³. ¹Department of Anthropology, University of Arkansas, ²Center for Human Evolutionary Studies, Rutgers University, ³National Natural History Museum, Arusha, Tanzania and Human Evolution Research Center, University of California, Berkeley.

Dental microwear texture analyses have allowed comparisons of diets among early hominins. However, samples studied have been limited given availability and taphonomic damage. This is unfortunate because large samples are needed to document within-species variation, and hopefully inform us on foraging strategies of fossil taxa.

Here we report on dental microwear of early hominins recovered between 1995 and 2007 by the Olduvai Landscape Paleoanthropology Project from Bed I and Lower Bed II at Olduvai Gorge. Six of nine newly discovered specimens had cheek teeth that preserved unobscured antemortem dental microwear, five for *Homo habilis* and one for *Paranthropus boisei*. Point clouds of enamel surfaces were generated with a white-light confocal profiler with a lateral sampling interval of 0.18 μm, a vertical resolution of 0.005 μm, and a work envelope of 276 μm x 204 μm. These data were analyzed using scale-sensitive fractal analysis software, and results were compared with previously published values for *P. boisei* and *H. habilis*. The new *P. boisei* specimen has microwear texture attributes comparable to previously reported values for this taxon: low complexity, anisotropy, and textural fill volume. This suggests a diet lacking hard, brittle foods. The new *H. habilis* data are also similar to published results for the species. *Homo habilis* individuals evince higher average microwear texture complexity and more variation than do *P. boisei* specimens. This suggests that *H. habilis* may have had a more varied diet than did *P. boisei* in the days or weeks before death. Funded by NSF, Wenner-Gren, Leakey Foundation, and Rutgers’ Center for Human Evolutionary Studies.

“Standard” cemetery population from fluctuating residential patterns: A decade-by-decade comparison of census records and cemetery demography from the St. Lawrence County Almshouse.

BETHANY M. USHER^{1,2}, KALEN CASEY^{1,3} and JESSICA CRANDALL ECHARD¹.

¹Department of Anthropology, State University of New York at Potsdam, ²Center for Teaching Excellence, George Mason University, ³Cultural Resources Branch, US Army, Fort Drum, NY.

In paleodemography, it can be difficult to determine if a cemetery is representative of the living population, and this issue is complicated because burials often accumulate over generation. During this time period, population fluctuations may occur. This study was undertaken to determine how recorded demographic changes in a living population affected the composition of the associated cemetery. The St. Lawrence County Almshouse, in Canton, New York, opened in the early 1800s, and by 1871 a cemetery for the residents was established on the grounds. The cemetery was active until the early 1900s. Using census records, cemetery burial records, and a survey of the extant cemetery, we examine how demographic patterns in the poorhouse were reflected in the associated cemetery from 1870-1910. Over 613 burials were recorded during this time period, and 823 residents were recorded in the census. Residence patterns changed significantly over the period of cemetery use. In earlier decades, the Almshouse was home to poor families and unwed mothers. Later, children were removed and mentally ill residents added. In the later periods, it became home for the elderly and infirm. While each decade of burial reflected the demography of the Almshouse as recorded in the census, with significant skewing in ages and sexes, the composite demographic profile of the cemetery appears “standard” for archaeological cemetery analyses. Therefore, significant changes in the demographic characteristics of a population may be not discernable when studying an archaeological cemetery unless specific phases of burial can be identified.

Growth and life history in indigenous children of the Argentine Gran Chaco.

CLAUDIA VALEGGIA. Dept. of Anthropology, University of Pennsylvania.

The timing, tempo, and variation in human growth have been the focus of attention of anthropological studies since the beginning of the discipline. Here I use a life-history approach to interpret variation in the timing and form of developmental events as a reflection of differing allocations of an individual's resources (time and energy) to competing life functions, specially growth, body maintenance, and reproduction. We collected anthropometric, developmental, and health history data from a total of n = 856 Toba children and n = 304 Wichí children ages 0 -18 years old living in rural and peri-urban villages in the northern province of Formosa. We used the Argentine and the WHO standard growth references to calculate z-scores. Peri-urban, but not rural, children showed a relatively high prevalence of stunting (28%). Body mass index values seem to be well above the expected ones during the first 5 years of age suggesting that energy might be allocated to fat reserves rather than linear growth. Girls in both settings tend to exhibit an accelerated growth trajectory, with early pubertal changes and a mean age at menarche of 12 y.o. Boys also tend to have an early age-at-take-off, but the difference with the standard

reference is not so marked. Health histories show a high prevalence of infectious and parasitic diseases, particularly during the first five years of life. In both populations, the pattern seems to suggest an investment in early reproduction, which is later combined with a fast-paced reproductive career. This study was funded by the National Geographic Society (#8395-08), the L.S.B. Leakey Foundation, and the U. of Pennsylvania Research Funds.

Habitual sleep tree use by white-faced capuchins (*Cebus capucinus*) and implications for seed dispersal.

KIM VALENTA¹, JEFFREY A. KLEMENS² and LINDA M. FEDIGAN³. ¹Department of Anthropology, University of Texas at Austin, ²Department of Biology, University of Pennsylvania, ³Department of Anthropology, University of Calgary.

Measures of disperser effects on dispersed seed survival and seedling recruitment include elements of the distance, direction and density of seed deposition. The repeated use of a sleep tree by a disperser can result in a high localized density of seed rain, thereby providing an opportunity to measure the effects of high-density seed input on seed mortality and recruitment. We examined density effects by measuring seedling communities beneath trees that are habitually used as sleep trees by two groups of white-faced capuchin monkeys (*Cebus capucinus*). Seedling communities beneath sleep trees were compared with those beneath two paired control trees in Santa Rosa National Park, Costa Rica. Seedling communities sampled were divided into non-capuchin dispersed taxa (N=311), taxa consumed by capuchins but whose seeds were destroyed by capuchin processing (N=11), taxa consumed by capuchins but seed survival was unknown (N=77), taxa dispersed intact by capuchins (N=391). Paired t-tests were performed to compare species richness, Shannon diversity, and seedling density in each of the four dispersal categories. Capuchin usage of sites did have not a strong effect on the seedling community, with only wind-dispersed taxa showing an increased density between monkey sleep trees vs. controls. Lack of a significant increase in seedling recruitment of capuchin-dispersed taxa beneath sleep trees provides support for the hypothesis of density-dependent seed mortality. Supported by the Province of Alberta, the University of Calgary and Sigma Xi (KV), a National Science Foundation Postdoctoral Fellowship (JAK) and by the Canada Research Chairs Program and an NSERC Discovery grant (LMF).

Sialic acids and the host-pathogen interface – roles in hominid evolution.

AJIT VARKI. Department of Cellular and Molecular Medicine, University of California, San Diego.

All cells in nature display a dense and complex array of cell surface glycans, which are involved in host biological processes, but also provide

binding sites for pathogens. Thus, host glycans are trapped in recurring evolutionary "Red Queen" cycles, with long-lived hosts needing to evade their more rapidly evolving pathogens by changing glycan expression, without compromising their intrinsic functions. Sometimes, a single glycan type is eliminated in one evolutionary lineage, e.g., the human-specific loss of the mammalian sialic acid (Sia) called Neu5Gc, which has affected multiple human pathogen regimes such as malaria. The loss of Neu5Gc also affected the binding properties and functions of human Siglecs (Sia-binding immunoglobulin-like lectins), which appear mostly dedicated to recognizing Sias as "self", and dampening innate immunity. In this regard, human pathogens commonly disguise themselves with human-like Sias (molecular mimicry) via convergent evolution, thus taking advantage of the Siglecs by masquerading as "self". Together, the >10 Sia-related genetic and biochemical differences between humans and other hominids have implications for unusual features of human biology and disease. In addition, incorporation of Neu5Gc into humans occurs from foods such as red meat. As all humans have circulating complement-fixing antibodies against Neu5Gc-containing glycans, this could explain red meat associations with late-onset diseases such as cancer and atherosclerosis. It is also possible that anti-Neu5Gc antibodies might restrict transmission of enveloped viruses carrying surface Neu5Gc derived from other organisms, and that the original loss of Neu5Gc could have lead to changes in fertility, allowing sympatric speciation (collaboration with Pascal Gagneux). This study was funded by grants from the National Institutes of Health and the G. Harold and Leila Y. Mathers Charitable Foundation.

Differential selection for color vision in two nocturnal folivores.

CARRIE C. VEILLEUX¹, EDWARD E. LOUIS² and DEBORAH A. BOLNICK¹.

¹Department of Anthropology, University of Texas at Austin, ²Henry Doorly Zoo, Omaha.

Recent work has identified variation in color vision among nocturnal primates. While some species have lost blue-sensitive S cones and dichromatic color vision, others retain S cones and exhibit evidence of selection on the S-opsin gene to maintain S cone functionality. The ecological factors responsible for this variation may have important implications for primate evolutionary scenarios. We therefore explored whether differences in nocturnal ambient light environments are driving differential selection for color vision. We compared selection on the S-opsin gene in two folivorous nocturnal lemurs (*Avahi* and *Lepilemur*) from forests differing in the availability of blue light. We sequenced the entire S-opsin gene in 15 *Avahi* (n=7 dry deciduous forest, n=8 rainforest) and 25 *Lepilemur* (n=12 dry deciduous forest, n=7 spiny forest, n=6 rainforest). We compared the frequency and nucleotide diversity of nonsynonymous and silent (synonymous+intron) mutations within each population, computed Tajima's D statistics, and conducted McDonald-Kreitman tests to identify

differences in selection between congeners from different forest types. We found that *Avahi* from both forest types have fewer nonsynonymous than silent mutations, suggesting that both groups are under selection to maintain dichromatic color vision. In contrast, selection on *Lepilemur* populations differs according to forest type. Deciduous and spiny forest populations exhibit evidence of selection to maintain S cone functionality, while the rainforest population exhibits evidence of relaxed selection on the S-opsin gene. We suggest that differences in both feeding ecology and nocturnal ambient light environment may influence selection for dichromatic color vision in these nocturnal lemur genera.

Geometric morphometric approach for sex determination using the great sciatic notch of the Maxwell identified adult skeletons (University of New Mexico, Albuquerque).

JANA VELEMINSKA¹, LENKA NEHASILOVA¹, JOSEF PELIKAN², PETR VELEMINSKY³, ALENA SEFCAKOVA⁴ and JAROSLAV BRUZEK^{1,5}.

¹Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Prague, Czech Republic, ²Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic, ³Department of Anthropology, National Museum, Prague, Czech Republic, ⁴Department of Anthropology, Slovak National Museum, Bratislava, Slovak Republic, ⁵PACEA-Laboratory of anthropology of past populations, UMR 5199 CNRS, University Bordeaux I, Talence, France.

Sex dimorphism in the great sciatic notch is one of the most important characteristics that are frequently used for sexual determination from the skeleton. Recent analyses of the great sciatic notch shape using geometric morphometrics have indicated the suitability of this methodological approach to sex determination. The aim of this study was to verify the possibilities of two-dimensional geometric morphometrics in estimation of sexual dimorphism and assess its application in forensic identification. The study was based on 114 photographs of pelvic bones of adult identified individuals (57 males and 57 females) from the Maxwell museum collection (University of New Mexico, Albuquerque). The great sciatic notch was digitized using MicroScribe G2X contact digitizer and Rhinoceros software as the curve between two specially defined landmarks. Several approaches to curve representation were used: semi-landmarks (10 points), circular harmonics and multi-resolution curve analysis. Consequent data were evaluated using multivariate statistics (discriminant analysis and Hotelling's test) and geometric morphometric methods (GPA, shape PCA and TPS). The great sciatic notch of males was deeper and varied from symmetrical to strongly asymmetrical but with a similar shape (longer edge of the inferior chord); the females' great sciatic notch was shallower and varied from symmetrical to an irregular type of asymmetry. Significant sexual difference and great accuracy in sex determination in this region was found (93% of study subjects

correctly classified). This study was supported by research grant MSM 0021620843, by Centralized Development Project C37/3 from the Ministry of Education, Youth and Sports of the Czech Republic and by GACR 206/07/0699.

The biological diversity of the early medieval European population in light of non-metric traits: Frankish empire versus great Moravia Empire.

PETR VELEMINSKY¹, JAKUB LIKOVSKY², JAROSLAV BRUZEK^{3,4}, JANA VELEMINSKA⁴, ALENA SEFCAKOVA⁵, MILAN THURZO⁶, ARNAUD LEFFEBVR⁷, LUMIR POLACEK⁸ and MILUSE DOBISIKOVÁ¹. ¹Department of Anthropology, National Museum, Prague, ²Institut of Archaeology, Czech Academy of Sciences, Prague, ³LAPP-PACEA, UMR 5199 CNRS, University Bordeaux 1, France, ⁴Department of Anthropology and Human Genetic, Faculty of Science, Charles University, Prague, ⁵Department of Anthropology, Slovak National Museum, Bratislava, Department of Anthropology, ⁶Faculty of Natural Sciences, Comenius University, Bratislava, ⁷National Institute for Preventive Archaeological Research, INRAP, Metz, France, ⁸Institute of Archaeology, Academy of Sciences of the Czech Republic.

Morphological diversity between European medieval populations of diverse geographic origin were studied rarely. We focused on the early medieval population of the Frankish Empire, which represented a centre of the medieval civilisation in Western Europe, as well as on the Great Moravian population that inhabited Central Europe.

The subject of our contribution is a study of the biological diversity of both populations on the basis of non-metric traits. The aims were: (1) to establish the range of morphological variability, (2) to evaluate the traits associated with physical activity and (3) to evaluate the hypostotic non-metric traits for the ontogenetic stress estimation. The evaluated material consist of (1) about 300 skeletons from the Merovingian burial-ground of de Norroy-le-Veneur (Lorraine) (5th – 7th century AD), and (2) about 800 skeletons from the Great Moravian cemeteries in Mikulcice (9th – 10th century AD). Approximately fifty non-metric traits were scored. In the case of “warrior” graves, we focused on postcranial traits that are also associated with a non-specific physical load on the locomotor apparatus. The Merovingian population demonstrated a higher incidence of traits relating to cranial sutures, whereas at Great Moravian burial-grounds, there was a higher incidence of traits relating to the outlets of vascular/nerve pathways and hyperostotic traits. Our conclusions thus contribute to the knowledge regarding the extent of biological heterogeneity of the early medieval inhabitants of these two parts of Europe. This study was supported by following research grants: GACR 206/07/0699, PAI-Barrande (MEB020936), VZ PM MK00002327201 and ECO-NET n° 1636 PB.

Intrapopulation variation in body size and shape: Social status and sex differences in an

Italian medieval population (Trino Vercellese, VC).

GIUSEPPE VERCELLOTTI¹, SAM D. STOUT¹, ROSA BOANO² and PAUL W. SCIULLI¹. ¹Department of Anthropology, The Ohio State University, ²Dipartimento di Biologia Animale e dell’Uomo, Università di Torino, Italy.

The phenotypic expression of adult body size and shape results from synergistic interactions between hereditary factors and environmental conditions experienced during growth. Even in genetically restricted populations, intrapopulation variation in body size and shape arises from different occurrence, duration and timing of growth insults. In particular, early perturbations have greater negative impact on long bone, rather than trunk, length. Understanding the causes and patterns of intrapopulation variation can foster meaningful information on early life conditions in living and past populations. This study examined variation in body size and shape in relation to environmental quality in a bioarchaeological population. Social status, inferred by archaeological evidence, was employed as a proxy for environmental quality. We investigated differences between sex subgroups of different status by testing the following hypotheses: 1) presence of no significant differences in trunk height; 2) presence of significant differences in limb bones lengths; 3) presence of detectable effects of sex and status on overall body size and shape. The analysis was conducted on 52 (21 female, 31 male) adult individuals from the medieval population of Trino Vercellese, Italy. Differences in element size and overall body size and shape were assessed through Monte Carlo and principle component analyses. Our results highlight a distinct pattern in body size and shape variation in relation to status and sex. Male subsamples exhibit a variation pattern in agreement with our hypotheses, while female subsamples express milder, non-significant differences. Such discrepancy between sexes likely resulted from the combination of biological factors and cultural practices.

Limited dispersal in mobile hunter-gatherer Pygmies.

PAUL VERDU¹, RAPHAEL LEBLOIS², ALAIN FROMENT¹, SYLVAIN THERY¹, SERGE BAHUCHET¹, FRANCOIS ROUSSET³, EVELYNE HEYER¹ and RENAUD VITALIS¹. ¹MNHN-Université Paris 7-CNRS UMR 7206, Ecoanthropology and Ethnobiology, Paris, ²MNHN-CNRS UMR 7205, Origine, Structure et Evolution de la Biodiversité, Paris, ³Université Montpellier 2-CNRS UMR 5554, Institut des Sciences de l’Evolution, Montpellier, France.

Hunter-gatherer Pygmies from Central Africa are typically described as being very mobile in the equatorial forest. Using neutral genetic data and population genetics theory, we explored indirectly the dispersal behaviour of the Baka Pygmies from Southern Cameroon, one of the largest Pygmy population in Central Africa.

Quite unexpectedly, we found a strong correlation between genetic and geographic distances, a pattern of Isolation By Distance that arises from limited dispersal of offspring from their parents' birthplace. Our study converges toward the notion that hunter-gatherer Pygmy populations that have a very mobile way of life in their natural environment do not necessarily disperse over a wide geographical area.

Juvenility in *Ateles geoffroyi*: Life history comparisons.

LAURA VICK. Department of Anthropology, Peace College.

Recent research has demonstrated that *Ateles geoffroyi* face sometimes perilous social and ecological challenges as they navigate immaturity and acquire adult skills. Part of a long-term project conducted at the Otoch Ma'ax Yetel Kooh (OMYK) Protected Area, Punta Laguna, Mexico, this study focuses on known individuals, followed, wherever possible, from infancy to adulthood. Previous findings suggest that adult gender differences in patterns such as association, aggression, and affiliation, are apparent by the juvenile phase. Primarily utilizing the focal interval method, this study examines interindividual as well as gender-based behavioral differences since the former may be key to understanding group dynamics. Also examined are trajectories in behaviors such as play: after a peak during infancy, the relative frequency of non-social play declines during the early juvenile phase, with males performing more overall. The relative frequency of social play is more robust over time; yet, females may engage in more social play as juveniles than males, despite the fact that adult males are more gregarious. Juvenile males associate in larger subgroups, generally, than do females, reflecting their attraction to subgroups containing mothers as well as adult males, although some males play greater roles in bridging the gap between male and female worlds. Just before adulthood, the average subgroup size may drop for individuals of both genders, but more precipitously for young females, perhaps in preparation for emigration. This study was funded in part by Peace College Faculty Development grants.

