

Abstracts of AAPA Poster and Podium Presentations

Risky business: an evolutionary perspective on placental nutrient transport and postpartum hemorrhage.

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Postpartum hemorrhage (PPH), the leading cause of maternal mortality worldwide, is responsible for 35% of maternal deaths. Proximately, PPH results from the failure of the placenta to separate from the uterine wall properly, most often because of impairment of uterine muscle contraction. However, despite its prevalence and its well-described clinical manifestations, the ultimate causes of PPH are not known and have not yet been investigated through an evolutionary lens. We argue here that vulnerability to PPH stems from the uniquely invasive nature of human placentation. The human placenta actively causes uterine vessels to undergo significant morphological and functional transformation in order to provide the developing fetus with a high plane of maternal resources; compared to other mammals with hemochorial placentation, the degree of this invasiveness and transformation in humans is unique. We argue that the particularly invasive nature of the human placenta increases the possibility of delays or difficulties in placental separation and therefore increased blood loss at parturition. We furthermore review both genetic and behavioral adaptations that may have evolved to mitigate the risk of PPH across human history.

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The longevity of phenotypic signatures of hybridization in descendent populations.

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Hybridization may have played a substantial role in shaping the diversity of our evolving lineage. Although recent genomic evidence has shown that hybridization occurred between AMHS and Neanderthals, it remains difficult to pin down precisely where and when this gene flow took place. Investigations of the hybrid phenotype in primates and other mammals are providing some insight into both, revealing evidence of

hybridization in the Middle East and nearby regions circa 100kya. However, an impediment to precisely delineating the timing of hybridization (both its start and cessation) remains: we don't know how long hybrid skeletal traits persist in the absence of continued gene flow, and therefore it is not clear whether observed hybrid phenotypes are evidence of recent or much earlier hybridization events. This problem is exemplified by the child skeleton from Lagar Velho, Portugal, which has been argued to reflect mixed ancestry despite living ~200 generations after the last known existence of Neanderthals in the area. Is this possible? Research in both plants and animals suggests that it is; 'new' variation that enters a system through gene flow can persist for a considerable amount of time – even for hundreds of generations. This is especially true if the traits are not linked to fitness. Although data for long-term, evolutionary time frames do not exist from primates, ongoing work in a hybridizing captive baboon colony also supports the conclusion that traits associated with hybridization persist into subsequent (recombined) generations. This has significant implications for interpreting the hominin fossil record.

Down the rabbit hole: a reanalysis of the 1988 Haasgat *ex situ* faunal assemblage, Cradle of Humankind, South Africa.

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Haasgat is an extensive cave system in the western part of the Schurverberg Mountain Range, 19km northeast of the Blaauwbank Valley sites (e.g. Sterkfontein, Swartkrans). In 1988, fossiliferous *ex situ* calcified sediment blocks were collected from Haasgat and mechanically processed. Two publications on the resulting Haasgat faunal assemblage in 1994 described a demographically-diverse sample of *Papio angusticeps*, specimens of an extinct colobine comparable to *Cercoptithecoides williamsi*, and a single hyaenid (*Chasmaporthetes nitidula*) maxilla - but an essentially modern range of ungulate species. Our team resumed geologic and paleontologic research at Haasgat in 2010 that included a reevaluation of the 1988 *ex situ* faunal assemblage. Here, I present a significantly revised Haasgat faunal list, specimen counts, and basic description of the entire craniodental and postcranial assemblage. Contrary to the originally published faunal descriptions, the occurrence of several

modern and fossil taxa in the sample cannot be supported, including giraffe (*Giraffa camelopardalis*), gray duiker (*Sylvicapra grimmia*), oribi (*Ourebia our-ebi*), grysbok/steenbok (*Raphicerus* sp.), hartebeest (*Alcelaphus buselaphus*), and *Megalotragus priscus*. In addition, the specific attribution of the suid and reduncine collections is not possible. Both the previously noted *C. nitidula* maxilla and catalogued black-backed jackal (*Canis mesomelas*) mandible could not be located in 2010; however, analysis of undocumented postcrania yielded a *Dinofelis* sp. fourth metatarsal. Results of this reanalysis indicate that the assemblage setting column widthpositional phases, and discussion focuses on the similarities in the fossil klippspringer (*Oreotragus major*) specimens to those from Makapansgat Member 3.

Joint moments in forefoot versus rearfoot strike running.

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This study focuses on the differences in joint torques between shod and minimally shod runners during both rear-foot-strike (RFS) and fore-foot-strike (FFS) gaits. Recent evidence shows that habitually shod runners are more likely to RFS and that habitually unshod or minimally shod runners are more likely to FFS, but published data on lower-extremity joint torques during running has largely been confined to shod runners with RFS gaits. We hypothesized that FFS gaits would result in higher torques about the ankle during the beginning of stance, even though the magnitude of loading is less, because FFS landings involve controlled dorsiflexion. Ten subjects able to both FFS and RFS ran at 3.5 m/s in four conditions: shod-RFS, shod-FFS, minimally shod-RFS, minimally shod-FFS. Using force-plate and 3D kinematic data, an inverse dynamics analysis calculated lower-extremity joint torques in the sagittal plane for all experimental conditions. The results show marked differences between RFS and FFS, with higher torque magnitudes about the ankle in FFS than RFS, but greater torque magnitudes about the knee in RFS than FFS. However, the results also indicate that torque rate may be a more important influence on performance differences than torque magnitude.

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Musculoskeletal stress markers and body mass index.

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Musculoskeletal stress markers (MSM) are commonly used to assess activity patterns in past populations, typically related to habitual action. While MSM analysis is common in bioarchaeology, testing of this method using modern known populations or recorded occupational data is limited.

In addition to activity, MSMs also correlate to sex, age and body size. The goal of this project was to assess the relationship between MSMs and an additional characteristic: weight. A sample of 184 white males of known age, stature and weight was divided into three BMI classes: underweight, normal weight and overweight. Thirteen MSMs were evaluated on both humeri and the left femur and tibia, and were scored according to standardization techniques presented by Mariotti et al. (2007).

Results of an ANOVA showed a significant effect of age on the left and right deltoid tuberosities and the gluteal line. An effect of BMI was reported at only one location: the left medial bicipital groove. However, subsequent t-tests found no difference in MSM expression between BMI classes.

These null findings are surprising, given that obesity has been significantly linked to biomechanical modifications in walking and sit-to-stand strategies, as well as increased muscle strength. They also contrast with results of a cross-sectional analysis conducted on the same sample which revealed a significant relationship between BMI and increased mediolateral dimensions of the proximal femur and both humeri. Because long bone cross-section is another commonly-used technique in activity assessments, this deviation warrants further investigation.

A "bone"ment: the reconciliation between MNI and MLNI in determining the population count of the death assemblage of the Saint Stephen's collection from Jerusalem.

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The purpose of this study is to obtain a more accurate count of the number of individuals for the death assemblage from St. Stephen's Monastery in Jerusalem using MLNI. This method is argued to be a more accurate way of estimating the total number as compared to methods such as MNI, NISP, LI, etc. In this study, the calcaneus, distal femur, and talus, were chosen to calculate MLNI because they were the most represented bones. After separating out the fragments, elements of all three bones were

sided, seriated, and measured. The bones were visually pair matched according to similarities between key landmarks, features, and paleopathologies. The resulting number of pair matches for each bone was used to calculate MNI and MLNI.

The calculated MLNI for the Saint Stephen's Collection was 214 using the calcaneus, 544 using the distal femur, and 256 using the talus. The numbers generated from the calcaneus and talus were more accurate than the MLNI derived from the femur due to the limitations of the original burial site. Also noteworthy is the effect of limited pair matching on MLNI calculation. The limited number of pair matches found for all three elements caused the high MLNI estimates, which are larger than the NISP: the supposed upper limit. Nevertheless, the study found that the tarsal bones provide a more realistic MLNI estimate than long bones because of greater practicality for pair matching, due to both the calcaneus and talus' numerous identifiable features and greater degree of preservation. This study was funded by the Undergraduate Research Opportunity Program (UROP) at the University of Notre Dame, grant numbers 3103 and 3125.

New excavations at the Late Miocene hominoid-bearing locality of Can Llobateres 1 (Vallès-Penedès Basin, Catalonia, Spain): Preliminary results.

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The Late Miocene (ca. 9.7 Ma) site of Can Llobateres (Vallès-Penedès Basin, Catalonia, Spain) yielded the most abundant and complete remains of the fossil great ape *Hispanopithecus laietanus*. Most of the hominoid remains came from the lower levels (CLL1, early Vallesian, MN9), although a partial skeleton was recovered from the upper level (CLL2, late Vallesian, MN10) during the 1990s. In 2010, after almost 20 years of inactivity, paleontological excavations were resumed at CLL1, with the aim to enlarge the sample of hominoid remains, as well as to gather more geological, taphonomic and paleoecological data. In order to reach the fossiliferous levels, about 6 m of overlying and nearly sterile sediments had to be removed from a surface of about 100 m² with the aid of a digger. This allowed us to recover abundant and well-preserved plant remains from several layers situated slightly

above the CLL1 classical levels; these macrovegetal remains will provide a wealth of relevant data for reconstructing the habitat inhabited by *Hispanopithecus*. Regarding the vertebrate levels, no systematic excavation was performed, although different levels from three different spots were excavated and screen-washed, in order to evaluate their richness regarding micro- and macromammals. These samplings led to the recovery of more than a hundred large mammal remains (including a partial equid skeleton), as well as abundant small mammal remains, from several levels. Thus, although no hominoid remains were recovered, the preliminary results are very promising for the upcoming campaigns, when systematic excavations will be performed in this site.

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The etiology of Porotic Hyperostosis and Spina Bifida Occulta in a high latitude hunter-gatherer.

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Porotic hyperostosis (PH) and spina bifida occulta are among the most common stress-markers and congenital defects found in skeletal collections. Although PH is commonly regarded as the result of iron-deficiency anemias, only megaloblastic anemias (genetic or acquired) lead to the medullar expansion that results in PH formation. Spina Bifida, on the other hand, has a complex etiology that includes genetic and environmental factors. In this case-study, we present evidence of both lesions in a high latitude hunter-gatherer from Cabo Nore, Tierra del Fuego, Chile (AD 1030 ± 80). The co-occurrence of these conditions, the type of diet, and the environment occupied by this individual suggests that a deficiency in vitamin B9 (folate) is the most likely explanation for the presence of both conditions. This case-study contributes to the on-going discussion regarding the etiology of Porotic Hyperostosis and spina bifida occulta. This study suggests that an analysis of co-occurrence among high-latitude populations may clarify the etiology of both conditions.

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

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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.

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Age differences in social support and health among elderly Kuwaitis.

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We report here data on social support elements and health status differences across three age groups of Kuwaiti elderly (60-69; 70-79, and 80 years and

above). Social support elements considered include total social support scale, frequency of contact with relatives and friends, strength of these contacts, religiosity, number of children, and number of children living with the elderly. This study evaluates health status in terms of systolic and diastolic blood pressure, glucose levels, and self-reported somatic symptoms, satisfaction with current health, and health over the last year. Differences by education and socioeconomic status are considered among the three age groups of the elderly. Examined for this study were 1,427 adults (472 men and 955 women) aged over 60 years representing all six governorates in Kuwait. Respondents were sampled from multiple sociocultural and economic backgrounds. Data collection consisted of obtaining informed consent, completing a questionnaire and an oral interview with the participant along with aid from the person most closely related to the interviewee currently in the home. The questionnaire included sociocultural/demographic data, medical history and self-ratings of health. Questionnaires, along with assessments of several aspects of physical health were completed. A ten-point scale was used to assess religiosity. The Social Support Scale (SSS), A Frequency of Contact Scale, and the Strength of Relations have been used. Self-rated scales of general health and health in the past year were used. A Somatic Symptoms Inventory (SSI) was used too. Systolic and diastolic Blood Pressure measurements were completed. SPSS was used all analyzes. The data show that there are important social support elements in all of the age groups. Social support, frequency of contact, strength of relationships, number of children living with the elderly, and religiosity are shown to influence the health and well-being of elders. Social support elements are shown to be higher in the oldest age group. Social support, frequency of contact, and strength of relations are related to somatic symptoms and systolic and diastolic blood pressure, while religiosity is related to somatic symptoms and systolic blood pressure. The factor of children living with the elderly in the same household was found to be related to, and predicted, somatic symptoms in all age groups.

Scaling of forearm muscle weights in primates.

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Among primates, it has been proposed that the differential development of the forearm flexor compartment is connected to substrate use. Likewise, the

projection of the medial epicondyle is thought to reflect this differential development. We examined the scaling properties of forearm muscle wet weights to test the hypothesis that the total masses of various muscle compartments are differentially developed among primates. The forearms of six strepsirrhine (*Eulemur fulvus*, *Lemur catta*, *Varecia rubra*, *Haplemur griseus*, *Galago senegalensis*, *Nycticebus coucang*) and seven haplorhine (*Callithrix jacchus*, *Macaca sp.*, *Papio sp.*, *Erythrocebus patas*, *Hylobates lar*, *Gorilla gorilla*, *Pan troglodytes*) primate specimens were dissected. Distal humerus dimensions and muscle wet weights were measured. Scaling properties of each muscle compartment within the forearm were examined via ordinary least squares regression. The total mass of the flexor and extensor compartments were both found to scale isometrically on total forearm muscle mass, with little unexplained variance ($p < 0.0001$, $r^2 = 0.99$). Likewise, the mass of the wrist flexors and digital flexors both scale isometrically to total forearm muscle mass ($p < 0.0001$, $r^2 = 0.98$). The mass of the total flexor compartment and the mass of the digital flexors both fail to significantly explain the variance in medial epicondyle projection, when body size is taken into account. It is concluded that the relative masses of the wrist and digital flexors do not predictably vary with substrate use. Locomotor differences in epicondyle development likely serve to reorient the muscles around the joint, rather than reflect any differential development of muscle mass.

Large-hominoid remains from the Middle Miocene locality of Castell de Barberà (Vallès-Penedès Basin, Catalonia, Spain).

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The Middle Miocene locality of Castell de Barberà (late Aragonian, MN8, ca. 11.5 Ma), located within the Vallès-Penedès Basin (Catalonia, Spain), is one of the few European localities that have yielded both pliopithecoid and hominoid remains. Whereas pliopithecoids are represented by dentognathic remains, apes are only recorded by a very restricted sample of unpublished postcranial remains—an upper canine from this locality, traditionally attributed to a female hominoid, does in fact belong to a male pliopithecoid. We provide a description and functional interpretation of the three available homi-

noid remains from Castell de Barberà: a pollical proximal phalanx (IPS4333), a partial pollical distal phalanx (IPS4335) and a partial mid-distal humeral shaft with no epiphysis (IPS4334).

The latter permits us to infer a body mass of about 50 kg, being tentatively attributed to a male specimen of *Dryopithecus fontani* (as opposed to the smaller specimen from Saint Gaudens, which would correspond to a female individual). This specimen, together with a partial femur from Abocador de Can Mata tentatively attributed to the same taxon, are indicative of a significant quadrupedal component. The pollical specimens more closely resemble other Miocene apes than extant great apes, being suggestive of a significant degree of powerful grasping assisted by the thumb during above-branch quadrupedalism and cautious climbing. As such, preliminary analyses indicate that the locomotor repertoire of *D. fontani* was probably more similar to that of the contemporary *Pierolapithecus catalaunicus*, than to that of the more suspensory *Hispanopithecus laietanus* from the Late Miocene.

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The role of biomes in the settlement of the Americas: testing Beaton's and Dixon's hypotheses.

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Until recently, the settlement of the Americas was seen as the product of a "bow wave" human expansion from north to south. Under this scenario, the archaeological sites of the first Americans should obey a chronological gradient following the same logic, independent of their longitude. Recently, however, specialists began to recognize that certain characteristics of different biomes could have favored different rates of demic expansion. Beaton (1991), for instance, suggested that human expansions in continental scales are much more conditioned by the ecological attributes of the macro environmental zones (biomes) involved than by linear geographic distances, an idea also espoused by Dixon (2001). In this study we test Beaton's and Dixon's ideas, as applied to the Americas, by investigating if the genetic structure of recent

Native American populations is influenced by the biomes they occupy. In order to do this, three different kinds of matrices were constructed based on the frequency of mtDNA and microsatellites from Native American groups: one formed by the genetic distances (Fst) among the populations, a second one formed by the geographic distances among the same populations in kilometers, and a last one formed by their "physiographic" distances. These matrices were compared by Pearson's correlation followed by Mantel and partial Mantel tests. The results obtained showed that in general the different biomes did not play a significant role in the Native American genetic structuring, at least as they are distributed today.

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Hormones, musculature, and strength across the life course of men from a rural Polish village.

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The steroid hormone testosterone has been hypothesized to regulate trade-offs between reproduction and survival in males through the management of sexually dimorphic muscle mass. Male physiology supports higher testosterone levels when ecological conditions are favorable so that musculature is augmented to increase competitiveness for mates, while testosterone production is down regulated when energetic stress is experienced to facilitate a diminished, thrifter phenotype. An underlying assumption of this hypothesis is that a tightly linked relationship persists between males' testosterone levels and musculature. Additional formulation of life history trade-offs specific to human males that takes into account the labor demands of men's productivity may provide further insight into the relationship between testosterone and body composition. For men who subsist through the efforts of intensive labor, musculature and strength across the life course are predicted to be maintained to a greater extent than testosterone levels. The association between testosterone, musculature, and strength was examined in a rural farm village in which men's work activities are often associated with demanding manual labor. Data were collected from 29 Polish men, ages 20-80 with a median age of 43 years. Grip and chest strength were assessed using a dynamometer, and musculature was estimated using arm circumference, adjusted for body fat. Testosterone levels were obtained from morning urine samples. Arm circumference, grip and chest strength were negatively and significantly associated with age. Results from hormone analyses are forthcoming, but age-related decline in testosterone is pre-

dicted to be more pronounced than either age-decline in strength or musculature. This research was supported by the Graduate Research Fellowship Program from the National Science Foundation, 2008-2011.

Gastrointestinal microbial community composition and habitat structure in howler monkeys (*Alouatta pigra*).

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Howler monkeys (*Alouatta* sp.) are among the most folivorous of the New World monkeys and have highly flexible diets. However, despite the fact that groups of howlers exhibit distinct diets depending on spatial and temporal patterns of resource availability, activity patterns are consistent across howler groups and species. High levels of fiber and toxins in leaves make gut microbial fermentative activity essential to howler nutrition, and based on studies with other mammals, it is possible that differences in gut microbial community composition allow groups of howlers in different habitats to take advantage of distinct resources to fuel the same activities.

To investigate variation in gut microbial community composition within a species, we collected fecal samples from five groups of black howler monkeys (*Alouatta pigra*) in Mexico over an eight week period (May-July 2009). Two of these groups inhabited a continuous, tall rainforest. The other three inhabited a fragmented, tall rainforest; a continuous, semi-deciduous forest; and a rehabilitation center.

Following the isolation and purification of microbial DNA from all samples, we used community fingerprinting (ARISA) and high-throughput sequencing of the 16s ribosomal RNA gene (V1-V3) to describe the microbial community structure in each group.

Our sequencing resulted in >2.6 million reads from 33 individuals, giving us unprecedented sequencing depth. Preliminary analyses indicate that differences in gut microbial community composition are related to the environment each group inhabits. Basic ecological data suggest that these differences are a result of diet composition. Differences in host monkey microbial communities may have important implications for primate adaptation, evolution, and conservation.

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Reconstructing the habitat preferences of *Ardipithecus ramidus* with paleosol and tooth enamel carbon isotopes: woodland or grassland?

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Paleosol (fossil soils) were sampled across a 7 km W-E transect of the Aramis Member of the Sagantole Formation in the Middle Awash Valley. Paleosol carbon isotope ratios are interpreted as reflecting floral habitats with 30% to 70% C₄ grass biomass, representing woodlands to wooded grassland. Pedogenic carbonate carbon and oxygen isotope ratios increase from west to east, reflecting more grassy drier habitats on the east, where *Ardipithecus ramidus* fossils are absent. These data are consistent with diverse lines of geological, paleontological, anatomical and dental isotopic evidence for the character and distribution of floral habitats associated with *Ardipithecus*.

Cerling et al. (Science 328:1105 [2010]) presented a new model for interpreting soil carbon isotopes from Aramis, and concluded that *Ardipithecus* occupied mainly wooded grassland to grassland habitats with less than 25% trees and shrubs, with narrow strips of riparian woodlands. If their model were correct then all previously published paleosol carbon isotope-based reconstructions of tropical and subtropical environments would be invalidated. However, rejection of nearly three decades of research is unnecessary. Their modern reference is based mainly on soils formed on Kalahari sands, and Australian sands that have biased preservation of woody plant carbon (Wynn and Bird, *Tellus* 60b:610, 615-617 [2008]). Therefore their model is inapplicable to fine-grained paleosols formed on volcanic parent materials like those of most hominid sites in Rift Valley settings. We thus stand by our conclusion that the carbon isotope ratios of Aramis Member paleosols show that the preferred habitat of *Ardipithecus* was woodland to grassy woodland.

X-chromosomal genetic diversity and linkage disequilibrium patterns in American populations.

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Understanding patterns of linkage disequilibrium (LD) is the basis for the design of association studies. It also pro-

vides information on populations' evolutionary history. We report X-chromosomal LD patterns in Amerindian (Kogi, Wayuu, and Zenu) and admixed Latin American (Central Valley of Costa Rica and Southern Brazilian Gaucho) populations. Short tandem repeats (STRs) widespread along the X-chromosome were investigated in 258 chromosomes. Diversity indexes were estimated for each population and the level of LD was inferred with an exact test. The Amerindian populations presented lower genetic diversity and a higher proportion of loci in LD than the admixed ones. Two haplotype blocks were identified, both restricted to the Amerindians. The first involved DXS8051 and DXS7108 in Xp22.22 and Xp22.3, while the second, found only among the Kogi, included eight loci in a region between Xp11.4 and Xq21.1, for which a network was built, indicating the action of genetic drift during the evolutionary history of this population. In accordance to previous work, human isolates, such as the Amerindian tribes, seem to be an optimal choice for the implementation of association studies due to the wide extent of LD that can be found in their gene pool. The low proportion of loci in LD found in both admixed populations studied here could be explained by events related to their history and similarities between the allele frequencies in the parental stocks.

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Bioarchaeology and taphonomy of human remains from San Francisco de Borja, a historic cave site in N. Mexico.

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San Francisco de Borja is a cave site in Chihuahua, Mexico that was excavated by Richard and Sheilagh Brooks in the 1950s and is now curated at UNLV. This site appeared to be a place where commingled remains were secondarily interred. Dating to the historic period, it is likely an ancestral group to the Tarahumara culture. A reanalysis of these remains was undertaken in order to more fully investigate some of the initial findings suggesting perimortem processing. In addition to estimating the minimum number of individuals, age, sex and pathological status were undertaken. The taphonomy of the burial site was reconstructed using original field notes.

Analyses indicate that a minimum of 11 adults and 7 subadults were interred at this site. The MNI is based on the presence of the left femora. Evidence for perimortem sharp force trauma was

found on one adult. Teardrop fractures, caused by hyperextension of the neck, were found in two adult second cervical vertebrae. Perimortem breakage was also found on the base of the occipital in two adult individuals. Many of the bone fragments show breakage patterns that suggest perimortem processing. Additionally, several skeletal elements showed signs of burning even though no evidence for fire was found within the cave. This suggests that the cave was a secondary burial site. Three competing hypotheses are discussed in light of these data that include (1) violence against enemies and display of the bones as trophies, (2) veneration of respected community members, or (3) sacrificial victims.

3-dimensional hominin whole body and facial reconstructions in European museums.

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Displaying hominin representations in museums introduces the public to human evolution. 3D life-sized representations are of three kinds, either a reconstructed face, bust or the entire body. There is little information about the types of hominin representations, their context or the range of taxa that are in museums. In 2006 European institutions (n=48) were visited in 10 countries. Out of 601 representations that were observed the majority were anatomically modern humans, only 94 were of earlier hominin taxa, these were present in 11 museums. They comprised of 68 complete bodies, 24 busts and 2 heads. Neandertals were the most common (n=62), followed by generalised australopithecines (n=5), *Homo erectus* (n=5), *A. afarensis* and *H. habilis* each had 4 representations, while *A. africanus*, *A. boisei*, gracile and robust australopithecines and *H. ergaster* had 2 representations each, and Kenyanthropus platyops, *H. heidelbergensis*, *H. rudolfensis*, and *A. anamensis* were represented by 1 specimen each. The Hessisches Landes-Museum in Darmstadt, Germany had the largest range of hominin taxa (n=9), while the Natural History Museum, London had 2 taxa only (Neandertal and an Australopithecus). Specimens were displayed with associated contextual information (48%) or in a series (33%), the others were found in solo displays (5%), in complete context (1%) or in storage (13%). Curators prefer to display representations so that variation can be compared. Although these displays are meant to help the public visualise similarities and differences of paleoanthropological finds, some of them have been made many years ago and may not convey the current knowledge.

This study was funded in part by the Walter and Dorothy Duncan Trust.

The pathological consequences of cranial vault modification: an analysis of human skeletal remains from Cuzco, Peru.

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Cranial vault modification, the intentional reshaping of the head, was practiced by ancient populations throughout the New World to symbolize group affiliation, beauty, or status. This practice could only be carried out on children while the cranial bones were still malleable, and researchers have long debated whether this practice detrimentally affected the children whose heads were shaped at an early age. In this study, we examine the possible pathological consequences of cranial vault modification through an analysis of 423 individuals from archaeological sites located in and around Cuzco, Peru. The sites included in this study date from the Early Intermediate Period (200 B.C. – A.D. 600) to the Late Horizon (A.D. 1476 – 1532) and include both Inca and pre-Inca burials.

The results reveal that conditions related to malnutrition and developmental health (porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasias) had no correlation with the presence of modification, modification type, or degree of intensity. Despite this result, it was also found that individuals with modified crania had an earlier age-at-death than their unmodified counterparts. In addition, individuals with tabular modification died at an earlier age on average than individuals with annular modification. The reasons for these findings may relate to the modification process, geographical affiliation, or other causes. The study also revealed that 6 sub-adults and 1 adult exhibited cranial porosity related to the modification process. This finding suggests that localized necrosis did occasionally result from the bindings and bandages used to artificially shape the children's crania.

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Developing a GIS-based predictive model for the identification of fossil bearing deposits in the Eocene of Wyoming.

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Successful identification of fossil-bearing sedimentary deposits in the field typically requires expert knowledge in geology and anatomy, the sharp eyes of a well-trained team of fossil collectors, and often, some degree of luck. Since most of our knowledge of Paleocene and Eocene mammals comes from enormous sedimentary basins in the American West that are typically thousands of square kilometers in extent, it is clear that one way to reduce the role of serendipity would be to develop predictive models. Recent advances in the fields of Geographic Information Systems and Remote Sensing have the potential to increase the likelihood of locating productive fossil-bearing deposits by identifying subtle combinations of geological, geospatial, and remote sensing features that distinguish between productive and non-productive localities.

Utilizing a GIS fossil database, detailed geological mapping, and remote sensing imagery from the ETM+ sensor on the Landsat 7 satellite, we have developed an artificial neural network model for identifying sedimentary deposits with a high potential for containing mammalian fossils in Eocene rocks of the Great Divide Basin. The algorithm identifies patterns of features that are common to fossil bearing deposits, and uses these features in a "fuzzy" fashion to classify other areas. The model's output provides a classification of unvisited sites within the study area along with associated probabilities of these sites being productive. The neural network approach that we have developed in the Eocene of Wyoming has broad implications for many other types of anthropological field research that also involve unique geospatial sets of features.

A histological reconstruction of crown initiation and formation using the developing dentition of Post-Medieval known-age children.

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Most of our understanding of the timing of crown development comes from radiographic studies and anatomical collections of known age children but few researchers report precise initial mineralization times for permanent teeth. This is in part due to the difficulty of x-raying or dissecting the early stages of dental development, represented by very small amounts of poorly mineralized tissue. Histological analysis of developed teeth can also be used to reconstruct the chronology of crown development by recording the incremental growth structures contained within the enamel. This approach has the advantage that the early crown formation is

recorded in the enamel above the dentine horn and can be studied in unworn or developing teeth. In order to investigate crown initiation and formation times, we sectioned the developing permanent dentition of five 18th century children aged between 2 and 4 years, from the crypt of Christ Church, Spitalfields, London. 100 μ m thin sections were used to record enamel cross-striation counts and the chronology of accentuated striae, allowing us to reconstruct with some precision the timing and sequence of crown formation. The results are comparable to other histological studies but the average initiation times of the lower/upper first molars (0.16/0.12 years before birth), lower/upper central incisors (0.17/0.23 years) and the lower canines (0.22 years) were earlier than previous estimates, whereas some of the cusp formation times were greater than expected. The results also confirm that, like the dentitions of great apes, there is an overlap in crown formation between M1 and M2 (0.33 years).

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Data archiving as a prerequisite for publication.

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As editors of *American Journal of Physical Anthropology* and *Journal of Human Evolution* we discuss the pros and cons of data-archiving as a requirement for publication. Currently, most journals do not require such archiving across-the-board. However, editors tend to follow the recommendations of those subfields that require archiving, as is the case for molecular anthropology.

Archiving published data seems reasonable to check the soundness of results. The availability of electronic "supplemental online material" sections and public archives, such as GenBank, TreeBASE and Dryad, increase the feasibility of requiring data-archiving. And some techniques, such as 3dGM or cladistic analyses, are tricky to evaluate without access to original data.

However, other issues are in play. At odds are the rights of individual researchers for subsequent use of their data and the scientific community's interest in open access. Perhaps data should be embargoed for some time or exemptions to archiving be allowed? What should be archived is contentious. Should we archive only new data in a study or all the comparative data necessary to recreate results, and should we include only the genetic sequences, metrics, or nonmetrics, or the specimens/fossils from which these were collected? There are unintended consequences of

the re-use of open access data as well. Combining data may be inadvisable for some data and analyses. We suggest the input and coordination of scholarly journals and professional governing bodies, such as the AAPA, are critical to the consideration of these and other aspects of whether and how to implement permanent data-archiving.

Variation in vocal structure reflects group history in primates.

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Acoustical properties of human accents often indicate geographic identity and migration patterns. Similarly, group signature calls can provide information about group membership in other species of vertebrates, but how inter-group acoustic divergence relates to population history is seldom known. We compared long neigh vocalizations emitted by philopatric male and dispersing female northern muriquis (*Brachyteles hypoxanthus*) to evaluate whether the acoustic properties of individuals' calls reflect current and/or past group membership. Spectrographic analyses were conducted on 470 high quality long neighs collected between April 2006 and March 2007 from 21 females and 21 males living in three adjacent groups at the Reserva Particular do Patrimônio Natural – Feliciano Miguel Abdala, Minas Gerais, Brazil. The acoustic properties of the long neighs correctly classified a higher percentage of males than females in their groups, but both males and females from the group that split more than 20 years ago clustered separately from the two groups that split more recently. A higher proportion of the females were misclassified in their current groups, and females showed higher levels of intra-group variation than the males. This suggests that, despite some convergence, females might retain some of the acoustic properties that characterized the neighs of their natal groups. Our results suggest that similar to human regional accents and dialects, under certain circumstances, acoustic variation within and between group members can be attributable to patterns of migration and group formation in long lived social animals. This research was supported by NSF Doctoral Dissertation Improvement Grant (#0621788), The Wenner-Gren Foundation, and The American Society of Primatology.

The FAST pipeline: A bioinformatics pipeline for automated retrieval, processing, and dataset construction for sequence data to infer phylogenetic trees.

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The construction of phylogenetic trees requires sequence data, yet the manual construction of such datasets is often time-consuming and error-prone. Moreover, due to data heterogeneity in public databases such as GenBank, many sequences may be missed, while others are of poor quality relative to other available data. Steps that are crucial for later analyses, such as the creation of multiple sequence alignments or the identification of an appropriate substitution model, are similarly time-consuming and error-prone when done manually. These concerns are particularly true for large phylogenetic trees.

Here, we describe the FAST pipeline (Fast and Automated Dataset Construction for Tree Inference), which is a bioinformatics pipeline for automated retrieval, processing, and dataset construction for sequence data to infer phylogenetic trees. The pipeline is particularly well suited for multi-gene analyses in conjunction with the program MrBayes, nullifies the aforementioned limitations, and makes it possible to construct higher-quality datasets with hundreds of species and multiple genes with minimum manual effort.

As an example, we applied FAST to the order Primates. The pipeline downloaded over 100,000 sequences and selected over 1750 sequences from 16 different genes for 466 (sub)species according to user-defined criteria for subsequent steps. After additional filtering, 308 (sub)species remained. Finally, FAST produced a Nexus file to serve as input for phylogenetic tree inference in MrBayes. In the near future, we envision using the FAST pipeline to produce Version 3 of *10kTrees* for primates, and for other mammalian groups that are commonly studied comparatively (such as carnivores or artiodactyls).

This research was supported by the National Science Foundation and Harvard University.

Primates consume functional foods: antioxidant properties of leaves eaten by gorillas and monkeys in Ugandan rainforests.

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Functional foods are those that contain a component that benefits health beyond having a nutritional effect. Antioxidants are substances that delay or retard reactive oxygen species (ROS) from destroying body tissue. While studies show that human diets contain antioxidants which are beneficial to human health, very little is known about the occurrence of anti-oxidants in the diets of wild primates. The objective of our study was to survey the staple foods (contributing >1% of annual dietary intake) eaten by mountain gorillas (*Gorilla beringei*) in Bwindi Impenetrable National Park, Uganda, and colobus monkeys (*Colobus guereza* and *Procolobus rufomitratus*) in Kibale National Park, Uganda to identify foods with antioxidant properties that may act as functional foods. We assessed antioxidant levels of 25 staple foods using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) assay, and used Rutin, a known powerful antioxidant, to standardize our assay. Our results show that 6.7% gorilla staple foods and 10% of colobus staple foods displayed anti-oxidant properties similar to Rutin, suggesting that functional foods are important components of primate diets. Although we surveyed only staple foods, at least 31 species of 158 gorilla dietary items are consumed by local human populations for medicinal purposes. These findings suggest that primate foods are functional foods conferring salutary health benefits, despite whether they were deliberately selected for these benefits. This study was funded by The New York Consortium for Evolutionary Primatology.

Marriage and migration: comparisons of biometric and mortuary data at three Fort ancient villages in southwest Ohio.

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The purpose of this project was to obtain biologically relevant information to assess social models of marriage and migration for eleven Fort Ancient populations (located in the Little Miami River Valley in southwestern Ohio). The results for six of these sites are presented here. Dental material was analyzed and both metric and non-metric data were recorded (totaling 231 individuals). Non-metric traits were scored according to the ASU system, and dental metrics included the mesiodistal and buccolingual dimensions at the cemento-enamel junction (CEJ) following a modification of Hillson et al. (2005) (outlined in Aubry 2009).

Intrasite biological distances were calculated using a hierarchical clustering model in SPSS to obtain interindividual distance matrices for each site. Multidimensional scaling (MDS) was used to visualize the placement of individuals in two-dimensional space for comparison with the burial pattern (Permap

11.8 MDS program). Intersite distances were calculated for non-metric traits using Mean Measure of Divergence and for metric traits using R-matrix analysis (provides an estimate of expected genetic heterozygosity for each site). These early results support two existing models. First, biometric data support the multiethnic nature of the sites that blend local Late Woodland and non-local Mississippian populations, identified on the basis of grave construction, associated grave goods, and proximity to distinct features. Second, female outliers identified at each of the sites suggest that intermarriage involved females moving between Fort Ancient villages indicative of marriage alliances, common practices in many ethnographic cases.