Levels of genetic differentiation at a small geographic scale in human and chimpanzee societies.

LJINDA VIGILANT, GRIT SCHUBERT and KEVIN LANGERGRABER. Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany.

Much attention has been paid to the structuring of human genetic variation on the global or continental scale. However, the genetic structure of human communities on small, local scales, is likely to be particularly relevant to the dynamics of social evolution. We assessed the degree of genetic differentiation of contemporary human populations living in close (< 200km) proximity using a new measure, D. This measure, unlike F_{ST} , is not biased by differing levels of variation in the populations compared. D values were

calculated using microsatellite genotypes from published studies of contemporary human populations at six localities. For comparison, we genotyped a total of 23 wild chimpanzee and bonobo communities from four localities and estimated D values. Results showed that levels of genetic differentiation were similarly moderate among humans, chimpanzees and bonobos. Some models seeking to explain the origin of altruism in humans include consideration of the magnitude of local genetic differentiation, and our results suggest that differences in fine-scale genetic differentiation may not have played a role in the development of differing cooperative tendencies between humans and our closest living relatives. Our work is funded by the NSF (USA), the Max Planck Society, the Wenner-Gren Foundation, the Leakey Foundation and the Alexander von Humboldt Foundation.

Cross-sectional variability of the femoral osteon population using stereological methods.

CHIARA VILLA^{1,2} and NIELS LYNNERUP¹. ¹Laboratory of Biological Anthropology, Institute of Forensic Medicine, University of Copenhagen, The Panum Institute, Blegdamsvej 3, 2200 Copenhagen, ²University of Milan, via Festa del Perdono 7, 20122 Milan.

In the study of femoral cross-sections for age estimation, a main problem is the location of the regions of interest (ROIs). While some methods provide a description of very specific areas of cross-section to be used, e.g. anterior and lateral sub-periosteal areas, there is some subjectivity in choosing these areas. We wanted to investigate the cross-section variability, using a stereological approach in order to perform an unbiased selection of the ROIs. Our sample consisted of 28 femoral cross-sections from Caucasoid males aged 20 to 89. A regular grid was overlaid to each cross-section and the ROIs were selected as close as possible to the periosteum in the anterior, lateral and medial areas. The structure consisting of all intact secondary osteons plus fragments were delimited and the total osteon density (TOD), percent total osteon population (pTOP), area (A) and perimeter (P) were calculated using stereological methods and software. Overall, no statistically significant differences were found neither between the several tested ROI locations within each cross-section (intra-section variability), nor the trend of a single ROI versus the other ROIs in all cross-sections (inter-section variability). This suggests that the different locations of ROIs do not affect the analyses. We also noted that a higher variability is present in mid-adult age (30-55 years). Finally, we observed that age determination using a single feature at a time (TOD, pTOP, A, P) appears impossible throughout the full range. A regression line could be applied for the Total Osteon Density only in younger ages (20-49 years). This study was funded by a grant from University of Milan, Italy.

Subadult age estimates of an Early Bronze Age charnel house at Bab edh-Dhra', Jordan.

CATALINA ISABEL VILLAMIL¹, JAIME ULLINGER² and SUSAN GUISE SHERIDAN³. ¹Dept. of Anthropology, University of Pennsylvania, ²Dept. of Anthropology, Ohio State University, ³Dept. of Anthropology, University of Notre Dame.

The subadult age distribution for the Bab edh-Dhra' charnel house A22 collection, dated to the Early Bronze Age II/III period (2800-2300 BCE), was constructed using femoral diaphyseal length estimates. Vertical head diameter and mediolateral neck breadth were measured for 56 fragmented left subadult proximal femora in order to estimate diaphyseal lengths using a regression equation (Hoppa and Gruspier, 1996). These lengths were used to place femora into an age category (fetal, infant, young child, old child, and adolescent) based on dental or functional development scales. Diaphyseal length ranges for these categories were constructed using available studies of other skeletal collections, including the Bab edh-Dhra' Early Bronze I cemetery (3150-2950 BCE). Age distributions based on the two separate scales were not significantly different ($\chi^2=3.38$, $p=0.34$). Using the dental scale, 10% of the remains were classified as fetal, 4% as infant, 19% as young child, 44% as old child, and 23% as adolescent. This profile was significantly different from four North American groups ranging in location and time period, but not to other comparative groups from around the world. The age profile was not significantly different from another constructed using mandible dental data for the Early Bronze II/III subadults ($\chi^2=2.16$, $p=0.54$) indicating a robust estimate, but it was significantly different from the Early Bronze I group ($\chi^2=16.35$, $p=0.001$). Preservation and conservation issues in A22 may have affected these estimates, or changes in settlement and subsistence strategies may have altered childhood mortality. This research was supported by the NSF-REU program (SES 0649088) at the University of Notre Dame, and the Center for Undergraduate Research and Fellowships of the University of Pennsylvania.

ABO blood group frequencies in a pre-Columbian Native American population from California.

FERNANDO A. VILLANEA¹, CARA MONROE^{1,2,3}, ALAN LEVENTHAL⁴, ROSEMARY CAMBRA⁵ and BRIAN M. KEMP^{1,3}. ¹Department of Anthropology, Washington State University, ²Department of Anthropology, University of California, Santa Barbara, ³School of Biological Science, Washington State University, ⁴Departments of Anthropology and Urban Planning, San Jose State University, ⁵Chairwoman, Muwekma Ohlone Tribe.

Almost all Native Americans belong to either the O₁ or O_{iv} blood group, with regards to the ABO blood group system. Some have suggested that the reduction of the otherwise common A alleles among Native Americans may have resulted from major selective pressure following the introduction of infectious disease, such as

smallpox, into the Americas by Europeans. However, the reduced diversity at the ABO locus may well predate the contact period, as it is believed that Native American populations derive from a relatively small Beringian founder population prior to migrating to the Americas. Thus it is probable that the bottleneck associated with this event (~15,000 years ago) decreased their heterozygosity at the ABO blood group locus. While previous studies have used ancient DNA analyses to determine if precontact populations also lack A blood groups, their sample sizes have been small and from scattered sites. In this study we analyze ancient DNA from an ancestral Muwekma Ohlone burial site in the San Francisco Bay Area in California that dates to approximately 1,500-2,000 years ago. CA-SCL-38 contains 210 burials, a more complete precontact Native American population that allows to demonstrate the high frequencies O₁ and O_{iv}, blood groups today is unlikely to be the outcome of population decline following European contact.

Selection, morphological integration, and *Strepsirrhine* locomotor adaptations.

BRIAN A. VILMOARE¹ and JENNIFER L. FISH². ¹Department of Anthropology, University College London, ²Department of Craniofacial Development, King's College London.

Changes in morphological integration are generally attributed to two forces: internal developmental constraints and external selection on function. One way to examine integration is to study an anatomical suite of characters that clearly corresponds to a specific well-understood adaptation, and contrast the expression in taxa that have the adaptation against the expression in taxa that lack the adaptation. If integration is exclusively the result of developmental factors, there should be a signature of integration irrespective of the presence or absence of selection for integration. If integration is, at least partially, the result of functional requirements, integration should be most apparent where selection is strongest and less evident where selection has been relaxed. Here we use patterns of integration in the Strepsirrhine fore and hind limbs as the test case. Strepsirrhine locomotion is relatively well-studied, and there are multiple clades that share different locomotor modes, allowing a direct test of the effects of the phylogeny. Our prediction is that arboreal quadrupeds have greater integration of the fore and hind limb than vertical leapers because quadrupeds use their fore and hind limbs in a highly coordinated fashion for locomotion. Therefore, selection may drive coordinated development of the fore and hind limb. We found that quadrupeds have greater limb integration than vertical leapers, even when controlling for phylogeny. Interestingly, limb size in vertical leapers is nonetheless integrated. These results suggest that variation can accumulate if selection for integration is relaxed. However, developmental constraints may restrict primate limb evolution more than expected.

Dental morphology and pathologies of Chinese immigrants from historic Carlin, Nevada.

JAMIE D. VILOS, JENNIFER L. THOMPSON and DEBRA L. MARTIN. Department of Anthropology, University of Nevada, Las Vegas.

This study uses a multi-disciplinary approach (ethnohistoric documents, skeletal analysis, dental forensics) to provide insight into the health of a small sample of Chinese immigrants who lived, worked, and died in Carlin, Nevada, in the late 19th-early 20th century. Using standard dental data collection techniques, morphological variants and a variety of dental pathologies were recorded. Of the thirteen individuals, 2 were edentulous and 1 was mummified in a way that precluded dental analysis. Ten sets of dentition provided observations for a total of 212 teeth. Antemortem tooth loss due to disease and/or caries was also analyzed. All ten individuals exhibited low levels of calculus. Caries were present in 7 individuals and abscesses were observed in 7 individuals. Signs of active periodontal disease were noted in 4 and enamel hypoplasia in only 2 individuals. Shoveling was identified on the central and lateral incisors of 7 individuals and bilateral winging in 2. Staining occurred on the teeth of all individuals to varying degrees, possibly due to tobacco or opiate consumption. Given that many of these individuals migrated into the area to work on the railroads and in the mines of Nevada, hypotheses about expected poor oral health were not supported. Although the ethnohistoric literature and the skeletal analyses (Schmidt 2006) suggest a life of hard work and hard knocks (healed trauma), the dentition shows fairly good health. It is possible that these Chinese-American immigrants continued to rely on a traditional Chinese diet that kept the dentition in relatively good shape.

A first look at jaw-muscle activity in free-ranging primates: The ecological physiology of feeding in howling monkeys (*Alouatta palliata*) at La Pacifica, Costa Rica.

CHRISTOPHER J. VINYARD¹, KENNETH E. GLANDER², MARK F. TEAFORD³, CHELSEA L. ROSE⁴ and SUSAN H. WILLIAMS⁵. ¹Department of Anatomy and Neurobiology, NEOUCOM, ²Department of Evolutionary Anthropology, Duke University, ³Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine, ⁴Department of Anthropology, University of South Carolina, ⁵Department of Biomedical Sciences, Ohio University.

Historically, laboratory-based *in vivo* studies of masticatory function and field studies of primate feeding ecology have been conducted independently of one another. This lack of integration forces primatologists to make significant assumptions when combining these lines of evidence in adaptive hypotheses explaining primate craniodental form and feeding behaviors. For example, laboratory-based studies of primate mastication must

assume that experimental foods elicit feeding behaviors typical of free-ranging primates. Likewise, when applying field data to questions about the evolution of primate feeding, we must assume that physiological processes related to mastication are correlated with observed feeding behaviors. As a first attempt to link laboratory- and field-based research, we recorded jaw-muscle activity during feeding in free-ranging mantled howling monkeys (*Alouatta palliata*) at La Pacifica, Costa Rica. To date, we have recorded superficial and deep masseter activity patterns during feeding from 8 individuals using a telemetered electromyography (EMG) system. Although we lack laboratory EMG data from howlers, we see qualitative similarities in EMG patterns between free-ranging howlers and captive platyrhines. Qualitative similarity supports the routine assumption that feeding mechanics are broadly similar in the laboratory and wild. More subtle differences will help laboratory-based researchers improve the naturalistic relevance of their work. Simultaneous observations of feeding behaviors and jaw-muscle activity allow us to quantify how much time monkeys spend strictly foraging versus chewing when feeding. The marked differences we observed between time spent foraging and jaw-muscle duty factors merit a careful consideration of how foraging data are applied to studies of primate masticatory apparatus evolution.

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A 3-D geometric morphometric study of the “keystone” tarsals: implications for diversity in the foot of early bipedal hominins.

KYLE MARIAN VITERBO¹ and WILLIAM HAROURT-SMITH^{2,3,4}. ¹IDPAS, Stony Brook University, ²Department of Paleontology, American Museum of Natural History, New York City, ³Department of Anthropology, Lehman College, CUNY, ⁴New York Consortium in Evolutionary Primatology (NYCEP).

Evidence for bipedal locomotion has been essential in identifying and tracing the hominin lineage in the fossil record. The overall architecture of the hominin foot and the morphology of its individual bones have long been argued to reflect functional differences associated with varying modes of locomotion. Among the tarsal bones, the intermediate and lateral cuneiforms have been little studied. As structural “keystones” in the transverse arch of the foot, these elements play crucial roles in efficient weight transfer during bipedal locomotion. In order to identify possible functional differences reflected in each bone, homologous 3-D landmarks for the intermediate and lateral cuneiforms were devised to summarize their shape, with special focus on the articular facets. The comparative sample consisted of cuneiforms from African apes, modern humans, and primary casts of three fossil hominins (OH8, Stw573, and LB1). The shape data were assessed via Morphologika and subjected to Generalized Procrustes Analysis. PCA revealed three distinct clusters that reflect overall shape differences consistent with known locomotor capabilities in each group. When

fossil data were added to the analysis, OH8 and LB1 fell within the human range for both the intermediate and lateral cuneiforms. Results for Stw573, however, suggested a mixed tarsal configuration; its intermediate cuneiform fell within the human range of variation, whereas its lateral cuneiform resembled *Pan*. These findings contrast with those based on other tarsals in the same fossils, suggesting unique patterns of mosaicism in the different taxa, which in turn could imply subtle differences in their forms of bipedalism.

How wild Bornean orangutans (*Pongo pygmaeus wurmbii*) cope with fruit scarcity: behavioral, physiological, and morphological adaptations

ERIN R. VOGEL¹, MARIA A. VAN NOORDWIJK², NATHANIEL J. DOMINY³, ARI MEIDIDIT⁴ and CAREL P. VAN SCHAIK². ¹Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ²Anthropologisches Institut und Museum, Universität Zürich, ³Department of Anthropology, University of California Santa Cruz, ⁴Department of Biology, Universitas Nasional Jakarta.

The dipterocarp forests of Southeast Asia show extreme supraannual variation in fruit availability. The frugivores of these forests are therefore expected to evolve mechanisms to cope with episodes of extreme fruit scarcity. For instance, Knott (1998) reported that orangutans compensate for inadequate energy intake by metabolizing fat reserves, and Vogel et al. (2008) proposed that the unique craniodental morphology of orangutans is well adapted to a diet of obdurate foods that are consumed when preferred fruit is scarce. It stands to reason that such patterns are also accompanied by complimentary changes in behavior, yet little is known of how orangutans vary their foraging behavior in response to fluctuating food properties. Here we examine supraannual variation in food selection at the Tuanan Field Station, Central Kalimantan. We predicted that during periods of fruit scarcity, orangutans would switch to a low-energy diet characterized by food items that are tougher and less elastic than preferred fruits. To help compensate for this switch, we predicted that orangutans would also reduce the amount of time spent traveling between food patches, increase the number of feeding bouts, and that patch profitability would decline. Indeed, during periods of low fruit availability, the orangutans switched to a more mechanically challenging diet, resulting in the reduced energetic profitability of each patch. However, ketone excretion did not mirror fruit abundance, probably because swamp forests do not experience mast fruiting. This study provides insights into the importance of integrating behavior, ecology, morphology, and physiology in understanding diet selection in wild primates.

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Geometric morphometric analysis of the human innominate for sex estimation.

JENNIFER VOLLMER¹, ALEXANDRA KLALES² and STEPHEN OUSLEY².

¹Department of Anthropology, Michigan State University, ²Department of Applied Forensic Sciences, Mercyhurst College.

The human innominate has often been cited as one of the best skeletal indicators of sex. The sex estimation component of the biological profile is then crucial for the assessment of the other aspects of this profile. The current study, utilizing a modern sample, validates the authors' previous work (Klales *et al.* 2009) on the estimation of sex through geometric morphometric analysis on a 20th century population. A total of 133 left innomates, 53 females and 80 males, from the William M. Bass Donated Collection (University of Tennessee, Knoxville) were digitized to capture 21 three-dimensional landmarks. Complete or near complete adult specimens over 19 years of age were selected to ensure that all 21 landmarks could be digitized. Immature and pathological innomates were omitted. These data were then subjected to a Procrustes' fit and the subsequent Procrustes' coordinates were then analyzed using discriminant function analysis. A cross-validated accuracy of 98.1% correct sex classification (96.2% of females and 100% of males correctly classified) from this study was comparable with the authors' previous study which achieved a 95.5% correct classification (94% of females and 97% of males correctly classified). Further work by the authors will analyze the possibility and direction of secular change between these two populations.

Parental investment strategies of teen and adult mothers: nighttime parenting behaviors and sleep-related risks to infants.

LANE VOLPE and HELEN BALL. Department of Anthropology, Durham University, Durham UK.

This project uses life-history theory to understand the nighttime parenting strategies of teen and adult mothers. Because adolescent mothers reproduce prior to completing their own physical and psychosocial development, life-history theory predicts that they will experience a greater degree of parent-infant conflict and will pursue a different child-rearing strategy than adult mothers. Since the biology of sleep is fundamentally different for infants and adults, it is logical to expect that infant demands at night will be incompatible to varying degrees with maternal needs and that mothers will engage in trade-offs in order to navigate this period of parent-infant conflict. The study hypothesized that teen mothers would engage in more "cost-cutting" behaviors than adult mothers, and that sleep-related risks to infants would arise as a function of maternal parenting strategies for both groups. The study measured feeding method, frequency and duration; maternal-infant proximity and amount of physical contact; infant sleep location; and frequency and duration of sleep-related risks. Significant

group differences were found, with teen mothers pursuing a more proximal care strategy that included bedsharing, formula feeding, and a high degree of proximity and contact. Sleep-related risks occurred for infants in both groups, but the risks were different depending on the mother's nighttime caregiving strategy. The study examines how key aspects of nighttime care can be explained by life-history theory, and considers how an evolutionary perspective on infant sleep and nighttime caregiving can contribute to more informed public health policies that are appropriate to a variety of social and behavioral contexts.