Proportions and population history: exceptions to ecogeographic expectations in the Americas.

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Recent, geographically diverse surveys of New World indigenous populations predating European colonization have demonstrated comparable morphological variation to Europeans and Africans in many body dimensions. Despite this diversity, correlations between body proportions, shape and size with climatic factors are diminished compared to correlations among Old World populations. Other factors, such as subsistence, may attenuate these relationships, but are difficult to examine in isolation. Moreover, geographically widespread interaction networks, in addition to large population movements, have introduced potential confounding factors to clinal patterns of morphological variation.

This study utilizes measurements taken from over 3200 indigenous, pre-contact adult humans from throughout the Americas to examine if population history, based on archaeological evidence and models, shapes morphological variation. All skeletons date from the Holocene (primarily the last 4000 years). Examining body shape, size and proportions derived from skeletal metrics, samples were compared within time periods across the continents and across time periods within regions, with and without climate and subsistence as covariates.

Despite a complex mosaic of morphological change over time, important patterns emerge. All humans from the Americas maintain higher body breadths and masses compared with Old World populations living in similar climatic conditions, possibly reflecting a shared "cold-filtered" ancestry. Within regions, such as the Great Plains or the Southeast, variation in intralimb and body proportions reflects archaeological evidence for cultural change or population movement, rather than thermore-

gulatory-related clines. The analyses indicate population history has been a strong factor in shaping patterns of human morphology in the Americas throughout the Holocene.

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Application of phylogenetic comparative methods to the adaptive radiation of Malagasy lemurs.

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The Malagasy lemurs form a taxonomically, behaviorally, and morphologically diverse radiation within strepsirrhine primates. While molecular clock estimates place their divergence from other strepsirrhines between 60-50 Myr or possibly before the K-T boundary (65 Ma), the fossil record for lemurs is only a few thousand years old. In the absence of a deep fossil record, clarification of the evolutionary processes that operated during this adaptive radiation requires analytical approaches incorporating phylogeny and branch length estimates as well as morphological and ecological information. In order to explore patterns of morphological diversification in Malagasy lemurs, we collected 3D cranial landmarks from both extant and extinct giant subfossil lemurs.

Results of our phylogenetic principal components analysis (PPCA), which corrects for non-independence in the data due to phylogenetic relatedness, did not differ markedly from traditional PCA results. Phylogenetic generalized least-squares analysis suggested that both size and dietary toughness explain differences in cranial shape along the first few components. Analysis of cranial shape disparity through time (comparing morphological variation within clades to that seen between clades) demonstrated a drop in subclade diversity around 40-30 Ma, which coincides with the estimated origin of many major lemur clades. Results also indicated that average subclade diversity is less than that predicted by neutral evolution (Brownian motion). A similar but even more striking pattern was seen in cranial size disparity through time. This pattern is consistent with theoretical work that predicts that available ecological niches are filled early in an adaptive radiation, with reduced diversification through time.

Monogamous owl monkeys differ in the structure of OXTR from other non-monogamous primates.

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The oxytocin (OT) hormone pathway is involved in a multitude of physiological processes, and one of its receptor genes (*OXTR*) has been implicated in increased partner preference and pair bonding behavior in mammalian lineages. This observation is of considerable importance for understanding social monogamy in primates, which is present in only a small subset of primate taxa, including owl monkey (*Aotus azarai*). To examine the potential relationship between social monogamy and oxytocin receptor genes we sequenced the regulatory (>2000 bp) and coding regions (2 exons transcribing 389 amino acids) of this locus in 125 owl monkeys from a wild population in the Argentinean Gran Chaco. We also assessed the interspecific variation of *OXTR* by sequencing the locus in 10 platyrrhine species that represent a set of phylogenetically and behaviorally disparate taxa. The resulting data revealed *A. azarai* to have a unique genic structure for *OXTR* that varies in coding sequence relative to other primate and mammalian species. Furthermore, the *A. azarai* sequence exhibits four (4) amino acid changes that may putatively increase the surface area of the ligand-binding domain. In addition, the Cebidae have an increased ratio of synonymous to non-synonymous amino acid changes relative to other platyrrhines, suggesting the possible occurrence of positive selection at this locus. Our findings suggest that, despite the polygenic characteristics of the OT pathway, the properties of the *OXTR* proteins have experienced lineage-specific evolution.

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Cooperation confers fitness benefits in a communally nesting primate.

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While communal nesting and cooperative infant care are common among some avian and mammalian taxa, such

shared maternal investment is rare among primates. While some primates, including callitrichines, participate in singular cooperative breeding, in which one reproductive female has 'helpers at the nest,' only humans have been conclusively shown to participate in plural communal rearing, where all females within a social unit reproduce and then collectively share in maternal responsibilities. Recently, however, this division of labor has also been observed in ruffed lemurs (*Varecia variegata*), a diurnal, moderately-sized, litter bearing lemur, suggesting that ruffed lemurs may represent the only other diurnal primate besides humans to converge on this unusual reproductive strategy. Here, we present data from the first systematic field study of communal rearing in the species to combine behavioral, genetic and infant survivorship data. Data included in this study represent over 1,220 observation hours of seven parous females ($n = 7$ litters, 19 infants) during late gestation through early infant dependence (September-December 2008). We demonstrate that communal nesting occurs most often among kin, and that shared maternal care benefits ruffed lemur mothers by allowing significant trade-offs between maternal responsibility and foraging effort. Moreover, the incidence of cooperative infant care predicts infant survivorship in ruffed lemurs, particularly during early infant development, thus these perceived trade-offs likely confer direct fitness payoffs to communally nesting mothers.

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Morphometric analysis and geochronology of Hominin fossils from Maba (Guangdong, China).

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The question of "replacement events" versus "transitional stages" has long been a strongly debated topic in paleo-anthropology. A good example of this is the question of the nature of hominin evolution in eastern Asia during the Middle to Late Pleistocene. Two major questions relevant to the eastern Asian record are: "Did *Homo erectus* evolve into modern *H. sapiens* with archaic *H. sapiens* as the transitional group?"; or

"Was *Homo erectus* replaced by dispersing *H. heidelbergensis*, a so-called "early" replacement event, only later to be replaced by modern humans from the western Old World?" In this paper, we analyze hominin fossils from the late Middle Pleistocene Maba Cave (Guangdong, China) to test these hypotheses. Maba is best known for the presence of a partial hominin cranium that has traditionally been allocated to archaic *H. sapiens*. We present a morphometric analysis of a hominin partial mandible and five teeth (four upper M1s and M2s and a lower M3) that were excavated from Maba in 1960 and 1984 but previously unreported in the Western scientific literature. The Maba partial mandibles from the Middle Pleistocene Old World (e.g., Mauer, Arago, and Tighenif). The Maba teeth are compared to data collected from selected hominin fossils and Holocene Chinese and Korean dental collections. A recent dating analysis of the Maba deposits suggest the age of the capping flowstone may be as old as 237 ka. We discuss the meaning of these new dates in this paper.

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Thinking outside the European box: dental metrics and morphology of African Middle Pleistocene hominins.

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Middle Pleistocene (MP) hominins from Europe are known to possess dental characters that link them to Neanderthals. However, whether or not these characters are unique to MP Europeans is unclear because much less attention has been given to the far fewer dental remains of this age outside of Europe. This study examines metrical and morphological dental characters in MP African hominins. We present results for characters that have been previously suggested to be distinctive in Neanderthals. The relatively large incisor to molar ratio that characterizes Neanderthals is not seen in MP Africans, which are more similar in this regard to *Homo erectus*. Morphologically, the MP Africans also lack the Neandertal dental pattern. For example, none possess the derived suite of lower P4 characters (asymmetry, transverse crest, and multiple lingual cusps) or a continuous trigonid crest on the lower M3. However, one individual (Rabat) does share certain morphological characteristics with Neanderthals (e.g., a relatively small upper M1 occlusal polygon area and a small upper M1 metacone relative to

hypocone, but not the distinctive Neandertal crown shape). A small occlusal polygon area has been also observed in one individual of the Layer TD6 in Gran Dolina (Spain), which may suggest that this pattern is not uniquely derived for the Neandertal lineage. The preponderance of evidence suggests that MP African hominins are characterized by retention of many primitive dental characteristics shared with *Homo erectus* and, unlike European MP hominins, show no clear affinity to Neanderthals.

Groovy teeth: unraveling patterns of dental use wear in a Medieval sample from Polis, Cyprus.

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Over 300 individuals are associated with two early sixth-century basilicas at Polis Chrysochous, on the northwest coast of Cyprus. One basilica was used to the eleventh century. The other was reused for burials from the thirteenth to sixteenth centuries. Eight of 54 individuals (14.8%) analyzed to date exhibit alterations on anterior teeth consistent with their use as tools. All are adults and seven are female. The eighth, represented by one tooth, is unattributable to an individual burial. Three distinct patterns of dental use wear suggest teeth were used in different ways. All patterns are associated with small incisal grooves on the mandibular incisors, oriented labio-lingually, but maxillary involvement differs.

Pattern 1 consists of grooves on the distal aspects of lateral incisors and lingual surface attrition of the maxillary teeth (LSAMAT) found in one woman buried with a bone needle (Baker et al. 2007). Harper (Harper and Fox 2008) found an identical pattern in five of 35 Venetian period burials at Athienou-Mallouva. Pattern 2 includes five individuals with V-shaped notches on the central incisors, first observed in another woman with a bone needle. Pattern 3, found in two individuals, combines grooves or notches on the lateral and incisal aspects of the maxillary incisors. All patterns contrast with the transverse grooves on anterior dentition that Erdal (2008) related to mouth spinning. Textile and clothing production in medieval Cyprus was principally a household activity. Dental use wear suggests that women were responsible for such work at Polis.

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The missing femur at the Mitla Fortress.

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A common belief across prehispanic Mesoamerica was that an individual's power was concentrated in the femur. Several elaborate burial contexts, beginning as early as A.D. 100, contained the remains of elite rulers along with one or more femora. Further, femora have been recorded as missing in other burial contexts in Oaxaca and elsewhere in Mesoamerica, but those burials were poorly preserved. Individual skeletons were not complete, so it was impossible to know when or how the femora were removed or if they were part of a primary burial context. Burial 13 at the Mitla Fortress provides documentation of a clear donor context in which the descendants of an important person carefully reopened his burial cist after death to extract the individual's right femur. This finding provides material support for the process of femur removal that was earlier only hypothesized for Lambityeco.

Such curation of human femora has largely been considered an activity associated exclusively with rulers or those of high status. Yet the residence excavated at the Mitla Fortress was not such a context, and so the removal of femora (at least in the Late Classic period Valley of Oaxaca) may not have been a practice limited to rulers. The individual missing his femur at the Fortress may have been a neighborhood head and/or a lineage founder, who was revered by his descendants. His descendants may have removed his femur in an effort to establish their status in at least the confines of their local community.

Damage and mortality effects of Cyclone Fanele on sifaka food trees in Kirindy Mitea National Park, Madagascar.

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Cyclones have been suggested to play a major role in the evolutionary history of the flora and fauna of Madagascar. However, very little is known about the effects of cyclones on Malagasy ecosystems. The high wind velocity of cyclones can snap or uproot trees and cause complete defoliation. With the loss of food species, primates may shift their diets to less preferred food items and/or narrow their diets. We assessed the damage to 1184 trees that are known food resources for Verreaux sifaka (*Propi-*

theus verreauxi verreauxi) eight months after Cyclone Fanele. Eighty-six percent of food tree species were damaged and 7.4% were dead. Twenty six percent of food trees experienced major branch damage and 26.5% showed major trunk damage. Tree damage was not distributed equally across all species ($\chi^2 = 45.2332783$, $df = 28$, $p < 0.0025$). We evaluated how cyclone Fanele impacted the sifaka food trees using generalized linear mixed modeling with Laplace approximations. A highly significant interaction between tree height ($p < 0.01$), DBH ($p < 0.001$), and damage was found. With each unit increase in tree height and DBH the odds of damage increased. With each unit increase in tree height the odds of dying increased ($p < 0.001$), but this relationship was not significant with larger DBH. Tree height is a stronger predictor of damage and mortality than DBH. Sifaka food resources were significantly reduced, suggesting that these lemurs have had to alter their feeding behavior as a direct consequence of Cyclone Fanele.

The *Runx2* gene is an important determinant of facial morphology in primates.

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The runt-related transcription factor gene (*Runx2*) encodes a transcription factor that is important for osteoblast development and normal osteogenesis. Previous research has demonstrated that the glutamine to alanine (Q/A) ratio contained within the protein-coding, tandemly-repeated portion of exon 3 of the *Runx2* gene is significantly, positively correlated with facial length within an artificially-selected species (*Canis familiaris*, domestic dog) and among species in a naturally-evolving order (Carnivora). However, the correlation of the Q/A ratio and facial length in primates remains unclear. The present study tests the hypothesis that the Q/A ratio within the *Runx2* gene is correlated with facial length in primates.

Data were collected from a taxonomically-broad sample of primates ($n = 24$). Q/A ratios were collected through DNA sequencing and from published data in national genetic databases. Craniometric data (including facial length and five variables used to correct for size) were collected directly from primate crania ($n = 24$ species; 306 individuals) in museum collections. Results indicate that the Q/A ratio of the *Runx2* gene is significantly, positively correlated with size-corrected facial length in primates ($r = 0.62$; $p < 0.01$); this correlation remains significant using statistical

methods that control for phylogenetic-relatedness among the species in the sample ($r = 0.52$; $p < 0.05$). These results suggest mutations in protein-coding regions of a developmental-regulatory gene can have important phenotypic effects in primates and demonstrate the utility of using genetic approaches to understanding primate morphology.

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The role of erect posture in shaping the hominid cranial base.

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The hominid cranial base has been studied extensively over the last 150 years, with most attention focused on the midsagittal plane. Many papers contrast ape morphology with human morphology and conclude that the massive brain expansion characterizing human evolution is the main mechanism that shaped the unique basicranial morphology of *Homo sapiens*. However, relatively few papers did a comprehensive comparative study of the cranial base that included early hominids.

In this work, three groups were studied: humans, chimpanzees, and early hominids. We followed the contour of the midsagittal basicranium, starting from the posterior aspect of the occipital bone, through the foramen magnum, clivus and the sphenoidal plane in the anterior cranial base. Angular measurements were first taken in relation to the Frankfurt horizontal plane. These include the nuchal plane, foramen magnum, clival line and planum sphenoidum. The second measurements, which did not require a reference plane, were angles that are formed between two adjacent segments of the cranial base: nuchal plane-foramen magnum; foramen magnum-clivus; clivus-sphenoid plane.

Our results indicate that early hominids achieve human-like appearance very early in the fossil record. Almost all australopithecines measurements lie closer to humans than chimpanzees. Furthermore, it appears that the entire section of inion-opisthion-basion-clivus behaves as one morphological unit by shifting to a more inferior-anterior position, and thus creating the steeper clival angle which is apparent in hominids. When taking into consideration the small brain volume of australopithecines, our results substantiate the important role that erect posture had on shaping early hominid cranial base.

Dental microwear and morphology correlation in *Pan*, *Papio*, and *Gorilla*.

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Prior research has suggested dental microwear and oro-facial morphology may be correlated, reflecting similar aspects of masticatory loading. If this association can be confirmed in living primates, it can be extrapolated to fossil hominin studies. This could add vital information when considering possible evolutionary relationships for specimens known only by incomplete or purely dental remains. In this study we searched for correlation between microwear (on the first, second, and third mandibular molars) and biomechanically relevant measurements of the skull in *Pan troglodytes* ($n=20$), *Papio anubis* ($n=20$) and *Gorilla gorilla* ($n=20$).

Dental impressions were taken from the mandibular molars. Resin casts were prepared. Digital micrographs were taken of facet 6 using a scanning electron microscope. The micrographs were analysed using Microware 4.02. Skull measurements were taken using digital callipers.

Findings indicate that striation length (mean=50.04 μ m) was correlated with corpus depth ($r=0.766$; $p=0.000$) in second molars from *Pan troglodytes*. Pit width was correlated with mandibular coronoid height ($r=0.605$; $p=0.005$) and ramus height ($r=0.600$; $p=0.005$) in third and first molars respectively from *Papio anubis*. Striation length was correlated with corpus width in third molars from *Gorilla gorilla* ($r=0.555$; $p=0.035$). Results are discussed in terms of dental morphology and orofacial muscular-skeletal proportions, as well as diet.

Evaluating the efficacy of household bleach in the removal of contamination from bone surfaces.

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While polymerase chain reaction (PCR) now routinely permits study of genetic markers contained in skeletal samples, it simultaneously represents a system that is hypersensitive to amplifying contaminant DNA. Contaminating DNA competes with degraded DNA during PCR amplification and this often leads to false positives and/or aberrant results, thus compromising these analyses.

In order to test the capacity of bleach to remove contamination, ~3500 year old Northern Fur Seal (*Callorhinus ursinus*) rib samples were intentionally contaminated with human DNA. Sub-sections of the contaminated ribs were removed and submerged in different concentrations of household bleach (sodium hypochlorite; ranging from 0.6%-6.0% w/v), during time trials ranging from 1 to 15 minutes, to determine which treatment could completely remove contamination while causing the least amount of damage to the endogenous Northern Fur Seal DNA. DNA copy numbers originating from human and Northern Fur Seal were determined with real-time PCR using species-specific fluorescently labeled probes.

These experiments demonstrate that bleach, even at low concentrations, is very effective at destroying contaminating DNA on the surfaces of bones. However, low levels of contaminant DNA, likely originating from tips, tubes, and other lab disposables, complicate these findings. In addition, while it appears that bleach causes some damage to the endogenous DNA, the ability to assess the degree of damage is complicated by the fact that the preservation of endogenous DNA is highly variable across each specimen. This paper discusses the implications of these observations.

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Prehistoric human foraging in the south San Francisco Bay Area: a stable isotope perspective.

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Variation in prehistoric human diets has been explored in the San Francisco Bay Area through studies of faunal and botanical remains from several large midden sites. Recent stable isotope research in the Bay Area has demonstrated significant temporal and regional variation in ancient human diets across the late Holocene (4500-200 B.P.), with the greatest changes occurring between the Early Period and the Middle Period (ca. 4500-1200 B.P.). Previous research on stable carbon, nitrogen, and sulfur isotopes has revealed a shift from a marine-oriented diet to one more focused on terrestrial plant and animal resources from C₃ ecosystems; however, regional patterns are

evident throughout the Bay Area, which may also reflect differential access to resources based on geography and territoriality.

This study builds on the foundation of previous research and evaluates new stable carbon and nitrogen isotope data from 85 late Holocene humans derived from eight south San Francisco Bay sites in Santa Clara County. Data from stable carbon and nitrogen isotopes of bone collagen and stable carbon isotopes of bone apatite reflect greater consumption of C₃ terrestrial resources in the region compared with the more marine-oriented diets of human foragers from sites along the eastern bayshore. Mean human bone collagen values varied from -17.0 to -19.0‰ for $\delta^{13}\text{C}$, and 6.0 to 9.0‰ for $\delta^{15}\text{N}$. Apatite $\delta^{13}\text{C}$ and the apatite-collagen spacing indicate significant variation in the contribution of different dietary macronutrients among individuals. These patterns are addressed in light of late Holocene resource intensification models proposed for prehistoric California.

A craniometric investigation of biological contacts between populations of the Iranian Plateau and Central Asia during the last three millennia B.C.

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Archaeologists have long contended that populations on and adjacent to the Iranian Plateau throughout the Bronze Age enjoyed close cultural contacts with and even migratory movements into south Central Asian populations (Masson & Sarianidi 1972). However, a recent dental analysis (Hemphill 2010) failed to identify any evidence of gene flow between the late Bronze Age populations of the north Bactrian oasis and the Bronze Age site of Tepe Hissar, located in northeastern Iran. This study employs a battery of eight craniometric variables among 154 individuals from Tepe Hissar, located at the western periphery of the Iranian Plateau and 88 individuals from Shahr-i Sokhta, located on the eastern plateau. These data are compared to 1,333 individuals from 28 samples from Central Asia, Indus Valley, China and Nepal to determine whether claims of contacts between south Central Asian and Iranian Plateau populations during the Bronze Age involved gene flow. Inter-sample differences were examined with hierarchical cluster analysis, neighbor-joining cluster analysis, multidimensional scaling and principal coordinates analysis.

Results consistently identify affinities between Iranian Plateau samples and samples from south Central Asia. However, these affinities lie with earlier

samples from the Kopet Dagh and Tedjen oasis, not the later samples from the north Bactrian oasis. Such results suggest contacts between populations of the Iranian Plateau and Central Asia likely occurred in the early Bronze Age, but then ceased. Affinities between Tepe Hissar and Hasanlu IV, located in northwestern Iran, suggest inter-regional contacts of Iranian Plateau populations shifted from south Central Asia to northern Mesopotamia.

Nasal form and function in Mid-pleistocene human facial evolution. A first approach.

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Large prognathic faces of Middle and Later Pleistocene humans contrast with smaller orthognathic faces of *H. sapiens*. Yokley et al. (2009) [PaleoAnthropology 2009:A39-40] have shown that facial prognathism decreases together with nasal breadth and body mass with the emergence and spread of modern humans. They speculated that for bioenergetic reasons large-bodied archaic humans need to inhale larger quantities of oxygen - facilitated by greater nasal breadth - than smaller-bodied modern humans. Anterior nasal breadth, however, relates to intake and pre-processing of respiratory air, whereas posterior nasal parts (choanae and epipharynx) are responsible for air transmission towards lower, non-cranial parts of the respiratory system. Thus, different nasal regions serve different aspects of respiratory physiology. But how do all these nasal regions relate to facial form? We explore these questions with 3D-geometric morphometrics in fossil and modern humans and hominoids analyzing morphological interactions between nasal and facial structures and its evolutionary implications. Results show significantly different scaling patterns in anterior and posterior nasal size. Also, levels of anterior and posterior nasal cavity shape integration are low. Integration between the entire nasal cavity and facial shape is higher. These patterns fit with mean shape comparisons. While posterior nasal structures may be more directly related to air intake, anterior nasal parts may be involved in additional physiological functions. Evolutionary factors might act differently on anterior and posterior nasal openings, both of which interact with facial form. The respiratory apparatus may offer one example for systemic integration of cranial and non-cranial systems within human organisms.

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Aymara mtDNA variation and demographic history in the Central Andes.

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In Central Andes, exploitation of marine resources and intensive agriculture led to population increase early in prehistory. The region is characterized by constant population movement as well. These events undoubtedly affected regional genetic variation, but the exact nature of these effects remains uncertain. In this study, mtDNA HVRI sequence variation in 61 Aymara individuals from La Paz, Bolivia, was analyzed and compared to that of other Latin American populations to examine how increased female effective population size and gene flow influenced the mtDNA variation among Central Andean and other western South American populations.

The Aymara and Quechua were genetically diverse showing evidence of population expansion and large effective population size when estimated using maximum likelihood methods that account for gene flow between subdivided populations. Spatial expansion models generally fit the mtDNA variation observed in Latin America well, especially among genetically less diverse populations, but a demographic expansion model fits the mtDNA variation found among Central Andean populations well.

These results suggest that female effective population had a greater impact on mtDNA variation than female gene flow among Central Andeans. However, migration rates and the results of AMOVA and multidimensional scaling analysis suggest that female gene flow was also an important factor, influencing genetic variation among the Central Andeans as well as lowland populations from western South America. The interaction sphere may have extended to the transitional zones between the Andes and Amazon making populations from these areas more genetically diverse and similar to Central Andeans.

Dental and mandibular integration in the common chimpanzee (*Pan troglodytes verus*).

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Mandibles and teeth vary greatly in size and shape among fossil hominins.

Evidence from experimental and comparative studies suggests that the development of teeth and the mandibular bone are under separate genetic control. However, together they form an integrated functional unit and evolve jointly. We quantify the covariation between teeth and mandibular bone, to understand the evolutionary dynamics underlying the morphological and functional differences among fossil hominins.

As a first step towards a methodological framework we investigate the overall tooth-jaw metric relationship of *P. troglodytes*. We expect that large postcanines require large and robust mandibular corpora to withstand the forces applied during mastication. We use μ CT data of the mandibles of two adult populations to quantify the volume of the segmented mandibular bone and that of the postcanines. We also generate standardized virtual cross-sections at each postcanine to calculate the robusticity index of the mandibular corpus.

Our results show a significant correlation between the postcanine tooth volume and mandibular bone volume. We also found that the M2 is the biggest tooth within the molar row suggesting that it is subjected to the highest occlusal forces. The mandibular robusticity index, however, increases from M1-M3 indicating that the posterior end of the mandible can sustain higher torsional forces. These results highlight the importance of a closer examination of robusticity related to force distribution within the teeth and the mandible. Our findings provide the basis for further studies on interspecific and intraspecific variation in the dento-mandibular complex among living and fossil hominoids.

Scurvy: a temporally and geographically ubiquitous disease of infants and child in prehistoric west-central Illinois.

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Scurvy has recently received a great deal of paleopathological attention and cases of infantile and childhood scurvy have been reported in skeletal collections representing a wide range of temporal and geographic contexts. This paper reports on the findings of skeletal evidence of scurvy in samples from prehistoric West-central Illinois.

Crania from 2,295 individuals from sites in both the Lower and Central portions of the Illinois River Valley were examined for osseous evidence of scurvy. Key to diagnosis was the presence of porous lesions on the greater wing of the sphenoid and on sites such as the anterior temporal, mandible, maxilla and superior orbits. Scurvy was diagnosed in a total of 79 individuals with a further 21 individuals considered likely to have had the disease. Ninety of the 100 individuals diagnosed with scurvy or

possible scurvy were infants or children. Cases of scurvy were found in both sub-regions of the valley and from all cultural horizons sampled: Middle Woodland, Late Woodland, Mississippian and Oneota.

The presence of scurvy and its temporal and geographic ubiquity force new considerations disease patterning and interpretations of health in prehistoric West-central Illinois. This nutritional deficiency disease may be tied to an inadequacy in the regular juvenile diet over the course of prehistory and/or to seasonal deficiencies which may have affected both subadults and adults. Because the presence of scurvy predates the intensification of maize agriculture it is no longer tenable to view agriculture as the sole cause of nutritional problems in the region.

This study was funded by The Wenner-Gren Foundation, Grant # 7597.

Comparative morphometric maps of virtually unrolled Neandertal and modern tooth roots.

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By using a high-resolution microtomographic record of extant and fossil human incisor and canine teeth, we applied morphometric mapping techniques to virtually unroll the dental roots and to comparatively assess their variation in dentine thickness topography. More specifically, the analyses were run in order to evaluate if the extant pattern evolves in a predictable way through life, and to compare the fossil and the extant conditions.

The fossil sample includes the deciduous teeth of the Neandertal immatures from La Chaise abri Suard and Roc de Marsal, in France, and of the Upper Paleolithic specimens from Lagar Velho, in Portugal, and La Madeleine, in France, as well as the permanent lower incisors and canines of the adult Neandertal from Regourdou, in France.

After threshold-based segmentation and surface rendering, the dental roots have been virtually unzipped vertically along the middle of their lingual aspect and then unrolled. The region of interest has been restrained and represents the dentine thickness variation comprised between 50% and 85% (upper) of the total root length.

Preliminary results show an evolving pattern of dentine thickness distribution through life in extant humans. Also, while broad similarities in the pat-

terns of thickness distribution are found between the extant and the fossil samples, as well as among the fossil specimens, in Neandertals these are accompanied by more marked localized contrasts, notably in proximity of the cemento-enamel junction. In this context, the early Upper Paleolithic child from Lagar Velho shows an intermediate repartition pattern between the Neandertal and the extant condition.

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Stable isotopes, diagenesis and FTIR: evaluating the differences in C/P and IR-SF values from three different sample preparation methods for spectral analysis.

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Stable isotope researchers use carbon stable isotope values from bone apatite to reconstruct ancient diets. Initially, the suitability of bone apatite analysis was debated because of possible diagenetic alterations affecting the bone mineral properties. Several studies have concluded that, through appropriate sample preparation treatments, bone apatite can yield *in vivo* signatures. Nonetheless, it is still necessary to evaluate samples for diagenetic alterations. One standard method of evaluating diagenesis in bone apatite is to use FTIR (Fourier transform infrared) spectroscopy to measure carbonate content (C/P) and bone mineral crystallinity or IR splitting factor (IR-SF). FTIR spectroscopy is a semi-quantitative method for analyzing chemical components within a material. Advances in technology have enabled new preparation methods for FTIR samples. In this study, 455 samples of modern, historic and prehistoric bone were prepared using three different methods to load and analyze FTIR samples. The methods that were compared (ATR, DRIFT, and hydraulic press KBR pelleting) use varying optic properties to analyze a sample. According to chemists, each spectra produced by each method is equivalent. In fact, each method does identify the same chemical components for a sample. However, it was found that each spectra yielded statistically significant different values for C/P and IR-SF, as well as different correlations between the values. It is therefore concluded that the sample preparation method used for spectral analysis does affect the resulting calculations that evaluate diagenesis in bone apatite and the different preparation methods should not be used interchangeably as they have been used in recent publications.

Community health at Nemea, Greece: a comparative bioarchaeological approach to the impact of sociopolitical change in Byzantium.

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This study compares the skeletal health of two agricultural communities dating to the Early Christian (n=123) and Middle to Late Byzantine (n=139) periods at Nemea, Greece using bioarchaeological methods. The aim of this approach is the exploration of changing living conditions in the latter period, during which time southern Greece was invaded by western Europeans and the Byzantine Empire experienced changes in political administration that had lasting, disruptive effects. Skeletal indicators of non-specific stress and activity were assessed in order to test 1) the extent to which political instability and invasions diminished quality of life among the Byzantine community and 2) whether or not different spheres of activity for men and women are suggested by sex-based differences in health within the Early Christian and Byzantine communities. The association between burial location and social status was also tested by comparing lesion prevalences across burial subgroups within the mortuary space at Nemea. Certain indicators of health such as cribra orbitalia and porotic hyperostosis remained relatively constant through time, while others such as periosteal reactions, vertebral osteophytosis, and trauma were found to be more prevalent in the Early Christian period. These results do not support the hypothesized general negative consequences for health in the Byzantine period. This study adds to the growing body of research demonstrating the utility of bioarchaeology in the evaluation of historical narratives.

This research was generously supported by a Food, Nutrition, and Chronic Disease Fellowship awarded by the Graduate School, Michigan State University.

Bone growth and loss in a Roman population using a multi-method approach.

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Most studies investigating bone maintenance and fragility in the past use a single method of skeletal analysis. Using data from the skeletal analysis of the Imperial Roman population of Velia, this paper demonstrates that the use of multiple methodologies and data collected from different skeletal locations provide a more complete approach to

better elucidate the complex etiology of bone loss and fragility. Three methods were used in the analysis of bone fragility at Velia: metacarpal radiogrammetry (n=79), analysis of vertebral trabecular architecture (n=67), and cortical rib histomorphometry (n=70), using three age cohorts (18-29; 30-45; 45+yrs.) The pattern of bone loss differs in important ways across the three methods. The radiogrammetry results show significant age-related changes in both males and females and the pattern of bone loss differs between the sexes. Females lose bone primarily in young reproductive age, while male cortical levels remain high until old age where cortical bone values drop rapidly. This pattern contrasts what is seen in the vertebrae, where bone volume declines only slightly with age, with varying compensating changes in trabecular architecture seen between sexes. Finally, cortical bone loss in the ribs shows gradual age-related change. These results highlight the need for multiple approaches to the investigation of bone maintenance and fragility in bioarchaeology. This study was funded by SSHRC, grant number 752-2005-1803.

Testing Fox's assembly rule with Bornean primates and other vertebrates.

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A central question in primate ecology is whether communities are structured by deterministic processes or are random assemblages of species. I investigate the role of competition deterministically shaping Bornean primate communities. Although primate communities are frequently viewed as self-contained communities, the species that compete with primates likely include non-primate taxa. Moreover, it has been argued that competition between primates and other mammalian taxa is stronger in Borneo than other regions. I therefore test the assumption that Bornean primates compete predominantly with other primates by investigating community assembly hypotheses for primates and a larger community of vertebrates. Specifically I investigate Fox's assembly rule for favored states, which postulates that if interspecific competition favors the entry of species that are most distinct from the community, then communities should be composed of even numbers of species across functional groups. I collected data for Bornean reserves from published sources. I gathered presence-absence data for arboreal vertebrates including primates, colugos, squirrels and flying squirrels and data on their dietary functional groups. I defined communities using primates, squirrels and all species combined. I compared the observed number of sites with even

numbers of species per dietary functional group with the expected distribution of favored sites generated from a null model using Monte Carlo simulations. Across community types, the observed number of favored states was significantly greater than expected, which supports Fox's assembly rule in Bornean vertebrates. My results therefore suggest that interspecific competition is important for Bornean vertebrate community assembly within and between taxonomic groups. This study was supported by an NSF graduate research fellowship to Lydia Beaudrot.

Estradiol as a biological measures of mood and female intrasexual competition.

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Within human evolutionary and clinical biology, estradiol is primarily studied a) within the context of peri- and postmenopausal women, b) as an indicator of fecundability in response to environmental stressors, or c) in cases of infertility and endocrine deficiencies. Elevated estradiol levels preceding ovulation in normally-cycling women may contribute to behaviors associated with female-female competition, such as narcissism and derogation. We hypothesized that women would report an increase in feelings of self-worth and attractiveness during the pre-ovulatory period when estradiol levels are at their peak. The participants for this project were 20 women ages 18-35 who completed the questionnaire 2 times during a single menstrual cycle; during the late follicular and the late luteal phase. The questionnaire recorded information on feelings of self-worth, attractiveness and general indicators of mood, regularity of menstrual cycle, birth control method, current relationship status, and sexual activity. Results of the questionnaires revealed a significant difference between Rosenberg Self-Esteem scores from the luteal phase and those of the individuals classified as periovulatory ($T = -2.37$, $p = 0.037$, $DF = 11$). However, results of the biological samples do not ($T = 0.9096$, $p = .3981$, $DF = 6$). These results indicate that estradiol levels obtained from the biological samples do not support the hypothesis that feelings of self-worth would increase when estradiol levels are at their peak. A possible reason for these results may be the small sample size of this study. Future research is needed to clarify the role of estradiol in mediating female sexual behaviors.

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How to measure dominance? Percentile vs. ordinal ranking systems.

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Dominance is a fundamental feature of many social animals. Most researchers agree that agonistic dominance is a critical factor that shapes the social structure of a particular species. However, there remains less agreement on how dominance should be measured – even for taxa with some of the most stable and linear dominance hierarchies. While some researchers utilize a more “relative” ranking system where animals are scored based on the proportion of individuals that they dominate (percentile ranking system), others use a more “absolute” system where animals receive a rank number based on how many animals are above them (ordinal ranking system). To date, there has been little discussion on the appropriateness of these measures for answering different research questions. Particularly when examining multiple groups of varying size, or one group that changes in size over time, the decision to use a percentile or an ordinal ranking system could change the outcome of analyses. Here, I describe several types of research questions that would benefit from one or the other measure of rank. I use geladas (*Theropithecus gelada*) as a model species to illustrate how the ranking systems differ. Because a gelada “group” (i.e., band) essentially comprises dozens of reproductive units (i.e., one-male units), all of varying size, each with its own stable linear dominance hierarchy among females, I am able to document the interactions between group size, research question, and ranking system.

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Performance: A uniquely human behavior.

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This paper addresses the question of the uniquely human ability to engage in performance, broadly defined as *purposeful enactment or display carried out in front of an evaluating audience*. Following Alfred Schütz, Erving Goffman, Deborah Tannen and others, the paper posits that performance “works” through the creation of behavior that is imbedded in cognitive “frames” that determine the symbolic interpretation of events. The framed event then allows the performer to stimulate the emotions

of the audience through pragmatically determined communication in a psychologically protected environment. Both performer and audience utilize the biologically-based human ability to predict the emotional states of others, currently known as "Theory of Mind," in order to generate and feel these emotions in an act of co-creation of experience. It is posited that performance has evolutionary value in allowing humans to practice the experience of emotions—crucial to critical decision making and to creating group solidarity, essential to human survival.

Advanced methods in analysis of dental remains.

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This study establishes the reliability of microCT and RAMAN as substitutes for destructive, less reliable techniques. Focusing on wear, root transparency/tubule occlusion, and pulp volume decrease/secondary dentine apposition, potential algorithms correlating measurements to age are developed. Until recently, many methods of aging dental remains were destructive, with high inter-observer variability. The last few years have shown advancement in technology available, allowing more standardized and non-destructive methods. However, the capabilities and limitations of such approaches have not been fully explored.

Maxillary incisors and canines from 30 individuals of known sex, age (24-87), and ethnicity were measured using traditional methods for measuring wear, transparency, and pulp volume. The teeth were also scanned in a microCT system, and analyzed with RAMAN spectroscopy. The project tests the hypotheses:

1. MicroCT can produce quantifiable measures of tooth morphology beyond the accuracy of hand measures.
2. RAMAN spectroscopy can quantify age-related changes through chemical analysis more accurately than visualization techniques.
3. There are consistent changes in teeth throughout aging so that regressions might be developed for age estimation.

MicroCT registers age related density changes corresponding to root transpar-

ency and SEM-visualized tubule occlusion. Morphological changes can also be quantified (e.g. pulp volume, enamel thickness) without sectioning. RAMAN microscopy can quantify the molecular composition from atomic wavelength shifts when laser-induced fluorescence is recorded. With mineralization causing root transparency, a visible shift in the spectrographs would be expected. Additionally, chemical differences between primary and secondary dentine could be registered by RAMAN scans.

This study received no external funding. Teeth on loan from University of Tennessee, Department of Anthropology, Forensic Anthropology Center.

New postcrania of *Rudapithecus hungaricus* from Rudabánya (Hungary).

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In 2009 and 2010 we recovered a nearly complete femur, the shafts of an ulna and humerus, a complete scaphoid, centrale, lunate, pisiform, trapezoid and several partial phalanges and metacarpals of the fossil hominid *Rudapithecus hungaricus*. They are consistent in size with male *Rudapithecus* and were found at the same elevation, in the same sediment and within a horizontal distance of less than two meters. They probably represent a single individual. Similar associations of postcrania of many other mammals from the same level have also been recovered. The femur and scaphoid are roughly twice the size of the same bones described previously (Kordos and Begun, 1999; Kivell and Begun, 2009). The femur has many characters typical of great apes, including a large head, low neck-shaft angle, and a robust, curved and platymeric shaft. The lunate and scaphoid contribute equally to the radiocarpal joint. The scaphoid tubercle is strongly projecting and the surface for the trapezium is large. The lunate's surface for the triquetrum is convex dorsopalmally. The pisiform is large and strongly keeled, and the proximal articular end is sellar in form, corresponding to a sellar joint on the triquetrum. There is no articular surface for the ulnar styloid or for an articular disk. Overall the carpals share features with both orangutans and African apes. The scaphoid tubercle and the pisiform indicate a deep carpal tunnel, consistent with powerful digital flexors, and a relatively large trapezoid, probably indicative a large and powerful pollex.

Supported by grants from the National Geographic Society and the Natural Sciences and Engineering Research Council of Canada.

Questions, answers, and more questions: using databases to explore the taphonomy and paleoecology of the African hominin record.

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Electronic databases derived from fossil collections are powerful tools for examining paleobiological spatial and temporal patterns as well as data quality issues affecting these patterns. It is easy to assume that numbers derived from these databases, such as the proportion of hominins or alcelaphines relative to other mammals, reflect original ecological reality to some degree. Sampling and taphonomic biases can affect this assumption, making it important to estimate ranges of error for taxonomic representation based on different field sampling methods, museum collections, and databases. Here we examine variation in the relative abundance of mammalian groups in space and time for the Turkana Basin. We utilize the Turkana Basin Database and the Evolution of Terrestrial Ecosystems (Paleobiology) Database as our primary sources for catalogued and published information on taxonomic representation, and standardized fossil surveys from East Turkana for comparative data on proportions of taxa in unbiased samples of surface fossils. Differences in the proportions of major taxonomic groups in these different types of samples indicate collecting biases in favor of rare or otherwise preferred taxa such as hominins, carnivorans, and suidae and against larger or abundant taxa such as proboscidea and hippopotamidae. Assessment of hominin abundances relative to taphonomically similar taxa (*Papio*, *Theropithecus*) likely provide the most realistic estimates of relative abundance and indicate that hominins were relatively rare as well as variable in distribution in different sub-regions of the Turkana Basin.

Spatial and temporal analyses of rodent communities in the Middle Paleolithic of the Southern Levant and their relationship to understanding hominin biogeography and population dynamics in the region.

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Faunal turnovers have been related to climate forcing as a cause for dispersal/extinction of hominins in the Southern Levant. Others have suggested that the inter-site variation in Middle Paleolithic (MP) fauna reflects the environmental mosaic and spatial differences within the region. Distinction between these

two hypotheses has implications for understanding the continuity vs. turnover in hominin taxa during this time period.

This study presents a two-tiered approach to test microfauna turnovers in the MP of the Southern Levant. First, a null model was developed by analyzing the distribution of extant rodent communities across different habitats in correlation with climatic variables. Second, the distribution of micromammal taxa was analyzed from fossil assemblages in the Southern Levant spanning MIS 6-3 in comparison to the null model distribution and to local paleoclimatic proxies.

Distribution of modern rodents shows that presence-absence patterns of taxa vary across a rainfall and vegetation gradient along an east-west trajectory and thus can be used to distinguish between Mediterranean and semi-arid regions in the Southern Levant. Subsequent analysis of MP micromammal assemblages suggests that inter-site differences do not necessarily reflect regional faunal turnovers but are consistent with the spatial environmental mosaic within the Southern Levant region.

Results indicate that despite climatic fluctuations, local micromammal communities are persistent during the MP throughout the Southern Levant. These results suggest that climate forcing was not the sole factor in the process of hominin turnover during the Upper Pleistocene in the Southern Levant.

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Combining 3D finite element method and occlusal fingerprint analysis for developing dynamic loading scenarios in molars.

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The masticatory cycle in humans combines a strong vertical mandibular movement with a varying lateral component. Finite Element Method (FEM) was applied for simulations of load in earlier studies, however without considering changes in contact distribution during the occlusal sequence. The contacts between antagonistic teeth create attritional wear facets on the crown surfaces. Based on dynamic occlusal information and wear facet pattern we investigated the stress/strain dispersion in a lower first molar (M₁) using 3D FEM.

The left lower M₁-M₂, and the left upper P⁴-M² of a dried modern human collection specimen were scanned by

μ CT in maximum intercuspation contact. The 3D models for enamel and dentine tissue were segmented and refined using Amira and Rapidform XOR. A virtual simulation of chewing patterns between M₁-M₂ and P⁴-M² was carried out in the Occlusal Fingerprint Analyser software. Contact areas per time-step were located. Stress/strain distributions of the M₁ in selective occlusal stages were analyzed in Strauss 7, considering occlusal information for individual loading direction and loading area.

Our results show that the stress/strain pattern is changing considerably during the masticatory cycle. Our combination of FEM and OFA also demonstrates how changing force distributions during occlusion might explain the creation of interproximal wear facets. This suggests to study a dynamic scenario such as ours rather than applying unidirectional forces to the entire occlusal surface to understand functional aspects of evolutionary adaptations, such as enamel thickening.

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Stable isotopes (¹³C and ¹⁵N) track socioeconomic differences among urban Colombian women.

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The stable isotope composition of mammalian tissues, such as hair, can serve as an indicator of dietary composition. Here, we present stable isotope data for hair samples taken from 38 urban Colombian women from two different socioeconomic status (SES) groups. The goal is to determine whether the two SES groups differ in stable isotope composition, and whether these differences track with long-term indicators of nutritional status, including BMI, five body circumference measures, and six skinfold measures. Hair samples were analyzed for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. There is a significant positive, but weak, correlation between $\delta^{13}\text{C}$ values and $\delta^{15}\text{N}$ values ($r^2=0.23$, $p<0.01$). The higher SES group has significantly greater mean $\delta^{13}\text{C}$ ($-16.4 \pm 0.5\text{‰}$) and $\delta^{15}\text{N}$ ($10.3 \pm 0.4\text{‰}$) values than the lower SES group ($-17.2 \pm 0.8\text{‰}$ and $9.6 \pm 0.6\text{‰}$) (Kruskall-Wallis, $p<0.05$). Discriminant function analysis using only $\delta^{13}\text{C}$ values and $\delta^{15}\text{N}$ values correctly classifies 79% of subjects into the two SES groups, further indicating a substantial difference

in isotope composition along socioeconomic lines. On the other hand, there are no SES differences in any of the 12 anthropometric measures. Furthermore, neither $\delta^{13}\text{C}$ values nor $\delta^{15}\text{N}$ values are significantly correlated with any of these variables. Contrary to expectations, stable isotope composition is a stronger predictor of SES than traditional indicators of long-term nutritional status in this sample. The observed differences reflect either variation in the isotopic composition of the diet, or variation in the isotopic spacing between diet and tissues as a result of differing dietary quality or nutritional status.

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A non-invasive method for collecting salivary testosterone in socially-housed captive monkeys.

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Saliva collection is an easy and non-invasive way to measure steroid hormones. However, salivary hormone measurements have yet to be routinely incorporated into studies of primate endocrinology. This is largely due to the difficulties of validating collection methods for the analysis of multiple hormones. Studies in humans have indicated, for instance, that methods used to collect saliva for cortisol analysis are not appropriate for analyzing testosterone. Here we devise a method of saliva collection for the analysis of testosterone, a hormone that has proved particularly difficult to measure accurately in saliva with common collection techniques. We collected saliva from brown capuchin monkeys (*Cebus apella*) socially-housed at the Comparative Cognition Laboratory at Yale University. First, we collected samples by allowing subjects to chew on non-flavored oral swabs, and second on oral swabs flavored with marshmallow fluff. Last, we validated the measurement of capuchin salivary testosterone with a commercially-available enzyme immunoassay kit. We found that while saliva collection using non-flavored oral swab was successful after training, subject cooperation was highest when marshmallow fluff was used. Although marshmallow fluff artificially decreased testosterone values, it did so in a linear and consistent manner. Moreover, we found a significant correlation between samples collected without flavoring and those collected using marshmallow fluff ($r^2=0.85$, $p<0.01$, $n=15$). Because capuchin monkeys are a model species in

many cognitive experiments, one major benefit of validated salivary hormone methods is that researchers can successfully analyze hormones in conjunction with measuring performance on cognitive tasks.

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A life course perspective on reproductive health among migrant Bangladeshis in the UK.

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In several cross-sectional studies, we have applied a life course approach to examine reproductive function and health in later life in different generations of UK migrant Bangladeshis. Despite recent improvements in development indices, Bangladesh still ranks as one of the poorest countries in the world. The environment in Sylhet, NE Bangladesh, from where 95% of UK migrants originate, has relatively high levels of infectious disease exposure, and poor sanitation and health care even for middle class Bangladeshis (our subjects) who enjoy good nutrition and low levels of energy output. Migrants who move to the UK as children therefore experience a significant environmental improvement. South Asian migrants generally have higher rates of metabolic syndrome (MetS), obesity and risks for cardiovascular diseases compared to Europeans, all of which interact with reproductive hormone levels and conditions such as polycystic ovarian syndrome (PCOS).

Our data consistently show that the childhood environment impacts later reproductive health, suggesting life history trade-offs between growth, maintenance and reproduction. Both men and women who grow up in the UK have significantly higher age-matched reproductive hormone profiles. Bangladeshis who migrate as children attain puberty at significantly earlier ages, and women reach menopause at significantly later ages com-

pared to those who grow up in Bangladesh. While these developmental differences may reduce risks for disease conditions currently associated with South Asians (such as PCOS and MetS), we speculate that risks for other conditions such as reproductive cancers will increase in later generations of Bangladeshi migrants in the UK.

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New remains of *Australopithecus sediba* from the Malapa site, South Africa.

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Continued work at the ca 1.95 Ma site of Malapa, South Africa has resulted in the recovery of additional hominin remains, all attributed to the species *Australopithecus sediba*. The newly recovered material includes a substantially augmented collection of postcranial elements of the holotype and paratype skeletons, including well-preserved bones of all aspects of the skeleton not previously described. These include a well preserved pelvis, a virtually complete hand, parts of the thorax, as well as bones of the upper and lower limbs of both individuals. Additional elements associated with other individuals have also been recovered. This new material assists in presenting a clearer picture of the overall pattern of primitive, derived and unique characters of the *Au. sediba* skeleton. The remains further enhance our understanding of the constellation of characters that appear to place this species as a good candidate ancestor for early members of the genus *Homo*.

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Reproduction by follower male geladas supports transactional model.

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Male primates can increase their reproductive success only at the expense of other males. Nonetheless, dominant males often tolerate subordinate males who may achieve some mating success. Models attempting to explain this tolerance typically fall into two categories: *transactional* (where dominant males concede some proportion of mating to the subordinate) and *compromise* (where dominant males are unable to monopolize all reproduction in the group). Here we test these models in geladas (*Theropithecus gelada*) living in the Simien Mountains, Ethiopia. Gelada society is based on reproductive units comprising one leader male, several adult females, and occasionally one or more subordinate follower males. We utilize variation in the number of males in a unit (1 vs. >1) to test these models. For leader males, a transactional model predicts that follower males deliver a net fitness benefit, while a concession model predicts a net fitness cost. We use behavioral observations and molecular genetic paternity analysis of 49 infants born across 28 units to characterize reproductive skew. We use longitudinal behavioral data to document differences in tenure length. Leader males sired 100% of offspring in units without followers, while followers sired 18% of offspring in multi-male units. Critically, the presence of a follower was associated with a 61% increase in tenure for leader males. These results suggest that follower males provide a net benefit to leader males (given a constant rate of reproduction) and are consistent with the hypothesis that leader males offer staying incentives to follower males in the form of reproductive concessions. Funding for this research was generously provided by the Wildlife Conservation Society (SSF 67250), the National Geographic Society (8100-06), the Leakey Foundation, the National Science Foundation (BCS-0715179), Duke University, and the University of Michigan.

Assessing molecular and morphological variation in the Americas: a comparative approach.

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Several studies conducted recently have explored whether morphological and molecular variations obey to similar micro-evolutionary forces. Most of these studies suggest that with very rare exceptions, cranial morphology seems to evolve primarily by means of stochastic mechanisms. In this study we assessed the biological variation of 22 Native Americans by using matched molecular and morphological data in order to contribute to this debate. The assessment involved the construction of three different matrices calculated for all pairs of populations: one composed of Fst for the molecular data, one composed of Mahalanobis's Distances for the morphological data, and one composed of linear geographic distances. The three matrices were compared by means of Pearson's correlation, followed by Mantel's Test to detect significance. The correlations obtained were 0.57 ($p=0.0001$) for molecular and geographic distances; 0.32 ($p=0.002$) for morphological and geographic distances; and 0.27 ($p=0.012$) for molecular and morphological distances. Contrary to recent evidences, our results suggest that variation at the cranial level does not strictly correspond to variation at the molecular level.

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Hormonal correlates of divergent growth trajectories in male anubis, hamadryas, and hybrid baboons.

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The Awash National Park Baboon Research Project (ANBRP) has gathered extensive behavioral and physiological data from baboon groups distributed across a geographical gradient along the Awash River. These groups are comprised of anubis, hamadryas, and hybrid baboons, which differ in a number of ways, both social and developmental. Adult male anubis baboons are larger than hamadryas, and have much larger testes. Male hybrids are smaller

than either parental species, but have large testes. These differences result from divergent ontogenetic trajectories, which themselves are clearly linked to aspects of reproductive strategies. However, any correlated variation in underlying physiological controls of growth and maturation remains to be elucidated.

Using serum samples ($N = 476$) collected from these populations over fourteen years, we employ enzyme immunoassay techniques to measure four hormones known to play key roles in processes of growth and maturation. Levels of insulin-like growth factor-I (IGF-I), insulin-like growth factor binding protein-3 (IGFBP-3), growth hormone binding protein (GHBP), and testosterone (T) are examined for their relationship to body mass, limb dimensions, and testicular volume throughout ontogeny. Hamadryas males have significantly higher levels of IGF-I and GHBP than anubis and hybrids. DHEAS, IGFBP-3, and testosterone levels are not significantly different among taxa, although our results suggest variation in age-related patterns of these hormones. These results are discussed in the context of variation in patterns of growth and maturation, and the hormones measured are suggested to provide important mechanisms by which these patterns may be modified in closely related taxa.

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Sensitivity of stresses and strains to variability in isotropic, orthotropic, and non-homogeneous material property values in a finite element model of a hominin skull.

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Finite element models (FEMs) of biological systems are becoming widely used in evolutionary biomechanics. The material properties of bone are fundamental inputs for such models, but these are difficult to measure, and are stochastic in nature, anisotropic and spatially non-homogeneous. To date, no formal probabilistic analysis techniques have been applied to assess how uncertainty in material property values affects stress and strain in complicated cranial FEMs. The lack of such information is an impediment to interpreting such models.

We used a probabilistic approach and FE analysis to assess how variability in material property values affect stress and strain in a cranial model of *Australopithecus africanus*. The material behavior of cortical bone was varied in three ways: isotropic and homo-

geneous, isotropic non-homogeneous, and orthotropic non-homogeneous. Material property values were then randomized using Latin hypercube sampling to approximate Gaussian distributions with CVs of 20% and means based on human data. In total, one hundred and ninety separate FE analyses were executed.

Variability in modulus had a statistically significant effect on variability in von Mises strain. Variability in von Mises stress decreased in high stress regions, but a similar association was not observed regarding von Mises strain. Thus, regions of high stress are relatively insensitive to variability in material properties, anisotropy, and non-homogeneity, but regions of high strain are comparatively sensitive to these variables. Thus, when there is uncertainty regarding craniofacial cortical bone material properties, it is best to model the cranium with low anisotropy and high homogeneity.

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Temporal Trends in Diet and Oral Health in Prehistoric East Tennessee.

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Patterns of consumption are reflected by the oral health of a population and are often linked to sex, status, and subsistence. Previous studies of Late Mississippian (AD 1300-1600) populations from Tennessee have demonstrated that dietary differences are related to socially significant burial patterns. Contrary to Late Mississippian period research elsewhere, previous studies in this region do not exhibit sex differences in oral health. In this study, we continue to test this pattern at the Hiwassee Island site, which includes an incipient agriculturalist (AD 600-900) sample. The orthodox archaeological interpretation of less subsistence and more ritual use of maize in the earlier horizon predicts sex differences in consumption.

Cariou lesions, antemortem tooth loss, and dental calculus were documented in the dentition of 130 adults, 82 from the Late Woodland (39 males, 29 females), and 48 from the Late Mississippian (19 males, 29 females). The results are socially and economically interesting. Consistent with previous research, there are no sex differences in the Late

Mississippian sample. The frequency of oral pathological conditions is predictably higher in the Late Mississippian maize-intensive sample. However, in the Late Woodland, females have a higher rate of carious lesions (chi-square, $p < 0.05$). If maize consumption is indeed non-subsistence based, then a sex-based ritual for the Earth Mother ("mother of corn") deity is possible and anticipates further research exploring this hypothesis.

This study was funded by an Individual Development Award of the New York State/United University Professions Joint Labor-Management Committees.

A test of the Out-of-Africa hypothesis using the pelvis and long bones reveals differential preservation of ancient demographic signature in the postcranium.

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Recent studies of cranial morphological variability have revealed a strong geographic pattern related to ancient and more recent demographic history. A worldwide pattern of decrease in within-population diversity has been detected for both genetic and cranial morphometric data, and it has been associated with a serial founder effect following the human expansion out of Africa and the colonization of the other continents. The presence of such demographic signature on the skull contradicts a purely adaptationist view of global cranial shape variation. No such study, on the other hand, has been undertaken on the postcranium, which is often considered to have been under strong selective pressure and subject to high plasticity.

Taking advantage of a freely available dataset of linear postcranial measurements, the Goldman dataset [<http://web.utk.edu/~auerbach/GOLD.htm>], we tested the presence of the Out-of-Africa demographic signature on intra-population diversity of the pelvis, humerus and tibia. 26 worldwide distributed population samples were selected from the dataset, comprising a minimum of 13 male individuals for each sample. All measurements were size-adjusted using the geometric mean. Once within-population morphometric variance was regressed on geographic distance from East Africa, significant results were found for the pelvis ($r^2 = 0.18$, $P = 0.039$) but not for the long bones, probably reflecting the effects of climatically influenced selection on the latter. The results suggest, therefore, that the cranium is not the only anatomical region informative of demographic history, and that the human pelvis also reflects neutral microevolutionary processes.

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Tree truthing: How accurate are substrate estimates in primate field studies?

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Field studies of primate locomotion and posture rely on ground-level estimates of substrate size, angle, and canopy location. These parameter estimates directly influence the selection of positional modes by both the focal animal and the observer identifying the behavior. Estimates are confounded by observer view to target, distance from target, and angles and sizes of adjacent substrates. In this study we aimed to test ground-level estimates against direct measurements of branch angles, diameters, and canopy heights in trees used by *Alouatta palliata* and *Cebus capucinus* at La Suerte Biological Research Station in Costa Rica. We climbed five trees (three *Ficus*, one *Pentaclethra*, and one *Poulsenia*) and measured 20 branches. Four observers (two experienced and two recently trained) collected measurements of each branch from different locations on the ground. Diameter estimates varied by 0–28cm (Mean: 5.44 ± 4.55). Branch angles varied by 1–55 degrees (Mean: 14.76 ± 14.02). Height in the tree was best estimated using a clinometer as estimates with a two-meter reference (standing by the tree) varied by 3–11 meters (Mean: 5.31 ± 2.44). For these observers, the best branch size estimates were those determined relative to the size of the focal animal and divided into broader categories. Branch angles were best estimated in 5-degree increments and then checked using a Haglöf clinometer in combination with a laser pointer. We compare methods used by previous studies to make recommendations for standardization of substrate measures across field studies of primate locomotion.

Using signals of natural selection at immune response genes to identify susceptibility loci for viral infection.

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Infectious disease has been a major selective force during the evolution and differentiation of modern humans. In fact, many of the genes exhibiting the strongest signatures of positive selection in the human lin-

eage encode proteins involved in immunity. Furthermore, many genes subject to local positive or balancing natural selection are associated with susceptibility to infectious diseases. Therefore, the effects of natural selection can be inferred from patterns of variation and used to identify alleles contributing to disease susceptibility. Here, we evaluated a panel of immune genes using 31 African, 31 European, and 31 East Asian individuals. Twenty-nine innate and adaptive immune genes were sequenced in the three populations to detect evidence of local adaptation. We applied three tests that detect departures from neutrality including Tajima's D , F_u and Li's D^* , and F^* to assess population specific patterns of variation. Next, in order to identify susceptibility alleles for modern infectious diseases, single nucleotide polymorphism (SNP) - specific FST values were computed for each allele. At a majority of the loci analyzed, Africans showed evidence of putative balancing selection. For the East Asians and Europeans, evidence of both balancing selection and directional selection was detected. Overall, each population displayed a different spectrum of alleles, suggesting local adaptation to specific pathogens. In the future, these results can be used to 1) find functional alleles, 2) determine which alleles might be most useful in association studies, and 3) identify alleles that contribute to disease susceptibility.

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Differences in subadult pubic body widths and the implication for sex determination.

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Osteologists consider the pubic ventral arc to be a reliable sexing method; however, most studies concentrate on ventral pubis development but not pubic body width broadening. This study tests the hypothesis that pubic body widening and a pubic body width to pubic length index will be dimorphic among subadult individuals. The pubic bones of 52 individuals of known sex, aged one to 19, from the Hamann-Todd collection were examined. Sliding calipers were used to evaluate pubic body width (most narrow part of the pubic body from pubic symphysis to obturator foramen on the dorsal side), pubic length, and the pubic body width/pubic length index. Analyses show a significant correlation in the differences between male and female pubic body broadening in subadults. Pubic bone size differences did not significantly correlate between the sexes when all individuals were analyzed. However, when teens were separated from non-teens, significant

correlation was found in those aged one to 13. Pubic body width/pubic length index analysis showed an increasing index in females beginning at age three while male scores remained fairly steady; this index significantly correlated at all age levels. These results suggest that the pubic body begins to differentiate significantly between males and females at an early age and this element grows at a different rate than pubic bone length. Additionally, the pubic body width/pubic length index shows promise as a potential sexing tool for subadults.

Reproductive opportunism in unpredictable environments: the comparison of two wild mouse lemur species (*Microcebus rufus* and *M. griseorufus*) from eastern and western Madagascar.

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The diverse mouse lemurs (*Microcebus*) of Madagascar are found in a variety of habitats, including areas unoccupied by other lemurs, showcasing unique behavioral flexibility and resilience to environmental change. Although a myriad of studies have described mouse lemur reproductive behavior, only a few have addressed interspecific reproductive variation in non-sympatric mouse lemur species.

The number of litters that mouse lemur females have per season varies among populations and/or species. Habitat seasonality and climate predictability have been invoked as environmental factors that correlate with regular polyestry, i.e., multiple successful litters per season, as well as the duration of the reproductive season in mouse lemurs. Simply put, the "polyestry-seasonality" hypothesis states that more litters are expected in less seasonal habitats where there is a wider window of resource availability for females to acquire and invest energy into reproduction; the "unpredictability" hypothesis proposes that duration of reproduction is positively correlated with climate unpredictability rather than seasonality.

To test these hypotheses, we present reproductive and population data from two mouse lemur species: the eastern brown mouse lemur (*M. rufus*) from the rainforest of Ranomafana ($n=130$), and the western reddish-gray mouse lemur (*M. griseorufus*) from the dry deciduous and spiny forests of Beza Mahafaly ($n=400$). Our results show that neither hypothesis captures the reproductive variation we found between species.

We propose that reproductive opportunism is an important strategy in mouse lemurs, particularly for *M. griseorufus*

at Beza Mahafaly, who face frequent energetic constraints and display shorter life spans than *M. rufus* at Ranomafana.

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Status and the lower class: Health, disease, and biological affinity of the Late Classic Maya suburb community of Guerra, Benavista del Cayo, in the Western Belize Valley.

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As part of the San Diego State University Mopan-Macal Triangle Archaeological Project (MMTAP), both large urban centers and small, rural Maya communities were excavated in order to gain a comprehensive understanding of Maya social structure and daily life (Ball and Tascheck, 1991). This study focuses on the low status community of Guerra, which surrounds the site of Benavista del Cayo in the Western Belize Valley. Previous analysis has been done on the royal elite individuals (Mitchell, 2006) and the sub-elite individuals (Black, 2007) of Benavista concluding that the groups were not biologically related. The major question of this study centered on whether the low-status individuals of Guerra were related to the sub-elite individuals, showing both ascribed and achieved status existing simultaneously in this Maya community. Standard protocol data collection was used for age, sex, and pathological assessment. Using non-metric dental traits Guerra individuals exhibit similar characteristics to the sub-elite population suggesting a biological relationship between the two sub-groups, and the possibility of achieved status. Additionally, this study looked at overall health and disease of the Guerra community. The results indicate the existence of infectious disease and malnutrition through the documentation of boney changes such as osteomyelitis, and cribra orbitalia. And dental pathology which includes linear enamel hypoplasias, ante-mortem tooth loss, calculus build-up, and dental wear. This indicates that the population underwent biological stress throughout life. Together with the previous studies, these findings add to the comprehensive understanding of Maya daily life, the original goal of the MMTAP.

This study was partially funded by the Al Sonck Memorial Scholarship.

Relative robusticity of the *Homo floresiensis* tibia and fibula.

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Although previous studies of the long bones of *Homo floresiensis* revealed that this species retained primitive characteristics of body shape and interlimb proportions, the *H. floresiensis* fibula remains an unexamined part of the equation. The leg of modern humans reflects our status as habitual bipeds and is signaled by a gracile fibula relative to a more robust, weight-bearing tibia. This study investigated whether LB1, the type specimen of *H. floresiensis*, possesses a robust fibula or displays the gracile fibula that is the signature of our species.

CT scans of the fibula and tibia of LB1 and a sample of small-bodied modern humans ($N=10$) were used to analyze cross-sectional geometric (CSG) properties (e.g., cortical area and polar section modulus, Z_p) of the tibia and fibula at midshaft. These new data were added to the much larger sample published by Marchi (2007), which included modern humans, chimpanzees, gorillas, orangutans and gibbons. External contours of additional fossils of the genus *Homo* (e.g., OH 35, KNM-WT-15000) were also examined in order to evaluate when the modern condition arose during the course of human evolution.

Results indicate that LB1 manifests tibial/fibular robusticity indistinguishable from that of modern humans. Analysis of external contours suggests that a gracile fibula arose relatively early in human evolution and was already in place by ~1.5 mya. Although analysis of hindlimb vs. forelimb CSG of LB1 suggested a diverse locomotor repertoire (Jungers et al., 2009), this study emphasizes the importance of habitual bipedalism in *H. floresiensis*.

This work was supported by grants from the Wenner-Gren Foundation, the Leakey Foundation, the National Geographic Society, and the Australian Research Council.

Let's talk about sex: principal component analysis of sexually dimorphic traits in the human pelvis.

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The pelvis is considered the most reliable skeletal element for sex determination, as sexual dimorphism in the human pelvis is inferentially related to

parturition. Most morphological traits used to distinguish sex from the pelvis are qualitative; therefore, results rely on experience of the observer and accuracy of the traits used. Principal component analysis (PCA) increases accuracy of sex estimation by reducing trait redundancy and determining which observed variables account for the most variance.

We scored 10 standard sexually dimorphic traits (sub-pubic concavity, ventral arc, medial aspect of the ischio-pubic ramus, obturator foramen, preauricular sulcus, greater sciatic notch, parturition pits, pelvic inlet shape, robusticity, and ischio-pubic index) of 50 adult male and female ossa coxae and sacra (aged 18-93 years old) of known sex from the Hamann-Todd Collection (n=100). PCA and "leave-one-out" cross validation were used to determine which traits accounted for most of the morphological variance between sexes and would therefore serve as criterion variables in accurate determination of sex from the pelvis. Intra- and inter-observer error was also determined to account for trait scoring precision.

When combining all 10 traits, sex was determined with 97% accuracy. PCA results indicate that sub-pubic concavity score accounted for 55.1% of the variability when the sexes were combined. Between sexes, 73-85% variance was attributable to only 4 principal components using the mineigen criterion: sub-pubic concavity, ischio-pubic ramus, obturator foramen, and greater sciatic notch. The other 6 traits are redundant and do not account for a meaningful amount of variance between the sexes.

Differential treatment of neonatal and infant remains in the Anglo-Saxon period: evidence from the early medieval cemetery of Church End, Cherry Hinton, Cambridgeshire.

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Church End, Cherry Hinton is an Anglo-Saxon Christian cemetery dating to approximately 900-1100 AD. Excavation of the cemetery in 1999 yielded the remains of nearly 700 individuals, of which 40% were juveniles under the age of 18 years. A total of 201 juveniles were examined in this analysis, of which 37 (18%) were found to be between the ages of 22 gestational weeks and 6 months postnatal. This figure contrasts markedly with reported data from 12 early Anglo-Saxon cemeteries, where less than 1% of the total remains belong to individuals identified as neonates. While in later cemetery populations infants are more likely to die in the postnatal period, the Church End, Cherry Hinton data shows a more even distribution of deaths occurring in the neonatal and post-neonatal periods.

This, however, differs from several contemporaneous cemeteries where more deaths occurred from endogenous causes (at <40 gestational weeks) than in the months following birth. Although preservation and recovery biases may account for some of the differences between the abovementioned sites, it seems likely that differential burial practices, in conjunction with discrepant risk factors, better explain the divergent data. The Anglo-Saxon period (ca. 400-1200 AD) saw changes in religious practices, while differences in cemetery locale (rural vs. urban) and conditions in the exogenous environment also likely play a role. This analysis examines both the osteological data as well as the possible biocultural factors affecting inclusion of neonates and infants in the Church End, Cherry Hinton cemetery.

Stable isotopes in wild gorilla feces document seasonal dietary change and rainfall patterns.

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Stable carbon and nitrogen isotope composition of gorilla feces and plant foods is used to quantify short-term intra-annual diet changes in four wild gorillas from Bwindi Impenetrable National Park, Uganda. Gorillas have a diverse diet including herbaceous leaves, fruit, tree leaves, pith, and peel, and are known to be seasonal frugivores. Carbon isotope analysis of staple foods, cumulatively comprising ~96% of dietary intake, demonstrates that fruits consumed by these gorillas exhibit more enriched $\delta^{13}\text{C}$ values relative to other dietary items. Stable carbon isotope values of gorilla feces from these individuals, each represented by at least two samples per month, exhibit several distinct peaks. These isotopically identified dietary changes are corroborated by feeding behavior recorded concurrently with feces collection, which exhibits a similar pattern of corresponding increases in observed fruit consumption to greater than 40% of total diet. The $\delta^{13}\text{C}$ peaks can thus be interpreted as recording seasonal shifts in frugivory. Stable nitrogen isotope values of gorilla feces correspond in time to seasonal rainfall patterns. Correlation of isotope patterns from multiple individuals suggests that isotope data from a single animal records the behavior of the group. Previous work on the diets of these same gorillas provides a rare op-

portunity to compare a high-resolution isotope record of known seasonal changes in dietary composition in a wild primate with variation in nutrient intake and dietary quality. In addition to reporting isotope values for an under-sampled taxon, this work highlights the limitations of bulk tissue analysis for reconstructing both living and fossil primate diets.

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The Turkana Basin 3.4 million years ago.