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Another hole in the head?: Brain treatment in ancient Egyptian mummies.

ANDREW WADE¹, ANDREW NELSON¹, and GREG GARVIN². ¹Department of Anthropology, University of Western Ontario, ²St. Joseph's Health Care, London.

Variability in the removal of the brain, as a part of the Egyptian mummification process, is poorly appreciated in the literature, as clear demonstrations of variation in mummification technique over time and across social strata are few and far between. Reporting of brain treatment is often inconsistent, greatly simplified, or simply absent in descriptions of mummified remains. In order to demonstrate the limitations of the literature and some of the variability in mummy excrebration this study makes use of two samples: (1) a literature-based sample of 125 mummies, and (2) a sample of 6 mummies examined directly using computed tomography. Three primary treatments of the brain in mummification are discussed in relation to their treatment in the literature, their radiological indicators, and their technical considerations. A pattern of increased prevalence in transnasal craniotomy, beginning around the Middle Kingdom and peaking in the Roman Period, was noted, as was the precedence of elite use of each brain treatment style relative to non-elites.

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Social bonding and benefits of gregariousness among East African chimpanzee (*Pan troglodytes schweinfurthii*) females at Ngogo, Kibale National Park, Uganda.

MONICA WAKEFIELD. Department of Anthropology, Yale University.

Social structure reflects a trade-off between the costs and benefits of group living, and fission-fusion sociality enables individuals to adjust to changing ecological and social conditions that affect this cost/benefit balance. East African female chimpanzees are generally less gregarious than males, presumably due to high costs of feeding competition. If and how they benefit from associating and forming social

bonds with other females remains unclear given that relatedness and cooperation among females are low. My previous research showed that females at Ngogo are highly gregarious relative to females at other East African sites and actively form differential social relationships with other females, but female dominance relationships are not salient. Here I examine how females may benefit from associating with other females by testing hypotheses that address association and grooming patterns among anestrous females using 1700 hours of focal female observation. Group randomization tests demonstrated that anestrous females displayed affinity for other anestrous females significantly over other classes. In addition, significantly more dyads than expected formed preferential social and grooming relationships, but these were not explained by presence and age of offspring or similar life history stages. This suggests that females can form strong social bonds even in the absence of frequent cooperative or competitive behavior and these bonds are not based on short-term interests such as offspring socialization strategies. Patterns of Ngogo female sociality are comparable to those reported for West African chimpanzees, but notably different from other East African sites, further demonstrating the range of behavioral flexibility in chimpanzees.

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Remodeling variation in the human appendicular skeleton.

ROBERT A. WALKER. Department of Basic Sciences (Anatomy), New York Chiropractic College.

Haversian remodeling in part reflects response to mechanical forces bone is subjected to during life. Variation within/among bones may thus reflect life history, once variation due to other causes is understood. Previous work in our laboratory has demonstrated bilateral symmetry in density of haversian structures (complete and fragmentary osteons) in cats, chickens, and the human forelimb. Here, we extend this work to examine histomorphology throughout the human appendicular skeleton. Densities of haversian structures at the midshafts of the femur, tibia, fibula, humerus, radius, ulna and clavicle are examined in a sample of contemporary human males and females (n = 34; 20 female, 14 male) aged 39 to 98 years. Results demonstrate that there are significant differences in mean complete and fragmentary osteon densities among bones. Proximal bones of both upper and lower limb show lower haversian structure densities than more distal elements. Males demonstrate higher complete osteon densities than females, except in the clavicle. Females exhibit higher concentrations of fragmentary osteons, and higher amounts of bone resorption. In addition to sexual differences, bone resorption is higher in proximal limb elements than in distal. The femur demonstrates more bone resorption than tibia and fibula, and the humerus more than the radius and ulna. Sexual differences in osteon densities are less marked when differences in area of bone resorbed is controlled for. Among

both sexes, osteon and fragment densities are negatively correlated with bone resorption. Higher rates of bone resorption in females results in a lower density of osteons and fragments.

Energetic costs of feeding in primates: Methods and preliminary data.

CHRISTINE E. WALL¹, MATTHEW C. O'NEILL² and JANDY B. HANNA³. ¹Dept. of Evolutionary Anthropology, Duke University, ²Dept. of Anatomical Sciences, Stony Brook University, ³Biomedical Sciences, West Virginia University.

Studies of the functional morphology of the feeding apparatus, feeding ecology, and bioenergetics provide fundamental data for understanding primate adaptation and evolution. The lack of a comparative dataset on the energetic costs of feeding is a major gap in our knowledge that limits our ability to make connections between the biomechanical events that occur during feeding and the selective pressures that influence feeding in a socio-ecological context. Here we report on methods to study the energetic costs of feeding in primates using respirometry, a non-invasive technique that provides summary information about biomechanical events during feeding (including chewing and body movements) expressed quantitatively. We recorded oxygen consumption and digital video for 4 adult *Lemur catta* males feeding on raw sweet potato and for 2 adult human females feeding on raw carrot and celery. Results show substantial variation in mass-specific feeding costs (FMR). We also recorded mass-specific resting metabolic rate (RMR). The theoretical "feeding energetic constant" (Coehlo 1974) is the ratio FMR/RMR and is set at 1.38. However, this constant is based on data from one human female. Our data show that this ratio varies between 1.24 and 1.92 and averages 1.68 for *L. catta* and 1.33 for *H. sapiens*. These findings suggest that use of a single feeding energetic constant for all primates is not appropriate, and that FMR/RMR may vary by food type. The data also emphasize the importance of measuring feeding costs for different foods and for species that vary in body size, phylogeny, and diet.

Activity, genes, and diaphyseal structure.

IAN J. WALLACE¹, KEVIN M. MIDDLETON², SVETLANA LUBLINSKY³, SCOTT A. KELLY⁴, STEFAN JUDEX⁵, THEODORE GARLAND JR.⁵ and BRIGITTE DEMES⁶. ¹Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, ²Department of Biology, California State University, San Bernardino, ³Department of Biomedical Engineering, Stony Brook University, ⁴Departments of Nutrition and Genetics, University of North Carolina, Chapel Hill, ⁵Department of Biology, University of California, Riverside, ⁶Department of Anatomical Sciences, Stony Brook University.

Limb bone diaphyseal structure is frequently used to infer hominin activity levels from skeletal remains, an approach based on the well-

documented ability of bone to adjust to its loading environment. However, diaphyseal structure is also influenced by non-mechanical factors, particularly genetics. It is therefore important to ask if genetic variation in diaphyseal structure might also have functional significance in an evolutionary context. Phenotypic traits individually acquired through a plastic response to environmental stimuli might later, under the influence of selection, become assimilated into an organism's developmental repertoire. In this scenario, genetic variation in diaphyseal structure would reflect the activity levels of members of a lineage. To address this issue we adopted an experimental evolution approach. We tested for differences in femoral diaphyseal structure in one-week-old mice artificially selected for high voluntary wheel running and unselected controls. As adults, selected mice are significantly more active and have thicker diaphyses. Structural differences at one week can be assumed to primarily reflect the effects of selection rather than direct mechanical stimuli since the onset of locomotion in mice is shortly after day seven. We hypothesized that if genetically determined diaphyseal structure reflects the activity patterns of members of a lineage, selected animals will have larger diaphyseal dimensions at one week compared to controls. The results provide strong support for this hypothesis and suggest that limb bone cross sections may not always reflect the activity levels of particular fossil individuals, but nevertheless convey a functional signal providing information about hominin activity in the past. This study was supported by Stony Brook University (IJW), Turkana Basin Institute (IJW), Leakey Foundation (IJW), NIAMS (KMM), NIAMS (SJ), NSF (TG).

Bonobo ranging behavior, the absence of lethal raiding, and the implications for human evolutionary models.

MICHEL WALLER¹, FRANCES WHITE¹, AND AMY K. COBDEN². ¹Department of Anthropology, University of Oregon, ²Department of Anthropology, Emory University

Chimpanzees (*Pan troglodytes*), our closest phylogenetic relatives, show inter-community lethal raiding that enhances mating opportunities and increases the number of feeding locations within an encroaching communities' expanded range. Consequently, this behavior has been used as a starting point for the study of the evolution of war and aggression in humans and has historically shaped the manner in which human evolutionary scenarios are constructed. As phylogenetically close to humans and having split from chimpanzees between 1.5 and 3 million years ago, bonobos (*Pan paniscus*), however, have not been found to engage in inter-community lethal raiding and, with notable exceptions, their behavior has not been given equal attention when it comes to human evolutionary models. This study compares and contrasts the size and ecology of the *Pan* species' community ranging areas, sex ratios and party sizes near ranging peripheries, and the social behavior that precludes or prevents inter-community lethal

raiding. We used GIS and GPS to plot 205 bonobo sightings at the Ndeli field site within the Lomako Forest during various field seasons spanning from 1984-2009 and compare the results with published data from chimpanzee sites. Initial analysis reveals that, unlike what is reported for chimpanzees, bonobo party sizes are not significantly larger nor are they more male-biased near a communities' border. This evidence, combined with observed peaceful interactions between neighboring community groups solidifies the notion that bonobos do not engage in lethal raiding and should aid those interested in refining the conflict/cooperation aspects of human evolution. This study was funded by The Leakey Foundation.

Evolutionary tradeoffs: How thermoregulation and the cost of mobility impact morphology.

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

In the study of human evolution and modern human diversity, the issue of evolutionary tradeoffs is of great importance. In particular, understanding the manner in which mobility strategies and thermoregulatory strategies impact the evolution of morphology is of vital importance in assessing the selection pressures on hominin populations throughout the world. In this study 10 people (5 males, 5 females) were asked to walk and run outdoors at 4 self-selected speeds for each gait while their velocity, metabolic rate and core temperatures were measured. Males and females were significantly different from each other in terms of core temperature (t-test: females being cooler, $p=0.031$) and metabolic cost (males using more energy, $p<0.001$). Males and females did not show significantly different velocities for walking, though males tended to be faster during running ($p=0.480$ for walking; $p=0.116$ for running). Core temperature was not significantly correlated with either velocity or metabolic cost for either males or females; instead, core temperature significantly increased during each trial ($p<0.01$). In other words, time spent doing activity (walking or running, slow or fast), was the most powerful predictor of core temperature for both males and females. Finally, in each of the predictive models of cost and thermoregulation, the tradeoffs between thermoregulation and mobility become more apparent: bi-iliac breadth has a positive relationship with core temperature ($p<0.001$) and a negative relationship with cost ($p=0.049$) (mass, sex and velocity are included in each model), adding further evidence that postcranial morphology reflects a balance between these two key pressures. This study was funded by the Murdock Charitable Trust, reference number 2006194:JVA:11/16/2006.

Biological affinity of ancient *Leptiminus*: An analysis of dental morphological traits.

CHERIE K. WALTH. Cultural Resources Project Manager, SWCA Environmental Consultants, Albuquerque.

This study reveals the biological affinity of the Leptiminus people. The use of dental morphological data to determine population affinity provides information on the origins, relationships, migrations, and admixture of these people with other contemporary Mediterranean populations. These studies improve our understanding of the variability of human populations by tracing historical relationships. The dental remains for Leptiminus are from individuals buried in two cemeteries that date from the 2nd to 4th century (A.D. 100-300). The comparative samples are all from published sources. These samples include one from Carthage, one from Egypt, two from Nubia, five from Italy, and one from the southern Levant, Israel. The use of dental morphological data for population affinity studies provides a means of estimating biological affinity. Frequencies of the dental traits are computed identifying common local and regional occurrences of specific traits. Phenetic similarities are ascertained with the aid of inferential statistical analysis, by comparing the suite of dental traits from the Leptiminus samples with other local and regional populations. The results indicate that the Leptiminus and Carthage samples are phenetically similar supporting the hypothesis of a distinct biological Carthaginian population. Phenetic similarity was shown to exist between one of the Leptiminus samples and a sample from south of Naples, Italy (Campani). This supports the assertion that Italian settlers were installed at Leptiminus as the historical references state. This study was funded by Kelsey Museum at the University of Michigan.

Mitochondrial DNA from pre-Columbian Tainos and the prehistoric colonization of Puerto Rico.

ALEX WANG¹, AIDA MIRO-HERRANS², WILLIAM PESTLE³, ANTONIO CURET⁴, EDWIN CRESPO⁵ and CONNIE J. MULLIGAN¹. ¹Department of Anthropology, University of Florida, ²Genetics and Genomics Graduate Program, University of Florida, ³Department of Anthropology, University of Illinois, Chicago, ⁴The Field Museum, University of Illinois, Chicago ⁵University of Puerto Rico, Rio Piedras.

The colonization of the Caribbean is believed to have originated from two possible sources: (1) the Yucatan peninsula or (2) the northern coast of South America. Archaeological and bioanthropological data suggest that the Tainos, the main pre-colonial inhabitants of the Caribbean, originated from South America. Studies of modern Puerto Rican mitochondrial DNA (mtDNA) propose that the modern population is primarily Amerindian, supporting the popular local belief that the Tainos are ancestors of modern Puerto Ricans. However, one study suggests that the modern population is more similar in genetic constitution to the Amerindians of the Yucatan peninsula. These opposing ideas led us to question whether the Tainos in Puerto Rico did in fact originate from South America, or whether there was a post-contact migration from Yucatan to Puerto Rico that has been previously undetected. In order to

address these questions, we studied the mtDNA of a prehistoric Puerto Rican population. DNA was extracted from fragments of long bones from pre-contact Tainos (radiocarbon dated to 640 - 1140 AD), which were collected in Punta Candelero on the eastern coast of Puerto Rico. Five out of 12 samples have successfully undergone PCR amplification for the 9 base pair deletion that defines mitochondrial haplogroup B. Of the five amplified samples, we found that two belonged to haplogroup B. Also, we found that addition of 0.8 mM spermidine to the amplification reaction increased the consistency and strength of the amplification.

The global impact of sutures assessed in a Finite Element Model of a macaque cranium

QIAN WANG¹, A.L. SMITH², D.S. STRAIT², C.D. BYRON³, I.R. GROSSE⁴ and B.W. WRIGHT⁵. ¹Division of Basic Medical Sciences, Mercer University School of Medicine, ²Department of Anthropology, University at Albany, ³Department of Biology, Mercer University, ⁴Department of Mechanical & Industrial Engineering, University of Massachusetts, ⁵Department of Anatomy, Kansas City University of Medicine and Biosciences.

The biomechanical significance of cranial sutures in primates is an open question because their global impact is unclear, and their material properties are difficult to measure. In this study, eight bone-suture functional units representing eight facial sutures were created in a finite element model of a monkey cranium. All the sutures were assumed to have identical isotropic linear elastic material behavior that varied in different modeling experiments, representing either fused or unfused sutures. The values of elastic modulus employed in these trials ranged over several orders of magnitude. Each model was examined under incisor, premolar, and molar biting simulations. Results demonstrate that skulls with unfused sutures permitted more deformation and experienced higher total strain energy. However, strain patterns remained relatively unaffected away from the suture sites, and bite reaction force was likewise barely affected. These findings suggest that suture elasticity does not substantially alter load paths through the skull or its underlying rigid body kinematics. An implication is that, for the purposes of finite element analysis, omitting or fusing sutures is a reasonable modeling approximation for skulls with small suture volume fraction if the research objective is to observe general patterns of craniofacial biomechanics using static analyses.

The manner in which suture morphology and ossification affect the mechanical integrity of skulls of small size awaits further investigation, and their viscoelastic properties call for high speed dynamic simulations. The work is supported by NSF HOMINID Grant 0725183.

Analyzing human midfacial outlines with conventional and elliptic Fourier transforms: a case study comparing two mathematical techniques

SEBASTIAN K. T. S. WÄRMLÄNDER^{1,2} and SABRINA B. SHOLTS¹. ¹Department of

Anthropology, University of California in Santa Barbara, ²Division of Biophysics, Stockholm University.

Fourier analysis has been frequently employed in physical anthropology as a tool for the quantitative comparison of biological forms, since Fourier coefficients capture different and often more detailed shape information than traditional Euclidean distance measurements. Since its development in the 1980's, elliptic Fourier analysis has increasingly been used in morphometric studies due to its non-parametric format and applicability to complex outlines. For less complicated outlines, however, conventional Fourier analysis remains a viable morphometric approach, given that the procedure generates fewer coefficients and more easily accessible information on shape symmetry. In this study, we compared the performance of traditional and elliptic Fourier transforms for analyzing the shape of contours obtained from the midfacial region of 3D digital models of human crania from different geographical populations. The resulting Fourier coefficients were used to quantify aspects of symmetry in the crania and to develop discriminant functions for differentiating the crania with respect to geographical affinity. The different results obtained using elliptic and conventional Fourier transforms illustrate the advantages and disadvantages of the two techniques for anthropological problems.

Metric assessment of the human bicondylar angle.

ERIN B. WAXENBAUM¹, MICHALA K. STOCK¹ and DAVID R. HUNT². ¹Department of Anthropology, Northwestern University, ²National Museum of Natural History, Smithsonian Institution, Department of Anthropology.

Investigations of the primate bicondylar angle (BA) have historically centered on the interspecific distinction between humans, nonhuman primates and hominid ancestors. The literature cites no single standard osteometric definition; BA is not a common measure in forensic or human variation studies. The goal of this presentation is to introduce participants to a method for measuring the femoral BA, tested through multiple inter- and intra-observer analyses. Two populations, male and female of a broad age range, were analyzed - Terry Black (n=50) and Terry White (n=50). All remains are housed at the National Museum of Natural History, Smithsonian Institution. Left femora were marked at 1/3, 1/2, and 2/3 of the maximum length and positioned with the distal condyles flush against an osteometric board. BA was assessed by placing a compass against the board above the femur and lining up the attached wire (positioned at the base of the compass) with the previously measured midshaft marks. This method provided readings of between 3° and 17.5° for this sample. To implement the inter- and intra-observer analyses, the femoral BA was measured independently by each observer (first two authors) twice on separate occasions. Inter-observer comparisons resulted in non-significant

variation ($p>0.8032$; $p>0.8284$); similar results were found for the intra-observer analyses (EBW, $p>0.9007$; MKS, $p>0.9281$). This presentation demonstrates the efficacy of this metric assessment of the human bicondylar angle by offering a pilot study of this methodology and suggests prospects for future research investigating potential variation in this feature by sex, age and/or population ancestry.