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The time around 3.4 Ma has received renewed attention with the discovery of stone-tool-modified bones in the Afar of Ethiopia. Although *Australopithecus afarensis* is the only hominid species known in the Afar at this time, *Kenyanthropus platyops* occurs in the Turkana Basin of Kenya. With different hominid species in East Africa and potentially different behaviors, it becomes important to establish the degree of environmental heterogeneity across local and regional scales. Here we present a multiproxy analysis of fauna, sedimentology, and stable isotopes from the lower part of the Tulu Bor Member of the Koobi Fora Formation (~3.4-3.2 Ma), with comparisons to contemporaneous basin-wide strata from the nearby Nachukui and Shungura Formations. Sedimentological analysis indicates primarily fluvial conditions and stable isotope data from soil carbonates reflect a mix of C3 and C4 vegetation. Vertebrate specimens were collected using a systematic methodology to record all fossil occurrences along well-constrained stratigraphic intervals. Most of the specimens (88%) are mammals, but the sample also includes crocodiles, turtles, birds, and fish. Environmental heterogeneity at a local scale is indicated by abundant Reduncini and Alcelaphini (grazing bovids) in some areas co-occurring with colobine monkeys (arboreal primates). Faunal assemblages from the Tulu Bor Member are similar to contemporaneous assemblages from the Nachukui Formation but significantly different from the Shungura Formation. These results indicate a high degree of environmental heterogeneity at local

and basin-wide scales at a time when hominid species were diversifying and, in some areas, exhibiting new patterns of behavior.

Phylogenetic analysis reveals relaxed constraints in primate encephalization during mammalian descent.

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Encephalization is an increase in brain mass relative to body mass. Humans are the most encephalized mammal and this high degree of encephalization is associated with the evolution of cognitive abilities, including the skills needed for complex language and culture. Encephalization is not exclusively human and there is evidence for degrees of encephalization in non-human lineages. To provide insight into the timing of major changes in encephalization during mammalian descent, ancestral state reconstruction of brain mass, body mass, and encephalization quotient (EQ) was performed using squared-change parsimony. We examined brain and body mass in 631 mammalian species. Linear regression confirms a significant relationship ($r^2=0.954$, $p<0.0001$) between body mass and brain mass, and the relationship remains significant ($r^2 = 0.881$, $p < 0.001$) after correcting for non-independence of character traits by standardizing contrasts. To perform ancestral state reconstructions, phylogenetic relationships were taken from a published supertree. We considered species to be encephalized when $EQ>1$. The ancestral node EQ for all mammalian species is 0.874 and the EQ ranged from 0.139–6.292. Primates ($n=76$) emerged as outliers among all mammalian orders, with a crown node EQ of 1.984, and they encompassed the most diverse range of encephalization ($EQ = 0.898-6.292$). Haplorrhines demonstrate the most variable EQ, and we present evidence for both EQ increases (e.g. platyrrhines) and decreases (e.g. colobines) throughout primate evolution. These results demonstrate both expansion and reduction in primate brain mass relative to body mass, suggesting constraints on body and brain mass in this order were relaxed.

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Intergenerational and transnational correlates of health for Bangladeshi adult daughters and their mothers: Project MINA.

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Project MINA explores the relation between Migration, Nutrition, and Ageing of Bangladeshi women. The Bangladeshi community in the United Kingdom (UK) is thriving; however, many of its members are socially disadvantaged and suffer from high levels of disability, obesity, diabetes, and cardiovascular disease. Little is known about the causes. We use a Life History Theory perspective to analyze trade-offs in growth, reproduction, and aging in a sample of 40 mothers (45+ years old) who migrated to the UK, 36 of their daughters (18-35 years old) born in the UK, and 22 mother-daughter pairs of the same two age groups in Bangladesh (BD). All women are of short stature ($X=150.5$ cm, $sd= 6.4$), with no significant differences between or within generations or countries. The UK sample has relatively greater knee height for stature, indicating that immigrant mothers and their UK born daughters had better health in infancy and childhood. All measures of fatness and arm muscle area are significantly larger in the UK women. This indicates greater energy intake, less energy expenditure, or both for UK women. The mean age at marriage for mothers (16.4 years, $sd=2.9$) is significantly less than that for daughters (18.6 years, $sd=2.7$). A 7-component lower body physical function test for older adults finds that BD mothers have significantly better total scores than UK mothers. Greater age at first birth and time lag between marriage and first birth are associated with greater physical function score. The results indicate that trade-offs in reproduction and energy balance do impact health and ageing.

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Skeletal fusion timing in *Pan paniscus* with comparisons to *Pan troglodytes*.

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Skeletal fusion provides markers of growth and is one component of a chim-

panzee's physical development. Epiphyseal closure ends bone growth and signifies a mature skeleton. 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 timing of skeletal fusion for female captive *P. paniscus* ($n=5$) whose ages are known and range from .83 to age 11.68 years. Observations were made after death on skeletons. Results show that in the .83 yr old only the pubic ramus is fused. In the 6.74 and 7.30 yr old, additional elements of the elbow joint are fused (distal humerus, proximal ulna and radius—only partial fusion in the 7.30 yr old proximal radius). In the 8.54 yr old fusion of the hip, knee and ankle joints have commenced, with full fusion of the acetabulum, greater and lesser trochanter. In the 11.68 yr old, all long bones were fully fused while the iliac crest and acromial process remained unfused. Comparison between captive *P. paniscus* and captive *P. troglodytes* confirms a general uniformity in the absolute timing in their skeletal fusion patterns. Therefore, like the case in captive versus wild *P. troglodytes*, we posit that captive *P. paniscus* skeletal growth is accelerated compared to that of wild populations.

Evaluation of secretion vs. maturation in human dental enamel from LA-ICPMS compositional profiles.

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The appositional process of human tooth enamel formation stores time-series information of environmental proxies including mobility, palaeodiet or heavy-metal exposure, potentially readable at daily resolution. However in mature enamel, the protracted mineralization processes may have partially erased environmental signals initially laid down.

We used laser-ablation inductively-coupled-plasma mass spectrometry (LA-ICPMS) to analyze profiles of compositional changes through enamel thickness on thin sections under histological control. The sample includes human permanent and deciduous teeth ($n=6$) from archaeological and modern collections. Chemical data are combined with enamel histology to determine the chronological sequence of the profiles.

Time-equivalent tracks in enamel are analyzed 1) parallel (and very close to) the enamel-dentine-junction (EDJ) and 2) parallel to enamel prisms, which both are connected along 3) isogrowth

lines (NNL or other Retzius lines). This approach facilitates an evaluation of the topographical effect of secondary maturation and offers clues on the reliability by which varying environmental signals are stored in and can be retrieved from enamel. Results suggest that different elements show very different responses to secondary enamel maturation. Notably Zn shows an enrichment of >10x from the EDJ towards outer enamel. Sr and Mg concentrations uniformly decrease (approx. 1.5x) parallel to prisms and along NNL/Retzius towards outer enamel, but not along the EDJ. In contrast, Pb appears unaffected by maturation because it show up similarly along EDJ and parallel prisms, and appear 'frozen-in' along NNL/Retzius. Enamel closest to the EDJ appears to escape some of the enamel maturation process and may better preserve environmental signals.

The coxo-femoral joint: insight from the three-dimensional analysis of the labrum.

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Humans are characterized by a permanent bipedalism which entails a decrease of the base of support and a rise of the body centre of mass implying a loss of stability. To ensure a stable equilibrium configuration, the skeleton of our ancestors was modified in the course of evolution in response to the constraints imposed by gravity. Some biomechanical models such as the one proposed by Pauwels described this stable equilibrium configuration and point out the crucial role of the coxo-femoral joint. We explored the structure of this joint by analysing the three-dimensional orientation of the acetabulum and its relation with the orientation of the femoral neck.

An innovative cadaver study of the labrum was developed to shed light on the questions surrounding the proper quantification of the three-dimensional orientation of the acetabulum. Digitalisations on 20 cadavers using a MicroScribe were analysed and data were analysed using a custom-designed library in R.

Our results suggest that the anterior and posterior rims of the acetabulum form an angle of 23.8° on average, rather than being in a same plane. The value and the orientation of this angle allow us to predict ($p < 0.0001$) the orientation of the labrum, a fibrocartilage not present in fossil material. Moreover, a new plane was established and its biomechanical implications were investigated.

The three-dimensional orientation of the acetabulum is a fundamental parameter to understand the locomotor system and has applications for THA

surgeries. Currently, we are expanding our study on a large sample of dry skeletons.

New interpretation of a standard statistic for principal components in physical anthropology.

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Inside many applications of principal component analysis (PCA) to landmark location data in physical anthropology and paleoanthropology a serious logical fallacy may be concealed. Such studies usually exploit PCA via an ordination combining the first principal component, probably representing size allometry, with the next one or two in a search for trends or clusters. This practice typically ignores the issue of whether those successive components are well-defined. The issue is particularly salient in applications to geometric morphometric analyses of landmark location data, where the subspace of diffusion-like (spherical) noise is always present and may account for most of the variance of shape. As prophylaxis one can apply a classic Anderson approach for testing sphericity of successive components. His standard formula can be modified into an assessment of whether a specific high-order component, such as the second, can be treated as interpretable or must instead be seen as "more likely than not" inextricable from the following component(s). For samples of 50 specimens, the PC1-PC2 plot is declared uninterpretable if the ratio of the second eigenvalue to the third is less than 1.5. For larger samples, this critical ratio drops as 1 plus a multiple of the reciprocal square root of sample size. The problem becomes more serious as samples become smaller, which is typically the case for applications in paleoanthropology. Examples of published data are shown where this approach permits interpretation of the conventional ordinations, and also examples where interpretation should be prohibited on strictly statistical grounds.

The indirect nature of male bonobo aggression.

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Male chimpanzees increase their reproductive success through aggression in agonistic contests, coalitions and alliances, male dominance interactions and coercive mating. Aggression in male bonobos, in contrast, is described as less intense and less effective. However, male bonobos do engage in agonistic conflicts over dominance and male rank is still correlated with mating success. This study presents both wild and captive data to examine the function of

male aggression within the female-centric social system of bonobos. In both wild and captivity, male-male aggression often occurred away from females. Adult males engaged in conflict significantly more than other age/sex classes (captive: $G = 10.530$, $p < 0.05$, wild: $G = 89.989$, $p < 0.001$). Participation was significantly and positively correlated with male rank trajectory in rank changing males (captive: $r = 0.971$, $p < 0.05$). Male aggression against females was directed at low-ranking, peripheral, or juvenile females significantly more than adult or core females (captive: $G = 5.084$, $p < 0.05$, wild: $G = 12.667$, $p < 0.01$). 65.22% of total conflicts in captivity included an impartial third party intervention performed by females 88.57% of the time. Adult males performed third party agonistic interventions into affiliative dyads and only targeted the dyads of a rival male with a female (captive: $G = 23.028$, $p < 0.001$). These interventions may have replaced direct male-male contest competition in bonobos because females intervene and stop male-male contests. Our results suggest that factors related to female cohesion reduce the benefits of male direct and coalitionary aggression and instead have selected for alternative individual male strategies utilizing indirect agonism.

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Molecular regulation of tooth versus jaw morphogenesis.

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To understand the origins of developmental variation in primate dentitions it is important to know how embryonic tooth and jaw development are coordinated in time. Do these systems self-regulate their developmental timing or does an external factor set the pace? A sensible starting place is to tease apart the signaling networks that regulate tooth versus jaw morphogenesis in the presumptive mandible. As such I contrasted gene expression in the first pharyngeal arches (PA1) of two mouse models, one ($p63^{-/-}$) in which mandibular development is normal but tooth development arrests before bud stage, and the other ($p63^{+/-}$) in which both tooth and mandibular development are normal. Genes with significantly decreased expression in the "toothless" $p63^{-/-}$ embryos would be candidates for a signaling network exclusive to dental tissues.

Embryos collected between gestational days (GD) 10-13 were genotyped. Total RNA extracted from $p63^{-/-}$ and $p63^{+/-}$ PA1's was hybridized to Illumina MouseWG-6 v2.0 Expression Bead-Chips. As expected, between $p63^{-/-}$ and

p63^{-/-} embryos aged GD10-13 I saw no significant difference in the expression of genes known to be important to mandibular development. In *p63*^{-/-} embryos aged GD13, by which time tooth morphogenesis had failed, I saw significantly decreased expression of genes known to be important to tooth morphogenesis, such as keratin and collagen genes, as well as genes with no published link to dental development. Expression was increased for only one gene, claudin6, directly implicated in tooth development. This work begins to disentangle the molecular regulation of dental and mandibular morphogenesis.

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An ancient DNA study of tuberculosis in Europe.

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In 2008 there were an estimated 20 million cases of tuberculosis (TB) with 1.82 million deaths. TB is thought to infect one-third of the world's population. Some infected individuals develop skeletal lesions (3-5%) such as destruction and deformation of the lower spine. These have been identified in European skeletal remains from as early as the 6th millennium BC. Some remains contain ancient DNA (aDNA) derived from the bacterium *Mycobacterium tuberculosis*. The objective of this research is to examine aDNA in skeletal remains to study the evolution of TB in Europe over the last 3000 years. Previous work on TB aDNA has been hampered by false-positive detections due to the presence of related bacteria from soil in skeletal samples. We have designed specific tests and used these to screen 488 skeletons from 136 European sites, the largest set ever studied in this way. Positive results for TB aDNA were obtained for 144 skeletons (29.5%), with a correlation between aDNA presence and the extent to which a skeleton displayed TB indicative lesions; some skeletons with no lesions gave positive results. Using a new methodology for aDNA sequencing, we are currently typing the genetic variations between the *M. tuberculosis* strains present in the positive skeletons. The results are enabling us to test hypotheses regarding the spread of TB in prehistoric Europe, the differential evolution of the disease in urban and non-urban regions, and the relationship between European TB and the less virulent dis-

ease present in the New World before Contact.

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Dental topographic variables (Orientation Patch Count, Relief Index, Dirichlet Energy) of platyrrhine second mandibular molars.

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Recent work with 3d digital imagery of teeth of non-anthropoid euarchontans and other mammals suggests Orientation Patch Count (OPC), Relief Index (RFI) and Dirichlet Energy (DE) can, in several ways, be more effective for capturing dietarily significant variation than molar shearing-crest measurements. Here we evaluate whether such variables also reflect differences in diet among platyrrhines using a pilot sample of 40 m/2's representing *Alouatta*, *Brachyteles*, *Ateles*, *Callicebus*, *Aotus*, *Cebus*, *Lagothrix*, and *Saimiri*. We predicted that OPC, RFI, and DE are highest in folivores and insectivores. Samples were laser-scanned as dentitions using an LDI RPS-120 and then cropped to m/2 and patched using Geomagic.

Results of ANOVA's on OPC do not show significant differences by taxon or diet groupings. ANOVA's on RFI are modestly significant, yet *Ateles* exhibits significantly higher RFI than *Alouatta*, contrary to predictions. In contrast, DE is highly significant, differentiating taxa utilizing different diets.

Previous findings of significant variance in OPC and RFI among primate taxonomic and diet-groups used microCT scans of isolated teeth, creating concern that low variance found here is due to using models cropped from laser scans of tooth rows. Measuring six microCT-generated models of atelids reveals *Ateles*' average RFI to be 5% lower than *Alouatta*'s, but non-significant. Furthermore, this difference is dwarfed by 22-23% differences separating the two in both DE and quantifications of relative crest length, using laser-scan or microCT data. We suggest that *Ateles* exhibits high RFI, despite low crest development (as captured by DE and shearing ratios/quotients) due to increased hypsodonty.

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Does prenatal androgen exposure in mixed-sex litters of non-human primates affect later reproductive fitness?

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Sex hormones, such as testosterone, can diffuse through amniotic fluid and fetal membranes, and developing fetuses can receive substantial hormone doses from adjacent littermates. Females with male littermates can risk exposure to high levels of fetal testosterone, and such exposure has been shown to have masculinizing effects and fitness consequences in some mammals, including humans. While most primates give birth to single offspring, several New World monkey and prosimian species regularly give birth to twins or small litters. We examined whether neonatal testosterone exposure might be detrimental to females in these mixed-sex litters, and if so, whether primate mothers bias litter sex ratios to avoid mixed-sex litters. We compiled data from long-term breeding records of seven species that regularly have multiple births, including one monkey species (*Saguinus oedipus*; 822 individuals, 401 litters) and six prosimian species (*Varecia variegata*, *Varecia rubra*, *Microcebus murinus*, *Mirza coquereli*, *Cheirogaleus medius*, *Galago moholi*; 97-250 individuals, 57-173 litters). For all seven species, measures of reproductive success, including survivorship, latency to first birth after pairing, inter-birth interval, birth rate, and offspring-survivorship rate did not differ significantly between females born in mixed-sex vs. all-female litters. Similarly, litter sex ratios did not differ from the expected 1:2:1 ratio in twins and 1:2:2:1 ratio in triplets. These data on sex ratios and reproductive success indicate that litter-producing non-human primates successfully avoid the detrimental effects of prenatal androgen exposure in mixed sex litters, and we are now examining the possible proximate mechanisms underlying this capability.

Evolutionary perspectives of bony labyrinths in humans, chimpanzees and baboons: high resolution three-dimensional comparisons.

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The bony labyrinth consists of three parts (the two vestibular sacs, the three semicircular canals and the cochlea) and houses two functional systems. The vestibular system provides one way of motion detection in a three-dimensional space. The cochlea is specialized for sound detection. The close anatomical relationship between the bony labyrinth and the corresponding receptor endorgans provides an opportunity to study osteological specimens (including fossils).

The investigation of the three-dimensional (3D) anatomical variation of the bony labyrinth in extant species represents a prerequisite for the interpretation of their fossil closest relatives. This prerequisite has not been completely fulfilled yet due to (i) the 3D geometry complexity of the labyrinth; (ii) the difficulty to acquire high resolution data; (iii) the few proposed expert-independent comparative methods.

Here, we use 3D geometrical models of 40 bony labyrinths reconstructed from micro-CT scans of extant humans, chimpanzees, bonobos and baboons. We use recently developed automated computational tools allowing to process 3D free-form surfaces, and more specifically to assess the mean anatomy within a sample, the pattern of variability around this mean, and to compare samples.

Our results allow us to identify the most common features and most striking differences within and between species. The use of such automated, 3D and objective techniques, coupled with standard linear, surface or volume measurements, may allow to gain further insight into the co-evolution of the two functional systems housed in the inner ear of the extant and extinct higher primates.

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Genetic diversity of Native Americans in the multilingual area of Vaupés-Guaviare, Colombian Amazon.

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Amazon region in Colombia harbor a lot of different ethnic groups, some of these belonging to East Tucano and Guahibo language families. With the goal to estimate biological diversity in this multilingual area, we sequenced 546 pb of the mtDNA control region, typing 5 Y-STR and the Q-M3 SNP of two Tucano groups (Vaupés and Guaviare n=66) and one Guahibo group (Guaviare n=23). Tucanos of Vaupés presented 40 polymorphic sites (according to rCRS) and 29 haplotypes, Tucanos of Guaviare 34 and 19 haplotypes and Guahibos of Guaviare 15 polymorphic sites in 4 haplotypes, all belonging to the major Native American haplogroups A-D. The Guahibos mtDNA haplotype diversity is low, which is typical of Hunter – Gatherer groups, likely representing a drastic reduction of population size and the latter fixation of the present haplotypes. The Tucano scenario is different, represented by bigger gene diversity (average 0,900) and higher number of haplotypes. All Y Chromosomes belong to Q-M3 lineage; Tucanos do not share Y-STR haplotypes with Guahibos. The data show that Tucanos and Guahibos are two different groups, the Tucanos exogamous practices respect to the language, probably generate a more biological and linguistic diverse populations in the Vaupés area, Southeast of Colombia. We are reporting DNA data of two linguistic families that improve our knowledge about the biological diversity of Amazon ethnic groups.

We thank to ethnic groups and the volunteers who donated the samples.

Aquatic resources use by Pleistocene hominins in the Turkana Basin.

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The incorporation of animal tissue into the diet of early Pleistocene hominins is often considered to be a key attribute that distinguished the later members of our genus from earlier ancestors. The expansion of the brain during this time is likely linked to a suite of other adaptations such as reduction in tooth and gut size. Current evidence of animal tissue acquisition by hominins is some-

what lacking compared to the abundant evidence for tool manufacture found throughout East Africa. This dearth of evidence has sometimes been associated with the increased risks associated with a carnivorous diet (i.e. competition with large mammalian carnivores). Here we present evidence from archaeological assemblages from the Koobi Fora Formation (Turkana Basin) that supports the hypothesis that an array of aquatic resources was part of a dietary adaptation for Pleistocene hominins. In particular, we review the evidence from high density sites where the archaeological data suggest hominins incorporated a diversity of aquatic resources in their diet. These resources are high in critical brain-selective nutrients that may have relaxed selective pressures to allow for expansion of hominin brain size. These specific nutrients would have been important given the physiological constraints of increasing brain and body size. Evidence of aquatic resource use in many Pleistocene localities is sparse and we explore possible explanations for this. We believe the data from the Turkana basin suggest that an increase in the diversity of dietary adaptations was important to the success of our ancestors prior to the appearance of *H. erectus*.

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The chemistry of omega-3 fatty acid, docosahexaenoic acid (DHA), is critical for human brain function.

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The omega-3 DHA is special among fatty acids. It comprises more than 1% of the dry weight of brains of all species including that of humans. When dietary omega-3 fatty acids are absent during brain development, they are replaced by the closest structural analogues that can be made from omega-6 fatty acids. DHA is found as a component of phospholipids in neuronal cell membranes, particularly the synapses. We hypothesized that a lack of DHA in specific modern diets leads to cognitive deficits, and that redundant molecular systems would be limited in their ability to synthesize DHA from plant-based precursors. Supporting this hypothesis are dozens of studies including our own showing that omega-3 deficiency causes visual, cognitive, motor, and mood-related deficiencies, indicating that DHA is especially crucial for proper higher neural function. These observations predict that molecular mechanisms for upregulating DHA synthesis would be limited in humans. This hypothesis is supported by our data showing that the key biosynthetic enzymes, the desaturases, are upregulated when

diet DHA is limiting but unable to support brain DHA at the same levels that are achieved by consuming preformed DHA. The omega-6 DHA analogue, docosapentaenoic acid (DPA) replaces DHA in neural membranes, compromising retinal and brain function. We conclude that the ability of humans to biosynthesize DHA from plant-based omega-3 precursors is very limited, thus suggesting that the growth of a runaway brain depends on a steady dietary supply of DHA during human brain expansion, and consistent with frequent consumption of shore-based foods.

A geometric morphometric approach to the question of open social networks in the European Upper Palaeolithic and Mesolithic.

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It has been proposed that open social networks over vast areas of the European continent offered Late Pleistocene hunter-gatherers an adaptive strategy that allowed them to maintain contact and biological continuity. Open social networks were further advanced as an explanation of the relative homogeneity of material culture across wide geographic regions of the continent during the Early Upper Palaeolithic. It is generally thought that there is a shift to more closed social networks towards the end of the Late Pleistocene as population density increased and human groups became more sedentary.

Digitised cranial landmarks were analysed using geometric morphometric analysis to examine whether there is a shift towards greater regionalisation of cranial traits from the Early Upper Palaeolithic to the Late Mesolithic periods. Landmarks were registered by Generalised Procrustes Analysis and analysed using multivariate statistics.

The degree of cranial variation in the Upper Palaeolithic is consistent with the presence of open social networks. In contrast, there is increased regionalisation of cranial traits in Mesolithic populations. While the cranial variation of all populations in this study are relatively homogeneous through time and space, there is evidence of closure of long distance social networks during the Mesolithic.

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Hormones, life history trade-offs, and male reproductive health.

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Hormones are key agents that regulate life history trade-offs in all vertebrates,

including human males. Moreover, non-pathological hormone variation in males between and within populations is considerable, suggesting that ecological factors such as diet, lifestyle, energetic expenditure, and immunological burdens are significant. This presentation will illustrate recent empirical and theoretical developments regarding the role of reproductive, metabolic, and stress hormones in regulating life history trade-offs in human males and subsequent ramifications on reproductive health in men. The overarching hypothesis is that hormone fluctuation and differences incur distinct costs and benefits on survivorship and reproductive effort, often resulting in the emergence and prevalence of health challenges. In particular, issues such as the associations between prostate cancer, aging, somatic condition, and risk taking will be examined in light of non-pathological hormone variation between and within populations living under different ecological circumstances. Recent comparative metabolic hormone results from chimpanzees will also be presented to exemplify male life history trade-offs that are unique to *Homo sapiens*. Results support the assertion that variation in hormones such as testosterone is reflective of adaptive functional mechanisms that optimize trade-offs between the health costs and benefits of hormone variation, as well as investment in survivorship and reproductive effort in human males.

Innate immune function has evolved differently in old world monkeys, apes and humans.

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Innate immunity is the initial host defense against invading pathogens and involves activation of innate immune cells via Toll-like receptors (TLRs). Humans, chimpanzees and baboons are estimated to share >92% genomic identity, yet very differently manifest diseases that are, in humans, characterized by overt activation of innate immunity (HIV, hepatitis). These species are hypothesized to have divergent histories of pathogen exposure due to differences in geographic distribution and behaviour. To examine if humans, chimpanzees and baboons have evolved different innate immune responses to environment-specific infectious agents, fresh whole blood from these species was stimulated with TLR-detected molecular components from pathogens unevenly distributed across primate evolutionary habitats (i.e. *Mycobacterium*, *Yersinia*

pestis). Blood was stimulated for 90 minutes. Immune activation was assessed by measuring RNA expression levels of cytokines and chemokines by real-time PCR. Strong inter-species differences in cytokine/chemokine levels (IL1B, IL1RN, TNFa, CXCL2, CCL3) were detected, suggesting divergence in innate immune function among catarhines over the last 23-29 million years. Surprisingly, baboons and humans express very different innate immune responses to *Mycobacterium*, a presumed Savannah-originated pathogen with which both species are assumed to have had a long history on African grasslands. Furthermore, chimpanzees which share 98.6% genomic identity with humans express significantly stronger pro-inflammatory responses to LPS than humans or their more distant relative, baboons. These observations suggest that the evolutionary divergence of innate immunity among catarhines cannot be explained solely on the basis of their geographical environment and pathogen exposure but may be the result of more complex evolutionary interactions.

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The use of foramen magnum dimensions for sex determination in an indigenous South African population.

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Determining the sex of an individual is a critical step in routine biological profiling. While the occipital bone has proved useful for this purpose in other population groups, discriminant function equations based on the cranial base and applicable to a South African black population are as yet to be derived. In this study we examined sexual dimorphism in the cranial base of 120 (60 males, 60 females) randomly selected adult skulls, aged between 20 and 60 years of age, from the Raymond Dart Collection of Human Skeletons. Significant sexual dimorphism was detected in the cranial base of this sample population. Univariate discriminant function analyses revealed that the percentage of correctly classified crania within this population group ranged from 60.8% to 65.8%. Cross validation producing fairly similar results. A bivariate discriminant function using foramen magnum length and foramen magnum breadth yielded

a percentage accuracy of 62.5%, with 65% of males being correctly classified while only 60% of females were correctly classified. A preliminary investigation into the use of artificial neural network for sex determination based on the foramen magnum revealed that percentage accuracies could be marginally increased in males to 68.9% whereas percentage accuracies in females tended to drop to just above 50%.

Overall these results indicate that there is significant expression of sexual dimorphism in the cranial base of a South African black population and highlight the utility of foramen magnum dimensions for sex determination when no other parameters are available.

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The use of CT scans for quantifying bovid tooth morphology and the implications for reconstructing past hominin environments.

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Isolated teeth of the Family Bovidae are the most common fossils found in southern Africa, and they often form the basis for paleoenvironmental reconstructions. However, taxonomic identification of fossil bovid teeth is often imprecise and subjective. Biasing factors such as age and degree of occlusal attrition complicate identifications and often result in considerable overlap in the shape and size of teeth of different species. Previous work suggests that bovid teeth can be reliably identified based on the occlusal surface of their teeth (Brophy, 2010). This study expands on that research and investigates whether the average shape of the occlusal surface of a tooth remains consistent over the lifespan of a bovid regardless of age and attrition. This research assesses intra-tooth variation by taking computed tomography (CT) scans of a sample of teeth from the bovid tribes most commonly recovered from South African fossil sites. I applied Elliptical Fourier Function Analysis (EFFA) to specific increments of CT scan slices from the same tooth and used discriminant function analysis to compare the results of the EFFA across the different scans from the same tooth with a dataset of known teeth. Results indicate that the shape of the tooth throughout an animal's life does not change significantly enough to impede identification of that tooth using the occlusal surface. The findings support the use of occlusal outlines as reliable indicators of bovid species. Accurate taxonomic diagnoses of fossil bovid teeth will aid in producing more precise reconstructions of hominin paleoenvironments than are presently available.

Going to extremes: body size and obstetrical adaptation.

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Sexual dimorphism of the modern human pelvis is generally attributed to obstetrical adaptations in females. While females are larger than males for obstetrically critical dimensions, new research suggests that there are dissimilar patterns of dimorphism between populations, particularly with gross differences in body size. Smaller-bodied women may even be absolutely larger for obstetrically critical dimensions. This study tests the idea that populations with different body types exhibit dissimilar patterns of sexual dimorphism. The obstetrical dimensions between the relatively wide-bodied Native American Arikara and the relatively narrow-bodied Medieval Kulubnarti were analyzed using 3D geometric morphometrics.

Landmarks (k=43) were collected on the assembled pelvis of male and female Arikara (N=31;32) and Kulubnarti (N=29;30) individuals. Generalized Procrustes Analyses (GPA) and Euclidean Distance Matrix Analysis were used to localize shape differences between the two populations.

GPA identified significant shape differences between the populations ($\alpha=.05$); relative to other landmarks, the ischial spines and sacrum move posteriorly, the pubis moves superiorly, the ischial tuberosities move medially, and anterior superior iliac spines move anteriorly in Kulubnarti individuals. However, a two-way, full-factorial MANOVA found no significant interaction between sex and population, suggesting patterns of sexual dimorphism are comparable. EDMA analyses identified linear distances with significant differences in sexual dimorphism between Kulubnarti and Arikara samples ($p<.05$). Sexual dimorphism in the Kulubnarti was greater for the posterior mid-plane, while the Arikara sample had greater dimorphism for pubic height. Although overall patterns of dimorphism are similar between these two samples, localized morphological changes may still provide compensatory mechanisms.

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Perinatal remodeling patterns in the orbit of tarsiers.

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In adult haplorhine primates, the orbits exhibit substantial postorbital closure by bone. Due to the rarity of subadult samples and difficulty in studying this delicate region, orbital growth patterns are unknown for most primates. In this study, three *Tarsius syrichta* (one fetal; two perinatal) were assessed using a novel combination of histology and microCT. By microscopy, we superimposed spatial relationships of soft tissues structures with bone, and related this to distribution of bone cells. In one perinatal specimen, we resampled microCT images to correspond to histological sections. Histological sections or CT slices were annotated according to the distribution of osteoblasts and osteoclasts along osseous boundaries of the orbit. The annotated cross-sectional views were used to generate three-dimensional reconstructions, color-coded to show "depositional" (osteoblastic) and "resorptive" (osteoclastic) surfaces in the orbit. Results indicate minimal resorptive activity in the anterior orbit, mostly isolated foci along the maxilla (relating to adjacent nasolacrimal or vomeronasal system structures) and the frontal bone (relating to the adjacent eye). The floor of the anterior part of the orbit is almost entirely depository. By contrast, more widespread distribution of osteoclasts is seen in the posterior orbit. In particular, the orbital surface of the maxilla, frontal, and/or sphenoid is resorptive from the level of M2 posteriorly to the optic foramen. Spatially, these resorptive patterns relate to the adjacent eye, extraocular muscles, and optic nerve. By reconstructing the distribution of bone cells, perinatal "growth trajectories" can be inferred, thus maximizing the information available from a limited sample of rare specimens.

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Neurocranial evolution in Middle Pleistocene: a paleoneurological study of Jebel Irhoud 1.

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The late Middle Pleistocene human fossil record is rather scanty and geographically fragmented. In Europe, after archaic morphotypes like Ceprano and Sima de los Huesos, the endocranial morphology of specimens like Saccopastore 1 display clear Neandertal traits. In Africa the situation is more heterogeneous, and evolutionary hypotheses must be more tentative. Despite its good preservation and possible relationship with the origin of the modern humans, the phylogenetic position of Jebel Irhoud 1 remains debated. Here we compare the neurocranial and

endocranial shape and features of this specimen with other Middle and Upper Pleistocene specimens to provide further paleoneurological information on the early stages of the evolution of modern human brain. Although facial traits suggest a phyletic relationship with early modern human dispersals, the neurocranial and endocranial morphology of this specimen is definitely non-modern, resembling instead the contemporary European morphotypes. The fossil's slight bulging of the frontal squama is probably associated with bone's orientation and facial reduction rather than actual changes of the frontal profile. The midsagittal neurocranial geometry fits comfortably within African and European Middle Pleistocene human variation; lateral proportions are somewhat similar to those of Neandertals. If Jebel Irhoud represents western relic populations of an early, proto-modern dispersal, we must assume that the origin of this proto-modern lineage emerged before the evolution of a fully modern brain. This study was funded by the Program GR. 249, Junta de Castilla y León (Spain), by the Project CGL2009-12703-C03-01 Ministerio de Ciencia e Innovación (Spain), and by the Italian Institute of Anthropology.

Diet and polyspecific associations affect nearest-neighbor distances of redbtail monkeys in Kibale National Park, Uganda.

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The possibility of predation and the need to consume shared foods are central to understanding primate social organization and affect spatial patterns of individuals within groups. Fruit, typically a clumped resource, is predicted to bring individuals in closer proximity during feeding than leaves and insects, which are more widely dispersed. Polyspecific associations are also expected to affect spatial patterns because the presence of more individuals presumably provides increased protective effects. We examined the effects of food type and polyspecific association on nearest-neighbor distances of redbtail monkeys (*Cercopithecus ascanius*) in Kibale National Park, Uganda by observing adult males and females in one group from November 2008- May 2010 (N=3916 scans). When redbtails consumed fruit, they were closer in proximity to their nearest neighbor than when they consumed leaves or insects. When other monkey species (n=5 species) were present within the group, redbtail monkeys were farther from their near-

est neighbor than when alone; however, this effect was apparently driven by redtail associations with red colobus monkeys (*Procolobus rufomitratu*s) and grey-cheeked mangabeys (*Lophocebus albigena*) specifically, as when neither mangabeys nor red colobus were present, nearest-neighbor distance was not affected. Prior research suggests that mangabeys and red colobus are more aggressive towards predators than the other monkey species, which may account for this result. Our results support expectations regarding the ways in which food distributions and predation affect primate spatial patterns and suggest mechanisms to study predation risk.

Comparing estimated ontogenetic molar wear rates of *Australopithecus africanus* and *Paranthropus robustus*.

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Differences in the masticatory apparatuses of *Australopithecus africanus* and *Paranthropus robustus* have been hypothesized to result from broad dietary differences, with *A. africanus* consuming a diet of relatively softer and/or less abrasive foods relative to *P. robustus*. Recent comparative analyses suggest instead that these hominins consumed similar diets differing primarily in critical resources. Molar macrowear may assist in addressing this question. Experimental studies indicate that harder foods cause relatively higher rates of wear in molar teeth. Wear rates can be estimated by sampling wear from multiple individuals of assessed age. I examined casts of 23 deciduous second molars and 39 permanent first molars attributed to juvenile *A. africanus* and *P. robustus* for which age-at-death had been estimated in the literature using an ape-like development schedule. Area of exposed dentin and Scott wear scores were quantified. For each species and tooth type wear scores and the square root of dentin area were regressed separately on age and slopes were compared with a GLM. A second analysis was completed with variables multiplied by a relative enamel thickness constant to control for enamel thickness. Wear rates between these species do not differ significantly for either dentin area or wear score, regardless of controlling for enamel thickness. Additionally, wear rates for second deciduous molars are significantly higher than for permanent first molars in both species. These results do not support the hypothesis that *A. africanus* and *P. robustus* had broadly different diets, but are consistent with suggestions that these species exploited different critical resources.

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Fertility theory and evolutionary games.

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Traditional life history theory models how natural selection shapes the timing of particular life course events such as age and size at maturity, number and size of offspring, and reproductive senescence. However, these models often assume that individual fitness is unaffected by population density and the frequency of strategic interactions between individuals. Under these assumptions, it is thought that parents invest in offspring quality (e.g. investment in education) at the expense of offspring quantity (i.e. total number of offspring) at the point at which fitness is maximized according to some budget constraint. Parental investment decisions are considered to be unaffected by the social environment.

When social interactions play an important role in fitness, the proper mathematical language is game theory rather than optimization. Recent advances in eco-evolutionary feedback and adaptive dynamics model evolutionary processes that are density and frequency dependent. In particular, they model the social environment as an important background against which life histories evolve. Here we advance a model of human life history that embeds evolutionary dynamics in social interactions. In doing so, we show that if parental investment decisions are contingent upon the investment decisions of other parents, then observed fertility may not rest at a fitness maximizing equilibrium. Rather, the possibility of multiple equilibria emerges under certain conditions. This model has implications for a deeper evolutionary understanding of human demographic trends.

Inferring the dispersal behavior of the Kinda baboon (*Papio kindae*) from multilocus genetic data.

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Dispersal -- the migration of individuals from their natal group -- is a key behavior that affects not only the structure of social groups but also how alleles are distributed spatially and (via demo-

graphic processes) temporally within and between populations.

Here we present genetic data on the dispersal behavior of the little-known Kinda baboon, *Papio kindae*, from south-central Africa. *Papio* baboons display a range of dispersal behaviors, from the strict female philopatry and male dispersal of *Papio anubis* to the male philopatry and limited, involuntary female dispersal of *Papio hamadryas*. Kinda baboons are much smaller than other baboon species and appear to have a unique suite of behaviors, including unusual patterns of grooming and affiliation between adult males and females.

To investigate kinda dispersal behavior, we used mitochondrial sequence data (~350bp of HV1), as well as allele frequency data from eight autosomal and two Y-chromosomal microsatellites to probe patterns of genetic variation in a set of ~50 baboons from five localities in Zambia. Our results show that maternally inherited mitochondrial genetic variation is highly geographically structured (e.g., $F_{ST} = 0.948$, $p < 0.001$) while autosomal and Y-chromosomal variation ($F_{ST} = 0.033$, $p < 0.001$, 0.038 , $p > 0.05$, respectively) is not, suggesting that females are philopatric and that gene flow is predominantly driven by male intergroup dispersal. This finding has implications for our understanding of the behavioral evolution of *Papio*, and aids studies of hybridization between kindas and other baboon species.

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Fiber-type characteristics of the primate orbicularis oris muscle: evolutionary divergence of lip function.

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It has been shown that mammalian skeletal muscles have heterogenous fiber-type composition that reflects their functional demands. Such data are important to understanding the often subtle relationship between muscle morphology and function and their evolution. The purpose of the present study was to assess fiber-type characteristics

in the orbicularis oris muscle of primates in order to elucidate its structural basis for function across wide phylogenetic and behavioral ranges. Sections of the upper lip were sampled from human, chimpanzee, rhesus macaque, and black lemur cadavers and were studied using myosin heavy chain immunohistochemistry for either type I (slow-type) or type II (fast-

type) fibers. Percentages of slow- and fast-type fibers were assessed in each slide and compared across species. Preliminary results suggest that the percentage of fast twitch fibers was highest in the black lemur (96%) and lowest in the chimpanzee (19%). Results for slow-twitch immunohistochemical procedures reveal that the orbicularis oris muscle of chimpanzees has proportionally more slow-twitch fibers (50%) compared to either humans (27%) or black lemurs (4%). Present results were inconclusive for fiber type distribution in the rhesus macaque. Macaque muscle fibers were either non-reactive or weakly reactive to the slow-type marker and moderately reactive for the fast-type marker. These preliminary results suggest that the fiber type distribution in the orbicularis oris muscle of the primate species sampled reflects the particular functional demands of this muscle in each species' facial displays and feeding methods, use of the upper lip as a prehensile tool in chimpanzees, and in human speech.

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A new method of dentine microsampling of deciduous teeth for stable isotope analysis.

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Carbon and nitrogen stable isotope analysis is used to reconstruct diet. Serial sampling of the dentine can reconstruct an individual's changing diet and the diet of the population. Previous serial studies have used homogenized samples that give broad results. This study presents a new microsampling technique for use with stable isotope analysis that reconstructs diet associated with specific and important juvenile life stages: fetal life, breastfeeding, and weaning.

A sample of 23 modern deciduous teeth was collected in collaboration with the Department of Pediatric Dentistry, University of Alberta. The teeth were longitudinally sectioned. One half of each longitudinally cut tooth was examined histologically to find the level of the neonatal line. The other half is sampled for isotopic analysis. Microsamples of dentine were collected occlusal to the neonatal line, directly apical to the neonatal line, and from the growing edge of the tooth. Collagen was extracted from the samples using standard procedures. The formation schedule of deciduous dentine suggests that these samples will reflect the diet of the mother during pregnancy, breastfeeding diet, and weaning diet. The results of the isotopic assay on this modern sample can be reasonably explained in terms of modern infant feeding practices and demonstrates the potential value of the technique for research on archaeological remains. The method created by this study is simple and utilizes readily available

equipment. While the technique will be useful to many stable isotope researchers, it is particularly suited for studying the changing diet of a single individual.

Fracture and pathological analysis of a high velocity train accident through skeletal reconstruction.

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We present one forensic anthropology case involving a train versus pedestrian accident to highlight (1) the fracture mechanics of bone and (2) how antemortem skeletal pathologies affected perimortem fracture propagation.

Train accidents produce skeletal injuries that are similar to those induced by car versus pedestrian accidents; although, the former produces more severe damage. Our analysis of an unidentified male provided an opportunity for skeletal reconstruction and categorization of perimortem fractures relative to the observed antemortem skeletal pathology. The remains were radiographed, macerated, dried, and reconstructed. We examined the skeletal remains focusing upon fracture margins, crack propagation, and categorization (i.e., comminuted, transverse, burst, avulsed, and butterfly). Antemortem observations included periostitis, *hallux valgus*, diffuse idiopathic skeletal hyperostosis (DISH), healed sternal and maxillary fractures, and an intradiploic epidermoid cyst inferior to the cruciform eminence.

Approximately 90% of the skeletal remains were fractured with most fractures being comminuted. As expected and in keeping with the biomechanical properties of bone, the perimortem fractures did not transect the sites of the healed antemortem fractures or the DISH-related hypertrophic bone. In addition, fractures were observed running to, but not through, the intradiploic epidermoid cyst.

Ethical currents in anthropological genetics: introduction to the AAAG symposium.

GRACIELA S. CABANA and BRANNON I. HULSEY. Department of Anthropology, University of Tennessee, Knoxville.

Last year, the American Association of Anthropological Genetics (AAAG) sponsored a symposium on the technological, methodological and analytical challenges associated with today's "genomics era." This year, we turn to the potential ethical challenges posed by large-scale genetics and genomics research and ask, what do these challenges mean for today's anthropological genetics?

Recent advances in genetics and genomics reveal two significant trends: (1) the emergence of large-scale population studies and genomic databases and (2) the commercialization of genetic and genomic information.

Both trends challenge established notions of informed consent. Traditionally, the protection of human subjects has rested on three principles: respect for persons, beneficence, and justice. How do we continue to honor these principles when research in genetics and genomics is requiring the acquisition of, and access to, a tremendous number of human DNA samples? Private companies and public institutions currently maintain (or are moving toward creating) population-based biobanks. The storage and broad sharing of biospecimens and data at such an unprecedented large scale make it impossible to foresee the future research for which they might be used. Therefore, future risks for individuals and groups are impossible to assess. What is the meaning of individual privacy and informed consent in this case?

In many respects, the “genomics era” offers a future of expanded opportunities in anthropological genetic research. However, we must recognize that our responses to these and future ethical concerns – whether proactive or retroactive – will undoubtedly impact our ability to take advantage of those opportunities.

And thanks for asking!: some answers to “What makes us human?” from biological anthropology.

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Not long ago, the question “What Makes Us Human?” was most commonly addressed by “the humanities”, with an emphasis on literature, art, history, and language. Biological anthropology was thought to have little to contribute. Even within anthropology, defined as the study of humanity, biological anthropology has had a hard time gaining a receptive audience on this fundamental issue. More recently, and given major scientific advances in human biology, genetics, and neuroscience, an increasing number of non-scientists have recognized that discussing what makes us human without some grounding in these areas leaves a vast void. Biological anthropologists are not only well-equipped to provide such information, but encouragingly, are more likely to be asked by colleagues far outside our field for our thoughts. Yet ironically, although the very issue of “what makes us human” initially attracted many of us to the discipline, comprehensive answers are difficult to formulate, given that our individual research requires more narrowly defined projects. Thus, it is an appropriate time for our subfield to assess what we can and cannot say about human nature, from paleoanthropology, primatology, human biology, neuroscience, and related perspectives. While we recognize there certainly is no

single answer, there should be some common themes, and perhaps more consensus exists than expected. As biological anthropologists, we should welcome and be well-prepared to advance multidisciplinary theoretical discussions and useful applications of understanding of who we are as a species. If not, investigations of this fundamental question of our subfield will certainly go on without us.

Housing conditions and stress in a captive group of male baboons (*Papio* sp.).

JOSEPH CALIFF. Department of Anthropology, New York University, New York Consortium in Evolutionary Primatology (NYCEP).

Psychological well-being is a crucial component of primate management and welfare in captivity. Two variable aspects of group housing are available space per individual (total individuals relative to enclosure size) and group composition (sex and number of cage-mates). In addition to behavioral investigation, physiological indicators of stress, such as elevated levels of glucocorticoids (GCs), are useful in attempts to assess the effect of housing conditions on the psychosocial welfare of captive groups. Baboons are socially complex primates whose psychophysiological health may be particularly susceptible to the effects of differences in housing arrangement.

This study investigates the connection between modes of social housing and GC concentration across a large, captive population of male baboons (*Papio* sp.) maintained at the Southwest National Primate Research Center. Most study subjects (n=221) lived in 13 separate all-male enclosures, five measuring 93.0m² (1000ft²) and eight measuring 46.5m² (500ft²). The remaining individuals (n=19) occupied 46.5m² enclosures and were housed in single-male groups with multiple females. Fecal samples (n=907) were collected and GCs were extracted and measured by radioimmunoassay in the Altman Laboratory (Princeton University). Controlled conditions minimized or eliminated variation in diet and other external factors while individual differences in other important variables (age, body weight) were incorporated into analyses. Group composition had no effect on GCs. Unexpectedly, males in 500ft² enclosures exhibited significantly lower GCs than males in 1000ft² enclosures (p<0.02). These results challenge common assumptions and suggest that psychosocial welfare of captive groups should be assessed on a species-specific or, even, case by case basis.

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.

The contribution of the Fels longitudinal study to European auxology.

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The Fels Longitudinal Study has a remarkable and unique place within the history of research in human auxology. It was not the first longitudinal study of human growth and development but was preceded by studies initiated in the universities of Chicago in 1904, Iowa (1917), Harvard (1922), Minnesota (1926), Yale (1927), and Colorado (1927). In 1929, however, the Fels Longitudinal study was founded privately by the Fels Foundation and became the world's longest running research project, pioneering many of the methods we now use to undertake longitudinal studies. In the summer of 1948 James M Tanner, the British physician and physiologist, was awarded a travel fellowship by the Viking Fund to visit the existing American growth studies. The Fels study formed a significant and profound influence on Tanner and on his return to the UK he was to describe “the volume ... and...excellence [of the American growth studies]...as an inspiration...and a stimulus to all biologists of whatever variety who realise the overwhelming importance of form [of child growth] and the seemingly overwhelming problems raised by it.” This call to action resulted in the initiation of the Harpenden longitudinal study in 1949 and over the next two decades an exponential increase in European research in human growth and development which was accompanied by the formation of regular international research meetings at the Centre Internationale de l'Enfance in Paris, and the International Association of Human Auxology as a global society for research in human growth and development.

Influence of occupational activity on the rate of degenerative change of the pubic symphysis in a sample of 19th-20th century Portuguese male individuals.

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The various existing approaches for age estimation from the pubic symphysis have

been criticized for their low reliability. Among the arguments is the influence of occupational activity in the aging process. This study wishes to determine if occupational influences the aging process in the pubic symphysis.

We analyzed 161 male individuals (18 to 96 years) of known age from two Portuguese identified skeletal collections. The sample was divided in two groups according to the occupation of the individuals (manual and non-manual) and to the index of femoral robustness (robust and gracile). The manual and robust groups represent individuals with physically demanding occupations and the non-manual and gracile groups represent of less physically demanding occupations.

Absence and presence of characteristics associated with the degenerative process of the pubic symphysis, as described by Brooks and Suckey (1990), were recorded and the influence of occupation was determined by comparing the age of transition from absent to present using logistic regression. Median ages for absence and presence of characteristics were also compared between the two groups using a Mann-Whitney test. Our results show that, overall, individuals of manual occupations and robust individuals show younger ages of transition, suggesting a faster rate of aging. Although differences between the groups rarely reach statistical significance, the findings are very consistent across all characteristics observed. Mann-Whitney tests does not support this results. Overall, the statistically significant results show that robust individuals have a slower rate of aging (older median ages) compared to gracile individuals.

Survival is in the balance? Asymmetry in obstetric dimensions and mortality.

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Directional asymmetry is minimal in the lower limbs of humans: it is slightly left-biased and exhibits cross-symmetry with the more asymmetric upper limb. In addition, it has also been demonstrated that the sacrum exhibits left-biased asymmetry in its alar dimensions. Given this precedent, though some asymmetry may be present in pelvic dimensions, it would be anticipated that this would be minimized by developmental constraints imposed by locomotor efficiency and, in females, obstetric sufficiency.

This study explores directional asymmetry in pelvic dimensions among seven archaeological North American indigenous groups. Individuals were placed into two broad age classes for comparison in order to assess asymmetry and mortality. Measurements were taken on bilateral dimensions related to obstetrics. In addition, we measured femoral dimensions with documented patterns of asymmetry in human populations. Measurement error was assessed to be low (<2%) for all measurements. Results show no sexual dimorphism in any observed asymmetries, matching previous findings. No significant correlations (or greater than $\rho = 0.25$) between femoral and pelvic dimension asymmetries were found. Nonparametric analyses further demonstrate no significant directional asymmetry in any dimensions with the notable exception for pubic length, which has a significant right bias. Further analysis demonstrates the right bias is found in young individuals and is greater in females, who also show a right bias in a proxy for sacrospinous ligament length. Older individuals exhibit small (<1%) asymmetries that are more likely the result of fluctuating asymmetry. Though preliminary, this implies possible associations between obstetric dimension asymmetry and younger female mortality.

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Quantifying a twisted curve: 3D digitization of sciatic notch shape using a microscribe.

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Obstetrically related sexual shape dimorphism has long made the pelvis highly useful for estimating sex in skeletal remains. Sciatic notch shape is regularly used as a diagnostic feature. Traditionally, the shape of sciatic notch has been assessed qualitatively or with linear metrics, and more recently captured from digital images. Here we present a novel methodology for capturing the shape of the sciatic notch using a 3D digitizer.

The sciatic notches of 20 (10 male/10 female) modern human os coxae were captured digitally using an Immersion microscribe. This was done by collecting three specific landmarks (two Type II and one Type III) that define the

plane of the sciatic notch and then 500-1000 additional points by dragging the digitizer stylus across the sciatic notch while continuously capturing data points. Custom software was written to project vertices onto the plane defined by three specific landmarks and then to extract the shape of the sciatic notch from the digitized points. Sciatic notch shape was compared to the shape obtained from 3D surface models (generated from CT images) of the same 20 bones. Extracted curves were aligned and root-mean-square values calculated to compare the two methods.

We found that the novel methodology accurately captures the shape of the sciatic notch as compared to the surface models. Advantages of this methodology are that it can be used when collecting other landmarks and it avoids issues with digital image distortion. The method could easily be extended to capture other biological shapes (e.g., crania).

This study was funded by a National Science Foundation Collaborative Research Grant, BCS division, #0962752.

New evidence concerning the emergence of tuberculosis in South Africa.

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Numerous studies suggest an African origin for the *Mycobacterium tuberculosis* complex, yet, with the exception of Egypt, little is known about the emergence and spread of tuberculosis on the continent. In South Africa, a review of the literature has produced no evidence of pre-colonial tuberculosis; however, the archaeological record has not been examined in this context. Here we present results of ongoing research into the emergence and spread of tuberculosis in South Africa. Of the 1484 Holocene and historical specimens examined thus far, eleven show pathology suggestive of tuberculosis. Preliminary results from ancient DNA analysis support these diagnoses. Five of these specimens have been reported on previously; at least one specimen dates to the late 1700's (possibly earlier), a time of limited European contact. For the remaining six specimens, two show lytic lesions of the lumbar vertebrae and four show abnormal bone deposition on the pleural surface of the ribs. All of these specimens appear to date to the colonial period. Three specimens are from an urban context, but the context is unknown for the remaining three specimens. Eight of the eleven specimens identified thus far with tuberculosis were unearthed in the Northern Cape Province. With the discovery of diamonds in the late 1800's, the region became an early focus for

mining activity. The skeletal evidence supports the early emergence of tuberculosis in this region during this period of extensive, close-quarter contact.

This study was funded by the Wenner-Gren Foundation Wadsworth African Fellowship.

Google Earth and ArcGIS Server as database sharing tools for research and education in paleoanthropology: examples from the Hadar Geoinformatics Project.

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The goal of the Hadar Geoinformatics Project (HGP) is to merge disparate data sources into a paleoanthropological geodatabase for research, education, and conservation in the greater Hadar region of Ethiopia. In cooperation with the Dikika Research Project, we have developed an ArcGIS and Microsoft Access-based geodatabase that provides the geospatial framework critical for addressing fundamental questions concerning hominins and their paleoenvironmental context. Although detailed research queries require desktop versions of the geodatabase, technological advances in easy-to-use GIS-based web applications allow large and detailed datasets to be shared and manipulated by a wide range of users. Such databases abound in the geosciences, but are exceptionally rare in paleoanthropology.

Starting with the Hadar faunal catalog, the HGP is in the process of making more than three decades of field collected data freely available to the public for scientific or education use via Google Earth and ArcGIS Server. Custom-built scripts in both applications parse the HGP database such that the user has a multitude of search options. Queries and map displays are not limited simply to localities, but can be used to explore specific taxa, stratigraphic intervals, fossil density and taxonomic diversity (or specific combinations in ArcGIS Server). Web-links embedded in each locality "pin" redirects the user to the complete locality-specific faunal catalog that can be exported as a worksheet for additional data manipulation. The HGP aims not only to make a tremendous collection of data easily accessible for research and education, but also to set a precedent in paleoanthropological data sharing.

The HGP is funded by the Late Lessons from Early History initiative at Arizona State University.

Life and death in the Middle Bronze Age. The case study of the necropolis of Olmo di Nogara, Verona (Italy).

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The cemetery at Olmo di Nogara (Verona, northeast Italy) is one of the most important protohistoric burial sites that have come to light in Italy during recent years. The anthropological sample considered in this study includes all adult males buried in the cemetery consisting in a total of 116 individuals and 65 adult women. From the palaeopathological point of view, 11 cases of perimortem lesions, which may be interpreted as the results of injuries inflicted during life by metal blades and arrows, were found on the males. This corresponds to a prevalence of 9,5% of the male sample thus suggesting a considerable degree of conflict involving the community.

The composition of grave goods, with armed individuals, and the anthropological evidence of conflict at Olmo di Nogara imply social complexity that finds little comparisons in coeval sites of other areas of the Peninsula. We have carried out an isotope study on several skeletal series from northern and southern Italy to test for further differences in the dietary practices of these Bronze age communities; stable carbon and nitrogen data reveal an interesting dichotomy in the use of resources between the two areas of the Peninsula, with the reliance on extremely diverse plant species. We associate such differences not only to the traditional pattern of diffusion of domesticated crops, but mostly to cultural practices that might only partially be connected to environmental constraints and more likely associated with the habitus of these human groups. This study was funded by MIUR and Department of Archaeology, university of Padua.

Early Y chromosome lineages in Africa: the origin and dispersal of *Homo sapiens*.

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The study of Y chromosome variation in extant populations has provided significant insights into the genetic history of *Homo sapiens*. Focusing on sub-Saharan Africa, demographic events associated with the spread of languages, agriculture and pastoralism have been targeted but little is known on the early history of the continent. The first two branches of the Y chromosome genealogy, namely haplogroup A and B, are African specific, with average continental frequencies of 14-34%, reaching up to 65% in groups of foragers. Despite the potential of such lineages in revealing signatures of the ancient peopling of the continent, an exhaustive investigation of their distribution and variation is currently missing. Here we show that their systematic dissection provides novel insights into the early history of our species. We highlighted complex pattern of populations' dynamics among hunter-gatherer communities, evidence for the peopling of western and southern Africa, and showed the retention of the very early human Y chromosome lineages in eastern and central but not southern Africa. These results open new perspectives on the early African history of *Homo sapiens*, with particular attention to areas of the continent where human fossil remains and archaeological data are scanty.

Fracture analyse of historical long bones.

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In the course of archaeological excavations traumatic injuries are often found, especially fractures, which can be detected relatively well in human bone. Fractures are defined as a disruption of the continuity of a skeletal element, exceeding the maximum limits of the structures elasticity under the forces of pressure, tension or bending. The identification of such lesions leads to important information about the interaction of a prehistoric population with warfare, interpersonal violence and other aspects of daily life (Aufderheide and Rodriguez-Martin 1998).

Because of a long exposure to the burial environment or through the impact of different forces, e.g.: root predation, low pH-value or mechanical deformation by the soil, some fractures cannot be recognized as such (Wahl 2001).

In most published studies, a warlike past is in the main focus. Skeletal series-covering fracture types are seldom determined and compared with each other.

The object of this study is a comparison between modern clinical data from the Institute for Legal Medicine in Munich and ancient fracture types, to check whether certain fracture patterns are phenomena of recent times or whether fracture types occur intertemporally and irrespective of the prevalent forces. For this, long bones from different medieval, spatiotemporally defined skeletal series at the Bavarian State Collection for Anthropology and Paleoanatomy with notation of a trauma were selected. Because most fractures have healed well, a method consisting of morphological analysis, x-ray and CT-scan is used to make the fracture line visible and to identify the fracture type.

Isotopic nutritional ecology at Ngogo, Kibale National Park, Uganda.

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Despite the acknowledged significance of dietary shifts in human evolution, anthropologists today are only marginally closer to understanding dietary niches of early hominin lineages. The use of stable isotopic analyses to reconstruct paleodiets has largely been limited to gross distinctions of C₃ versus C₄ consumption and hampered by a poor understanding of ecological factors con-

trolling isotopic variability. This project is the first to utilize bulk as well as compound specific isotopic analyses within a forested East African environment resident to over 7 species of large and small bodied primates. As such, this project seeks to create a methodological baseline from which to begin refining previous and future analyses of tissue $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in the reconstruction of early hominin dietary patterns.

Collection of plants from Ngogo, Kibale National Park in Uganda, spanning both wet and dry seasons resulted in over 400 individual samples from 40 different species. Sampling included those foods most commonly consumed by endemic chimpanzees, as well as a number of less consumed species to ensure representation by each class of food items (including flowers, pith, cambium, leaves, fruit, vertebrate prey, etc). Bulk and compound specific isotopic analyses were then conducted on nested groups of samples to tease apart the origins of amino acid and bulk level variability. Analyses revealed seasonal, as well as intra- and inter-species differences in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ that inform our understanding of isotopic variability in an East African tropical forest habitat and provide a foundation for interpreting isotopic signatures of early hominin material.

This study was funded by the National Science Foundation, grant number 0925785, and The Leakey Foundation.

Linearity in the real world – an experimental assessment of non-linearity in terrestrial locomotion.

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Cross-sectional geometric properties of long bones are widely applied in inferring primate behavioral repertoires. Amongst hominins, these are particularly useful for reconstructing mobility patterns. Experimental studies of long bone loads characterizing locomotor activities, however, demonstrate disconnect between measured and theoretical loads predicted from bone morphology. This complicates population-level comparisons. The lack of a consistent definition for mobility, likely a multifactorial phenomenon, further complicates these comparisons.

In order to contribute towards a consensus definition of mobility, I address one specific factor – non-linear locomotion. Following an instantaneous focal sampling protocol, locomotor behavior was documented multiple times per day for individuals. Custom-designed cages accentuated zig-zag (condition 1) or linear locomotion (condition 2), while control mice inhabited standard laboratory cages. At the termination of the experiment, limb bones were harvested for microCT scanning and structural analysis. Combining results from a previous experiment using

growing BALB/cByJ female mice (n = 30), and a second experiment (n = 35) using growing C57BL/6J female mice, I compare structural effects of movement regimes amongst them, and by lineage.

Femoral cross-sectional properties (e.g., cortical areas, second moments of area, polar moment of area, shape ratios) and activity profiles were compared. C57BL/6J groups differed amongst themselves in activity level more than BALB/cByJ groups. Zig-zag mice tended to have more elliptical diaphyses in both groups. Linear and control mice differed less often in many properties. Distinctiveness of shapes in zig-zag mice across the lineages supports the idea that non-linear movements (e.g., turning) likely have a recognizable effect on long bone structure.

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Ramifications of insufficient DHA: evidence from studies during pregnancy and infancy.

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The 22 carbon n-3 fatty acid, DHA, accumulates rapidly in forebrain beginning around the 24th week of gestation and the concentration increases at a near linear rate through the first 2 years of age. Although the increase in brain DHA in the last trimester is quite dramatic, it is small compared to accretion in a) adipose tissue of the fetus and b) forebrain in the first 2 years of post-natal life. The DHA that accumulates in adipose tissue during fetal life is believed to be a reservoir for postnatal DHA needs of the newborn; e.g., the amount of DHA as a percent of total fatty acids in adipose tissue declines rapidly after birth. Studies of postnatally administered DHA have asked, "Is DHA a conditionally essential nutrient for infants or can adequate amounts be synthesized from its essential fatty acid precursor, α -linolenic acid?" "Not surprisingly, given the inability of the pre-term fetus to accumulate normal brain or adipose tissue DHA, DHA supplementation has been shown to benefit cortical visual acuity and outcomes related to cognition. Results of term supplementation studies are more variable, possibly reflecting differences in maternal DHA status due to dietary intake of DHA and genetic differences in DHA biosynthesis by both mother and fetus/infant [individual alleles for fatty acid desaturases (FADS1/2) have been correlated with 20 and 22 carbon PUFA status]. There are only a few DHA supplementation trials during pregnancy, however, numerous observational studies find benefits of higher maternal DHA intake.

The author's Phase III randomized clinical trials (RCTs) are funded by NICHD and Mead Johnson Nutrition.

More valuable meat: energetic effects of cooking on a key hominin resource.

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The relative contributions of meat consumption and food processing in supporting increased energy budgets in early *Homo* are poorly understood and are sometimes presented as alternatives. However food processing could in theory increase the energy gained from a meat diet. Literature reviews suggest several mechanisms by which food processing might improve the energy value of meat, but no studies have quantified the net effects experimentally. To start to fill this gap, we conducted feeding trials in a model animal to test the hypotheses that thermal and non-thermal food processing increase the net energy value of meat. Adult mice ($n = 16$) were fed beef in four treatments, based on a counterbalanced within-subjects study design: raw/whole, raw/pounded, cooked/whole, cooked/pounded. Two-way repeated-measures ANOVA revealed that cooking ($p < 0.001$), but not pounding ($p = 0.138$), improved energy gain as indexed by body mass. Changes in body mass were neither attributable to food intake, which was higher for raw treatments, nor to activity level, which was similar across diets. Preference tests indicate that nutritional benefits influenced perception: after exposure to cooked, pounded and raw meat diets, fasted mice presented with equal rations of the four treatments concurrently selected cooked treatments at rates exceeding chance. Combined with recent data showing that cooking also yields increased energy from starch-rich foods, our results indicate for the first time that the energetic effects of cooking would have been positive and significant regardless of the level of meat consumption at the time that cooking was adopted.

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Patterns of selection on hominoid seminal protein coding genes.

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In primates there is a general trend of rapid evolution of reproductive proteins. What remains unclear, however, is the driving force behind this trend. Hypotheses include post-mating reproductive isolation, sperm competition, or reduced

antagonistic pleiotropy. Humans and the great apes are a group of closely related species, but yet exhibit large variation in socio-sexual behavior. As such, distinguishing among the above hypotheses in hominids in particular may help understand such variation.

From publicly available genome sequence data of human, chimpanzee, gorilla, orangutan, and macaque—supplemented with in-house sequence data—we obtained DNA sequences for 848 genes that code for proteins found in human semen. We calculated pairwise estimates of the nonsynonymous to synonymous substitution rate ratio (Ka/Ks), as well as maximum likelihood branch-specific estimates, for these homologs. We compared Ka/Ks to annotated protein function, cellular location, tissue origin, tissue specificity, and relative protein abundance in semen.

Of the 554 homologs with gap-free alignments, we identified 87 genes suggestive of positive selection in either the chimp or human lineage (branch-specific $Ka/Ks > 1$), with only 15 evolving rapidly in both lineages. Proteins with higher Ka/Ks ratios along the chimpanzee branch are disproportionately secreted extracellular proteins ($p < 0.001$), while protein-lipid remodeling proteins are overrepresented among rapidly evolving proteins in humans ($p < 0.01$). The different patterns observed between human and chimpanzee suggest that species-specific factors may be driving selection in different lineages. These and other results are discussed in the context of the evolution of hominid social and sexual behavior.

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The advantage of standing up to fight and the evolution of habitual bipedalism in hominina.

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Many quadrupedal species stand upright on their hindlimbs to fight. This posture allows the forelimbs to strike an opponent with the range of motion that is intrinsic to high-speed running, jumping, rapid braking and turning; the range of forelimb motion over which peak force and power are produced. To test the hypothesis that bipedal posture provides a performance advantage, we measured the force and energy produced when human subjects struck from quadrupedal and bipedal postures. Down- and upward directed striking energy was measured with a custom designed transducer consisting of 31 kg pendulum with a rotational inertia of 1.79 Nm^2 . Side and forward strikes were monitored with a 45.4 kg punching bag instrumented with an accelerometer placed at the bag's center of mass. When subjects struck downward

from a bipedal posture the work was 48 % greater than when they struck from a plantigrade posture. In side and forward strikes the force impulses were 45 % and 43 % greater from a bipedal posture than a quadrupedal posture. Importantly, subjects did 240 % more work in downward than in upward directed strikes. Thus, bipedal posture provides a performance advantage for fighting with the forelimbs. The mating systems of great apes are characterized by intense male-male competition in which conflict is resolved through force or the threat of force. Great apes also often fight from bipedal posture. These observations, plus the findings of this study, suggest that sexual selection may have contributed to the evolution of habitual bipedalism in hominins.

Perceptions of black Americans toward medical research and racial health disparities: a focus group approach.

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The percentage of Black participants in medical research studies is typically lower than that of White participants. One reason this occurs is that many studies do not investigate variation across racial groups and focus on a single group, typically White Americans. However, low percentage of Blacks in medical research studies is also related to potential participant mistrust towards medical research and researchers. This mistrust reflects centuries of mistreatment towards Blacks in medical settings. Based on our ongoing study in Tallahassee to examine genetic and sociocultural risk factors for hypertension in Blacks, we are particularly interested in Black Americans' perceptions of research into racial disparities in complex diseases, or diseases influenced by both genetic and environmental factors. We also aim to identify factors that promote or inhibit participation in research. Building on our community-based participatory research approach, we designed a focus group study to broadly assess current views and understanding of medical research into complex diseases. We conducted eight focus groups in Tallahassee. Participants in each group were of similar age, education, and gender, allowing for comparisons across groups on these variables. Open-ended questions targeted issues of health disparities in the community, perceptions of medical research, and the perceived role of genetic factors in disease. We hope this research will elucidate Black Americans' concerns and interests regarding medical research and, furthermore, indicate

ways in which minority participation in medical research can be improved. This work was supported by the National Science Foundation through a Graduate Research Fellowship.

Being human means that “being human” means whatever we say it means.

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“What does it mean to be human?” is not an empirical question. If it were, its answer would consist of a list of autapomorphies of the Hominini or some included subtaxon. “What does it mean to be human?” is a question about symbolic meaning. It asks which of our species' apomorphies we should canonize as markers or justifications for drawing a status boundary between people and beasts. Throughout most of Western history, the ability to speak and reason has been at the top of the humanistic canon, followed closely by our cognitive and technical abilities. Recent writers have tended to stress our intrinsic niceness as uniquely “prosocial” animals, innately predisposed to sharing and generosity. It is not clear that these new formulations are more realistic than their predecessors.

Some conventional ways of thinking about these issues mistakenly confuse properties of sets with properties of their individual members. Some of the things that we think of as making our species special (e.g., language, cultural norms, exchange of goods, aggregation of knowledge) are properties of human groups, societies, or collectives, not individuals. Others (biomass, environmental impact) are properties of multispecies aggregates that involve and depend on co-evolved nonhuman populations. We suggest that the tendency to conflate these different sorts of attributes reflects a desire to inflate the moral importance of “humanness” as a property of individuals.

Tooth ablation and social identity in North Africa.

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The practice of body modification has long been recognized as one method that groups can use to distinguish themselves from others. One such form of body modification, tooth ablation, consists of the purposeful removal of healthy teeth from individuals. Here, we extend the geographic and chronological distribution of tooth ablation to the Central Sahara Desert where this practice is documented among Early

Holocene foraging and Middle Holocene pastoral communities that lived near a freshwater lake (Gobero). We focus on describing the practice and evaluating its presence in light of craniometric variation from these time periods.

Results for the Early Holocene indicated 50% of the adult sample was affected by ablation and individuals with ablation typically had between 15% and 25% of incisors removed. During the Middle Holocene period, fewer individuals presented incisor ablation (approximately 25%) but those individuals that had ablation removed more teeth (~60% of incisors). This difference is statistically significant ($p=.01$). Intra-site analysis of craniometric variability indicates a common phenotype among those individuals with ablation regardless of time period. This suggests partial population continuity across the 8.2kya arid spike, followed by aggregation of a greater diversity of peoples at the drying lake. These autochthonous peoples can ultimately be related to the Late Pleistocene inhabitants of the Maghreb where incisor ablation was ubiquitous (Taforalt). The combination of craniometric and ablation analysis documents the development of a multi-ethnic community where a minority element intensified the expression of a cultural practice by removing more dental elements, thus marking their group identity.

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Life in Imperial Rome: a multivariate approach to detect relationships among several necropolis.

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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 Malnome, Collatina, Casal Bertone, Via Padre Semeria, Osteria del Curato and Quarto Cappello del Prete (Rome, Italy). Each cemetery was analyzed and the skeletal individual profiles were recorded in two open access databases. The field data were, if possible, complemented by archaeological informations. 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 1100 individuals from the six 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 row data can overcome this difficulty. The five cemeteries are unlinked themselves, and three of them (Castel Malnome, Casal Bertone and Osteria del Curato) lie to the “extremes”, reflecting the peculiarities of the singles sites. Castel Malnome 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, like Quarto Cappello del Prete. 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.