Step width and carrying: A biomechanical mystery solved.

DAVID WEBB and SARA BRATSCH. Dept. of Anthropology, Kutztown University, Kutztown, PA.

Initial research with a small number of subjects suggested that people carrying a heavy load in one hand (e.g., a suitcase or toolbox) make two sorts of adjustments to the placement of their feet on the substrate. The first and most obvious change is a decrease in foot angle (intoing) on the unloaded side. This puts the anterior part of the foot further under the center of mass when carrying a load in the contralateral hand and has been amply documented in subsequent studies. The second and more subtle change is a decrease in step width, a practice which also moves the foot on the unloaded side closer to the center of mass of the body-load system. However, tests subsequent to the original study did not show a consistent or significant use of this technique. Indeed, some subjects increased step width in response to moderate and heavy loads. This discrepancy between original and subsequent results in step width can be explained by the level of expertise which various subjects had. Experience carrying heavy loads may be required for most subjects to develop ways of accomodating loads. For this project, subjects were tested under two conditions: carrying an empty canvas bag; carrying the same bag with 21% of their body weight in it. All subjects walked on paper runners, wearing paint-soaked socks to leave footprint trails. Subjects were asked to walk once with no weights followed by three more times with weights. They were then given 10–15 min of practice with the weighted bag, then asked to repeat the protocol, for a total of 8 trials (2 unweighted and 6 weighted). Results show that practice does indeed make a difference in the use of a narrower step when carrying a heavy load. Specifically, the first three weighted trials show a decrease in step width that is non-significant, but the last three evince a significant reduction as compared to unweighted trials. We conclude that the initial study involved subjects who already had experience carrying a unilateral heavy load.

Analysis of lipping on appendicular joint surfaces in known age and sex samples from the Terry and Spitalfields collections.

MICHELLE L. WEBB and FRANK L. WILLIAMS. Department of Anthropology, Georgia State University.

Lipping of appendicular joint surfaces are accumulations of bony tissue where contact between two bones occurs. The degree to which

lipping of articular surfaces occurs as a function of age and sex can be resolved with cemetery populations of known individuals, such as the Terry (19-20th century) and Spitalfields (17-18th century) collections upon which we report ($n = 322$; 162 males and 160 females). Using the five point scoring system 0-4 of lipping from the Chicago Standards Guide we ask whether (1) age has an influence on the accumulation of lipping; (2) sex differences are present in patterns of lipping; and (3) museum origin is partly responsible for explaining intensity of lipping. Spearman rank correlations between joint surfaces and age are all significant. The upper limbs of males generally exhibit stronger correlation coefficients, and the proximal tibia and glenoid fossa of the scapula in females are more strongly correlated, respectively, with age. Females exhibit a significantly greater degree of lipping on the knees and proximal humerus than do males. A principal components analysis show a pronounced effect from age on the first axis, suggesting males and females age similarly overall, whereas the second axis shows females with a greater emphasis on the decay of the joints associated with the knees, whereas those of males are more often associated with a greater lipping in the upper limbs. Museum origin had a marginal but detectable effect with the Terry collection exhibiting greater intensity of lipping than the individuals deriving from Spitalfields.

A taphonomic analysis of Hadar hominins and cercopithecids: Implications for predation pressure during the Pliocene.

PAMELA WEIS¹ and ELIZABETH H. HARMON². ¹Center for Human Evolutionary Studies, Rutgers, The State University of New Jersey, New Brunswick, ²Department of Anthropology, Hunter College of the City University of New York (CUNY).

A taphonomic analysis was conducted on original mandibular and postcranial specimens of *Australopithecus afarensis* and the Cercopithecidae (*Theropithecus oswaldi darti* and Cercopithecidae indet.) from the Sidi Hakoma member (~3.4 – 3.22 mya) of the Hadar Formation. Fossils were examined for carnivore damage, breakage type and location, root etchings, insect damage, abrasion, trampling and plastic deformation. If the hominins and cercopithecids inhabited similar niches and were consumed by the same types of carnivores, this will likely be reflected in the surface modifications and skeletal part and portion representations of their fossil remains. Indeed, the results show that carnivore and non-carnivore induced traces on bone are present in broadly similar proportions between taxa, suggesting that the hominins and cercopithecids had similar taphonomic histories. However, some differences were found. The hominins exhibit a lower frequency of root etchings on mandibles than the cercopithecids. The hominins also preserve a higher proportion of tooth-marked specimens and a lower proportion of limb ends than the cercopithecids. One interpretation of this outcome is that cercopithecids and hominins experienced different levels of predation pressure based on

habitats utilized and predator types. This study was funded in part by the Wieland Fund, Department of Anthropology, Hunter College of the City University of New York.

Exploring the relationship between craniofacial morphology and cause of death in the modern Portuguese using three-dimensional geometric morphometrics.

KATHERINE WEISENSEE¹ and KATE SPRADLEY². ¹Department of Sociology and Anthropology, Clemson University. ²Department of Anthropology, Texas State University at San Marcos.

This study explores the relationship between craniofacial morphology and cause of death in the New Lisbon skeletal collection. Three-dimensional landmark coordinates were collected from 210 individuals with known cause of death. The birth dates in the sample range from 1806 to 1960. The individuals in the sample are representative of the period during which Lisbon was undergoing the modern health transition. The modern health transition is defined by a shift in mortality patterns from a period during which most deaths occurred as a result of infectious diseases, to one in which most deaths occurred from degenerative diseases. The recently proposed Fetal Origins Hypothesis suggests that environmental factors that impact early growth and development lead to long-term consequences in adult disease patterns. This study explores the effect of the modern health transition on craniofacial morphological variation, specifically examining whether factors that affect craniofacial asymmetry and differential growth and development in early life are related to cause of death in adulthood. The results suggest a significant difference in craniofacial shape between individuals that died from infectious diseases, compared to individuals that died from degenerative diseases. The relationship between asymmetry and cause of death in these two groups is also explored using geometric morphometrics. Geometric morphometrics allow for the reflection of landmarks across a plane of symmetry and therefore are especially well-suited for examining asymmetry patterns in the crania. The broader implications of this study help to interpret the underlying causes of the secular changes in cranial morphology observed in several modern populations.

Cultural continuity and cranial indices in prehistoric California Amerinds.

ELIZABETH WEISS. Department of Anthropology, San Jose State University.

Cultural continuity is frequently used as a proxy indicator for biological continuity, but anthropologists have found cultural continuity does not always indicate biological continuity. The current study examines 98 individuals from a California population (CA-ALA-329) that spans from 200 BC to 1800 AD to determine whether the site represents a single homogenous population through time. Studies conducted on this sample assumed the site's cultural

continuity signified biological continuity and homogeneity. However, skeletal indicators of homogeneity have not been tested. Cranial length and breadth were measured with a spreading caliper and cranial indices (dolichocranial, mesocranial, brachycranial) were calculated using Bass's (1995) formula. Age and sex were determined through standard procedures. Temporal periods for each burial were determined previously through radiocarbon dating and burial depths. The time periods were the Middle Period (200 BC – 899 AD), Late Period Phase I (900 AD – 1499 AD), and Late Period Phase II (1500 AD – 1800 AD). Forty-three individuals are dolichocranial, 44 individuals are mesocranial, and 11 are brachycranial (Chi-Square = 21.355, P < 0.001). Thus, data reveal biological heterogeneity. However, temporal differences in cranial index frequencies are not significant (Chi-Square = 5.193, n.s.), suggesting no population changes over time. Sex and age differences in frequencies are also not significant (Chi-Squares = 3.397 and 4.508, n.s.), which suggests differences are not related to mating patterns or growth. In conclusion, more tests are needed to determine the sample's biological heterogeneity and this study provides additional evidence that cultural similarities do not always correspond with biological relatedness.

High incidence of craniostenosis in a large ossuary collection from Switzerland (17th-19th c. AD).

ALEXANDRA WENK¹, FRANK SIEGMUND², GERALDINE D' EYRAMES¹, VIVIANE ROTH¹, CATHERINE STUDER¹ and CHRISTINA PAPAGEORGOPPOULOU^{1,2}. ¹Archaeological Service Graubünden, Switzerland, ²Seminar für Ur- und Frühgeschichte, University of Basel, Switzerland.

Craniostenosis is a condition in which some or all of the sutures in the skull of an infant close prematurely causing skull deformities and brain growth problems. Craniostenosis can occur as an isolated defect and less common as part of a syndrome (e.g. Crouzon, Apert). The prevalence of craniostenosis is one per 2200 births (Kabbani and Raghubeer, 2009). The oldest case reported comes from Atapuerca, Spain and dates to 530,000 BP (Gracia et al., 2009). The present study reports a high incidence of craniostenosis (1,1%) found in an alpine Swiss population. The sample concerns 637 skulls from Poschiavo ossuary (17th-19th c. AD). Three cases of anterior plagiocephaly (unilateral coronal synostosis), one case of posterior plagiocephaly (unilateral lambdoid synostosis), two cases of scaphocephaly (sagittal synostosis) and one case of brachycephaly (bilateral coronal synostosis) were found. Diagnosis was based on macroscopic and radiological examination. The cases were observed at 3 adult men, 3 adult women and a six years-old child. The individuals exhibit skull deformities and they have probably suffered from increased intracranial and intraorbital pressure. Differential diagnosis concerning positional plagiocephaly i.e. flattened head without premature synostosis and torticollis, i.e.

misshapen skull due to tilting of the head to one side, is also discussed. Similar cases of craniostenosis have been reported in geographically close alpine populations (Papageorgopoulou, 2009). Regarding the rarity of the condition according to clinical data and the few reports on the bioarchaeological record the presentation of such cases offers a great insight on the biological history of past populations.

Reconstructing habitual activities in Paleoamericans.

DANIEL J. WESCOTT. Department of Biological Sciences, Florida International University.

Subsistence, mobility, and other behaviors of the early Holocene inhabitants of North America can be reconstructed using long bone morphology, as biomechanical properties of human long bones provide valuable evidence for reconstructing past activity patterns of individuals and populations. The biomechanical evidence can then be combined with archaeological and other biological information to obtain a clearer view of the lifestyle of Paleoamericans. These early Holocene Americans are characterized as having great terrestrial mobility and a high dependence on megafauna, but little is known about regional variation in subsistence activities among these early inhabitants of America. Biomechanical properties of early Holocene skeletons from Kennewick, Horn Shelter, Wizard's Beach, Spirit Cave, Prospect, and Gore Creek were calculated. The strength, shape and asymmetry of both upper and lower limb bones was examined and compared among Paleoamericans and other Holocene populations practicing a variety of subsistence practices. The Paleoamericans are similar in having relatively strong lower limbs and asymmetrical upper limbs, a pattern also shared by populations reliant on inland resources. Unique patterns of long bone strength and asymmetry, however, probably reflect regional variation in the way these early Americans exploited local environments. This study demonstrates the importance of using biomechanical data from human skeletal remains to obtain a clearer picture of the lifeways of early Holocene inhabitants of North America.

Interpreting late Pleistocene footprints at the Willandra Lakes, southeastern Australia.

MICHAEL C. WESTAWAY¹, HARVEY JOHNSTON², DAVID RAICHLEN³, MATTHEW L. CUPPER⁴ and IAN GRAHAM⁵.

¹Department of Archaeology, Flinders University and Cultures and Histories, Queensland Museum, ²Department of Environment, Climate Change and Water, ³School of Anthropology, University of Arizona, ⁴School of Earth Science, University of Melbourne, ⁵School of Biological, Earth and Environmental Sciences.

Fossil footprints of humans, marsupials and birds have been recently described from Lake Garpung in southwestern New South Wales (Webb et al. 2006, Webb 2007). Webb et al.

2006 and Webb 2007 examined the footprints and their age and stratigraphic context, and interpreted the morphology, stature, weight, and speed of the people who made the prints. Here we provide additional information about the palaeoenvironment of the site and refine its age through new OSL dates. We also reassess the speed estimates calculated by Webb (2007) and discuss some of the problems associated with identifying morphological robusticity (Webb et al. 2006) from footprints in late Pleistocene populations.

Red howler defecation behavior and the hygiene hypothesis.

JESSICA L. WESTIN. Department of Anthropology, Dickinson College.

A distinguishing feature of humans is that we keep areas for defecation separate from areas for food consumption. How and when did this unique trait develop? Currently, there is great concern about the contamination of food with microorganisms, and about whether the exposure to pathogens reduces the susceptibility to allergies and asthma, i.e., the hygiene hypothesis. If other primate species exhibit such hygienic behaviors, we may need to reassess this hypothesis. I present data from red howler monkey behavior and parasite infection in Suriname, South America. Red howlers utilize latrines that are characterized by the repeated use of specific tree branches for group defecations. These branches are positioned over gaps in the canopy, in the periphery of the canopy, and lower than branches used by the monkeys for other activities, including feeding and resting. In this way, red howler latrines function to minimize exposure to a group's previously defecated feces, and care taken to avoid such should result in lower incidences of intestinal parasites. Red howlers are in effect acting hygienically. Preliminary comparisons of hygienic versus unhygienic primate behavior are explored in relation to the hygiene hypothesis and how these practices may relate to atopic disease.

This study was funded by the Rackham Graduate School and the Department of Anthropology at the University of Michigan, and by the National Science Foundation Graduate Research Fellowship.

Behavioral observations of Kinda baboons (*Papio cynocephalus kindae*) in Zambia.

ANNA H. WEYHER. Department of Anthropology, Washington University in St. Louis.

Previous work by Phillips-Conroy and Jolly suggested that Kinda baboons have distinctive friendships characterized by extensive grooming bouts in which male grooming of females predominate. In order to explore this further, I collected focal data on male-female dyads in a group of Kinda baboons (*Papio cynocephalus kindae*) in Kafue National Park, Zambia. The group numbered 81 individuals, with 18 adult males and 25 adult females. 14 adult females

were lactating, 8 females were cycling, and 3 females were pregnant. 120 focal samples totaling over 13 hours were recorded. My findings showed clearly that Kinda males do groom females significantly more (69.90%) than females groomed them (30.10%), and that this is true across all female reproductive states. These figures stand in stark contrast to grooming data for male-female friends in Amboseli, Gilgil, Segera, and Filoha hamadryas harems where males groom females less than 30% of observed grooming time. Additionally, Kinda grooming interactions were initiated by males (Males approached females 90.32% of the time), and terminated by females (females withdrew from males significantly more 72.07% of the time). These are the first behavioral data collected on Kinda baboons, and show that friendships in Kinda baboons are both qualitatively and quantitatively different from other baboon subspecies. Further behavioral data in conjunction with endocrine and genetic analysis will help us to determine more specifically why these relationships may be unique. This work was supported by grants from Washington University in St. Louis and The Explorers Club.

Sex difference in human locomotion and its skeletal correlates.

KATHERINE WHITCOME¹ and JOHN PAUL O'CONNOR². ¹University of Cincinnati, Department of Anthropology, ²Harvard University, Department of Human Evolutionary Biology.

Human males and females differ in skeletal shape and size, notably within the pelvis. The correlates of this sexual dimorphism are known with respect to obstetric function but consequence in locomotor performance is less well understood. Given that a relatively wide pelvis and therefore a wide biacetabular distance generates more gravitational torque during swing phase than a narrow pelvis, we ask do pelvic determinants of male and female gaits differ, and if so, do sexes achieve similar locomotor results in terms of gait economy? To investigate we analyzed kinematic data captured by a 3D motion system as healthy adults walked at 1.25m/s and 1.75m/s. Our groups differed anatomically in mean body mass (male 77.3kg [1.8sd], female 60.8kg [1.7sd]) and mean pelvic width (male 262.8mm [3.4], female 258.9 [4.3]). They differed kinematically in that females have a greater dimensionless stride length at slower and higher speeds (1.57 [.07], 1.92 [.02]) than males (1.46 [.08], 1.82 [.01] and have smaller excursion angles of the pelvis in the transverse plane (38.3 [13.1], 47.0 [12.2]) than males (47.7 [8.3], 53.6 [3.6]). Greater hip translation in females occurs with less angular rotation due to wide relative hip breadth. This greater fore translation of the hip augments dimensionless stride length in females, and although females are disadvantaged by greater hip torque given their relative pelvic width, they benefit from translational effects of the wide pelvis with respect to stride length.

Bonobo adult male interactions with infants and why no infanticide.

FRANCES WHITE, ROSS TINDALE, INDIA MINTON and MICHEL WALLER. Department of Anthropology, University of Oregon.

Bonobos and chimpanzees differ in adult social bonding but there is less information on interactions of adults with immatures. Chimpanzee males are aggressive towards infants and juveniles, and commit infanticide. Infanticide has not been observed in bonobos. We evaluate male behavior towards immatures in Lomako bonobos from 466 hours of focal animal follows of 205 parties. Adult female data included only interactions with immatures other than their own. Adult males and females interacted affiliatively at different frequencies with infants, juveniles, and other adults ($G=6.1122$, $p < 0.05$). Affiliative behaviors included play, grooming, and socio-sexual behaviors. Both interacted affiliatively mostly with other adults. Males interacted affiliatively with infants more than females (15% vs 3%) and slightly less with juveniles (7% vs 9%). Adult males and females did not differ in their frequencies of agonistic interactions. Most aggression was among adults (85%, $n = 41$). Adult males were not aggressive towards infants, but were towards juveniles (11% of all aggressive interactions, $n=27$). Adult females were not aggressive towards infants or juveniles of others. Male affiliation was often targeted at infants of females with a large swellings and resulted in the male approaching closer and having future contact with the female. Unlike chimpanzees, bonobos often reproduced when their infants were small so that it was common to see mothers with two infants under the age of 5 years. Affiliative interactions between adult bonobo males and infants appear to be individual strategies to influence female choice and not male alliances to kill unrelated infants. This research was supported by NSF grants BNS-8311252, SBR-9600547, and BCS-0610233 to FJW and support from the Leakey Foundation.