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Do brain size and body size explain variation in the pace of dental development within the indriid-palaeopropithecid clade?

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The Indriidae comprises three genera (*Avahi*, *Propithecus*, *Indri*) while their close extinct relatives, the Palaeopropithecidae, comprise four (*Mesopropithecus*, *Babakotia*, *Palaeopropithecus*, and *Archaeoindris*). All members of the indriid-palaeopropithecid clade for whom the pace of somatic and dental development have been studied exhibit a characteristic pattern: dental development is fast and cranial and body growth are relatively slow. Reconstructions of dental development using histological methods exist only for one indriid: *Propithecus verreauxi*. We provide new histological data on dental development in *Indri indri*, the largest living lemur, and combine that with observations on *Avahi laniger*, the smallest indriid, to assess the relationships among body and brain size and the pace of dental development. We then assess how ecological factors may have shaped these relationships. Within extant

indriids, associations among brain/body size and dental development (using M1 crown formation time, % crown completion at birth, age at M1 crown completion or estimated age at eruption) are patterned such that smaller brained taxa (*Avahi*) possess accelerated dental development compared to *P. verreauxi* and *I. indri*. When extinct palaeopropithecids are included, both body and brain size fail to explain variation in the pace of dental development: while *Avahi* is the fastest, the larger-bodied and larger-brained *Palaeopropithecus* develops faster than the smaller-bodied and smaller-brained *Propithecus* and *Indri*. Our analysis suggests that the rate of dental development is tied to ecological factors such as early age at weaning, perhaps as part of a strategy of bet-hedging, and only weakly, if at all, to brain/body size. Supported by NSF grants BCS-0237338 and BCS-0503988.

Variation in cardiovascular disease risk in response to market integration in two transitioning populations.

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Cardiovascular and metabolic disease risks have been shown to increase as populations transition from traditional subsistence economies to market-integrated lifestyles. Despite multiple studies documenting the effects of this transition on cardiovascular and metabolic health, our understanding of specific mechanisms responsible for these effects remains incomplete. There is considerable variation in the risk factors among individuals from different ethnic and racial groups; however, few comparative studies exist that examine different cultural patterns of market integration (MI) and pre-existing, regionally-specific genetic adaptations. The present study compares trends in cardiovascular disease responses to MI in two indigenous groups—the Shuar of Amazonian Ecuador and the Yakut (Sakha) of northeastern Siberia—with the following objectives: 1) examine the relationship between MI and cardiovascular disease risk (blood pressure, cholesterol [total cholesterol, LDL, HDL,

triglycerides], glucose) within the two groups; 2) compare cardiovascular disease response trends between the two populations; and 3) discuss possible mechanisms responsible for these differences based on lifestyle differences and environmental adaptations. Anthropometric, health, and lifestyle data was collected from Shuar and Yakut (Sakha) adults (≥ 18 years). Results indicate different patterns of cardiovascular response to market integration. The Shuar sample shows higher percentage of clinically elevated cholesterol levels, while the Yakut sample has higher percentage of clinically elevated blood pressure. These differences in cardiovascular symptoms are likely based on regionally specific environmental and cultural factors, associated with specific types of processed and market foods consumed, levels of psychosocial stress, and metabolic adaptation. Support: NSF (ARC-0802390); FSRI Institute of Health; Northwestern University; University of Oregon. NIH (#5DP1OD000516-04, via Center for Evolutionary Psychology, UCSB); NSF BCS-0925910; NSF BCS-0824602; University of Oregon; Ryoichi Sasakawa Young Leaders Fellowship Fund; L.S.B. Leakey Foundation; Wenner-Gren Foundation.

Feeding behaviors and food mechanics during *Cebus libidinosus* ontogeny.

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The extended juvenile period observed in capuchins has been explained as a means to acquire the skills and physical strength needed to exploit high-quality foods encased in mechanically challenging tissues. Recent research has demonstrated that by age three to five wild juvenile tufted capuchins (*Cebus apella*) attain foraging success rates similar to adults when accessing mechanically challenging foods. However, little is

known about the relationship between age-related changes in feeding behaviors and food mechanical properties. Here we examine differences in total feeding time and the mechanical properties of foods eaten at various stages during tufted capuchin development. Data were collected from adults ($n=17$), sub-adults ($n=3$), and weaned juveniles ($n=8$) from two groups of wild tufted capuchins (*C. libidinosus*) at Boa Vista, Brazil during a period of ripe fruit scarcity. Behavioral data were collected using continuous sampling methods from focal individuals focusing on food processing behaviors. Food mechanical property data were collected using a portable universal mechanical tester. When the capuchins breached multiple tissues within a food, the food tissue with the highest mean and maximum values of fracture toughness and Young's modulus was selected, and those values were compared across age groups using a Kruskal Wallis test. Preliminary results indicate no significant differences in mean total processing time and mean and maximum food tissue toughness and stiffness across age groups. These results suggest that *C. libidinosus* juveniles and adults breach foods of comparable toughness and stiffness, with the exception those foods (e.g., palm fruits) requiring significant physical strength to access.

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Gibbons perform exceptional amounts of work when leaping.

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In addition to being remarkable brachiators, gibbons are excellent leapers. We used high definition video sequences to analyse the leaps of two white handed gibbons leaping about their enclosure. We report standing-start squat leaps exceeding 5 meters with acceleration to 8.3 ms^{-1} . Such jumps represent the highest single-motion muscle work per body mass of any animal measured to date, but field reports suggest that these probably aren't maximal; if applied vertically, a jump height of 3.5m would have been achieved. Due to the gibbon's relatively large size and use of its legs, trunk and arms to lengthen push-off duration and distance, muscle power requirements are not extreme. Despite mechanisms for 'power amplification' in smaller animals, their jumps appear limited by short legs and brief push-offs.

Heavy density liquids as a method for extracting microfaunal remains from sediments.

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Microfaunal analyses provide important insight in paleoecological reconstructions. Microfauna have a limited range, so the presence and abundance of a particular species is indicative of a particular climate. However, sorting through microfauna can be very tedious due to the small size of the skeletal elements and they very easily blend in with the surrounding soils. A method that can expedite this process will greatly improve microfaunal studies. One such method, heavy density liquid floatation, has been used for sorting phytoliths from soil samples. This technique can be applied to microfaunal analyses by limiting the amount of time sorting through sediments. This study uses materials excavated from Grotte des Contrebandiers, Temara, Morocco. The soils sediments were screen-washed at 5, 2 and 1 mm. Using the heavy liquid Lithium Metatungstate solution, these samples are separated into high density (stones, pebbles and some high density teeth) and low density (bones, pollens, woods) materials. The heavy density materials sink to the bottom while the low density materials float to the surface, sorting the materials for the researchers. This separation occurs in a funnel and upon the separation of high versus low density materials, the heavy density materials are released into one beaker and the lighter density materials are released into another beaker. Preliminary results have demonstrated that large amounts of microfauna can be sorted in a shorter amount of time than sorting by hand. This methodology can greatly help microfaunal analyses by decreasing the amount of time a researcher must spend sorting through sediments.

Intraskelatal variability and bone remodeling dynamics in a modern Mexican cemetery population.

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The rate of age-associated bone loss is inconsistent among skeletal elements of an individual and dependent on the proportion of cortical and trabecular bone and their habitual loading environments. Thus, intraskelatal variation in age-associated bone loss is problematic in the clinical field for discriminating between normal and osteoporotic bone. We employ histomorphology on a preliminary skeletal sample from Xoclán, a modern cemetery population in the

Yucatan peninsula, to compare the mid-shaft rib and clavicle from the same individuals to investigate intraskelatal variability in the histomorphometric variables. Through bone histomorphology, microstructures such as osteons are quantified to derive variables that are indicative of bone remodeling dynamics and patterns of age-related bone loss. The mean age of the sample is 50.75 years with 22 males and one female. Osteon Population Density (OPD), the density of intact and fragmentary osteons per unit area of bone and an accumulated product of bone remodeling, differs significantly between the rib (mean 30.320 SD 8.320) and clavicle (mean 17.743 SD 5.299) in the t-test for dependent samples and Wilcoxon Matched Pairs test ($p < 0.001$). The average cross-sectional area of the intact osteons, a variable necessary for deriving bone remodeling dynamics, did not differ significantly between the two skeletal elements in the t-test ($p = 0.205$) and Wilcoxon Matched Pairs test ($p = 0.191$). Although the rib and clavicle are abundant in cortical bone, the habitual loading environment for respiration and upper limb function may be distinct enough to produce different remodeling dynamics and histomorphometric values.

Gene gain and loss of protein expression driven by sexual selection, revealed by comparative proteomics of human and chimpanzee seminal plasma.

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Numerous anatomical and physiological traits have evolved in chimpanzees due to their presumed high levels of sperm competition, resulting from high female promiscuity. These traits include large testes, high sperm count, and the presence of a copulatory plug. As with most phenotypic differences between humans and chimpanzees, the molecular basis for these adaptations are not known. In order to investigate the molecular evolution of hominid seminal proteins, we subjected the seminal plasma of three humans and three chimpanzees (including the solidified plug) to two-dimensional gel electrophoresis followed by spot identification with liquid chromatography/tandem mass spec (LC-MS/MS), one dimensional SDS-PAGE gels with peptide identification by LC-MS/MS, and gel-free (or "shotgun") proteomic characterization with LC-MS/MS. This comprehensive proteomic characterization of seminal plasma revealed the complete absence of semenogelin 2 (SEMG2) in chimpanzees, despite being one of the most abundant human proteins, along

with upregulation of prostate-specific transglutaminase (TGM4) and fibronectin (FN1) in chimpanzees. Most surprisingly, chimpanzees express at high levels in their semen an extracellular secreted protein not found in human semen, and not previously reported to be expressed in reproductive tissues. Together, our data suggest that chimpanzees have evolved unique aspects of their reproductive physiology, including the acquisition of a copulatory plug, through up- and down-regulation of many proteins, and through the gain and loss of the expression of specific seminal proteins. The abundance and structure of these proteins allows us to hypothesize a mechanistic model to explain the origin of the chimpanzee copulatory plug in response to sexual selection.

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The history of anthropometry within the Fels Longitudinal Study: growth, development and aging in the 20th Century.

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Anthropometry has a long history, but its use in describing growth and development flourished with the establishment of the "longitudinal" growth studies in the United States in the early 20th Century such as the Fels Longitudinal Study. Early measurements were limited in their descriptive scope and borrowed from osteological measurement methodology. Increased interest in anthropometry occurred with World War II and the need for "standardized" uniforms and equipment. The increased prevalence of obesity furthered the development of methodology and equipment to measure body fatness such as skinfold calipers. Similarly, the greater proportion of older adults living to older ages in the world's population has increased the available equipment and specialized methodology for anthropology in the elderly. The use of anthropometry within the Fels Longitudinal Study has mirrored its application in the National Health Surveys of the United States and the World Health Organization.

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A reappraisal of the effects of phylogeny on social behavior.

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The socioecological model has been used extensively to identify correlations

between the behavior and ecological context of a species. However, this method often carries the inherent assumption that convergence is the sole factor responsible for this correlation, regardless of the evolutionary history of the species. Phylogenetic approaches, on the other hand, view the behavior of extant taxa within an explicitly historical framework. In 1994, Di Fiore and Rendall conducted a novel phylogenetic analysis to identify underlying constraints on the derived similarities of primate social behavior, revealing that social structure and female relationships may be highly conserved in some primate lineages, namely the cercopithecoidea. However, fifteen years of new field research on primate social behavior have generated a substantial amount of data that remain to be integrated into such an analysis. In this study, 34 behavioral traits encompassing three aspects of primate social behavior (social structure, social organization, and mating system) are coded for 12 genera not previously included in previous phylogenetic analyses. Incorporating these "new" genera into the existing phylogeny yields a more comprehensive picture of the evolutionary history of primate social behavior, suggesting additional phylogenetic conservation of behavioral traits within the ceboidea and strepsirrhines. Further, these results provide a framework for investigating the interplay between phylogenetic constraint and ecological adaptation in the social organization of primates, and have important implications for our understanding of behavioral evolution within primates and future methods of behavioral reconstruction in the fossil record.

Pro- and anti-inflammatory food proteins and their impact on maternal ecology.

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Undiagnosed gluten intolerance can lead to a number of serious fertility issues, including recurrent pregnancy loss and infertility. Independent of an immune response to gluten, diets high in refined carbohydrates, trans and saturated fatty acids, and sugar promote inflammation through the overproduction of pro-inflammatory cytokines. The overconsumption of refined carbohydrates (processed cereal grains as well as sugar) leads to high selectin-carbohydrate interactions that promote adhesion mechanisms that then help direct leukocytes to regions of inflammation.

This suggests that a high carbohydrate diet may produce inflammation even in individuals who do not have food intolerances. In contrast, prebiotics and probiotics (soluble fiber and bacterial cultures found in foods like yogurt) promote an anti-inflammatory response. Prebiotics, or soluble fiber, stimulate growth and activity of bacteria in the digestive system and has a local anti-inflammatory effect. Fermentation of soluble fiber by GI bacteria generates short-chain fatty acids (SCFAs), some of which are histone inhibitors and thus have the greatest potential role in immunity and inflammation.

This work reviews the potentially contrasting effects of many cereal grains and fiber content on local inflammation, which likely impacts pregnancy success. However, the relationship between systemic inflammation and cereal grains has not been tested. Thus, we also report the initial results from a pilot study to examine the relationship between C-reactive protein, a biomarker for inflammation used in clinical work and shown to correlate with pregnancy loss, and autoantibodies to gluten, as the first examination of this relationship.

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Holes in the record: millipedes as a source of disturbance at prehistoric sites.

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Over the last two decades, archaeologists and physical anthropologists have dedicated increasing attention to the myriad of ways that the archaeological/fossil records can be disturbed post-depositionally. This work has demonstrated that a detailed understanding of the taphonomic history of a site is critical to the development of accurate interpretations of site formation processes, stratigraphic relationships, and artifact patterning. Within this larger framework, it has become clear that the activities of even the most diminutive creatures can have a significant impact on the composition/preservation of prehistoric deposits. While the potential effects of termites, earthworms, and ants have been relatively well documented, one macro-invertebrate that has not received attention in this regard is the millipede. Millipedes are common throughout the globe and occupy both open-air habitats and caves/rockshelters; given their tendency to burrow into subsurface sediments, a detailed consideration of the types of disturbance caused by these invertebrates seems warranted. In this

paper, we explore the aspects of millipede life history, ecology and behavior that are most likely to impact the preservation of archaeological deposits. We then discuss several signatures of millipede activity and disturbance, using the Paleolithic site of Mughr el-Hamamah (Jordan) as a case study. This example illustrates the need for greater attention to the potential impacts of millipede activity on the integrity of buried deposits; as such, we close with a consideration of planned experimental work that is aimed at more directly quantifying the impact of millipedes on stratigraphy, the mobility of artifacts/ecofacts within the sediment, and soil chemistry.

Research at Mughr el-Hamamah was funded by NSF grant #1025352 to Aaron J. Stutz and Liv Nilsson Stutz.

Microhabitat differences affect frequency of social behavior in two populations of *Lemur catta* living in similar rocky-outcrop forest fragments in south-central Madagascar.

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Within-species variation regarding time spent in social behavior in primates can be dependent upon microhabitat variables. Two populations of *Lemur catta*, a highly social primate, were observed in July of 2009 and 2010 in two rocky-outcrop forest fragments in south-central Madagascar: Tsaranoro Valley and Anja Reserve. Habitat and fragment size is similar at both sites, but distribution of resources and *L. catta* population density differs markedly, with widely distributed food resources and a smaller population (~60 animals) at Tsaranoro, compared with highly clumped, plentiful, easily accessible food resources and high population density (~216) at Anja. Behavioral observations were collected utilizing five-minute scan samples, and we conducted between-site comparisons of instances of social behavior. In 2009, 14% of scan records at Anja and 18% at Tsaranoro involved social behavior, whereas in 2010, 22% of scans (Anja) and only 2.1% (Tsaranoro) were recorded as social behavior. The between-year difference at Tsaranoro is significant ($\chi^2=8.79$, $p<0.01$) and relates to groups studied: in 2009, two groups spent a large proportion of time feeding in the garden of a tourist resort, where food was plentiful, thus allowing more time for social interactions, whereas strictly forest-dwelling groups were observed in 2010. 2010 between-site difference in frequency of social behavior is also significant ($\chi^2=16.43$, $p<0.01$). At Anja *L. catta* had access to closely distributed, clumped resources while at Tsaranoro resources were patchily distributed. The difference in

resource distribution meant that Tsaranoro lemurs traveled farther to obtain daily nutrient requirements, ultimately allowing less time for sociality.

Examination of *Escherichia coli* populations in a captive zoological collection of nonhuman primates.

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Chronic enterocolitis in captive primates has long been a problem in both zoo settings and research colonies. The most common clinical symptom observed with chronic enterocolitis is diarrhea, making it a public health concern as well as an animal health and welfare concern. Management of chronic enterocolitis is confounded by its complexities, including the lack of a consistently identifiable causative agent.

A pilot study was performed during the summer of 2009 in collaboration with a local zoo in Saint Paul, MN, which was experiencing an increased incidence and severity of diarrhea among their nonhuman primate collection. Fecal samples were collected on a weekly basis from 33 animals representing 8 different species within the primate collection and *Escherichia coli* was isolated using previously published techniques. We recorded the fecal consistency of each sample, noting when abnormally watery diarrhea or bloody diarrhea occurred.

Suspect *E. coli* were assessed for phylo-type, virulence genotype and drug susceptibility and these data were combined with observational data in an effort to identify genetic or phenotypic traits that correlated with disease. Our findings suggest that a pathogenic strain of *E. coli* could be contributing to the incidences of enterocolitis observed in this nonhuman primate collection. Overall, our results suggest that the manifestation of enterocolitis in this nonhuman primate collection is indeed complex and likely involves multiple microbial agents in combination with environmental causes.

This study was funded by the University of Minnesota College of Veterinary Medicine.

Between-group variation in the activity patterns of cathemeral owl monkeys (*Aotus azarai*) under similar temperature and light conditions.

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The owl monkeys of the Argentinean Chaco are one of the few primate spe-

cies that regularly exhibit both nocturnal and diurnal activity. Although their activity patterns are known to be generally influenced by moonlight availability and ambient temperature, it has proven difficult to predict the onset and offset of bouts of activity for any given group on a particular day. To understand intergroup differences in activity patterns, we examined the predictive power of moonlight and temperature together with ecological and social factors (e.g. group size, season, food availability). Group activity was recorded during 17 full-day (24 hr) follows conducted on five owl monkey groups during 12 months (408 total observation hours). Hourly temperature and luminosity measurements were gathered automatically during the period of study. There was a positive correlation between luminosity and nocturnal activity (Spearman rank correlation test, $\rho=0.54$). Still, activity levels at low luminosity were highly variable among groups. Temperature had a lesser effect on activity levels than luminosity, and the effect was only present on nights with moonlight (Spearman rank correlation test, $\rho=0.40$). Groups differed in the timing of the onset and offset of activity even when under the same temperature and light conditions. Contrary to the highly predictable nocturnal activity pattern of other owl monkey species, cathemerality seems to be a more flexible activity pattern influenced by a range of abiotic and biotic factors.

Dental metric variation in *Homo erectus sensu lato*.

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Fossils of *Homo erectus sensu lato* have been found in Africa, China, Indonesia, and Europe. Pronounced cranial differences among regions have led to differing taxonomic interpretations. Two of these are: (1) *H. erectus* was a polytypic species that exhibited temporal, as well as geographic, population-level morphological differences; or (2) the morphological variation in *H. erectus sensu lato* is ascribable to taxonomic heterogeneity. This analysis considers whether the dentition of *H. erectus sensu lato* exhibits metric variation suggestive of multiple taxa. We test the single-species hypothesis using measurements of the permanent teeth of fossils from Africa,

China, and Indonesia. As an alternative to using univariate coefficients of variation, we assess overall levels of relative variation using a nonparametric multivariate approach, where the commingling of fossil assemblages (with all regions combined) is simulated in a comparative sample of modern *Homo sapiens* (from 70 populations with a worldwide distribution). We compare degrees of relative variation in randomly-generated fossil and modern assemblages ($N=1000$ for both) using multivariate rank statistics.

Our results indicate that the combined regional samples of *H. erectus sensu lato* are slightly more variable than the combined samples of modern humans, with a greater proportion of outlying observations. Therefore, there is some support for rejecting the single-species hypothesis on the basis of dental metrics. Further research will be needed to assess the relative contributions of time depth and regional differentiation to the larger magnitude of variation observed in the fossils.

The evolution of hearing sensitivity and vocal communication in primates.

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Extant primates, like most mammals, generally show good sensitivity to low-frequency sounds but are also able to hear frequencies in the ultrasonic range (>20 kHz). This wide range of sensitivity is not characteristic of any group of non-mammalian vertebrates and several hypotheses have been advanced to explain how mammals (including primates) evolved this unique hearing pattern. In this study, we examined the ear region in 17 species of fossil primates (60-20 Ma) and predicted their sensitivity to evaluate proposed evolutionary hearing scenarios.

To predict hearing sensitivity, we used high-resolution CT data to measure dimensions of the stapedial footplate and cochlea. Using these measurements, we estimated high- and low-frequency sensitivity using predictive equations taken from the literature. These predictions suggest that stem primates from the Paleocene and Early Eocene (plesiadapiforms) had good high-frequency but relatively poor low-frequency hearing, similar to extant tree shrews. Fossil prosimians from the Mid-Eocene also show good high-frequency sensitivity but later forms indicate increased low-frequency hearing on par with living strepsirrhines. For anthropoids, a possible eosimiid petrosal from

the Mid-Eocene suggests poor low- but good high-frequency hearing. Those from the earliest Oligocene and Early Miocene exhibit morphology suggesting hearing sensitivity similar to modern anthropoids, with relatively good high- and low-frequency hearing. These findings suggest that primates went through a poor low-frequency phase during the development of modern hearing patterns. By combining these results with data on ambient acoustics and vocalization frequencies in extant primate communities, we argue that early primates were likely limited to using high-frequency, short-range calls.

White-faced saki (*Pithecia pithecia*) vocalizations in relation to ambient noise at Brownsburg Natuurpark in Suriname.

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The bulk of primate vocalization research in relation to the environment has focused on long call adaptations; however, maximizing the transmittable distance for all calls would be detrimental to an individual. This would be both energetically costly and increase predator detection. It is likely that some primates have evolved vocalizations that camouflage short distance calls within ambient noise to reduce eavesdropping by predators. However, signals requiring transmission over long distances should contain frequencies outside of ambient noise to increase detection by potential receivers. Research was conducted on two groups of *P. pithecia* at Brownsburg Natuurpark Park in Suriname. Data collection included all occurrence digital recordings of vocalizations, as well as group spread at the time each call was produced. Short distance calls were classified as most commonly occurring during normal intra-group behavior, where all individuals were within short distance detection (<30 meters). Long distance calls were classified as occurring when group spread was greater than 30 meters or in the context of inter-group encounters. Peak frequencies of 475 recordings were analyzed for both the call and of ambient noise 0.1 seconds prior to the call. Our results show *P. pithecia* have adapted signaling behavior that maximizes the detection of long calls by avoiding ambient noise frequencies while minimizing predation risk by masking short distance calls within ambient noise. These findings are important in future study of complex vocal and social relationships, and how animals may alter their signals in order to conform to the constraints of the environment.

Automatic, landmark-free quantification of 3D endocranial asymmetries in extant and fossil species: new insights into paleoneurology.

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The study of endocranial asymmetries of hominids is a central topic in paleoneurology. However, our knowledge about the emergence of these asymmetries during human evolution is still limited. This is partly due to the fact that, so far, these 3D asymmetries have been mostly analyzed using landmarks-based methods. Such methods are limited as they only provide a partial description of the anatomy and thus of the possible asymmetries. The endocranial anatomy may be better described by its whole contour, and the recent advent of computational tools allowing to process 3D free-form surfaces opens new tracks for automated and objective characterization of 3D endocranial asymmetries. One key problem before assessing the evolution of patterns of asymmetry in hominids is the identification of confounding factors such as age, sex and intra-specific variability. For this purpose, we use a new method for the automated quantification of 3D virtual endocranial shape of 60 *Pan paniscus* and 59 *Pan troglodytes* of different dental age and sex. 3D statistical analyzes are led to assess significantly asymmetrical areas on the endocasts within each population, and a comparison is made between the two populations. Several fossil hominin endocasts (such as Australopithecine species and fossil *Homo* species) are then reexamined in light of the previously estimated variability with these two extant *Pan* species. These new computational tools may offer a new way to address the question of how the typical endocranial asymmetries within modern humans (*e.g.* protrusions of the frontal and

occipital lobes) emerged during evolution.

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The first complete fourth metatarsal of *Australopithecus afarensis* from Hadar, Ethiopia.

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The first known complete fourth metatarsal (AL 330-160) of *Australopithecus afarensis* was recovered in 2000 from Hadar, Ethiopia. This 3.2 myr-old fossil provides the opportunity to investigate whether the foot of *A. afarensis* had well developed pedal arches and was characterized by metatarsophalangeal dorsiflexion, attributes unique to humans among hominoids. AL 333-160 was compared to a sample of N=10 each *Homo sapiens*, *Pan troglodytes* and *Gorilla gorilla* MT4s. Novel non-landmark-based morphometrics using 3D laser-scan data with Polyworks software were used to quantify and compare articular surface orientation and distribution, as well as its linear and angular geometry. Normals to articular surfaces were fit, and surface curvatures compared using deviations from spheres and planes. Results indicate that this specimen had roughly 17° of torsion, comparable to that of humans and Dmanisi *Homo erectus*, clearly indicating the presence of a transverse arch. The proximal end of the bone is dorsoplantarly elongated, with an expanded ligamentous attachment area near the base, and is less dorsoplantarly concave than in extant apes, thus resembling the MT4 of other hominins including *Ardipithecus ramidus*. As in other hominins, the plantar surface of the distal articular surface faces more distally than in apes. AL 333-160 also exhibits the dorsal doming of the head, reflecting habitual loading of the metatarsophalangeal joint in dorsiflexed postures that accompany toe-off during the human striding gait. This metatarsal shows that in its possession of both longitudinal and transverse arches the *A. afarensis* foot was fundamentally similar to that of modern humans.

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Comparison of Ateline limb bone biomechanical properties.

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Humeral and femoral parameters were compared for *Alouatta*, *Ateles*, and *Lagothrix*. *Ateles* was expected to have the largest values because *Ateles* exhibits the highest frequency of suspensory behaviors and is very active, followed by *Lagothrix* (Cant *et al.*, 2003). *Alouatta* is a generalized quadruped (Gebo, 1992).

Radiograph measurements were used to calculate midshaft humeral and femoral J. Humeral and femoral head surface areas were calculated following Runestad (1997). Lengths were measured from X-rays. Sample sizes were 39 *Alouatta*, 13 *Ateles*, and 13 *Lagothrix* individuals. Statistical analysis was complex due to narrow body size ranges and use of individuals as data. A mixture of t-tests, ANCOVA, and visual inspection of bivariate graphs was employed.

Results indicate that *Ateles* has the largest femoral properties and longest humeri. *Lagothrix* is slightly greater in these properties than *Alouatta*, excepting femoral head surface area which does not differ. *Alouatta* has greater humeral J and slightly greater humeral head size than the others.

Femoral results and humeral length results match expectations for *Ateles*, the most active and suspensory. *Lagothrix* has intermediate values, corresponding to intermediate locomotory behavior. Low *Ateles* humeral J may be explained by a kinesiological study (Hirasaki *et al.*, 2000) suggesting *Ateles* uses hindlimbs more than forelimbs for propulsion, compared to quadrupedal macaques. Results for humeral head size do not suggest greater shoulder mobility for *Ateles*. However, humeral head shape was not investigated and it may be a better indicator of motion range.

Paranthropus was not a sea otter: convergent adaptation to hard object feeding.

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The large, bunodont postcanine teeth in living sea otters (*Enhydra lutris*) have

been likened to those of certain fossil hominins, particularly the 'robust' australopiths (genus *Paranthropus*). We examine this evolutionary convergence by conducting fracture experiments on extracted molar teeth of sea otters and modern humans (*Homo sapiens*) to determine how load-bearing capacity relates to tooth morphology and enamel material properties. *In situ* optical microscopy and x-ray tomography during simulated occlusal loading reveal the nature of the fracture patterns. Explicit fracture relations are used to analyze the data and to extrapolate the results from humans to earlier hominins. It is shown that the molar teeth of sea otters have considerably thinner enamel than those of humans, making sea otter molars more susceptible to fracture. At the same time, the base diameter of sea otter first molars is larger, diminishing the fracture susceptibility in a compensatory manner. We also conduct nanoindentation tests to map out elastic modulus and hardness of sea otter and human molars through a section thickness, and microindentation tests to measure toughness. We find that while sea otter enamel is just as stiff elastically as human enamel, it is a little softer and tougher. The role of these material factors in the capacity of dentition to resist fracture and deformation is discussed. From such comparisons, we argue that early hominin species like *Paranthropus* most likely consumed hard food objects with substantially higher biting forces than those exerted by modern humans.

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Positional behavior of *Cercocebus torquatus* (red-capped mangabey) at Sette Cama, Gabon.

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Positional studies of extant taxa are vital for reconstructing behaviors of extinct primates. Nevertheless, the degree that locomotion and posture vary both ontogenetically and across different habitats is contested. Here we present data collected from May – September 2009 on the positional behavior of *Cercocebus torquatus* ranging across two structurally distinct forests in Sette Cama, Gabon. Our null hypothesis is that locomotion, posture, and habitat use do not vary significantly across habitat types or age and sex classes. We used scan sampling methods to record information on maintenance activity, positional behavior, habitat type, and support characteristics for members of all age and sex classes. Age and sex comparisons were made using Fisher Exact tests ($p=0.05$). The data ($N=1,519$ scans) indicate that *C. torquatus* spend approximately 44% of their time on the ground. Overall locomotion is primarily

quadrupedal (81.8% of scans) followed by climbing (11.1%) and leaping (6.7%). Sitting is the most common posture (73.9%) both on the ground and in the trees. There is no significant difference between adult male and female locomotion ($p=.091$), but the locomotion of juveniles differs significantly from that of subadults ($p=.001$). Positional behavior and habitat use does not change with habitat type ($p=.000$). These data suggest that positional behaviors are maintained across different habitats and that younger individuals display more locomotor flexibility than adults. *C. torquatus* at Sette Cama is less terrestrial than other *Cercocebus* species; additional research is needed to determine whether this habitat difference is reflected post-cranially. Study supported by an IPS Research Grant.

Strontium isotopes from early hominin sites in South Africa can provide new insights in paleoecology and taphonomy.

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Strontium isotopes (⁸⁷Sr/⁸⁶Sr) in tooth enamel reflect the geological substrate on which an animal lived during tooth development. As such, strontium isotopes are often used in archaeology to assess residence or migration of ancient humans. In our studies of Plio-Pleistocene fossils from the Cradle of Humankind cave sites in South Africa, we found that strontium isotope analysis is useful for addressing a broader scope of issues, including behavioral, taphonomic, and paleoecological questions. We documented biologically available ⁸⁷Sr/⁸⁶Sr in the region by collecting and analyzing strontium isotopes in over 150 plants at 25 sampling sites representing 8 geological zones within 50 km of Sterkfontein and Swartkrans. We used laser ablation MC-ICP-MS for analyzing ⁸⁷Sr/⁸⁶Sr in >130 modern and fossil teeth. Results indicate that strontium isotopes can be used as a taphonomic tool by indicating the presence and proportions of non-local individuals, as we show in a case study of modern and fossil rodents from Gladysvale. Analyses of 19 australopiths from Sterkfontein and Swartkrans suggest that strontium isotopes can be used to address early hominin dispersal patterns. We propose that strontium iso-

tope analysis would complement paleo-habitat reconstructions such as those using carbon isotopes in teeth, in which knowledge of whether an animal lived locally or far away when its tooth was mineralizing is useful.

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Experimental investigations of the effects of exercise, hormones, and diet on cranial vault thickness.

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In 1996, Lieberman found that exercised animals had thicker cranial vaults relative to their unexercised sibling controls. One mechanism that could lead to such a finding is exercise-induced increases in growth hormone causing a systemic increase in skeletal robusticity. In order to test this hypothesis against one of localized masticatory strains affecting cranial vault thickness, we undertook two experiments. In the exercise study, 50 mice from lines artificially selected over 60 generations for endurance running ability and 50 controls were split between cages with wheel access and no wheel access. After 3 months, all skeletal elements were harvested at the conclusion of the experiment, and the humerus, femur, mandible, parietal and interparietal bones were μ CT scanned. Wheel access correlated with thick parietal bones in the selected but not control lines, while interparietal thickness varied by line type but not activity type. A second experiment with similar parameters used 50 inbred and 50 wild-type mice, divided into three dietary groups: soft, cold, and control. The soft diet group was fed food the consistency of dough, while the cold group was housed in a 10°C room in order to manipulate their food consumption by increasing resting metabolic rate. All inbred mice showed relatively thicker cranial vaults than the outbred mice, while the soft diet groups had significantly thinner vaults than the other groups. It appears genetic background has a greater effect on cranial vault thickness in mice than do the material properties of their diet or their exercise levels.

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Mandibular development in humans and chimpanzees: the effect of spatial packing of teeth and muscles on mandibular shape.

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It has been suggested that dental development influences sexually dimorphic growth of the mandibular symphysis in humans and other primates. We provide new insights into this developmental relationship by integrating muscle positioning at the lingual side of the symphysis with geometric morphometric descriptors of mandibular shape.

Our sample consists of CT scans of 166 humans and 14 chimpanzees, ranging from fetal stages to adulthood. We use geometric morphometric methods and conjoint measurement to analyze mandibular shape, muscle insertions, and tooth mineralization and position over ontogeny.

In humans, mandibular growth and tooth mineralization are tightly correlated over the first two years of life. However, the mandible's sexual dimorphism is not related to any corresponding dental dimorphism. Symphyseal shape changes and tooth reorientation are tightly associated over development with relocation of the tongue and suprahyoid muscle insertions.

During earlier fetal stages, both humans and chimpanzees have a V-shaped mandible. While the chimpanzee mandible maintains its V-shape, the reshaping of the human mandible incorporates apposition of a shallow U-shaped alveolar process to a V-shaped basilar bone. During infancy, the inclination of the chimpanzee symphysis is coordinated with the emergence of the deciduous canine.

In both species, the symphysis orientation may be related to hyoid bone position during ontogeny. Muscle orientations and insertions would have substantial effects upon symphysis shape, tooth orientation, and the timing of tooth emergence. Initial differences in size and position of the teeth would be related to the earlier appearance of the U-shaped alveolar process during human ontogeny.

Season at death for the Moche giants.

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Dps Cabezas, a prehistoric site in northern Peru that dates to AD 100-800, has yielded, among other things, five skeletons of extraordinary stature and sharing in bone pathologies unique among

their population. These five individuals - the Moche giants - were elite males. Stratigraphic analysis indicates that the men were buried with a 6 month period. A histological technique has the potential to confirm that these individuals all died within the same season: dental cementum increment analysis. For this study, five teeth from four of the Giants were embedded in Buehler EpoKwik Resin under vacuum pressure. The embedded teeth were then sectioned with a Buehler low speed saw to create 300 micron thick wafers. The wafers were each mounted to a petrographic glass slide and ground to a thickness of 100 microns, polished, and viewed under an Olympus BX-41 transmitted polarized light microscope. Digital micrographs were captured using an Olympus DP70 digital camera. Of greatest interest was the outermost cementum increment which was evident in four of the five teeth. All four teeth exhibited a dark outer increment, indicating that the four individuals died in the same season. This poster will include the photomicrographs and data on when the light and dark bands transition in South America, a clue to during which months these men might have died.

Molecular diversity and evolution in the Bioko colobus monkeys.

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Bioko (Equatorial Guinea, West Central Africa) is an island found 32 kilometers off the coast of Cameroon and harbors one of the most species rich insular primate communities in the world. Members of this community include Pennant's red colobus (*Procolobus pennantii pennantii*) and the Bioko black colobus (*Colobus satanas satanas*), both of which suffer from illegal hunting, extremely restricted ranges, and habitat destruction and are listed as Endangered by the IUCN. Molecular diversity has not yet been surveyed in these populations and is an important variable in understanding a population's potential to adapt to a changing environment. This work represents the first population genetic research performed on any Bioko primate.

DNA was extracted from fecal and tissue samples from Pennant's red colobus (n=20) and the Bioko black colobus (n=17), and individuals were screened at 12 microsatellite loci to infer levels of genetic diversity. Preliminary data show that heterozygosity is higher in the red colobus, and inbreeding coefficients (F) suggest the presence of inbreeding in the black colobus but not the red colobus. We also surveyed molecular diversity in the closest mainland relative of

Pennant's red colobus (Preuss's red colobus; *Procolobus preussi*), and an AMOVA showed more molecular variation within populations than between populations. We will continue collecting molecular data for other Biokomanland cercopithecoid taxon pairs to better understand their evolutionary history, colonization and speciation processes, the biogeographic history of the region, and to aid in designating conservation priorities for these threatened taxa.

Variable definitions provide varying ages: towards a standard methodology in bone histomorphometric aging.

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Since Kerley (1965) introduced the use of bone histomorphometry to estimate age at death, multiple researchers have revised his original method. Although the importance of histomorphometric aging methods when identifying human remains, especially fragmented remains, has been recognized, there is no agreed upon standardized methodology. A fundamental concern of using histomorphometric techniques is the inherent difficulty in discriminating between histological variables, which represent the history of remodeling events. Ambiguity between different researchers' definitions of these variables introduces subjectivity when identifying features and creates a potential source of error, thus reducing the method's reliability and accuracy. A previous study (Cosgriff-Hernandez and Stout, 2010) addressed this concern, finding significant inter-observer error when quantifying complete and fragmentary osteons using Kerley's original definitions. The purpose of this study is to investigate the consistency with which individuals of varying degrees of experience in skeletal biology can identify complete and fragmentary osteons using modified and published definitions (Stout, 1983). Complete osteons are defined as having $\geq 90\%$ of the Haversian canal perimeter intact. Fragments are defined as remnants of complete osteons having $< 90\%$ of the Haversian canal intact. A mixed model nested ANOVA is used to test for differences among mean counts of complete osteons, osteon fragments, and summed counts, between and within expertise groups (inter-observer error) and between each individual's successive readings (intra-observer error). This study builds on our previous findings and further emphasizes the need for refined histological definitions to reduce inter- and intra-observer error, thereby increasing accuracy and reliability in histomorphometric aging methods.

Differences in vertebral shell structure among great ape and human thoracic vertebrae.

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Spontaneous vertebral fractures are the most common osteoporosis related fracture in humans; however, apes with extremely low bone mineral density do not experience these types of fractures. Finite element models of ape and human vertebral body compressive strength indicate that young adult humans have weaker vertebrae than expected for body mass despite similar amounts of bone mass among all hominoids. That the relationship between vertebral body bone mass and body mass does not differ among species, suggests that there are biomechanically important differences in vertebral body bone microstructure between humans and apes. We examined the vertebral shells of the T8 vertebral body in humans and great apes using three-dimensional micro-computed tomography. The shell in apes and humans becomes thicker at the midheight region of the body, with a concomitant reduction in trabecular bone. This structural pattern reflects the pattern of load sharing between the vertebral shell and trabecular bone (i.e., the more load carried the thicker the shell, or more dense the trabecular bone) (Eswaran et al., 2006, JBMR). Humans displayed low trabecular bone volume fraction and thinner shells than would be expected for body mass. While chimpanzees exhibited thin shells with high trabecular bone volume fraction, and gorillas and orangutans demonstrated varied trabecular bone volume fraction with very thick shells. The disproportionately thin vertebral shell thickness in humans was unexpected because it appears contrary to biomechanical demands suggesting that the difference in allocation of bone may protect the vertebral bodies in apes from fracture following bone loss.

Abundance of primates in a West African bushmeat market: implications for cercopithecoid conservation in eastern Liberia.

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Bushmeat hunting is the primary cause of primate loss in West Africa. Several recent studies indicate that current off-

take rates are unsustainable and at least three taxa endemic to Upper Guinea forests are in danger of extirpation. Here I report results from a bushmeat market survey located on the Cavally River which serves as the Liberia - Côte d'Ivoire border. Based on reports from actors in the bushmeat chain, meat arriving at this market derives primarily from forests in the Konobo district of eastern Liberia. The formal market, located near the Ivorian village of Tai, operates year round, two days a week but bushmeat is transported across the river daily. Over a 4 month period in 2009/2010, we visited this market and tallied the number of primate species traded. During the sampling period, we observed 723 animals for sale, including 264 primates, 68% of which were smoked. A minimum average of thirty-three primates was exchanged weekly, yielding a highly conservative estimate of 1,716 ind/year for this market. *Cercopithecus petaurista* (25% of all primates) was the most abundant primate, followed by *Cercopithecus diana* (19.3%), *Cercocebus atys* (12.1%), *Colobus polykomos* (11.4%), *Procolobus verus* (10.6%), *Cercopithecus campbelli* (10.2%), and *Procolobus badius* (9.5%). Given the volume of meat sold at the Cavally market, our figures are likely gross underestimates of off-take levels. Based on known group sizes and population densities of these species in the adjacent Tai National Park, we conclude primate populations in Liberia's Konobo district are not being hunted at sustainable levels. Supported by the Primate Society of Great Britain, NSF BSC-0921770, and The Ohio State University.

Femoral diaphyseal shape and mobility: an ontogenetic perspective.

LIBBY W. COWGILL. Department of Anthropology, University of Missouri.

The ratio of midshaft femoral anteroposterior (I_x) to mediolateral (I_y) second moments of area has been suggested as a possible indicator of mobility, and has been applied as an analytic tool to paleoanthropological and archaeological samples with variable success. Under this model, biomechanical loads associated with increased mobility modify the shape of the femoral midshaft from a roughly circular cross-section to a anteroposteriorly reinforced one. While previous research indicates that immature femora respond to changes in the manner of locomotor loading (Ruff, 2003; Cowgill et al., 2010), relatively fewer studies have examined population-level differences in immature femoral shape as a product of overall group mobility. This study uses seven immature Holocene human samples (n=626) to explore three questions: 1) When do population differences in midshaft femoral shape emerge during ontogeny? 2) Do the differences detected correspond to pre-

dicted mobility levels? 3) Does the midshaft femoral shape ratio correlate of other cross-sectional properties of the femur? The results of this analysis indicate that while population-level shape differences appear relatively late in human ontogeny (>12 years of age), these differences only loosely correspond to expected levels of group mobility. Furthermore, elevated levels of A-P reinforcement do not necessarily correlate with high levels of torsional strength. It remains unclear what factors directly impact midshaft femoral shape during ontogeny, and, while mobility levels may be a factor, additional influences need to be evaluated. Support provided by the Leakey Foundation, Wenner-Gren Foundation, and NSF BCS-0549925.

Diet as a functional and adaptive explanation for glenoid region evolutionary changes: a comparative analysis of humans, non-human primates and fossil hominins.

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Recent research suggests that neither the functional nor the adaptive basis for many of the evolutionary changes in the glenoid region of the hominin skull is well understood. The research indicates that evolutionary change occurred outside the context of brain expansion and "transformation" of the cranial base, and is instead most likely related to a dietary shift made evident by the dentognathic record. To investigate influence of diet on the mandibular fossa of the glenoid region, we correlated both left and right mandibular and maxillary tooth dimension (one of five dental proxies used to indicate diet [M1/M3 area ratio]) with mandibular fossa dimensions (length, breadth, depth, and index) in a bivariate analysis. 101 human (n=9), non-human primate (n=74), and fossil hominin (n=18) specimens were comparatively analyzed. The authors adjusted the method used by Wood (Wood, 1991), the method predominantly used for measuring human mandibular fossae, in order to accommodate for the variation observed between mandibular fossa dimensions of smaller primates. Bivariate analysis suggested that the variables are positively correlated in that: as M1/M3 area ratio increases (i.e. the specimen ingests a softer diet), mandibular fossa index (length/breadth) increases. This implies that diet does affect the glenoid region of the hominin skull. Moreover, as the diet of non-human primates is known, comparing results of the non-human primates to the fossil hominins serves as a useful tool for future reconstruction of hominin diet, in addition to quantitative microwear studies of diet.

This study was funded by The Kirtlandia Society, Donald S. Dean Adopt-A-Student Program at the Cleveland Museum of Natural History.

The cave of the dead children: a case of possible ritual sacrifice.

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The La Cueva de los Muertos Chiquitos site (AD 600-1430) is located just north of Durango, Mexico. A reanalysis of the human remains from this site, excavated in the 1950s by Sheilagh and Richard Brooks, has yielded important new information. This cave site contains at least 18 burials of infants and children (n=17, most being <3-4 years of age) and at least two adult female burials all associated with the Gabriel San Loma culture. Using long bone lengths and radiographic analysis of dental development, age approximations for the subadults were refined. All of the children exhibit active cases of nonspecific periosteal reactions on the cranium. Sixty percent of the 17 children also exhibit periosteal reactions on the long bones. In addition, porotic hyperostosis (n=7) and cribra orbitalia (n=5) are present. A number of cases of possible juvenile scurvy (n=4) were also identified.

Taphonomic indicators of the mortuary context revealed evidence of burning and intentional sequenced interment suggestive of ritualized burial treatment. Results from the analysis of coprolites and quids found in the cave (Reinhard, et al. 1988) provide additional information on diet and health. Vegetative data noting the presence of botanicals used for drug production at the site (Foster 1984), suggests that an unusual occurrence such as ritual sacrifice likely precipitated the deaths of up to 17 infants and children as well as two adult females. Large quantities of corn and beans may have also been a part of the ritual offering.

The role of marine lipids as a determinants of evolution and Hominid brain development.

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Lipids played a major, as yet unrecognized, role as determinants in evolution. Docosahexaenoic acid (DHA) is the principle acyl component of the membrane lipids in the photoreceptor, synapse and the gray matter of the brain. To test the hypothesis that its role in these signalling systems has evolutionary significance we have used gas liquid chromatography and mass spectrometry, to analyse the lipids in the dinoflagellates, cephalopods, fish, amphibia, reptiles,

birds and some 42 species of mammals. The results confirm the constancy of DHA in neural signalling systems. This data suggests DHA has been the key component of signalling systems with no evidence that it was replaced over what represents 500 million years of evolution, by docosapentaenoic acid which differs by only 2 protons. The conclusion is that the full six member, methylene interrupted, double-bond sequence is essential to neural signalling. Molecular dynamic assessment of the π -electron behaviour suggests a potential quantum mechanical behaviour consistent with the absolute conservation of DHA in signalling systems. This extreme conservation as a determinant of the brain together with the molecular biology of DHA provides a rationale for the dependence of human evolution on a DHA rich, namely an aquatic food resources.

Patterns of gene flow into the indigenous populations of the Aleutian Archipelago.

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Contemporary populations of the Aleutian Islands resulted from admixture between Native Aleuts and Europeans. To accurately measure gene flow, the following information is required: (1) the gene frequencies of the parental and admixed populations; (2) identification of the origins of the parental groups; (3) information about other forces of evolution—e.g. signature of selection; (4) determination of differential maternal versus paternal migration. The sampling of DNA from eleven Aleut populations, geographically distributed 1500 kilometers from the Alaska Peninsula to Kamchatka, Siberia, offers an opportunity to measure gene flow rates. The Aleut gene pools were characterized using: autosomal STRs, RFLPs and sequences of mitochondrial DNA, Y chromosome SNPs and the HLA system. Using Admix 2.0 Program and 9 STR frequencies, 40% of the admixed Aleut population is of Russian origin and 60% is Aleut. However, there is considerable variation in admixture locus by locus (12%-79% Russian). All of the mtDNA haplogroups are either A or D in the western or central islands—suggesting no admixture based on female migration. However, 85% of the Y-chromosomes are of European origin, with the most common being R1b 22%; R1a 26%. A total of 24% of the HLA haplotypes are Aleut specific, while 14% are East European. This study demonstrates considerable variation in estimates of admixture (m) when different genetic markers are used. The majority of the admixture was European males (Russians, Scandinavians or English) and Aleut females. This form of mate selection was encouraged by the Russian government as a political control mechanism. This study was funded by NSF grants OPP-9905090 and OPP-0327676.

The impact of natural substrates and load bearing on bipedal gait dynamics in human females.

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The ability to walk bipedally is the defining characteristic of the hominin lineage, and studying the origins of bipedalism is therefore important for understanding hominin evolution. The earliest hominin postcranial morphology differs significantly enough from that of modern humans to make it unlikely that early hominins were well adapted for long-distance, striding bipedalism. Additionally, the efficiency of early hominin bipedalism was likely impacted by environmental factors, particularly natural substrates.

This study examines the effects on four healthy adult females of load carrying while walking in wet sand. Each subject conducted four walks across a 6x1 m sand tray. Three load conditions were examined for each subject: one in which the subject wore a 9.1 kg pack strapped tightly to the upper back to simulate a heavier torso and arms; one in which the subject carried a 4.5 kg bag of potatoes to simulate carrying an infant; and one in which the subject both wore the backpack and carried the "infant". A control trial in which none of the loads were introduced was also conducted for each subject. Gait dynamics, including speed and stride length, were captured using two digital video cameras with overlapping capture fields.

The current study presents available field data on the effects of load carrying and natural substrates on human bipedalism. Preliminary results indicate a decrease in speed and stride length for each of the load variables as compared to the control variable. These data will be used to increase our understanding of early hominin bipedalism.

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This project was approved by the Rutgers Institutional Review Board (#10-451).

Skeletal evidence for the dissection of children at the Philadelphia Almshouse, 1732-1834.

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In the 1700s, the "Edinburgh model" of medical education emphasized the use of dissected bodies to demonstrate human anatomy and instruct surgical techniques. This style of teaching was

adopted in colonial America in 1765, when the first American medical school opened in Philadelphia. Pathologic specimens from dissected corpses were often retained in pathology museums while the rest of the autopsied remains were buried in potter's fields. The vast majority of the cadavers were from adults, but the remains of children also were dissected for study and surgical practice.

Philadelphia constructed its first public almshouse in 1732. An associated burial ground was used until ca. 1834, when the much larger Blockley Almshouse and its cemetery, located in West Philadelphia, replaced it. Recent excavations of the first almshouse burial ground revealed the well-preserved skeletal remains of 16 infants and children placed in separate coffins but buried together in a single grave shaft. The coffins were undisturbed. Of the 16 individuals, 12 had died before their first birthdays, including four premature infants and two newborns. Three other children were between two and three years of age. The causes of death are indeterminate. Of greatest significance, the heads and first two cervical vertebrae of three of the oldest children had been surgically removed prior to their interment, as indicated by thin cut marks visible on the remaining vertebrae. A necessary but unsettling component of medical education even today, skeletal evidence for the dissection of children is uncommon in the bioarchaeological record. This presentation links medical education in early Philadelphia and the procurement of cadavers from the almshouse morgue.

Differential sex distribution of skeletal trauma in an institutionalized historic population.

LORI A. TREMBLAY CRITCHER. Department of Anthropology, The Ohio State University.

In bioarchaeological studies of skeletal trauma, there has been little focus on institutionalized populations from the historic period in the United States. The aim of this study was to determine the differences of frequency and distribution of skeletal trauma between males and females in a late 19th century population associated with the Oneida State Custodial Asylum in Rome, New York. I tested the hypothesis that there would be statistically significant differences in the frequency and distribution of traumatic lesions between males and females due to the different labor therapy tasks assigned to, as well as behavioral practices of, each sex. Using macroscopic visual methods, the remains of 55 males and 20 females were examined and both antemortem and perimortem fractures were recorded.

Overall, there were no statistically significant differences in frequency and distribution of total trauma for both sexes ($p = .306$), with the exception of

trauma to the tibia. This study revealed that this population not only exhibits a high rate of tibial trauma for the time period but also a statistically significant difference in sex distribution ($p = .0375$), with a higher rate among females (15%) than males (2%). Although it is unknown how these injuries occurred, and whether they were the result of accidents or some form of interpersonal violence, this unequal distribution suggests that the different kinds of behavioral activities that females and males engaged in produced varying levels of risk for injury in late 19th century institutional settings.

A health assessment of an Etruscan skeletal sample dating from the VIII century to the III century BC.

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We examine the frequency of paleopathological lesions exhibited by 278 skeletons recovered from several Etruscan Necropolis located near the city of Tarquinia, Italy. The necropolis dates from the VIII century BC to the III century BC. The purpose of this presentation is to compare lesion frequencies by sex and over time. Skeletal lesions appear in 65% of the adults; 64.8% of females and 66.4% of males. The following lesions were recorded OA, DJD, trauma, cribra orbitalia, porotic hyperostosis, caries, enamel hypoplasias, and periodontal disease. The differences in rates between the sexes for this sample of Etruscan burials are not statistically significant. Twenty percent of the subadults presented skeletal or dental lesions. The presence of lesions caused by chronic health stressors in the subadult sample indicates that they were likely under the same health constraints as the adults. Additionally, it is likely that acute health problems lead to many of the subadult deaths. Finally, our findings are compared to early Iron Age samples from the Tarquinia necropolis of Villa Bruschi Falgari (VBF), Italy and to an Imperial Roman skeletal sample from Urbino, Italy. For some of the lesions (cranial pitting and DJD) this Etruscan sample sits between the VBF and Urbino samples in occurrence. The rate of periostitis is similar in the VBF and Etruscan samples (12.4% and 12.1% respectively) and both frequencies are lower than the Urbino burials (36%). In general, we see that over time the frequency of lesions either remains constant or increases among these Italian burial groups.

Variability in the realized resource holding potential of capuchin social groups levels the balance-of-power between unevenly matched neighbors.

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In many social species, large groups have a competitive advantage over their smaller neighbors which can impose substantial costs including reduced reproductive rates and increased mortality. How do small groups persist when the potential ramifications of power imbalances are so severe? We propose that because the defense of shared resources requires the coordinated efforts of many individuals, a group's strength, its *realized* resource holding potential, may vary substantially from one contest to the next and be only weakly related to the *maximum* resource holding potential of the group as a whole. Where payoff asymmetries create context-dependent fluctuations in the balance-of-power between neighbors, groups of unequal strength should be able to coexist. Here, we experimentally demonstrate that asymmetries in both location and group size affect the likelihood that *Cebus capucinus* participate in territorial defense. We show that focal individuals were more likely to approach a playback speaker when territorial intrusions were simulated in the center as opposed to the edge of their range. This variation in participation provides a mechanism to explain the home-field advantage previously described in this population. We also show that individual strategies tend to even the odds in competitive encounters between unevenly matched groups; group-members were more likely to defect when they outnumbered their opponents. Our study is the first to demonstrate how individual responses to the social and ecological context of territorial intrusions can level the balance-of-power between groups, and provides a mechanism to understand how group-size variation is maintained in the face of intense intergroup competition.

A structural approach to cranial variation in the genus *Alouatta* (Primates, Atelidae).

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Howler monkeys (genus *Alouatta*) display a peculiar cranial architecture, characterized by a high degree of airo-

rhynch. This condition may be evolutionarily influenced by a largely folivory diet (with selective pressures on mandibular and splachnocranial dimensions), social structure (related to the development of vocal sacs), or by the interaction between these or other more subtle factors. In terms of functional craniology, airorhynch may be related to structural changes associated with the morphology of the supraorbital anatomy, with the spatial relationships between face and cranial base, or with morphogenetic variations of the pteric area. However the evolutionary changes associated with the cranial organization in *Alouatta* are still currently unknown. This study is aimed at investigating the variation and covariation patterns in howler monkeys, considering both inter- and intragenetic morphological differences. We also investigated the structural role of the pteric area within the cranial functional matrix, in order to test possible relationships between its variation and the degree of airorhynch. To address these objectives we applied landmark-based analysis and multivariate statistics to a comparative dataset of atelid adult skulls. Our results suggest that the cranial architecture in howlers is influenced by an allometric vector, which associates higher degrees of airorhynch with splachnocranial enlargement, basicranial lengthening and neurocranial flattening. On the other hand, the relationship between pterion and airorhynch could not be confirmed. Either way some minor morphological differences were identified, suggesting that variations of the pteric area may be instead related with the relative development of the masticatory apparatus.

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A dietary source of brain selective nutrients helped free nutritional and energetic constraints during human brain evolution.

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Two parameters constrain successful brain development in humans – (1) sufficient access to a cluster of dietary 'brain selective nutrients' (BSN) including the omega-3 fatty acid – docosahexaenoic acid and several minerals including iodine, iron, zinc, copper and selenium, and (2) an extraordinarily high energy requirement. We hypothesize that since shore-based freshwater and marine fish and shellfish are the richest known dietary sources of BSN, regular access to these food resources would have helped free the nutritional constraints on primate brain development and function by hominins. This hypoth-

esis predicts that an inadequate dietary supply of BSN would negatively impact on human brain function today, a prediction confirmed by neurodevelopmental deficit due mainly to iron and iodine deficiency in ~20% of the world's population. Although the adult human brain is 3-4 times bigger than in other primates and consumes about 23% of the body's energy intake, energy requirements of the infant brain are considerably higher (74% of energy intake). Unlike other organs, the brain requires ketones as an alternate to glucose and cannot use fatty acids as fuels. We hypothesize that the high energy requirements of the newborn human brain were reliably achieved by the evolution of a significant layer of body fat at birth. Through ketone production, this fat layer supports the high energy needs of the developing human brain to a degree not available in other primates. Access to BSN in shored-based freshwater and marine food resources therefore played a critical role in the tripling of brain size during human evolution.

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Mechanical advantages of roasting undomesticated tubers.

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Cooking is a central component of modern human behavior. It expands the range of edible foods and reduces the energetic cost of chewing and digestion. Such profound advantages have been linked to key anatomical changes associated with the origin of *Homo* ca. 2.0 Ma. Yet evidence of cooking is scarce beyond 800,000 years ago, and the effects of roasting behavior on the plant foods available to early *Homo* are largely unknown. Here we report on the mechanical advantages of roasting undomesticated tubers consumed by two African hunter-gatherer populations, the Hadza and the Twa. The Hadza inhabit a savanna and consume fabaceous tubers, whereas the Twa inhabit a rain forest and consume Dioscoreaceous tubers (yams). Although all tubers were similar in size and shape, the mechanical properties of the raw tubers differed between habitats, as did the traditional open-fire roasting behaviors of the two populations. The Hadza roasted tubers with substantial mechanical defenses for ca. 2 min at 700-900 °C, whereas the Twa roasted relatively undefended tubers for ca. 30 min at 500-700 °C. In both cases, cooking resulted in significant mechanical changes; roasted tubers were less stiff and tough and therefore easier to chew

than raw tubers. Yet such changes cannot alone account for the roasting behavior of the Twa. Tubers roasted by the Hadza -despite immense mechanical changes in a mere 2 minutes- exceeded the toughness of all raw, inedible yams available to the Twa. We suggest that chemical detoxification is sometimes the primary reason to roast tubers.

This study was funded by the David and Lucile Packard Foundation and the Department of Anthropology, Dartmouth College.

Assessing the impact of exogenous grit and plant silica on primate tooth wear: A field and laboratory experimental approach.

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Potential causes of primate, and thus mammalian, tooth wear include exogenous grit and plant silica. We tested the hypothesis that plant silica, in the absence of exogenous grit, is a significant source of primate tooth wear. We experimentally "scratched" ring-tailed lemur dental specimens housed in the Beza Mahafaly Special Reserve (Madagascar) Osteology Collection with plant foods known to be eaten by lemurs, and collected just prior to their experimental use. A single lemur jaw (lower right mandible) was used for each round of "rubbing". Dental impressions were collected prior to, and after 25, 50, and 100 rubs with each plant species, to simulate multiple feeding bouts on each plant type. Prior to their rubbing on teeth, each plant specimen was cleaned with laboratory grade (90%) alcohol to remove exogenous grit. Initial analysis of lemur plant foods using an SEM with an EDX probe indicate the presence of endogenous silicates (opal phytoliths) in surface layers of specific lemur plant foods thought to cause abrasion based on long-term study of feeding ecology and collection of tooth wear data. Micro-wear analysis of experimentally rubbed lemur teeth indicates that leaves containing silica produce new microwear features after 100 rubs. As leaves were cleaned prior to their rubbing on lemur teeth, these data refute the hypothesis that only exogenous grit is a significant source of tooth wear. Our new data illustrating that leaves containing silica produce new microwear features challenge published hypotheses that such endogenous phytoliths are not a significant cause of mammalian tooth wear. Funding - National Science Foundation BCS-0922465.

Open habitats of four Eurasian early Pleistocene sites demonstrated with Cervidae ecomorphology.

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Much attention has been paid to the issue of hominin dispersal throughout central and eastern Eurasia at ~2 Ma. Pivotal to understanding how and why dispersal occurred at that time is the elucidation of the types of environments available to hominins in the early Pleistocene. Were hominins adapted to a single habitat type that was spread throughout Africa and Eurasia or did they occupy a wide variety of habitat types, thus displaying behavioral flexibility?

Ecomorphology allows for the reconstruction of paleoenvironments by investigating an organism's functional morphology as it relates to adaptations to different habitats. Recently, it has been shown that geometric morphometric analyses of Cervidae (deer and relatives) post-cranial remains can be used to reconstruct past habitats (Curran 2009). Expanding ecomorphological methods to Cervidae is imperative in studies of Eurasian sites, as cervids are often the dominant taxon in such assemblages.

This study reviews ecomorphological results for extant cervids and applies the methods to cervid remains from four early Pleistocene sites (Grăuncanu, Romania; St. Vallier & Senèze, France; and 'Ubeidiya, Israel). While all four sites have large faunal assemblages that include primate remains, only the last site contains hominin remains.

Similar to other contemporaneous hominin sites, all four sites are reconstructed as being "intermediate open" to "open". This is due, in large part, to the presence of several Pleistocene giant cervid species. *Eucladoceros*, especially, is reconstructed as having been adapted to open conditions. Thus, environmental conditions would not have precluded hominin occupation of these early Pleistocene western Eurasian sites.

The Daren Kelley case: how forensic anthropology helped solve a 15 year old homicide.

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Sometime in June 1995, 23-year-old Daren Kelley disappeared from his home near Milton, Florida, never to be seen again. He was not formally reported missing until 1998, at which time suspicion fell on his wife, Kimberly Cannon. Although Ms. Cannon claimed to police that Kelley had deserted her in 1995, other informants reported that she had

killed her husband, dismembered the body, and buried it on their 13-acre property. Investigators from the Santa Rosa County Sheriff's Office (SRCSO) searched the property in question on three separate occasions, but found no evidence as to the fate of Mr. Kelley. In 2007, SRCSO asked for the assistance of the UWF Department of Anthropology in conducting another, final search of the property. A team of 22 anthropology undergraduate and graduate students volunteered to participate in the search under the supervision of three department faculty. Field methods included systematic foot search of the property, GPR investigation of suspicious depressions, and hand excavation and backhoe trenching of high probability locations. A single 20-cm fragment of human fibula was recovered during the search. This presentation describes the field methods employed by the forensic anthropologists, the results of the analysis of the recovered fragment that led to the conviction of Ms. Cannon in 2010, and argues for stronger reliance on the specialized skills of forensic anthropologists in cold cases of this nature.

Age at death evaluation by tooth cementum annulation (TCA) - a software for an automated line counting.

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A valid age at death estimation is required in historical and also forensic anthropology. *Tooth cementum annulation* (TCA) is a method for age at death estimation of adult individuals. The method uses light microscopic images acquired from tooth root cross sections. The age is then estimated by counting the number of visible tooth cement incremental lines and adding the result to the assumed age of tooth eruption. Manual line counting, however, is time consuming, potentially subjective and the number of individual counts is insufficient for statistical evaluations.

Here a custom-made AutoTCA software is presented that allows automated evaluation of TCA images using Fourier analysis and algorithms for image analysis and pattern. It involves "line-by-line" scanning and the counting of gray scale peaks within a selected region of interest (ROI). Each scanning process of a particular ROI yields up to 400 counts, thus minimizing the potential error induced by manual line counting. This simple and time saving program can substitute manual counting and provides consistent and reproducible and user independent, unbiased results. In either case, however, reliability of

the results depends largely on the state of preservation of the analyzed material, the preparation, the choice of the thin section and image quality. These factors have to be standardized to get consistent and reproducible results.

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Body composition over the lifespan.

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Body composition is an important indicator of health status. Numerous methods are available to assess body composition that partition the human body into different components including fat, muscle and bone. Body composition during childhood is important in assessing adequate growth and nutrition, as well as risk for type 2 diabetes mellitus (T2DM) and obesity. Body composition assessment in middle age can inform us about chronic disease risk, while body composition in the elderly can provide useful information regarding frailty, sarcopenia, and osteoporosis. Data collected from the Fels Longitudinal Study over the past 80 years have been vitally important in documenting the nature of body composition change over the lifespan, particularly as it relates to health risk. Analyses of Fels Longitudinal Study data have documented significant sex differences in body composition during adolescence and shown how body mass index (BMI) alone is a poor estimator of adiposity during adolescence. A recent longitudinal analysis of data collected from 226 participants older than 60 years of age reveals significant age-related decreases in stature, weight, bone mineral density, sitting height, and fat-free mass in men. For women, there were significant decreases in stature, bone mineral density, and fat-free mass accompanied by significant increases in percent body fat, waist circumference, and BMI. These results indicate that there are significant sex differences and considerable variability in body composition changes associated with normal aging. An understanding of the nature of these changes will aid health practitioners in the assessment and treatment of individuals at risk for chronic disease.

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Craniometric variation at Tell el-Amarna: Egyptians or interlopers at the "Heretic King's" city?

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In the fifth year of his reign, the ancient Egyptian pharaoh Amenhotep IV

severed his ties with the traditional religious institutions, changed his name to Akhenaten to reflect his ideological shift, and moved his capitol to a "virgin" site situated in middle Egypt (Akhetaten); commencing the Amarna Period (1352-1332BCE). Occupied for a scant 15-20 years the modern archaeological site of Tell el-Amarna provides a snapshot of life in Egypt during the Amarna Period. This project uses craniometric data from 73 individuals excavated from the South Tombs Cemetery (STC) at Tell el-Amarna to address questions of the morphological and genetic diversity of the worker population at Akhetaten and identify the potential for immigration to the capitol city from areas outside of ancient Egypt. Preliminary data analysis suggests the Amarna sample is a highly diverse population. Discriminant function analysis failed to differentiate Amarna individuals based on gross cranial morphology, and only had middling success (9/18 individuals correctly classified) when facial variables were included, suggesting there are few defining "Amarna" cranial characters. Additionally, the coefficients of variation observed in the STC sample are greater than those for a pooled sample of Egyptians from the Badarian to Middle Kingdom, yet less than that observed for the pooled sample when an intrusive Greek sample is included. All of this suggests the inhabitants of Amarna came from throughout Egypt, not outside Egypt.

Microwear of *Cercocebus atys* from the Tai Forest: implications for inference of hard-object feeding in the fossil record.

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Early hominin gnathodontal morphology has been interpreted as a functional complex adapted for hard-object feeding. A recent study (Strait et al., PNAS 106: 2124-2129) proposed that *Australopithecus africanus* preferentially processed large (>10mm) hard objects using the premolars. It was further suggested on theoretical grounds that the premolars would possess a microwear signature distinct from that of the molars, and that premolar microwear pitting would be relatively slight. The sooty mangabey (*Cercocebus atys*) represents an ideal extant model against which to test this hypothesis owing to the species' habitual feeding on hard *Sacoglottis* nuts (>10mm diameter), its expanded P4s and thick molar enamel. Sooty mangabeys open these nuts using powerful postcanine bites. We examined microwear of the P4s and M1s of *Cercocebus* specimens collected from Tai Forest, Ivory Coast. We tested three hypotheses: 1) the "phase II" micro-

wear facets of P4 and M1 do not differ in microwear texture attributes, 2) microwear texture complexity – a variable known to identify hard-object feeders – is higher in *Cercocebus* than taxa which do not or only seasonally ingest hard objects, and 3) the narrow diet of the Tai mangabeys is reflected in reduced variance of microwear texture.

The microwear of P4 and M1 are statistically indistinguishable. In addition, sooty mangabeys have higher texture complexity than most other primates studied to date, including *Lophocebus*. Further, *Cercocebus* has relatively invariant microwear texture complexity, notably so compared to *Cebus apella*. These results suggest that feeding on large, hard objects leaves similar microwear patterns on premolars and molars.

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Mortuary rituals in the Early Holocene population of Lagoa Santa: The Harold Walter collection.

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The Lagoa Santa region in central Brazil has been excavated since the 1830's, providing dozens of human skeletons dated to the Early Holocene period. This collection is singular in terms of antiquity, degree of preservation and number of skeletons in the context of the New World. Based on this material a consensus was developed in which the mortuary practices of the region during this period were particularly homogeneous, consisting of primary burials in flexed position with rocks on top. Nonetheless, recent excavations undertaken at Lapa do Santo rockshelter documented diversified and far more elaborated mortuary rituals. Here, we re-evaluate the skeletal remains from the Harold Walter collection that was gathered by the homologous archaeologist between 1930 and 1950, to test whether they conform to the traditional paradigm or not. Specifically, we investigate the occurrence of modified human bones. The bones analyzed are commingled, representing at least 51 individuals based on skull count. We found 20 long bones and 3 diaphyses with cut off extremities diagnosed by multiple chopper marks at the sectioned margins of the bones. Regarding individual bones, at least 3.07% of the humerus, 2.53% of the femurs and 3.50% of the tibiae have extremities cut off. In addition, four cranial vaults (7.84%) show multiple green fractures. These results show that body manipulation did occur, attesting that the mortuary practices in Lagoa Santa were not simple and homogeneous. The exact extension of body manipulation in Lagoa Santa deserves further investigation including

analyses of ochre, defleshing marks and spiral fractures.
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Collagen fiber orientation heterogeneity (CFO-Het): evaluation of this new characteristic in antler, primate, and non-primate bones shows that it does not correlate well with load history.