Ritual, integration, and female kiva societies: Bioarchaeological insights into social structure at Pot Creek Pueblo.

CATRINA BANKS WHITLEY. Department of Anthropology, Southern Methodist University, Dallas.

Identifying the labor roles of men and women in past societies and their access to power and prestige is an important aspect of identifying community organization. Bioarchaeological comparisons between males and females revealed little differentiation between the sexes, but analysis of musculoskeletal stress markers and osteoarthritis within the females revealed the presence of two female labor groups at Pot Creek Pueblo (AD 1260-1320) in the Northern Rio Grande. However, unraveling the relationship between labor groups and access to power and prestige also required spatial analysis of individual burials. Observed spatial clustering of graves around each roomblock suggests circumscribed burial locations for each roomblock. Females from both labor groups are buried in each burial cluster. The presence of mealng rooms and a female labor group with

musculoskeletal stress markers and osteoarthritis changes expected of individuals who grind corn suggest a female kiva society with access to specialized ritual knowledge. Additionally, labor groups may provide an integrative feature necessary for societal cohesion and the presence of a female kiva society may serve as an integrative function between the roomblocks, thus possibly increasing prominent roles and political power for women in the community. By focusing on a single site occupied for a relatively short period of time, approximately 60 years, and through modifying the scale at which bioarchaeological and mortuary data were combined, by analyzing musculoskeletal stress markers, health, and osteoarthritis within each sex, a more detailed understanding of the social structure was illuminated. Research funded by a National Science Foundation Graduate Research Fellowship, the William P. Clements Center for Southwest Studies, and a Philanthropic Education Organization Scholarship.

Complete mitochondrial DNA sequencing of Siberian populations.

MARK WHITTEN¹, MINGKUN LI², and BRIGITTE PAKENDORF¹. ¹Junior Scientists Group on Comparative Population Linguistics, Max Planck Institute for Evolutionary Anthropology, ²Department of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology.

The Sakha (Yakuts) are a Turkic-speaking, pastoralist population currently inhabiting northeastern Siberia in the Republic of Sakha. Archaeological evidence points to an ancestral population around Lake Baikal that migrated north around the 13th century. From about the 17th century, the Sakha underwent a population expansion in the area now known as Yakutia. Linguistic evidence shows structural changes in the Sakha language under the influence of Evenki (a Tungusic language), though previous research shows no evidence for language shift from Evenki to Sakha. It is still unclear whether these changes in the Sakha language arose from admixture between populations or social contact without admixture. Because there is wide sharing of mitochondrial DNA haplogroup C sequence types among populations in this region, it is possible that previous studies based on HVRI were unable to detect admixture between Sakha and Evenks. To gain more analytical power, we used a novel method of multiplexing and target enrichment for sequencing complete mitochondrial DNA genomes on the Illumina Genome Analyzer II. Approximately 400 entire mitochondrial DNA genomes were sequenced from five ethnolinguistic groups in Siberia (Sakha, Evenk, Even, Tuvan, Yukaghir). Our results show that a single lane of sequencing on the GAI provides an average of 50X coverage for 50 samples. By comparing these sequences to previously published HVRI sequences, we were able to verify the accuracy of this method. Using these complete mtDNA genomes will allow us to uncover any putative admixture between the populations, thus providing better insights into

the prehistory of the Sakha. This study was funded by the Max Planck Society.

Ecogeographical analysis of nutritional status in South African vervet monkeys.

PATRICIA WHITTEN¹, TRUDY TURNER², PAUL GROBLER³, JOSEPH G. LORENZ⁴, CATHERINE BARRETT⁵, MICHAEL ORTIZ¹ and JAMES D. PAMPUSH². ¹Department of Anthropology, Emory University, ²Department of Anthropology, University of Wisconsin at Milwaukee, ³Department of Genetics, University of Free State, South Africa, ⁴Department of Anthropology, Central Washington University, ⁵Neuroscience Graduate Program, Emory University.

Hormonal data from wild primate populations provide important information on physiological state that can inform conservation programs. We have reported previously that serum leptin varies across four populations of Kenyan vervet monkeys, with higher leptin in habitats and seasons with higher rainfall. However, while a number of assays have been developed to measure steroid hormones noninvasively, there are few noninvasive methods available for assessing peptide hormones like leptin that reflect nutritional state. Here we report the application of a minimally invasive procedure for sampling hormone levels using ear prick blood spots dried onto filter paper. The goals of this study were 1) to determine whether leptin could be measured in dried blood spots obtained from wild vervet monkeys; 2) to test the correlation between longitude, latitude, temperature and leptin levels in local vervet populations. An ultrasensitive leptin RIA (ALPCO) was tested using varying punch-outs of blood spots. Recovery of serum controls was estimated before and after spotting on filter paper. Leptin levels in dried blood spots of 10 adult females from 5 different sites were compared by longitude and latitude. Results indicated that measurable levels of vervet leptin could be recovered from dried blood spots using an ultra-sensitive commercial assay. Leptin recovery was highest when the entire blood spot was used. Leptin levels in adult females were significantly correlated with longitude, reflecting east-west patterns of rainfall and maximal summer temperature. These data indicate that blood spot leptin can be used as a physiological signal of habitat quality in wild primates. Funding for this research included NSF (BCS 0116465, BNS 7703322, BCS 0115993, BCS 0629321) and an Emory College IBIS grant.

Rapid field assessment of mycobacterial exposure in primates.

ALICIA WILBUR^{1,2}, LUZ-ANDREA PFISTER², ANNE STONE² and LISA JONES-ENGEL¹. ¹Washington National Primate Research Center, University of Washington, ²School of Human Evolution and Social Change, Arizona State University.

Despite decades of eradication attempts, the mycobacterial diseases tuberculosis and leprosy remain significant health threats to humans.

Tuberculosis is also known to be a significant health threat to nonhuman primates (NHPs), and it is noteworthy, both from a public health and from a primate conservation perspective, that the areas of the highest tuberculosis and leprosy incidence are those rich with NHP species. We have developed quantitative PCR assays to detect the causative agents of TB and leprosy, *Mycobacterium tuberculosis* and *M. leprae*, respectively, from a swab of the oral mucosa. A decade of research in Asia on free-ranging NHP populations representing 13 species has shown that *M. tuberculosis* and *M. leprae* DNA can be detected in oral swabs of NHPs who otherwise show no overt signs of disease. Independent immunological assays have confirmed infection status in swab-positive animals. Our buccal swab assays are phylogenetically-based, taking advantage of quantitative PCR technology, extensive mycobacterial genome data, and bioinformatics and computing advances. We are currently developing strain-typing protocols in order to maximize the use of this procedure as an early indicator of exposure to tuberculosis and leprosy in NHPs and potentially in humans. Development of this rapid, noninvasive, sensitive, and specific indicator has direct implications for management of wild and laboratory NHP populations. Further, the ability to monitor exposure in humans may inform strategies to interrupt early stages of mycobacterial transmission.

Female chimpanzees in the Kanyawara community form social bonds and utilize valuable relationships despite female dispersal and male-bonded philopatry.

KYLEB D WILD. Department of Anthropology, University of California San Diego.

The subtle and often less dramatic social lives of female chimpanzees have frequently lead researchers to underestimate the significance of female social relationships. The current study adds to a growing body of recent research demonstrating that this assumption is unwarranted. Using behavioral data collected during 15 months of study among the Kanyawara community of Kibale National Park, Uganda, the social interactions of female *Pan troglodytes schweinfurthii* are explored. Results suggest that female social relationships are more prevalent and complex than previously suspected. The results of the current study agree with recent research showing that females have high dyadic association indices (non-parametric, 2-tailed, $p < 0.05$) and selective association patterns. In addition, generalized linear models and matrix correlations show that females routinely utilize these relationships in multiple social contexts. Proximity is sought and maintained with valuable dyad partners, females solicit and receive assistance from allies during aggressive conflicts, and female allies are used to protect against the threat of infanticide. Coalitions of females compete with each other for food and status in the female hierarchy and are also used to mitigate and retaliate against male aggression. Significant individual variation exists in the choice of alliance partners, methods of relationship formation, and how these strategies are employed. These results show

significantly more complex female relationships than expected for a male-bonded species, despite the serious ecological and social constraints that limit female bond formation. This research was supported by a grant from the L.S.B Leakey Foundation.

Hand pressure during Oldowan stone tool production

ERIN MARIE WILLIAMS^{1,2} and BRIAN G. RICHMOND^{2,3}. ¹Hominid Paleobiology Doctoral Program, ²Center for the Advanced Study of Hominid Paleobiology, Department of Anthropology, The George Washington University, ³Human Origins Program, National Museum of Natural History, Smithsonian Institution.

Later *Homo* possesses a highly derived thumb that is robust and long relative to the other digits, with increased pollical musculature compared to chimpanzees. Researchers have hypothesized that this anatomy was selected in part to generate high forces and withstand high forces acting on the thumb during hard hammer percussion. Functional and EMG studies indirectly support these hypotheses; however, data are lacking on loads experienced during stone tool production and their distribution across the hand. Using a dynamic pressure sensor system (200 Hz), pressures acting across the hand were collected from a sample of experienced knappers replicating Oldowan tools. Knappers used hammerstones requiring five-digit power and three-jaw chuck grips. Using a power grip, peak pressures occurring at strike were significantly higher on digits I-III compared to pressures measured for digits IV-V. Pressure acting on digit I was not consistently higher compared with pressure on digits II-III. The distal phalanges experienced significantly greater peak pressures compared to more proximal regions of the hand. Using a three-jaw chuck, pressure at strike was significantly higher on digit II compared to the other four digits. Digit I experienced low to moderate loads across all knappers. Similar to the results during power grip, pressure during the three-jaw chuck grip was frequently highest at the distal phalanx. These results do not support the hypothesis that loads experienced during stone tool production are significantly higher on the thumb compared to the other digits. This calls into question hypotheses linking modern human thumb anatomy specifically to stone tool production. This project was funded by the Wenner-Gren Foundation's Dissertation Fieldwork Grant (#7995), the National Science Foundation's Doctoral Dissertation Improvement Grant (#BCS-0903652) and Integrative Graduate Education and Research Traineeship (IGERT #DGE 0801634) and The George Washington University's Selective Excellence Fund.

Carrying the load: Is there evidence for infant transport in the human fossil record?

FRANK L. WILLIAMS¹, LIA Q. AMARAL² and DEBORAH L. CUNNINGHAM³.

¹Department of Anthropology, Georgia State University, ²Department of Applied Physics,

University of São Paulo, Brazil, ³Department of Clinical Science and Medical Education, Florida Atlantic University.

The forearm in early bipeds may have evolved novel non-locomotor uses during the emergence of bipedalism and its dimensions should reflect these behaviors. An analysis of forelimb proportions tests whether fossil hominines, and in particular, A.L. 288-1, resemble the forelimb proportions of humans ($n = 65$) or the great apes [*Gorilla* ($n = 104$), *Pan* ($n = 64$) and *Pongo* ($n = 39$)]. Additionally, scaled joint surface dimensions are investigated for evidence of load-bearing potential among the great apes, humans and *Australopithecus afarensis* (A.L. 288-1 and A.L. 438). Brachial indices link most hominines with extant *Homo* specimens, and principal components analyses of scaled radial and ulnar joint dimensions distinguish the extant taxa. A.L. 438 falls within the range of extant *Homo* and *Pan* for nine scaled ulnar dimensions, while A.L. 288-1 falls within or near the 95% confidence ellipse for extant *Homo* for all analyses pertaining to the scaled joint dimensions of the radius and ulna. Additional differences between the hominines and the great apes include forearm bone curvature which is nearly absent in A.L. 288-1 and only moderately visible in A.L. 438. Unlike the great apes, hominines generally show a close alignment of the radius with the ulna, and a marked interosseous crest, albeit insipient in A.L. 288-1. Evidence of load-bearing potential among the great apes, humans and *Australopithecus afarensis* is discussed using the concept of the forearm as a lever of the third kind to help explain constraints imposed from manual infant transport. This study was funded by the NSF (BCS-0234193), Sigma Xi and AMNH.

Heritability of axial quantitative ultrasound measures of bone strength in children from the Jirel population of eastern Nepal.

KIMBERLY D. WILLIAMS¹, JOHN BLANGERO², MIRYOUNG LEE³, THOMAS DYER², JANARDAN SUBEDI⁴, BHARAT JHA⁵, SARAH WILLIAMS-BLANGERO² and BRADFORD TOWNE³. ¹Department of Anthropology, Temple University; ² Department of Genetics, Southwest Foundation for Biomedical Research; ³Department of Community Health, Wright State University; ⁴Department of Sociology and Gerontology, Miami University; ⁵Tribhuvan Institute of Medicine (Kathmandu, Nepal).

Bone strength and quality predict fracture risk, and risk of osteoporosis in later life. These important aspects of bone health are largely defined during childhood and are influenced by genetic and environmental factors. Measures of speed-of-sound (SOS) obtained using quantitative ultrasound (QUS) reflect properties of bone including cortical thickness, bone density, trabecular microstructure, and elasticity. In contrast to more commonly used calcaneal QUS measures that serve as proxies for skeletal bone strength and quality of the skeleton, this study presents results pertaining to properties of long bones. Specifically, we present initial findings from axial QUS measures

of load bearing and non-load bearing bones in children from the Jirel ethnic group of eastern Nepal. In this pilot study we sought to test the feasibility of collecting these assessments in a rural field setting, and to estimate the heritability of these measures in a subset of this study population. Data were collected from 226 children (116 boys, 110 girls) aged 4 to 18 years, most of whom belong to one very large extended pedigree. We used a variance components-based method to estimate additive genetic heritabilities of SOS measures of the distal radius (SOSarm) and the midshaft tibia (SOSleg). The heritability of both measures of axial bone strength were highly significant (SOSarm: $h^2(\text{SE}) = 0.77(0.18)$, $p < 0.00003$; SOSleg: $h^2(\text{SE}) = 0.52(0.15)$, $p < 0.00009$). This work serves as a foundation for a more comprehensive study examining specific genetic and environmental factors influencing bone development and health in different parts of the growing and maturing axial skeleton. This work was supported by a Wright State University Boonshoft School of Medicine Seed Grant, and NIH grants F32HD053206, R01HD40377, R01AI37091, R01AI44406, and R37MH59490.

Morphological integration and the knuckle-walking “complex”: Implications for the evolution of knuckle-walking and bipedalism.

SCOTT A. WILLIAMS. Department of Anthropology, University of Illinois, Urbana-Champaign.

Current debate surrounding the evolution of knuckle-walking is concerned with whether or not knuckle-walking behavior and its associated morphologies are homologous in chimpanzees and gorillas. Some researchers have discussed the presence of a “complex” of highly inter-correlated morphologies in the chimpanzee and gorilla wrist and hand. That traits related to knuckle-walking might interact as a functional complex and evolve in a correlated bundle suggests that they could have been relatively easily recruited and evolved in parallel in gorillas and chimpanzees, thus increasing the likelihood of homoplasy. This research tests the hypothesis that a knuckle-walking complex exists (i.e., strong correlations among knuckle-walking traits and shared patterns of integration among knuckle-walkers) using the methods of morphological integration. Twenty-eight linear distances of the third manual ray and capitate are measured from museum specimens of the following species using digital calipers (*H.sapiens*, $n=88$; *P.troglodytes*, $n=76$; *P.paniscus*, $n=17$; *G.gorilla*, $n=86$; *G.beringei*, $n=34$; *P.pygmaeus*, $n=42$).

Because variation due to sexual dimorphism can obscure inter-trait correlations, a difference of means sex correction is applied to each species. Observed correlation matrices are compared by examining patterns and magnitudes of integration and conducting a series of Mantel and Dow-Cheverud tests. Results indicate that chimpanzees and gorillas are not characterized by high magnitudes or unique patterns of integration to the exclusion of non-knuckle-walking taxa. These results suggest that a distinct knuckle-walking “complex” does not exist and provides evidence for both the

homology of knuckle-walking in chimpanzees and gorilla and the contention that hominin bipedalism evolved from a knuckle-walking ancestor.

Sleep as a risk factor for cardiovascular disease: The relationship between sleep, sleep quality, blood pressure and inflammation in older Americans.

SHARON R. WILLIAMS. Department of Anthropology, Purdue University.

Sleep has recently been a focus of research on the development of chronic diseases at older aged. Both short sleep duration and poor sleep quality have been associated with the development of chronic diseases such as cardiovascular disease and diabetes, but the potential mechanisms are unclear. In order to explore the relationship between sleep and more traditional risk factors associated with cardiovascular disease, self reported sleep duration, sleep quality, blood pressure and C-reactive protein levels from a nationally representative sample of older adults (age 58-85) in the United States ($n = 3002$). Data was collected in the homes of participants during 2005-2006. Both males and females reported a similar number of hours of sleep and similar rates of restless sleep. Sleep quality and hours of sleep were not associated with age in women, but older men reported longer sleep duration than younger men. Neither C-reactive protein levels nor blood pressure were associated with number of hours of sleep. Sleep quality was significantly associated ($p < 0.05$) with C-reactive protein levels in males but not females. Sleep quality was not significantly associated with systolic or diastolic blood pressure for either males or females, when controlled for age. The results of this research suggest that there is no clear pathway for the relationship between sleep and cardiovascular disease through more traditional cardiovascular disease risk factors. The National Health, Social Life and Aging Project (NSHAP) is supported by NIH - the National Institute on Aging, Office of Women's Health Research, Office of AIDS Research, and the Office of Behavioral and Social Science Research (5R01AG021487).

Ancient Swahili origins: A mitochondrial study of ancient inhabitants of the Kenyan coast.

SLOAN R. WILLIAMS¹, CHAPURUKHA M. KUSIMBA² and KEN BATAI¹. ¹Department of Anthropology, University of Illinois at Chicago ²Department of Anthropology, The Field Museum, Chicago.

Scholars have long assumed that the ancestors of Swahili peoples were protoBantu who immigrated into the region some three thousand years ago from West Africa. Despite recent studies of modern population genetics in East Africa, the population dynamics of the coastal region remains poorly known. We carried out a

genetic study on human remains excavated at three coastal sites Mtwapa (ca. 1732 BCE), Tuaca (ca. 800 AD), and Jumba (ca. 1000 ACE). MtDNA was extracted from the well-preserved teeth of five Swahili samples. Partial HVRI mtDNA sequences were obtained for each sample. The three MtwapamtDNA sequences are early African in origin and belong to haplogroups L2a, L0f and L1c. The first two haplogroups are found throughout East Africa in Bantu-, Nilotic- and Cushitic-speaking groups. Both haplogroups are present in modern Taita (L2a=6%, L0f=13%) and Mijikenda (L2a=14%, L0f=2%) who live in the area today. The L1c haplogroup is common in central African Bantu groups and is also found in the Taita and Mijikenda in low frequencies (4% and 7% respectively). The Jumba sequence contained transitions at nps 16223 and 16290, placing it in either the L0 or L2 haplogroup. The Tuaca sample was poorly preserved, but one sequence fragment contained anp 16189 substitution. The preliminary results show a diverse coastal population that likely included genetic input from nonBantu groups as well. This research was funded by the African Research Council.

The feeding experiments end-user database (FEED).

SUSAN H. WILLIAMS¹, VLADIMIR GAPAYEV², XIANHUA LIU², REBECCA Z. GERMAN³, CHRISTOPHER J. VINYARD⁴ and CHRISTINE E. WALL⁵. ¹Dept. of Biomedical Sciences, Ohio University, Athens, ²NESCent, Durham, NC, ³Dept. of Rehabilitation & Phys. Med., Johns Hopkins University, ⁴Dept. of Anatomy and Neurobiology, NEUCOM, Rootstown, OH, ⁵Dept. of Evolutionary Anthropology, Duke University.

Over the past 35 years, researchers have collected impressive datasets on motor patterns of muscles and associated movements and forces in the jaws and oropharyngeal apparatus during feeding across a wide range of primates and other mammalian species. Individually, the datasets demonstrate the physiological and behavioral complexity of mammalian feeding. Further understanding of the evolutionary basis of this complexity depends on inter-specific comparisons which are not possible without bringing individual datasets together in a comprehensive database. The utility of a database for synthetic research, in turn, depends on aligning the data recordings, behaviors, morphologies, and data acquisition protocols with respect to a common ontological language. Here we report on a database that will serve as a repository for experimental physiological data on mammalian feeding and efforts to develop an ontology for behavioral, morphological and physiological feeding data. The Feeding Experiments End-user Database (FEED) will be a publicly available, web-based resource and the first major database of organism-level physiological data. The most common types of data within FEED are EMG, bone strain, and kinematic recordings made during chewing and swallowing. FEED will support easy upload and storage of raw data recordings and associated metadata. End-users will be able to search FEED using controlled attributes and keywords

in free-text descriptions, and to download raw data recordings and associated metadata in formats suitable for post-processing and statistical analysis. We anticipate that the use of FEED will lead not only to new scientific findings but also to new studies on novel mammalian species. FEED is funded by the National Evolutionary Synthesis Center (NESCent), an NSF-funded center that facilitates synthetic research in the biological sciences.

Secondary osteon cross-sectional size and morphotype score are independent in limb bones subject to habitual bending or torsion.

TYLER J. WILLIAMS, CHASE N. JARDINE, KENDRA E. KEENAN, JOHN G. SKEDROS and CASEY J. KISER. Dept. of Orthopaedics, Univ. of Utah School of Medicine, Salt Lake City.

Secondary osteons enhance mechanical toughness (energy absorption) in cortical bone. Osteon-related characteristics that enhance toughness include: 1) interfaces provided by cement lines, and 2) osteon cross-sectional size (diameter). An additional, less studied, characteristic involves variations in osteon collagen/lamellar organization known as 'morphotypes' (Skedros et al., 2009 BONE). In view of data showing that differences in osteon diameters can differentially influence tissue mechanical properties by influencing osteon pullout (Hiller et al., 2003 J. Orthopaedic Research), a relationship may exist between osteon diameter and morphotype score. As we and others (van Oers et al., 2008 BONE) have suggested, when osteon diameter optimizes pullout as a means for absorbing energy in tension environments, deleterious shear stresses increase toward the cement-line interface. Consequently, morphotypes that influence pullout (e.g., peripherally "hooped" morphotypes) would be expected when a beneficial influence of osteon diameter occurs; e.g., in large osteons in "tension" locations. We tested this hypothesis by correlating osteon diameters with morphotype scores using five osteons from each image from our previous study. This diameter/morphotype relationship was also examined in: 1) "tension" vs. "compression" cortices, and 2) between smaller/larger osteons (150 micron diameter cutoff). In addition to using bones previously studied (horse radii and calcanei, and deer calcanei), we examined the proximal (80%) diaphysis sections from eight adult chimpanzee femora. Results reject the hypothesis that larger osteons are associated with "hooped" morphotypes; this was consistent whether the data were evaluated in correlation analyses, in comparisons considering tension vs. compression regions, or with the 150-micron diameter cutoff.

Status and health at the King Site revisited: Results and conclusions from recent burial and DNA analysis.

MATTHEW A. WILLIAMSON¹ and DAVID J. HALLY². ¹Department of Health and Kinesiology, Georgia Southern University,

²Department of Anthropology, University of Georgia.

Located on the Coosa River in northwest Georgia, the King Site (9FL5) was occupied during the middle decades of the sixteenth century. Extensive excavation, detailed documentation, good preservation, and collection of 249 burials make it an ideal location for using mortuary analysis to look for status differences in health and lifeways. Since the topic was first addressed by Blakely and colleagues (1988), more detailed artifact and structure analyses have been performed, additional burials have been excavated and analyzed, and more detailed pathological analysis has been done. Both ascribed and achieved statuses have been identified at King. Burial of several adults and children north of a public plaza suggests membership in the town chief's matriline. Artifact assemblages found in burials indicate several achieved statuses including warrior, ritual specialist, and craft specialist. Results indicate that intentional cranial modification is absent among individuals of high status. Indeed, only two individuals with cranial modification had any burial artifacts at all. Periostitis is also absent among high status individuals while lesions are present on 25 percent of low status individuals. There is a very low frequency of carious lesions among those of high status but the frequency of enamel hypoplasias was about the same between the two groups. The lack of periostitis and carious lesions suggest that the high status individuals enjoyed better overall health and perhaps a more varied diet. Finally, special attention will be given to an apparent female warrior who was interred with artifacts found almost exclusively with males.

Southeast Asian leaf monkeys.

MARY S. WILLIS¹ and BARTH W. WRIGHT². ¹Department of Anthropology, University of Nebraska Lincoln, ²Department of Anatomy, Kansas City University of Medicine and Biosciences.

Colobine primates are united in their exploitation of a high percentage of leaf matter and have been described as 'quite homogeneous' in terms of dental morphology. However, these observations obfuscate substantive differences in morphological, developmental, physiological, and behavioral traits, which may reflect the degree to which Asian colobines rely on mastication, versus gut volume and retention time, when ingesting and digesting leaves. In this study, we integrate data related to food acquisition, ingestion, and digestion, e.g., dental, craniofacial, physiological, developmental, and behavioral data, with data on the mechanical and nutritional properties of colobine foods to examine ecomorphological relationships among Southeast Asian taxa. We identify variation in dental and craniofacial patterns among species and genera, many of which extend the life of the dental occlusal surface and hence minimize gut passage time. Furthermore, we uncover a variety of specializations in one or more areas of the food acquisition and processing complex

which contextualize a given dental pattern. For example, captive studies of Vietnamese colobines revealed morphological differences that are related to the site where food processing is longest in duration. Although there were no significant differences in selected leaf toughness or time spent chewing leafy foods, there were significant differences in feeding rate. *Trachypithecus* species chewed foods twice as fast as *Pygathrix* species; thus the former likely emphasizes food comminution by mastication while *Pygathrix* emphasizes the breakdown of leaf matter in the gut. This multifaceted analytical approach to food acquisition and processing provides new insights into colobine variation and ecomorphological adaptation.

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Food resources affect the timing of intercommunity interactions in the Kanyawara community of chimpanzees, Kibale National Park, Uganda.

MICHAEL L. WILSON^{1,2}, MICHAEL WELLS², SONYA KAHLENBERG³ and RICHARD W. WRANGHAM⁴. ¹Department of Anthropology, University of Minnesota, ²Department of Ecology, Evolution and Behavior, University of Minnesota, ³Department of Biology, Bates College, ⁴Department of Anthropology, Harvard University.

Intergroup aggression by male chimpanzees (*Pan troglodytes*) has been documented at all non-isolated long-term study sites, and continues to inspire efforts to explain the origins of human warfare. Nonetheless, the primary function of intergroup aggression in chimpanzees remains unclear. Several different functions have been proposed: recruiting fertile females, eliminating rivals, and acquiring access to key food resources. While these hypotheses are not mutually exclusive, they do yield contrasting predictions. To test these hypotheses, we analyzed 15 years of data on intercommunity interactions, ranging and feeding behavior in the Kanyawara community of chimpanzees, Kibale National Park, Uganda. We found that intercommunity interactions occurred infrequently (median = 0 per month), except during times of abundant crops of non-fig fruits. One species in particular, *Uvariopsis congensis*, had a strong effect on the timing of interactions, likely due to its occurrence in groves located along the boundary with a powerful rival community. Months in which chimpanzees fed predominantly on *Uvariopsis* fruits accounted for only 4% of the study period, but yielded 29% of all intergroup interactions. The patterns of interactions documented in this dataset support earlier findings that male chimpanzees are highly motivated to recruit new females and to eliminate rivals when (low-cost) opportunities to do so present themselves. However, such opportunities are rare, whereas every day, male chimpanzees are also highly motivated to find, monitor and consume food

resources. In this population, the timing of intercommunity interactions appears strongly driven by the distribution and abundance of food resources. This study was made possible by funding from National Science Foundation grants IOS-0416125, BSC-0648481 and the University of Minnesota.

Musculoskeletal markers of the ankle and foot: another look at obesity's effect on modern American white males.

REBECCA WILSON¹, KANYA GODDE^{1,2} and ERIN KNAPP¹. ¹Department of Anthropology, University of Tennessee, Knoxville, ²Department of Health Sciences, South College of Tennessee.

Markers of occupational stress are frequently evaluated in skeletal analyses in order to suggest possible activities in prehistoric populations. Recent biomechanical research suggests that long term morbid obesity may cause a greater expression of muscle development (Godde and Wilson 2008; Knapp et al. 2009). Due to the lack of published research evaluating the lower tibia, fibula, and tarsal muscle attachment sites for differences in robusticity scores, this research identifies and defines important muscle attachment sites and highlights differences in both robusticity and severity scores among different body masses. The study utilizes a sample of 105 modern American white males from the William M. Bass Donated Skeletal Collection to identify trends in the ankle and foot for average, obese, and athletic individuals. Robusticity and stress scores for each muscle were scored following Hawkey and Merbs (1995), and were evaluated using logistic regression to identify possible models for predicting activity level. The results suggest that the calcaneal muscle attachment sites display the most significant differences between obese and non-obese individuals, followed by those on the lower fibula. These findings support previous results for the hip and knee in which there is significant difference in the distribution of the severity of robusticity markers across body weight and activity. These associations support both activity (Hawkey 1988; Hawkey and Merbs 1995; Lane and Steen 1998) and body weight (Weiss 2003; Zumwalt et al. 2000) as contributors to the formation of musculoskeletal stress markers. However, they acknowledge another contributing factor, joint stabilization.

Dental chipping: Contrasting patterns of microtrauma in Eskimo and European populations.

JACOB R. WINN and G. RICHARD SCOTT, Department of Anthropology, University of Nevada, Reno.

While the study of dental wear has enjoyed wide popularity for over 100 years, dental chipping, or microfractures of the tooth crown, has received little attention. Observations on dental chipping in populations from the Arctic (St. Lawrence Island, Alaska) and Europe (medieval Norway and Spain) reveal patterns of microtrauma that provide insights into the

dietary and tooth-tool use behavior of earlier populations. St. Lawrence Island Eskimos, with an emphasis on consuming tough and frozen foods, in combination with extensive tooth-tool use, exhibit a pattern of chipping that is characterized as 'molar dominant.' The two European samples both exhibit an 'incisor dominant' pattern but contrast markedly in frequencies, with medieval Norwegians showing significantly more chipping than medieval and post-medieval Spanish. The systematic study of chipping promises to provide a new perspective on how populations used and/or abused their dentitions in earlier times.

Evidence that selection against aggression juvenilized bonobo social psychology.

VICTORIA WOBBER¹, BRIAN HARE² and RICHARD WRANGHAM¹. ¹Department of Human Evolutionary Biology, Harvard University, ²Department of Evolutionary Anthropology, Duke University.

Bonobos exhibit significantly lower levels of aggression than chimpanzees, potentially due to selection for reduced aggression. We propose that this selection, in turn, caused differences in multiple social behaviors between the two species. Mammalian populations that have been artificially selected for low levels of aggression tend to exhibit altered patterns in the ontogeny of their social behavior. Therefore we tested the reduced aggression hypothesis by comparing the development of social behavior in bonobos and chimpanzees. First, we compared tolerance during food sharing across ages. We found that chimpanzees become increasingly intolerant of sharing as they reach adulthood while bonobos maintain juvenile levels of tolerance into adulthood. Second, we investigated the ontogeny of social inhibition skills involved in feeding competition. In two different tests, we found that bonobos exhibit developmental delays relative to chimpanzees in the acquisition of adult levels of social inhibitions. These findings suggest that bonobos underwent selection acting on developmental pathways that altered both their social behavior and cognition and resulted in reduced aggression. Given that unique human social cognition may have evolved due to developmental shifts as well, understanding bonobo evolution will allow for inferences regarding the role of ontogenetic change in our own species' evolution. The research of B.H. was supported in part by a Sofja Kovalevskaja award received from The Alexander von Humboldt Foundation and the German Federal Ministry for Education and Research.

The functional and phylogenetic implications of *Paranthropus boisei* gnathic and dental morphology.

BERNARD WOOD Center for the Advanced Study of Hominin Paleobiology, Department of Anthropology, The George Washington University, Washington, DC and the Human Origins Program, National Museum of Natural

History, Smithsonian Institution, Washington, DC.

The dominant signal from alpha taxonomic studies and from cladistic analyses is that *Paranthropus boisei* is both morphologically distinctive and one of the most, if not the most, derived of all hominin taxa. So researchers (including this one) have tended to assume that all of its distinctive gnathic and postcanine tooth morphology is derived, but this assumption has not been tested. This presentation will use the available fossil comparative data to test that assumption. It will also suggest ways in which the same morphological evidence can be used to generate testable hypotheses about the masticatory adaptations of *P. boisei*. Research incorporated into this presentation was supported by the George Washington University's Selective Excellence Fund.

Where do men's foods go? The sharing and eating of male acquired foods among the Hadza.

BRIAN M. WOOD¹, FRANK W. MARLOWE². ¹Department of Human Evolutionary Biology, Harvard University ²Department of Anthropology, Florida State University.

Our research among Hadza hunter-gatherers of northern Tanzania indicates that men distribute the foods they acquire in ways that directly benefit their wives, their households, their kin, and their wife's kin. We base this claim on measures of the distribution of more than 200 male acquired foods, including large game, small game, honey, and fruit, acquired between 2005 and 2009. Across all resource classes, the acquirer's household typically retains shares much larger than those received by other households in camp. Using a sample of 52 complete food distributions by married men, we show that wives eat more of their husband's foods than do other women in camp, and that wives eat more of their husband's foods than he does while in camp. We also show that children who live in the household of a male acquirer eat more of his food than do other children in camp. We argue that men's food acquisition and sharing practices reveal a strong motivation to provision spouses and children. We believe this feature of the sharing and eating of male acquired foods is a defining trait of Hadza pair bonds. These findings refute some key aspects of the costly signaling and show-off hypotheses as they have been applied in previous studies of Hadza foraging. We discuss these results as they relate to the origins of foraging, food sharing, and reproductive strategies. This study was funded by the Leakey Foundation, the Wenner Gren Foundation, and the National Science Foundation.

The space of war: Connecting geophysical landscapes with skeletal evidence of warfare-related trauma.

HEATHER WORNE¹, CHARLES R. COBB², GIOVANNA VIDOLI¹ and DAWNIE WOLFE STEADMAN¹. ¹Department of Anthropology, Binghamton University. ²South Carolina Insti-

tute of Archaeology and Anthropology, University of South Carolina.

This paper examines the topography of warfare among Mississippian groups in the Middle Cumberland Region (MCR) of Tennessee. Few studies thus far have focused primarily on warfare in the MCR, however, the presence of fortifications, pictographic representations of warfare and osteological evidence of trophy taking suggest that intergroup warfare was present in the region. Our paper explores the geographic patterning of warfare from a number of cultural and ecological perspectives. Approximately 1761 individuals from 13 MCR skeletal samples were examined for the presence of interpersonal trauma, including cranial blunt force trauma, scalping, projectile point injuries, and decapitation or dismemberment. Approximately 3.3% of the entire MCR sample shows evidence of interpersonal trauma, with individual sites having rates ranging from 0-13.6% (although sampling bias may have had a considerable effect on the higher rates). Of the 3.3% of individuals from the MCR showing evidence of interpersonal trauma, 22% were female, 64% male. The most common types of injuries present were cranial blunt force trauma and scalping. GIS analysis of over 300 sites allows integration of skeletal data with ecological and physiographic variables to better examine the topography of warfare. Key variables in this study include how trauma frequency correlates with inter-site distances (village aggregation), site size, presence of fortifications, and ecological catchments. Preliminary analysis suggests that, through time, site density and the prevalence of fortifications increase. Further, settlements disperse to secondary drainages in higher elevations. These and other patterns suggest a spatial response to chronic regional conflict with direct implications for health. Supported by NSF grant to DW Steadman and CC Cobb (BCS-0613173).

Ranking morphological characters by phylogenetic signal: an approach using null models.

STEVEN WORTHINGTON. Center for the Study of Human Origins, Department of Anthropology, New York University, and New York Consortium in Evolutionary Primatology (NYCEP).

Morphological characters often carry mixed 'signals' reflecting functional, phylogenetic and developmental processes, which increase the degree of 'noise' in phylogenetic studies. It would therefore be advantageous to be able to distinguish between those traits that are conserved over a given phylogeny and those that reflect more proximate influences. To do this, the signal content of individual traits must be emphasized over that of whole character matrices. Metric data on sixty morphological characters were collected for twelve extant anthropoid taxa (n=520). Traits were coded and then compared on their ability to recapture phylogenetic relationships inferred from molecular data. For each trait, observed states were randomly permuted (using the maximum

number of possible enumerations) and each iteration was superimposed onto a molecular-based tree topology producing a null sampling distribution of tree lengths. This null model represents an hypothesis of no phylogenetic signal in the trait for the taxa sampled. The states in the observed data were then forced onto the same tree topology, and the number of evolutionary transformations (steps) under parsimony were counted for each trait. P-values were calculated that represent the probability of achieving a tree as short, or shorter, than that for observed data under the null model. Traits were then ranked against one another based on their p-values. For tree inference, it was found that character matrices composed of highly ranked traits performed significantly better than those that also included lowly ranked traits, since they reflect a better 'noise' to 'signal' ratio for the sampled taxa. This study was funded by NSF 0824496, NSF (NYCEP IGERT) 0333415, The Leakey Foundation, and the Systematics Research Fund of The Linnean Society of London.

Early maltreatment, adrenal regulation, and adult depression among rural Nepali: gene-environment interactions in life history.

CAROL M. WORTHMAN¹, BRANDON A. KOHRT¹, KERRY J. RESSLER² and ELISABETH B. BINDER². ¹Department of Anthropology, Emory University, ²Department of Psychiatry and Behavioral Sciences, Emory University School of Medicine.

Mounting evidence supports a role of allelic variation in sensitivity to early experience for facultatively adjusting psychobehavioral dispositions and mental health risk, exemplified by development of psychiatric disorders from gene-environment interactions involving the hypothalamic-pituitary-adrenal (HPA) axis and early trauma. In a cross-sectional community study of 705 adults in Jumla District, Nepal, depression was assessed with the Beck Depression Inventory (BDI), posttraumatic stress disorder (PTSD) with the PTSD Checklist-Civilian Version (PCL-C), and childhood maltreatment with the Childhood Trauma Questionnaire (CTQ). Single nucleotide polymorphisms in the FKBP5 gene were genotyped for 682 participants. Cortisol awakening response (CAR) was assessed in a subsample of 118 participants with three days of salivary cortisol collected at and 30 minutes after waking. The FKBP5 tag-SNP rs9296158 showed a main effect on current depressive symptoms ($p=0.03$), whereby homozygous carriers of the A allele manifested greatest symptom severity. Interaction of rs9296158 and childhood maltreatment predicted adult depressive symptoms ($p=0.02$) but not PTSD. A significant interaction also was observed between rs9296158 and childhood maltreatment on CAR. Overall, FKBP5-by-maltreatment interaction explained 14% of between-subject CAR variation. Long-term effects of childhood maltreatment on CAR were restricted to A allele homozygotes, with a negative CAR and overall hypocortisolism in the rs9296158 AA genotype and child abuse group. In sum, in this population FKBP5 polymorphisms interact with

early trauma, leading to long-term dysregulation of the HPA axis and significant depression symptoms. Findings support the relationship of psychosocial resources to reaction norms and underscore the adaptive significance of epigenetic processes in psychobehavioral variability.

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Sex differences in stick use by subadult chimpanzees (Kanyawara, Kibale, Uganda).

RICHARD WRANGHAM¹ and SONYA KAHLENBERG². ¹Department of Human Evolutionary Biology, Harvard University, ²Department of Biology, Bates College.

Sex-typical play behavior has been documented in human children cross-culturally, including more play with dolls by girls and more play with weapons by boys. Hypothesized causes of such differences include influences from biology (e.g. higher fetal androgen exposure in boys) and environment (e.g. children modeling sex differences in behavior of adults). Young chimpanzees are known to play with objects such as sticks, including carrying them for no obvious purpose and using them as weapons, but sex differences in object play have not been studied to date in any wild non-human species. Here we review 14 years of observational data from habituated chimpanzees of the Kanyawara community in Kibale National Park, Uganda. We test the hypothesis that sex differences occur in subadult object play, and that they are explicable by sex differences in adult behavior. Using more than 120 observations of stick use, we found that stick carrying was the most common form of object use by subadults, and was significantly more common among females than males. By contrast use of sticks in aggressive displays was more common among males. Adult males also used sticks during aggression more than females, supporting the possibility that subadult males copied adults. However, adult females never carried sticks in the manner of juveniles. Our data show that, like humans, young chimpanzees exhibit sex differences in object play, and we hypothesize that stick carrying by females may be a form of doll play. This study was made possible by National Science Foundation, grant number 0416125.

You are how you eat: hard food feeding behavior in primates.

BARTH W. WRIGHT and KRISTIN A. WRIGHT. Department of Anatomy, Kansas City University of Medicine and Biosciences, Kansas City, Missouri.

Reconstructing the dietary niches of extinct primates is a central goal of paleoanthropology. Recent findings suggest that the trophic niches of particular hominins were defined by the seasonal, or year round but infrequent, consumption of large hard foods. Alternative views suggest that small hard foods may account for the morphological features we see in these hominins, while others emphasize the use

of large, tough underground storage organs. What all these existing models lack is a detailed analysis of the structure of consumed items and the manner in which foods, particularly mechanically demanding foods, are processed by extant primate species. In this study we qualitatively and quantitatively describe the foods and feeding behavior of various primates. We first emphasize the foods and feeding behavior of tufted capuchins, which exploit hard items, yet incorporate their extremities, tools, and anterior dentition in various combinations to gain access to easily digested tissues. We then turn to two lineages of SE Asian colobine, which superficially appear to have comparable diets and ingestive behavior, and yet demonstrate variation in the degree to which they rely on their dentition and upper digestive tract for leaf processing. These colobines also exhibit variation in positional behavior that reflects their different leaf feeding strategies. The findings from this study reveal the need to incorporate detailed data on extant primate food structure and ingestive behavior in reconstructions of fossil primate dietary niches. It appears that "hard" is a very relative term when it comes to primate foods, feeding behavior, and morphology. This study was funded by NSF grant BCS #0725136 and the Kansas City University of Medicine and Biosciences.

Adaptations in prosimian glenohumeral joint structure relative to posture and locomotion.

ADRIAN S. WRIGHT-FITZGERALD¹ and ANNE M. BURROWS^{2,3}. ¹Department of Health Sciences, Sargent College of Health and Rehabilitation Sciences, Boston University, ²Department of Physical Therapy, Duquesne University, ³Department of Anthropology, University of Pittsburgh.

While the comparative osteology of the shoulder joint complex across primates is relatively well understood, the soft-tissue morphology is relatively poorly understood. The present study compares soft-tissue morphology of the shoulder joint components (the acromioclavicular, coracoclavicular, and glenohumeral joints) among broad phylogenetic, locomotor, and postural behavior ranges in prosimian primates. Adult specimens of *Galago moholi* (a vertical clinger and leaper), *Cheirogaleus medius* (an arboreal quadruped), *Eulemur macaco* (an arboreal quadruped that also frequently engages in suspensory behavior), and *Tarsius syrichta* (a vertical clinger and leaper) were dissected. Due to their role in glenohumeral joint movement and stabilization, the rotator cuff muscles were also dissected and weighed among the species. Results showed that muscle mass of individual components of the rotator cuff musculature do appear to be adaptive in the present study. Two soft-tissue components of the glenohumeral joint, but not the acromioclavicular and coracoclavicular joints, also were adaptive. The quadrupedal species, *C. medius* and *E. macaco*, both had glenohumeral ligaments and *E. macaco*, which also uses suspensory postures, had a relatively deeper articular surface for the humerus due to the shape of a deep, "cup-like" glenoid labrum.

Additionally, the present study noted a lack of a teres minor muscle in *G. moholi*, *C. medius*, and *E. macaco* despite previous studies describing them. A relatively robust teres minor muscle was found in *T. syrichta*. Overall, these results show that soft-tissue joint morphology itself may not be as adaptive as osseous morphology.

Strong lemurs, tough foods: Interpreting feeding ecology through food mechanical properties.

NAYUTA YAMASHITA¹, FRANK P. CUOZZO², and MICHELLE L. SAUTHER³.

¹Dept. Anthropology, University of Southern California, ²Dept. Anthropology, University of North Dakota, ³Dept. Anthropology, University of Colorado-Boulder.

Knowledge of dietary mechanical properties can provide insights into the behavioral approach an animal takes to procuring and ingesting particular foods. Furthermore, food properties can be informative about the relative impacts of particular foods in the diet and the physical consequences to their lemur consumers during ingestion and mastication. We measured and compared toughness values of individual food parts in the diets of two dry forest lemurs, *Lemur catta* and *Propithecus verreauxi*, in two sampling periods, 1999-2000 and 2008. Toughness, among other properties, of food parts was measured with a portable mechanical tester in the field immediately following food collection.

We report on toughness values of different food species and plant parts across seasons in the diets of the two lemurs and focus on toughness differences among foods. Toughness patterns within lemur species are not necessarily seasonal and show strong intraseasonal signals. For *L.catta*, the ripe and unripe fruits of *Tamarindus indica* are the toughest foods eaten in either season ($R = 3504 \text{ J m}^{-2}$ and 1313 J m^{-2} respectively) and are solely responsible for the high toughness of their diets. For *P.verreauxi*, several plant species contribute to the toughest segment of their diets. We further compare the two species when describing physical costs to dental health of feeding on tough foods, and especially foods for which the morphology is not well-suited. By including information on feeding ecology and dental morphology, this synthetic approach provides novel insights as to how sympatric primates differentially respond to challenging food properties.

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Social interactions of male and female Sichuan snub-nosed monkeys (*Rhinopithecus roxellana*).

CAIE YAN¹, PAUL GARNER¹ and BAOGUO LI². ¹Department of Anthropology, University of Illinois at Urbana-Champaign, ²College of Life Sciences, Northwest University of China.

Sichuan snub-nosed monkeys (*Rhinopithecus roxellana*) live in multi-level social groups, which are organized into one-male units (OMUs). Multi-level societies of *R. roxellana*

are proposed to have evolved through the aggregation of one-male groups since the majority of other Asian colobines live in one-male groups. The aim of this study is to identify specific behavioral strategies that *R. Roxellana* use to cope with the challenges of living in multi-level social societies. From September 2007 to August 2008, behavioral observations were conducted on a habituated band of *R. Roxellana* living at Zhouzhi Natural Reserve of China. Four types of behaviors were recorded: sexual behaviors, inter-unit interactions, allogrooming, and the formation of new OMUs. Most copulatory behaviors (91 out of 92 cases) occurred between females and males of the same OMU. Aggressive and affiliative interactions between adult members of different OMUs were infrequent. During the course of 660 hours of observation, we recorded only 50 cases of agonistic interactions and six cases of allogrooming between members of different OMUs. Affiliative interactions were limited principally to members of the same OMU. Our results indicate that OMUs of *R. Roxellana* are more cohesive than one-male groups formed by other Asian colobines. *R. Roxellana* OMU members spent more time (9%) allogrooming, including harem males actively allogrooming resident females, and females supported males during inter-unit aggression. New OMUs formed when solitary males attracted females from existing OMUs. We conclude that male-female tolerance and affiliation play an important role in OMU formation and persistence. Funds to support this research were provided by National Science Foundation Dissertation Improvement Grant (Grant number: 0824466), Dissertation Travel Grant of University of Illinois, Lewis and Clark Fund, ASP General Small Grant.

Intestinal microbial community composition in monkeys.

SULEYMAN YILDIRIM¹, BRENDA A. WILSON¹, ABIGAIL SALYERS¹, REBECCA M. STUMPF¹, TONY L. GOLDBERG², TORRALBA MANOLITO³, KAREN E. NELSON², BRYAN A. WHITE¹ and STEVEN R. LEIGH¹. ¹Institute for Genomic Biology, University of Illinois, ²J. Craig Venter Institute, Rockville, MD, ³University of Wisconsin, Madison.

Microbes residing in the primate alimentary system may play critical roles in food processing and digestion, contributing energy surpluses independent of primate host physiology. We use new direct-DNA sequencing approaches to characterize resident bacteria in a variety of cercopithecoid and one platyrhine sample, testing for variation in microbial community composition within and among species. We extracted DNA and sequenced conserved regions of the bacterial 16S rRNA gene from fecal samples of black-and-white colobus (*Colobus guereza*), red colobus (*Piliocolobus rufomitratus*), red-tailed guenon (*Cercopithecus ascanius*) from Kibale National Park, Uganda; macaque (*Macaca fascicularis*) from Indonesia; and howler monkey (*Alouatta palliata*) from Argentina. Sequence data were subjected to the Ribosomal

Database Project (RDP) pyrosequencing pipeline to identify microbial taxa. Results illustrate both modal (high abundance, low diversity) and rare (high diversity, low abundance) microbiomes residing in the primate gut. Firmicutes and Bacteroides predominate in these samples. Diversity among species exceeds diversity within species, but guenons seem to show higher diversity than other species. Howler monkey and macaque samples show comparatively low diversity. Patterns of microbial diversity in the guts of primates may relate to dietary differences among taxa, with microbes playing different functional roles among primate species. Although sample sizes are small, gut microbial diversity appears to be independent of phylogenetic relationships among primate hosts. Support for this project was provided by the J. Craig Venter Institute and the University of Illinois Institute for Genomic Biology. Drs. A. Fuentes and M. Kowalewski graciously provided samples for analysis.

Cross-sectional variation in human nasal passages and the effect on heat and moisture exchange.

TODD YOKLEY. Department of Basic Sciences, Touro University Nevada, Henderson, NV.

Heat and moisture exchange in the nasal passages are facilitated by a large mucosal surface and a narrow stream of resired air. Given the demands of their respective environments, individuals whose ancestors evolved in cold and/or dry climates should exhibit greater mucosal surface areas and/or narrower air streams than individuals whose ancestors evolved in hot, humid climates. These two parameters can be assessed at a given point along the passages by measuring the perimeter and area of a coronal cross section. Cross-sectional perimeter measures mucosal surface area, while the perimeter-to-area ratio gauges the breadth of the resired air stream (greater ratios indicate narrower streams). Previous work by the author has shown that European Americans have greater perimeter-to-area ratios than African Americans at the anteroposterior mid-point of the nasal passages, but only when a decongested state is reconstructed. The present study builds on this previous work by examining decongested cross-sectional dimensions at additional points along the passages. Data were collected from CT samples of European and African Americans used in the previous analysis as well as from a newly obtained CT sample of native South Africans. Throughout the nasal passages, European Americans were found to have greater decongested perimeter-to-area ratios than the other two groups, but the groups showed little differences with regard to decongested cross-sectional perimeter. These results indicate that individuals of European descent have narrower resired air streams than individuals of African descent but relatively similar levels of mucosal surface.

Does diagonal limb phasing improve above-branch stability?

JESSE W. YOUNG¹ and BRIGITTE DEMES².

¹Department of Anatomy and Neurobiology, Northeastern Ohio Universities College of Medicine, ²Department of Anatomical Sciences, Stony Brook University.

Primates are distinguished from most other quadrupedal mammals by the habitual use of diagonal sequence, diagonal couplet gaits, where contralateral forelimbs (FLs) and hind limbs (HLs) move in close synchrony. Here we test the hypothesis, previously proposed by several authors, that diagonal limb phasings, in combination with grasping appendages, allow primates to exert balanced torques along a branch, thereby improving stability. Specifically, we test two predictions: 1) contralateral limbs should exert opposing torques and 2) decreasing the latency between diagonal limb contacts should improve mediolateral stability. Six juvenile squirrel monkeys (*Saimiri boliviensis*; mass range: 268-522 grams) were filmed as they traversed a 2.5cm pole into which two custom-built force transducers were incorporated. Force data and kinematic measurements were combined to calculate two components of the total craniocaudal torque of the center of mass (COM) about the pole: actuated torque (COM torque actively caused by muscular activity) and gravitational torque (COM torque passively induced by gravity). Consistent with the balanced torque hypothesis, directional changes in actuated torque were coincident with sequential footfalls in a contralateral pair (binomial test: $p<0.001$), indicating that diagonal limbs exert opposing torques. Moreover, shorter latencies between diagonal limb contacts led to relatively longer periods of diagonal bipedal support ($p<0.001$) and significantly decreased disruptive gravitational torque magnitudes ($p<0.01$). These data support the hypothesis that by closely pairing contralateral FL and HL touchdowns, diagonal limb phasings limit mediolateral displacement, mitigate disruptive gravitational torques and improve arboreal stability. This study was funded by the L.S.B. Leakey Foundation, grant number 38648.

Sonic Hedgehog (SHH) and the developmental basis for evolutionary variation in hominin craniofacial width.

NATHAN M. YOUNG¹, H. JONATHAN CHONG¹, DIANE HU¹, BENEDIKT HALLGRIMSSON² and RALPH MARCUCIO¹. Department of Orthopaedic Surgery, University of California, San Francisco, ²Department of Cell Biology and Anatomy, University of Calgary.

Variation is the raw material of natural selection, yet the mechanisms that generate differences among individuals remain as poorly understood today as when Darwin first published *On the Origin of Species*. One reason for this impasse lies in the difficulty of linking the manipulation of gene expression with the measurement of individual differences, particularly at embryonic timepoints. Using as our model the vertebrate face, a structure that

exhibits dramatic variation both among and within hominin species, we combined experimental embryology with advanced methods for quantifying multivariate shape to document the relationship of molecular and cellular phenomena to facial variation among individuals. Facial variation is thought to be coordinated with the brain but the developmental processes that underlie this relationship are unknown. After gradually altering Sonic hedgehog (SHH) signaling in a telencephalic organizing center critical for proper facial growth, we observed that the shape of the resulting upper jaw morphology was highly correlated with midfacial growth and gene expression levels in the vertebrate face. These results indicate that this signaling axis between the brain and face is a source of a large proportion of the normal and dysmorphic variation in vertebrate taxa including humans. Our combined analysis sets the stage for a better mechanistic understanding of the developmental basis for phenotypic variation in complex anatomical structures, a step that is ultimately necessary to fully link genotype to phenotype. This research was funded by National Institutes of Health grants F32-DE018596 (NY) and R01-DE018234 (RM), and National Science and Engineering Research Council of Canada grant #238992-02 (BH).

Let's talk about sex: using metric and non-metric features of the subadult ilium to identify males and females at Early Bronze Age Bab edh-Dhra', Jordan.

SARAH M. ZALESKI¹, ROBERT J. SMITH², JAIME M. ULLINGER³ and SUSAN G. SHERIDAN⁴. ¹Department of Anthropology, Dickinson College, ²Department of Anthropology, Emory University, ³Department of Anthropology, The Ohio State University, ⁴Department of Anthropology, University of Notre Dame.

Metric and nonmetric sexing techniques were analyzed for subadult ilia of a commingled collection from Early Bronze Age II/III (3000-2300 BCE) Bab edh-Dhra', Jordan. The skeletons were exhumed from Charnel House A22 at Bab edh-Dhra', and the sexes of individuals are unknown. This study hypothesized that a multi-feature model would more accurately sex the ilia than single feature models. The hypothesis was tested by assessing four features of 61 right subadult ilia: auricular surface elevation, the arch criterion, greater sciatic notch (GSN) angle, and GSN depth. GSN angle and depth were analyzed with ImageJ computer software to obtain more accurate measurements. Using the four iliac features, a final sex classification of 54% males and 46% females was determined. Eleven multi-feature combination models were created, and no particular feature combination was found to be significantly different from the final sex determination. Eight out of the eleven models displayed concordance rates of 85% or higher between features when bones of indeterminate sex were excluded. Models involving auricular surface elevation yielded lower concordance rates. This feature was determined not to be as

useful as GSN, which was in those models that had the highest concordance rates. Another conclusion of the study is that metric analysis can limit arbitrary factors associated with sexing subadults. The use of multi-feature models to determine sex is also recommended. The analysis of subadult sex in A22 has suggested no differential burial treatment of subadults by sex at EB II/III Bab edh-Dhra'. This study was funded by the National Science Foundation, Grant Number 0244096 (NSF-REU).

Deciduous molar enamel thickness distribution in the *erectus*-like sample from Tighenif (Ternifine), Algeria.

CLEMENT ZANOLLI^{1,2} and ROBERTO MACCHIARELLI^{1,3}. ¹Département de Préhistoire, UMR 7194, MNHN Paris, France, ²Forschungsinstitut Senckenberg, Frankfurt am Main, Germany, ³Département Géosciences, Université de Poitiers, France.

Following the recent advances in "virtual" dental anthropology, significant progress has been realized in the quantitative assessment of dental enamel thickness (ET). Fresh evidence shows that, compared to the modern condition, Neanderthal crowns are characterized by absolutely and relatively thinner enamel deposited over a larger volume of coronal dentine. Nonetheless, with few exceptions (Smith et al., 2009), lack of information on ET evolutionary variation (as well as on dental tissue proportions) still concerns the Early to Middle Pleistocene human dental record and, mostly, the pattern displayed by the poorly explored deciduous teeth. We report the results from the 3D virtual reconstruction and structural analysis of ET topographic distribution assessed on three deciduous molar crowns from the earliest Middle Pleistocene site of Tighenif (Ternifine), Algeria, commonly attributed to *H. erectus* (Tillier, 1980; Rightmire, 1990). The specimens, representing a left and a right upper m1 and a modestly worn upper left m2, have been detailed by means of high-resolution microtomography (μ CT) at the Centre de Microtomographie of the University of Poitiers (equipment X8050-16 Viscom AG; camera 1004×1004), at a resolution of 21.57 μ m. Comparative digital cartographies show that, differently from Neanderthals, the enamel distribution pattern in Tighenif approaches the modern human condition. Thicker deciduous molar enamel is found on the buccal aspect, at the base of each cusp. In the Um2, both estimates of the percent of the crown volume that is dentine and pulp and the relative ET (assessed for the buccolingual section through the mesial cusps) fit the modern values. This study was funded by French CNRS, Univ. of Poitiers (Centre de Microtomographie), Deutscher Akademischer Austausch Dienst, Nespos Society (Mettmann).

First steps: Trabecular morphology of the juvenile calcaneus.

ANGEL ZEININGER and TIMOTHY M. RYAN². ¹Department of Anthropology, University of Texas at Austin, ²Department of Anthropology, Pennsylvania State University.

The human calcaneus provides a lever arm for the triceps surae muscles. Peak calcaneal loading occurs near the end of stance when the triceps surae actively plantarflex the foot during toe-off. Epigenetically-sensitive trabeculae in adult human proximal calcanei are oriented posterodorsal to anteroplantar, consistent with plantarflexor loading patterns. By comparison, toddlers have weak plantarflexors and lack a propulsive toe-off at the end of stance. This study tested the hypothesis that calcaneal trabecular architecture in toddlers differs from that of adult humans. High resolution computed tomography scans of 5 juvenile human (1-3 years) calcanei were used to analyze trabecular bone structure within a proximal volume of interest and to compare to those of adult humans and great apes (Maga et. al, 2006). Degree of anisotropy (DA), bone volume fraction (BV/TV), and the primary trabecular orientation were calculated for each juvenile. Compared to adult humans, toddlers had a lower degree of anisotropy and an increased bone volume fraction. In fact, toddler DA was more similar to that of great apes than adult humans. Likewise, toddler BV/TV fell within the great ape range. Unlike adult humans, primary trabecular orientation in toddlers was posteroplantar to anterodorsal. Trabecular orientation in toddlers is likely representative of the weak ankle musculature and lack of a propulsive toe-off during immature bipedalism. This study highlights the importance of ontogeny when attempting to define functional correlates of bipedal locomotion using trabecular architecture, a tool capable of offering a reliable means of reconstructing locomotor behavior in fossil hominins. This study was funded by a National Science Foundation Graduate Research Fellowship.

Enamel prisms revealed in three-dimensions by phase contrast synchrotron microtomography.

JOHN P. ZERMENO¹, TANYA M. SMITH^{1,2} and PAUL TAFFOREAU³. ¹Department of Human Evolutionary Biology, Harvard University, ²Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, ³European Synchrotron Radiation Facility, Grenoble.

Enamel microstructure analysis has allowed for assessment of growth and development in fossil primates with greater precision than traditional skeletal techniques. However, there are large gaps in our knowledge of fundamental units of dental microstructure, including enamel prisms. Prisms represent the mineralized pathways taken by enamel-secreting cells (ameloblasts) that travel from the enamel-dentine junction (EDJ) to the tooth surface as a cohesive cellular growth front. Enamel prism geometry contributes to our understanding of dental development, tooth function, and primate life history. Previous studies of microstructure have been limited by their constraint to 2D physical sectioning. In this study, phase contrast synchrotron microtomography was tested to determine its capabilities in isolating individual prisms. Complete 3D prisms of cuspal and

lateral enamel were successfully segmented from samples of *Pan troglodytes* and *Homo neanderthalensis*. This study sought to assess the conventional cuspal prism correction factor of 1.15, used to calculate formation time, and to test the validity of current prism geometry models. Prism path lengths were shorter than predicted by Risnes' model (1.15 ratio), falling in the range of 1.03-1.07. Comparisons of segmented prisms to previous theoretical models revealed that prisms did not conform to simple geometric shapes. *Pan* enamel microstructure showed complex deviating prism paths that varied throughout regions. Prisms from Neanderthal lateral enamel differed from those of *Pan*, displaying more uniform geometry from the EDJ to enamel surface. The data revealed by this new imaging application may ultimately call fundamental models of ameloblast activity and cohesion into question. This study was funded Harvard University and the European Synchrotron Radiation Facility.

Coming of age in female *Pan paniscus*: biological attributes of juveniles.

ADRIENNE ZIHLMAN¹ and DEBRA BOLTER². ¹Department of Anthropology, University of California, Santa Cruz, ²Department of Anthropology, Modesto College, California.

Juvenile primates represent a life stage beyond infancy but before adulthood, a critical time of transition in several body systems. The stage of dental development, skeletal dimensions and lengths of long bones, and body mass are the most often studied aspects of anatomy, and these dimensions usually define "juvenile." Little is known about other body systems in apes, with information on *Pan paniscus* physical development the least known.

This study reports on soft tissue biology and anatomy of juvenile *Pan paniscus* in comparison to female infants and adults. Medical records during captivity, necropsy reports along with postmortem examinations in the lab and quantitative dissections provide new information on body proportions and body composition through the life stages.

Results give a glimpse into the mosaic fashion of body system growth in *Pan paniscus* beyond the dentition and skeleton: body proportions decrease from a heavy head and trunk in infants (~74% TBM) to about 65% in adults; organ mass decreases from over 12% to about 4% TBM; muscularity increases from 22% to over 40%. Although juveniles lie intermediate in organ mass (7%), muscularity and limb mass are higher than in reproductive adult females. The smaller juvenile body size masks the complexity of transformation in body systems to adulthood but offers insights into selective pressures during immaturity.

Bone and dental responses to masticatory loading: A shared regulatory mechanism?

KATHERINE ZINK, ANNE SIDERS and DANIEL LIEBERMAN. Department of Human Evolutionary Biology, Harvard University.

For proper occlusion and efficient mastication to occur, the upper and lower jaws and their associated dentition must maintain a nearly perfect fit throughout ontogeny as the face increases in size and changes shape. How is the growth of these diverse structures coordinated during ontogeny and over evolutionary transitions? We hypothesize that one possible contribution to craniofacial integration is through shared epigenetic responses to mechanical loading. In hominins and other late-erupting diphyodont mammals, the permanent dentition develops within a jaw that is regularly loaded when the deciduous teeth are present. Because the tooth germ develops within the bony crypt of the jaw while it is loaded during mastication, *in vivo* strains may upregulate growth factors and other proteins such as IGF-1 and DMP-1 that not only regulate bone cell activity, but also have paracrine effects on ameloblasts and odontoblasts. To test this hypothesis, 18 piglets were fed either "Hard" (normal chow) or "Soft" (water-soaked chow) diets. Every two weeks they were weighed and injected with Calcein, a fluorescent mineral label, to quantify dental growth rates. After 12 weeks, the animals were sacrificed, the crania CT scanned, and the teeth (M1 and M2) sectioned. Preliminary results indicate an increase in jaw growth and dentine secretion rates for the "Hard" group. These results suggest some degree of shared mechanisms of plasticity between the tooth roots and the jaws and raise the possibility that variations in root histology and length may provide data on diet. This study was funded by the American School for Prehistoric Research.

Coalescent modeling of Yakut origins points to small founding population based on mtDNA variation.

MARK ZLOJUTRO¹, LARISSA A. TARSKAIA², MARK SORENSEN³, J. JOSH SNODGRASS⁴, WILLIAM R. LEONARD⁵ and MICHAEL H. CRAWFORD⁶. ¹Department of Genetics, Southwest Foundation for Biomedical Research, ²Institute of Molecular Genetics, Russian Academy of Medical Sciences, ³Department of Anthropology, University of North Carolina, ⁴Department of Anthropology, University of Oregon, ⁵Department of Anthropology, Northwestern University, ⁶Department of Anthropology, University of Kansas

Based on archaeological and ethnohistorical evidence, the Yakut people of northeastern Siberia are considered to be descendants of ancient Turkic-speaking populations once living in the distant Altai-Sayan region on the Russian-Mongolian border. The results of phylogeographic studies on Siberian mtDNA variation have been generally concordant with a southern Yakut origin, although the timing of the northern migration, the size of the founder group and the degree of genetic admixture with non-Turkic Siberian populations are less apparent. In an effort to better understand Yakut origins, we modeled 25 demographic scenarios, including parameters such as effective population size, growth rate and gene flow, and tested by coalescent simulation whether any are consistent with the patterns of

mtDNA diversity observed in present-day Yakuts. The models consist of either two simulated demes that represent Yakuts and a South Siberian ancestral population, or three demes that also include a regional Northeast Siberian population that served as a source of localized gene flow into the Yakut deme. The model that produced the best fit to the observed data defined a founder group with an effective female population size of only 150 individuals, migrating northwards approximately 1,000 years BP and undergoing significant admixture with neighboring populations in Northeastern Siberia. These simulation results indicate a pronounced founder effect that was primarily kin-structured and reconcile reported discrepancies between Yakut mtDNA and Y chromosome diversity levels.

Wild Brown Mouse Lemurs Live Long and Prosper.

SARAH ZOHDY^{1,3}, STACEY TECOT^{2,4}, TOKY HERY RAKOTOARINIVO^{2,6}, JESSICA CARAG², STEPHEN J. KING⁵, JUKKA JERNVALL^{1,4}, and PATRICIA C. WRIGHT^{1,3,5}. ¹Institute of Biotechnology, University of Helsinki, Finland, ²Centre ValBio, Ranomafana, Madagascar, ³Institute for the Conservation of Tropical Environments, Stony Brook, New York, ⁴Department of Ecology and Evolution, Stony Brook University, ⁵Department of Anthropology, Stony Brook University, ⁶Department of Paleontology, University of Antananarivo.

Mouse lemurs are prosimian primates endemic to Madagascar, and the smallest primates in the world. Previous studies have shown that grey mouse lemurs (*Microcebus murinus*) live over 15 years in captivity (Perret, 2005), and typically develop neurodegenerative diseases and other signs of senescence that are found in aging humans. To test the hypothesis that brown mouse lemurs have limited longevity in the wild, we examined over 130 wild brown mouse lemurs (*Microcebus rufus*) from 2003-2009 in the southeastern rainforests of Ranomafana National Park, Madagascar. Using mark-recapture techniques and dental molds, we previously set the lifespan of wild brown mouse lemurs to eight years of age, and suspect they live even longer. Contrary to captive grey mouse lemurs, wild brown mouse lemurs do not undergo the typical signals of senescence that occur in captive congeners. Based on dental (wear on lower right mandible), hormonal (testosterone levels), and morphometric data (e.g., body mass, testicular volume, muscle measurements), we have found that not only do many mouse lemurs survive longer than 4 years in the wild (27% of captured individuals), but they appear to thrive in their old age. Moreover, of all aged individuals (>4 years), we captured more males than females. Males had lower fecal testosterone levels than females, which may in part provide a mechanism for this rare pattern of male biased longevity in mammals. This study, as a unique model of aging in the wild, could provide further insight into the basal primate impetus of senescence.

Reconsidering Neanderthal birth: Tabun mom, Kebara dad, Mezmaiskaya baby, and the consequences.

CHRISTOPH P. E. ZOLLIKOFER¹, MARCIA S. PONCE DE LEÓN¹. ¹Anthropological Institute, University of Zurich, Switzerland.

Modern human birth is characterized by rotation of the fetal head from transverse to posteroanterior orientation during its passage from the pelvic inlet through the outlet. Here we reconsider the question whether Neanderthal birth followed a similar mechanism, or whether it followed the supposed ancestral mode of transverse orientation throughout the passage. Answers to this question critically depend on the morphology of the Neanderthal neonate head, and on a computerized simulation of the birth process. Virtual reconstruction of the fragmentary and distorted female Neanderthal pelvis from Tabun shows that transverse dimensions are wide compared to modern humans. However, simulating the Neanderthal birth process with the neonate skull from Mezmaiskaya shows that the Tabun pelvis is not sufficiently wide to permit outlet-transverse birth of a Neanderthal fetus. This suggests that Neanderthals had rotational birth because of the large anteroposterior dimensions of the heads of their neonates. The latter dimensions can be used to estimate Tabun's anteroposterior pelvic dimensions, and a new reconstruction of the male Neanderthal pelvis from Kebara confirms that Neanderthal anteroposterior pelvic dimensions were larger than assumed in the Rak and Arensburg (1987) reconstruction. The hypothesis of shared human-Neanderthal birth mechanisms has interesting evolutionary implications. First, it is likely that rotational birth evolved already in the last common ancestor of these species. Second, the obstetric dilemma is not only a matter of neonate brain size, but of neonate head form.

Sex gets less dangerous: rapid evolution of syphilis in Renaissance Europe.

MOLLY ZUCKERMAN, AMBER CAMPBELL, and GEORGE ARMELAGOS. Department of Anthropology, Emory University.

Syphilis is widely regarded as the first credible example of the evolution of virulence in a human disease. Historical accounts suggest that *T. pallidum* may have become attenuated by the mid 16th century, possibly in response to selection for symptoms less evident to sexual partners. Records indicate that syphilis may have shifted from an acute, often quickly fatal condition to a mild, chronic one, with facial destruction, joint involvement, and gummatous decreasing in frequency. Conversely, some historians have interpreted these accounts as evidence that panic at the epidemic's onset may have generated exaggerated reports of severity. Direct evidence for this evolutionary phenomenon however, has never been evaluated. To address this, skeletons with evidence of syphilis (N=64) from England indirectly and radiocarbon dated to the pre-1550 or post-1550 periods were evaluated for evidence of historically documented shifts in the manifestations of syphilis. Results show decreases in frequency of joint involvement (Fisher's exact test, p=.079), no difference in the presence of gummatous but a decrease in individuals with >3 lesions (p=.037), and no differences in the frequency of acute vs. chronic infection but a higher frequency of healing in post-1550 individuals (p=.067), suggesting a reduction in associated mortality. Backed by phylogenetic data and forthcoming skeletal evidence showing that syphilis was a novel infection in post-Columbian Europe, this study may provide an opportunity to link pathogenic adaptive events to micro- and macro-level ecological, social, and demographic shifts, helping to predict changes in contemporary infectious diseases as they become established and inform interventions. The first and second authors were funded by National Science Foundation: Graduate Research Fellowships.