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High toughness of antler correlates positively with collagen fiber orientation heterogeneity (CFO-Het). CFO-Het, a largely unexplored histomorphological characteristic, is potentially useful for interpreting load history, and its degradation could contribute to compromised bone quality in aging humans. We compared the degree of antler CFO-Het with various primate and non-primate bones to test the hypothesis that CFO-Het is highest in tension and shear regions. Deer antlers and various other primate and non-primate limb bones were embedded in methacrylate, milled to 100 μ m, and examined in circularly polarized light. CFO-Het is expressed as the full-width at $\frac{1}{2}$ maximum (FWHM) of the gray level histogram profiles. Non-antler bones were examined in compression(C), tension(T), and shear(S) (i.e. neutral axes) regions. Antlers showed mean FWHM of 50 mm. In non-antler bones, CFO-Het measurements (mm) are: (1) proximal chimpanzee femur: 43(T), 135(C), 83(S); (2) human fibula: 23(T), 25(C), 27(S); (3) deer calcaneus: 47(T), 115(C), 58(S); (4) horse radius: 31(T), 92(C), 44(S); (5) horse third metacarpal: 33(T), 49(C), 72(S). In contrast to our previous studies showing strong correlations of predominant CFO with prevalent strain mode, these results show that CFO-Het does not correlate well with these load histories. This reflects the fact that the non-antler bones can produce toughening mechanisms that are not well represented by CFO-Het, including: (1) secondary osteons with variations in size and/or population density, and (2) specific secondary osteon morphotypes that can accommodate a regionally prevalent/predominant strain mode. But CFO-Het might prove useful for interpreting load history in bones with few or no secondary osteons.

Using body mass to examine Georgia coast stratification and the transition to agriculture.

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Past studies have shown that the transition to agriculture caused a dramatic change in community organization. This study investigates whether populations

in the Georgia Coast demonstrate a change in the mean and variance of their estimated Body Mass Index (BMI) and if a shift in social stratification can be determined via individual values for BMI.

Six sites (n=69) dating to before the switch to agriculture (at 1150 A.D.) and one site (n=157) from after the transition were studied. ANOVA and F-tests were implemented to ascertain differences in the mean and variance of BMI. The results indicate that there is no significant difference across the transition (p-value=0.7602 for males, p-value=0.6547 for females). For females, the variance of BMI values appears different, however, no significance is shown (p-value=0.4512). For males, the spread of BMI values is dissimilar, however, a test demonstrates that there is no significant difference in variance (p-value=0.1976). Overall, for hunter-gatherers, the range of BMI values is more compressed around the mean while agriculturalists have a distribution with a larger range of values.

Although the means and variances, within each sex, are not significantly different between subsistence strategies, the distribution and concentration of values is apparent. Indicating that with this change in social stratification in populations there is also a change in access to resources and resulting body mass (for height). Therefore, the distribution of BMI can be used as a proxy for social stratification and the degree present in that society.

Challenges in approaches to skeletal stature estimation: an example from prehistoric eastern Mississippi/western Alabama.

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Stature is a widely reported bioarchaeological health indicator, viewed as a composite reflection of childhood disease and nutritional experiences. Its determination and subsequent interpretation, however, are not always straightforward, being highly dependent on the formulae and/or bones used. Our case study involving prehistoric populations from the Tennessee-Tombigbee Waterway in Mississippi and Alabama illustrates this issue. A total of 154 burials from four Late Woodland sites and 191 burials from five Mississippian sites were considered. Previously published stature data were used, and stature was also recalculated employing several different formulae sets. Results of formulae using various combinations of bone elements were analyzed as well. Estimated statures were then compared by time period, region, and site size.

When only published data were evaluated, no consistent differences appeared for either sex using any organizing criteria. When a consistent method of stature determination was applied, however, trends did emerge. Using the formulae of Sciulli and Geissen (1993), male stature consistently increased over time whereas that of females peaked both during the Late Woodland and Middle Mississippian. A somewhat parallel pattern was seen when the formulae of B. Auerbach and Ruff were applied (2010), but individuals were somewhat taller and some of the differences approached statistical significance. Results, and thus interpretations, also varied depending on the particular bones used to estimate stature. Overall, these findings suggest that comparison of stature estimations must be made with great care at best, and perhaps maximum lengths of individual bones should be the variable analyzed whenever possible.

Sunning: A behavioral response to seasonal climatic change in South African vervet monkeys.

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Our understanding of the physiological and behavioral mechanisms of torpor in primates has largely focused on lemurs. Gray mouse lemurs are known to undergo physiological torpor in response to differences between skin and ambient temperature and also in response to seasonal changes in precipitation. Similarly, ring-tailed lemurs cope with cold temperatures by spending time basking in the sun. Recent work has indicated that other small-bodied primates in similarly temperate climates may also be capable of undergoing torpor.

Behavioral observation data was collected from two free-ranging vervet monkey troops in South Africa from April-July of 2010. We observed that during the shift from autumn to winter, both troops began to sunbathe for considerable periods in the early morning. On particularly cold mornings, entire troops were easily identifiable because individuals would cluster and perch on the forest edge or come to the ground, often sitting with their arms and legs opened up to face the sun. We examined potential links between sunbathing observation and climatic factors such as temperature, dew point, humidity, and precipitation to determine if sunning behavior was a response to seasonal climate changes. Vervets were observed sunning on days with cooler low temperatures ($F_{1,44}=30.49$, $p<.001$), less

humidity ($F_{1,44}=4.56$, $p<.05$), and lower dew points ($F_{1,44}=35.78$, $p<.001$). These data suggest that like ring-tailed lemurs, vervet monkeys in temperate areas cope with seasonal climatic changes by limiting their activity and sunbathing. Further data is needed to understand if vervets also use physiological mechanisms for coping with seasonal climatic fluctuations. This research was supported by NIH R01RR016300.

Mobility and function of the human foot during shod and barefoot walking.

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The foot is one of the key structures for assessing mobility and locomotor mode in hominins. Numerous adaptations in the foot and throughout the body have been related to the emergence of habitual bipedalism (for early hominins) and to its further fine-tuning toward highly efficient walking and endurance running (in *Homo*). Assessing form-function relationships in the foot relies heavily on insights from extant analogues. In the case of the modern human foot, the very recent habitual use of footwear might be a confounding factor obscuring natural form-function relationships. Additionally, experimental data on humans have typically been collected on artificial substrates.

We compared walking between native barefoot walkers and shod walkers, and we compared walking on an artificial (hard) and natural (softer) substrate – both walking barefoot and using ethnic (South Indian) footwear. Our results indicate that the use of footwear has an impact on the shape of the foot and on specific functional aspects, i.e. plantar pressure distribution. The effect of substrate (hard vs. softer) and footwear (barefoot vs. ethnic footwear) on biomechanical measures (impact acceleration, ankle kinematics, muscle activity) was more subtle than expected. We suggest that using native barefoot subjects on a natural substrate yields the most relevant results when assessing foot function in modern humans in a comparative context.

Assessing the population history of the Orkney Islands using phenotypic and genetic perspectives.

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Use of dermatoglyphic data in population genetic studies has a longstanding history in anthropology (Jantz et al., 1992, Jantz, 1997, Sokal et al., 1996). These phenotypic data have often been

used as an estimate of genetic relatedness between groups, despite suggestions that this may be misleading (Ousley, 1997). Given that certain dermatoglyphic characteristics such as ridge counts have been shown to be effectively selectively neutral (Jantz, 1987), these data should reflect population history in the same manner as genetic data.

The data were first applied to the question of variation between individuals from the Orkney Islands and individuals of British, Norwegian, and Breton nationality to determine if known ancestral connections between these populations are evident phenotypically (Roberts, 1985). Ridge count data, consisting of 20 variables representing 1194 individuals from the four groups were analyzed using principal components analysis and Mahalanobis distances.

In order to determine if utilizing a phenotypic distances would produce a significantly different result than using a genetic distances, the same populations were compared on the basis of ABO and MN blood groupings, as these are more tightly genetically controlled. A Mantel test was then applied to the results of both analyses in order to assess the difference between the two approaches. Preliminary results indicate that there is a difference between analyses conducted using phenotypic distances versus genetic distances, but that the differences do not strongly alter the conclusions ultimately drawn from the analyses.

Human variation in the periosteal geometry of the lower limb: Physique, biomechanics, and morphological integration.

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Behavioural influences upon human diaphyseal morphology are well documented, while variation in body size and shape is also known to influence diaphyseal morphology, particularly in the proximal limb. However, relatively little is known about the relationship between ecogeographic variation in body shape and the variation in diaphyseal strength parameters throughout the limb. This paper uses a new method to quantify shape variation throughout the length of the limb, testing the prediction that physique has a greater influence proximally, while behavioural biomechanics will have a greater influence distally.

Diaphyseal strength of the femora and tibiae was assessed among a range of hunter-gatherer populations, using a 3D laser scanning approach to extract cross-sectional biomechanical data from periosteal contours. The method quantifies periosteal size and shape parameters at 1% intervals along the length of

the diaphyses. The approach examines cross-sections as coordinate data and is fully automated.

Periosteal strengthening of the proximal femoral shaft is apparent in broader and heavier individuals and persists at least as far as femoral midshaft. Correlations between physique and geometric properties are strongest at proximal femur, but rise towards proximal and distal ends of femora and tibiae, a minimum is reached around tibial midshaft. This may represent the best location to investigate variation related to mobility. Variation in location of minimal cross-section strength merits further investigation.

This whole-limb approach may allow further isolation of behavioural signatures in long bone geometry and may refine our understanding of the processes causing variability in long bone shaft morphology.

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Human Leukocyte Antigen system: immunogenetic and population genetic analyses of three Ecuadorian populations.

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Due to its long exposure to infectious diseases, the human genome tends to be gradually modified through natural selection, especially at level of the Human Leukocyte Antigen (HLA) complex. The aim of this study is to explore HLA DQ variability in three northwestern Ecuador populations (Cayapas Amerindians, Taschilas Amerindians and Afro-Ecuadorians). Two HLA class II loci (HLA DQB1 and HLA DQA1) of 263 unrelated individuals have been analyzed. HLA high-resolution molecular typing was performed by direct sequencing (Sequence Based Typing, SBT). Differences in HLA DQ gene frequencies have been observed among the ethnic groups of the Ecuadorian population. The comparison among populations shows the key role of several HLA DQA1 alleles in susceptibility and protection to several disease. Interestingly, the allele DQA1*0401 is negatively associated with onchocerciasis, an infectious disease prevailing among Cayapas and Afroecuadorians, living the same onchocerciasis hyper-endemic environment. In order to test the human population relationships, worldwide reference populations have been selected to compare the HLA allelic pool by several phylogenetic methods. The compiled worldwide database finely resolved in different basal clusters with very high bootstrap values corresponding to four

geo-ethnic groups of Africans, Asians, Americans and Europeans, strengthening the findings revealed by other markers as mtDNA and Y-chromosome. Some misplacements may be epidemiologically explained: this double approach confirms that the HLA system is a valuable tool to explore both immunogenetic differences and genetic relatedness among populations, improving the informative role of such genetic systems in understanding the recent history of our species.

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Body size and stature estimation based on the first metatarsal in humans.

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Archaeological assemblages often lack complete long bones needed to estimate stature and body mass. The most accurate estimates of body mass and stature are produced using femoral head diameter and femur length. Foot bones, although frequently absent or disassociated from the rest of the skeleton, preserve relatively well in a range of archaeological contexts.

In this paper we present regression equations using the first metatarsal to estimate femoral head breadth, body mass and femur length in a diverse human sample. The skeletal sample comprised 87 individuals (Andamanese, Australasians, Africans, American Natives and British). Results show that all first metatarsal measurements correlate with femoral head diameter and length. The proximal articular dorso-plantar diameter yields the most accurate predictions of both femoral head diameter and femur length. Percent standard errors of the estimate are below 5%. Equations using two measurements show a small increase in accuracy. No direct predictions are made for stature due to the varied body proportions represented in the sample. Direct predictions of body mass have an error just over 7%. The equations were tested on a sample of 35 individuals from Christ Church Spitalfields. Percentage differences in estimated and measured femoral head diameter and length were less than 1%.

This study demonstrates that first metatarsals can be used in the estimation of body mass and stature. The equations presented here are particularly useful for assemblages where the long bones are either missing or fragmented and enable estimation of these fundamental population parameters in poorly preserved assemblages.

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Craniodental remains of *Australopithecus sediba* from Malapa, South Africa.

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Recent work in the ca. 1.95 Ma fossiliferous deposits at the site of Malapa, South Africa, has revealed two partial skeletons that we have assigned to a new taxon, *Australopithecus sediba*. The two skeletons are of a juvenile male and an adult female. The former is represented by a relatively complete cranium and mandible, and the latter by a mandible and isolated maxillary teeth. In this paper we undertake a detailed comparative examination of the craniodental morphology of *A. sediba* in relation to other hominin specimens, with the goal of assessing its taxonomic and phylogenetic relationships. The skull of *A. sediba* indicates that cranial reorganization preceded brain enlargement, and that post-canine dental reduction occurred independent of cuspal rearrangement. *A. sediba* shares a suite of characters of the cranium, face, mandible, and teeth with the australopiths, in particular *A. africanus*. At the same time, *A. sediba* presents a constellation of cranial characters that align it with specimens commonly assigned to early *Homo*, highlighting the intermediate nature of this taxon. In fact, *A. sediba* shares more derived characters with *Homo* than any other australopith taxon known. We hypothesize that *A. sediba* represents the ancestor of the genus *Homo*, or else a close sister-group to that ancestor, that arose from *A. africanus*. Additionally, the combination of primitive and derived characters in *A. sediba* prompts us to reconsider the taxonomic status of other craniodental remains in Africa, in particular specimens considered to represent early members of the genus *Homo*.

How relaxed selection contributes to the evolution of complexity.

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Although biologists have long recognized examples of regressive processes in evolution as well as a role for regressive processes in the development of brains, research interest tends to focus on presumably constructive and progressive processes under the influence of natural selection. Particularly in the case of human brains and their evolu-

tion, it is generally assumed that the neurological differences underlying the complexity of human language abilities must have arisen due to progressive improvements of function via selection favoring these traits. In this talk I will explore an alternative possibility: that devolutionary loss-of-function due to reduced selection, including degradation of developmental-genetic specificity, may contribute to the evolution of novel complex neural functions, such as language. The general logic of this argument originates from a critique of a commonly cited evolutionary mechanism: the Baldwin Effect. Song production in a domesticated species of finch, not bred for singing illustrates a reversal of the Baldwin effect and its paradoxical consequences: increasingly complex song structure, expanded involvement of forebrain mechanisms, greater flexibility of behavior, and a larger contribution from social learning. This is compared with other related examples to demonstrate how regressive evolutionary processes might play an important role in the evolution of biological complexity more generally.

The functional morphology of the metacarpophalangeal joint surface of hominoid manual phalanges.

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Many of the most fundamental and still unresolved questions in paleoprimateology stem from our limited understanding of the evolution of primate locomotor behaviour. Phalangeal morphology is routinely used to infer fossil primate positional behaviour and locomotor adaptations. While it is widely accepted that shaft curvature is an adaptive response to the habitual stresses of locomotion, relatively little is known about the functional morphology and scaling relationships of phalangeal articular surface area and shape. Given that manual phalanges are in repetitive direct contact with substrates, and that discrete locomotor behaviours are characterized by unique phalangeal orientations with dissimilar patterns of mechanical loading, it is reasonable to predict that proximal articular surface area and shape are a response to locomotor-specific patterns of mechanical loading. This study employs 3D shape analysis to test the hypothesis that anthropoids with metacarpophalangeal joints experiencing higher compressive loads (i.e. knucklewalkers, quadrupeds) will have proportionately larger joint surface areas and a surface morphology that resists mediolateral joint displace-

ment (i.e. greater mediolateral surface curvature). Surface areas were obtained from 16 anthropoid genera (n=200) with diverse locomotor adaptations, and comparisons of articular surface area and shape were made between discrete locomotor groups. Contrary to predictions, taxa with hand postures characterized by increased compressive loads do not have proportionately larger surface areas. Articular surface shape (i.e. mediolateral and dorsoventral curvature), however, varies among discrete taxonomic groupings (i.e. hominoids vs. cercopithecoids and ceboids) as a consequence of phylogeny, but also within individual groupings according to locomotor adaptation and hand posture.

Pleiotropy and coevolution among characters of the anthropoid canine honing complex.

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Among anthropoid primates, a previous assessment of interspecific correlations between maxillary canine height and mandibular premolar honing facet length suggested that a significant correlation exists for males but not for females. This was interpreted as evidence for the selective importance of honing function in males and its relative unimportance in females. In this study, patterns of interspecific correlation, using phylogenetically independent contrasts, were examined for mandibular and maxillary canine heights and mandibular premolar honing facet length in males (n=37 taxa) and females (n=38 taxa). Regardless of the method used to reconstruct branch lengths, significant correlations exist among all elements of the complex in both males and females. Additionally, 5 samples of males (*Gorilla gorilla*, *Pan troglodytes*, *Cercopithecus nictitans*, *Cercopithecus cephus*, *Hylobates lar*) and 6 samples of females (*G. gorilla*, *P. troglodytes*, *Colobus satanas*, *C. nictitans*, *H. lar*), for which sample sizes exceed 20 for all character pairs, were examined for intraspecific correlations among the characters of the honing complex. In all male and female samples, maxillary and mandibular canine heights are significantly correlated with one another and each is correlated with premolar honing facet length. These correlations remain significant when accounting for the size of the postcanine dentition using partial correlations. Characters of the canine honing complex are linked by pleiotropy and form a unique module within both the female and male anthropoid dentitions. In both males and females, characters of the canine honing complex have coevolved because selection acted upon a pleiotropically-associated set of characters.

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The need to account for pelvic size when examining pelvic dimorphisms.

HILLARY DELPRETE. The College of New Jersey.

Although there is a general consensus that the pelvis of males and females differ, thereby making the pelvis an excellent source for sex identification, there is some disagreement in the literature on the existence of sexual dimorphism of some traits (Tague 1992). It is likely that some of this disagreement stems from the lack of data adjustment for body and/or pelvic size and perhaps, the lack of consistency of this adjustment. For this study, pelvic data was collected from the skeletal remains of 239 individuals from the Hamann-Todd Skeletal Collection in order to determine if data adjustment affects the presence of sexual dimorphism of pelvic measures. The presence of sexual dimorphism was compared for the same individuals using both unadjusted data and data adjusted for pelvic size. Based on the results of the t-tests, adjustment of the data can have a profound effect on which variables appear sexually dimorphic. The following measures were affected by data adjustment: anterior space of the inlet, transverse diameter of the inlet, linea terminalis, anteroposterior diameter of the midplane, anterior space of the midplane, anterior space of the outlet, inter-acetabular distance, pelvic breadth, sacral breadth, length of the superior pubic ramus, inter-iliac breadth, and circumference of the inlet. Based on the way that these dimorphisms changed in conjunction with known shape differences between the sexes, using the size-adjusted values seems to provide a better understanding of pelvic sexual dimorphism.

Organizing, administering, and sustaining an open-access database, examples learned from PRIMO.

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Data in paleoanthropology are of many types: linear dimensions, landmark coordinates, images, surface and CT scans, strat-

igraphic and geographic locality information, taphonomic observations, specimen collection and life history information, bibliographic citations, and artifact dimensions, scar counts or mineralogy, among others. Beginning in 2000, Delson and NYCEP Morphometrics Group (NMG) colleagues have built PRIMO, the PRimate Morphometrics Online database, as an open source for metrical data supported by collection, specimen and related metadata (a term whose definition is controversial). Caliper data collected by Delson and others, mainly on extant and fossil cercopithecoids, were posted first, with landmark data collected by Microscribe added more recently. PRIMO is thus rare among databases in our field in providing original metrical data, mainly unpublished, for other scholars to employ in their own research. About 8000 individual specimens and over 600 linear measurements and landmarks are included. Most data are open access (following an emailed request for a login password), but some may be restricted by the collector to a subset of individuals granted access while primary research is ongoing; non-NMG researchers may deposit data. Geographic and stratigraphic data are being prepared for inclusion, as are scan data (which may require host institution permission). We are working with such hosts to reduce their restrictions on access and also with the coordinators of other databases to facilitate searches via an integrating "portal". Funding for PRIMO has come through NSF grants supporting 3D research, which is aided by the ability for collaborators to access and exchange data online.

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An assessment of the impact of small samples on the reconstruction of hominin phylogeny.

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Due to the vagaries of preservation and recovery, the samples used in hominin phylogenetic analyses tend to be small. To date, it has been widely assumed that this is not a problem. However, a handful of studies carried out recently suggest otherwise. For instance, Cobb and O'Higgins (2004) reported unreliable estimates of ontogeny and allometry in *Pan* with less than 15-20 individuals. Here, we report a study designed to assess the impact of small samples on the accuracy of fossil hominin phylogenetics. Experiments were conducted on craniodental measurements of extant hominoids and two outgroup taxa, *Colobus* and *Papio*. Sample sizes were reduced (with random specimen selection) from the maximum per taxon to 20, 10, 5, 2, and 1 individual(s). The data were subjected to isometric and

allometric size correction methods. Then, phylogenies were reconstructed in TNT (Goloboff et al. 2008). We generated 10,000 bootstrap replicates for each sample size. Lastly, the impact of sample size was assessed by comparing the trees yielded by the reduced sample size datasets with the tree obtained from the full dataset.

Reducing sample size had a major impact on the topology of the most parsimonious tree obtained, and the effect increased as sample size decreased. By the time each taxon was represented by 2 individuals, the most parsimonious tree was significantly different from the most parsimonious tree yielded by the full dataset. Thus, the study suggests that small sample size may well be a significant impediment to the accurate reconstruction of fossil hominin phylogeny.

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Genetic influences on the age at menarche: new findings from genome-wide association studies.

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Menarche, the onset of first menstruation, signals the imminent attainment of female reproductive capacity and is a key developmental event. Age at menarche varies widely between girls and is dependent on nutritional status. Early menarche is associated with several adverse health outcomes, including breast cancer, endometrial cancer, obesity, and type 2 diabetes, and is also associated with shorter adult stature. Studies of twins and extended families have shown that ~50% of the variance in menarche timing is attributable to genetic factors, but the identification of specific loci has been slow. Since 2009, a number of large ($N > 30,000$) genome-wide association studies have had success in identifying numerous genetic loci associated with age at menarche. This lecture will review the current state of knowledge on the genetics of menarche and possible pleiotropic effects of the identified genetic variants on height, body mass, and other growth and health-related outcomes.

New insights on the health status of a pre-contact population from New Mexico: enamel hypoplasias in the permanent dentition of the Gallina.

LAUREN C. DENTON. Department of Anthropology, Colorado State University.

Linear enamel hypoplasias are used to examine the incidence of childhood systemic metabolic stress in the pre-contact

Gallina population from northern New Mexico during the Pueblo III period. The sample is from the Llaves-Alkali area in Gallina Country, and consists of the permanent anterior teeth from 26 individuals with a total of 121 teeth. The incidence of hypoplasias in this sample is high, involving 94.4 percent of the individuals and 65.3 percent of the teeth. The earliest onset of enamel hypoplasia in individuals occurs most commonly at 1.5-2.5 years, with a peak age at 2.5-3.0 years. All individuals, regardless of sex or age at death, express a similar age of metabolic disruption; no significant difference exists between the groups. However, a significant difference in hypoplasia frequency between males and females exists with males accounting for almost double the total number of hypoplasias observed in females. Compared to Anasazi populations during Pueblo III studied by Malville (1994; 1997) and Karhu (2000), the Gallina show a higher incidence of metabolic stress. No previous studies concerning dental disruptions on the Gallina have been published; the present work provides new insights into the past health status of this southwestern culture.

Isotopic signatures of diet from the Bronze Age, Iron Age, and Anglo Saxon period in Kent, UK: preliminary results.

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Dietary reconstruction from stable isotope ratios is increasingly reported as a way of inferring protein consumption in human diets from the past. This has provided insights into periods of cultural and economic change. Here we investigated carbon and nitrogen isotope ratios in human bone dating to the Bronze Age, Iron Age, and Anglo Saxon period in Kent, UK. Nitrogen and carbon stable isotopic studies for this region of the UK are under represented in the literature. Samples used here are from previously excavated archaeological sites, South Dumpton Down (2100 BC-100 BC) and Ozengell (500-700 AD).

Mean stable nitrogen and carbon isotope values were 10.64 (± 0.55) and -23.44 (± 0.56) for the Bronze Age, 9.19 (± 0.01) and -22.18 (± 0.09) for the Iron Age, and 9.16 (± 0.49) and -22.2 (± 0.33) for the Anglo Saxon period. Enriched nitrogen and slightly depleted carbon signals during the Bronze Age suggest a greater consumption of terrestrial protein and less marine resources, compared to the other periods. Ongoing research for this region during these periods will investigate stable isotope ratios and social status, sex, and religious transition.

Cercopithecus mitis x *C. ascanius* hybridization in Gombe National Park, Tanzania.

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Most cases of hybridization between broadly sympatric species of *Cercopithecus* monkeys in the wild are rare and sporadic, and have little or no apparent, long-term phenotypic impact on the participating populations. An exception is the long-standing and very frequent hybridization between *C. ascanius* and *C. mitis* in Gombe National Park, Tanzania, where a significant proportion of all guenons are phenotypic intermediates. The Gombe population thus provides a unique opportunity to test for evidence of gene flow between two closely related sympatric primate species.

I surveyed the Gombe population and characterized animals from all parts of the national park phenotypically, and by using Y-chromosomal and mitochondrial DNA genetic markers. All Gombe guenons surveyed, including phenotypically normal *C. mitis*, carry mitochondrial haplotypes derived from *C. ascanius*, suggesting a past history of massive transpatric introgression via immigration and high reproductive success of male *C. mitis*. Y-chromosomal variation agrees with phenotype in the parental forms, while males with intermediate phenotypes have both *C. mitis* and *C. ascanius* Y-chromosomal haplotypes, indicating that males of both parental species cross-mate. The lack of evidence for Y-chromosomal gene flow between the two species suggests that male hybrids may have reduced fitness, supporting Haldane's Rule. This study provides the first genetic results from a *Cercopithecus* hybrid population and contributes to our understanding of the potential evolutionary outcomes of interspecific hybridization among sympatric primates.

This study was funded by the Wenner-Gren Foundation Individual Research Grant, Leakey Foundation General Research Grant, and National Science Foundation, Dissertation Improvement Grant Award.

Maternal perinatal diet alters offspring bone architecture: evidence for developmental programming of the skeleton?

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Is the fetal skeleton sensitive to its energetic environment? Maternal diet can induce developmental programming

of offspring metabolism, but potential skeletal effects are unknown. To test the hypothesis that maternal diet modulates offspring skeletal acquisition, we compared pups from female C57Bl/6J mice fed high-fat (HF, 45% kCal/fat) or normal (N, 18% kCal/fat) diet from 6 wks prior to breeding through gestation and lactation. We weaned 3-wk-old female pups from HF mothers (HF-N) and N mothers (N-N) onto N diet ad lib. Outcomes at 14 and 26 wks of age included body mass, body length, % body fat, total body bone mineral density (BMD), and cortical and trabecular architecture at midshaft and distal femur. At 14 and 26 wks of age, body mass, body length, and % body fat did not differ in HF-N vs. N-N. Total body BMD increased by 50% more in N-N vs. HF-N from 14-26 wks of age (+12% vs. +8%), suggesting maternal HF diet impaired skeletal acquisition. Midshaft femur cortical thickness was 6% lower in HF-N vs. N-N at 14 wks of age ($p < 0.03$). However, in the distal femur, trabecular bone volume fraction was 19-26% higher in HF-N vs. N-N at 14 wks of age ($p < 0.05$). These data suggest complex effects of maternal diet on offspring skeletal acquisition, perhaps via developmental programming. Female HF-N pups exhibit lower cortical bone mass, but higher trabecular bone volume vs. female N-N pups, suggesting maternal HF diet may impair postnatal cortical bone acquisition, but also slow age-related trabecular bone loss. This study was funded by NIH 1R01AR049265-01 (MLB), 1RC1AR058389-01 (MLB), and 5T32DK007028-35 (MJD).

The effect of social status on risks of mortality in Roman Dorset, England.

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Recent analyses have suggested that one of the consequences of the Roman conquest within the population of Dorset County, southwest England was an increase in health disparities in the Romano-British population compared to the earlier Iron Age population of the area. Average levels of frailty and the degree of heterogeneity in frailty might have increased post-Conquest for a variety of reasons, including increased status differences in housing (including house size and the use of plumbing) and diet. This paper contributes to an understanding of the health consequences of Roman Conquest in Britain by examining the effects of social status on risks of mortality in Romano-British cemeteries. This study uses a sample of 291 individuals from Romano-British cemeteries (dated to the 1st to late 4th centuries AD) in Dorset County. For

these analyses, burial type was used as a proxy for social status, and was modeled as a covariate affecting the Siler model of mortality. The estimated effects of the burial-type covariate suggests that being buried in a coffin (wood, lead, or stone) or a mausoleum was not significantly associated with elevated nor reduced risks of mortality during the Romano-British period in Dorset, when all ages are considered simultaneously. Therefore, these analyses did not reveal a significant difference in risks of all-cause mortality between individuals of higher and lower status in this population. Further analyses will reveal whether the association between burial type and mortality risk varies by age, sex, or across cemeteries. This study was funded by the University at Albany Research Foundation, the University at Albany Center for Social and Demographic Analysis, the University of Birmingham, and an Ian Horsey Award from Dorset Natural History and Archaeological Society.

Interbirth interval, age at dispersal, and sexual dimorphism in wild titis (*Callicebus discolor*) and sakis (*Pithecia aequatorialis*).

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Much of what we know of group composition and demography of wild titis and sakis comes from surveys and limited long-term studies of groups living in human-impacted landscapes. Few long-term field studies of these pitheciins have been conducted in primary tropical forests, where the ecological community (including other primates and possible predators) remains intact. Since 2003, we have collected demographic and morphometric data from individuals in several groups of wild titis and sakis in Yasuni National Park, Ecuador. Here, we report data on group composition, interbirth interval, birth seasonality, age at inferred dispersal, and sexual dimorphism based on captures and regular observations of individually-recognized animals.

Both titis and sakis lived in socially-monomogamous groups comprising a single adult male-female pair and up to 2-3 young. Interbirth intervals for titis averaged ~12 months ($n = 6$ offspring, 3 each born to two females in different groups) while for sakis averaged ~21 months ($n = 4$ offspring born to a single female). Titi births were more seasonal than saki births, concentrated between November and February. Inferred dispersal age ranged from 2.5 to over 5 years for titis ($n = 4$), while one saki was observed to disperse successfully at the high end of this range. Sakis were moderately sexually dimorphic (males ~25-40%

larger than females) while male and female titis were more similar in weight. Differences in life history and sexual dimorphism in these taxa may reflect variation in the factors underlying the evolution and maintenance of social monogamy.

This research was funded with grants from the National Geographic Society, the Leakey Foundation, and the Wenner-Gren Foundation.

Standardizing Paleolithic stone tool analysis: perspectives and prospects.

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Though there is a well-developed literature on techniques of stone tool analysis, there remains a tremendous amount of variability in terms of how stone tool collections are excavated, stored and analyzed. Variation in standards is apparent at every step of the descriptive and analytical process, from determining which artifacts are included in analyses (usually based on size), which measurements or observations are taken and how, and even how descriptive categories (i.e., types) are defined and presented. While other paleoanthropological disciplines have successfully dealt with these issues, published analyses in lithic studies vary considerably from one researcher to another, and in turn this means that comparing results among various researchers is extremely limited, if not impossible. In part to address these issues, the authors have, over the past twenty years, attempted to develop a set of excavation methods linked to specific taphonomic and stone tool analysis goals and designed to facilitate inter-site comparisons. These methods have now been applied to a series of Middle Paleolithic sites in France and this has resulted in inter-site patterns that have not previously been recognized. The larger problem still remains, however: how to encourage the development of standards that are accepted and used by the wider community of researchers. Until this is achieved, progress in this field based on scientific observation, predictive testing, and replicability is limited, and so too is any understanding of prehistoric behavior based on lithic remains.

Supporting evidence for a genetic component in the etiology of Mx.C.P1 transposition in a Rwandan sample from Africa.

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In 1963, Jacques Nenquin and his team excavated 91 human burials in Nyirankuba cave near Ruhengeri, Rwanda. Inhumations, pottery, iron tools, beads,

and animal bones were excavated and date from the Iron Age into more recent times.

Three of the 91 individuals (3.3%) from Nyirankuba cave display atypical maxillary tooth order, i.e., maxillary-canine-first premolar transposition (Mx.C.P1). Mx.C.P1 transposition is a reversal in position of the maxillary canine and first premolar. The dental anomaly has recently received increased attention in anthropological and clinical research in an attempt to shed light on the etiology of the condition. Prevalence of this anomaly in the modern, general population is estimated at less than 1%. Previous anthropological and clinical studies suggest that the etiology of Mx.C.P1 is at least partly genetic in expression, and in some isolated archeological populations is attributed to inbreeding. These conclusions are based on its high frequency in females and individuals with Down Syndrome; it is characterized by unilateral left-sided dominance, multiple cases in familial pedigrees, a high frequency in some small isolated archeological populations, and an increased prevalence of associated anomalies including tooth agenesis and peg-shaped maxillary lateral incisors.

The archeological cases reported here support previously published anthropological and clinical data that contribute to the growing body of evidence for a strong genetic component in the etiology of the Mx.C.P1 transposition anomaly. The high incidence rate of 3.3% among the collection is three times higher than expected, and may indeed suggest inbreeding in this potentially isolated population.

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Social learning in the ring-tailed lemur.

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Social learning allows for the rapid spread of novel behaviors and is a key component to understanding the evolution of culture. Although the complex cognitive abilities required for imitative social learning have been well documented in the great apes, relatively few studies have examined social learning capabilities in prosimians. The aim of this study was to determine if social learning occurs in a prosimian known for its sociality, *Lemur catta* (the ring-tailed lemur). Using a "puzzle box" with two distinct methods of being opened, a "demonstrator" was trained in using one of the two opening techniques. The demonstrator then opened the box mul-

iple times in the presence of fellow group members. The subjects were then individually tested to determine if they were able to open the box, and by which method. If subjects consistently opened the box using only the method they observed, it would be indicative of social learning occurring by the process of imitation. Controls were presented the box with no previous exposure to a demonstrator. Overall we found that subjects significantly outperformed controls in their time to solve the box ($p < 0.05$, Mann-Whitney U Test) and successful solvers replicated the method demonstrated to them 100% of the time ($p < 0.01$, Fischer's exact). These results support our hypothesis that lemur social learning occurs through imitation, suggesting higher cognitive functioning in prosimians. Such findings call for a broader investigation of imitative capabilities of prosimians and other primate species.

This study was funded by the Duke University Undergraduate Research Support Office.

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

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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 behavior in a primate species.

This study was funded by the American Society of Mammalogists, International Primatological Society, and Sigma Xi.

Phylogeny of primates based on muscular characters, with special attention to the relationships of hominoids and the phylogenetic position of *Tarsius*.

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In this presentation we report the results of the first comprehensive cladistic analysis based on muscular characters that addresses the relationships among the major groups of living primates and taxa such as tree-shrews and colugos. This analysis is based on information obtained from a review of the literature and from dissections of more than 50 specimens of various primate and non-primate taxa. The genera included in the analysis were: *Rattus*, *Tupaia*, *Cynocephalus*, *Lemur*, *Propithecus*, *Loris*, *Nycticebus*, *Tarsius*, *Callithrix*, *Pithecia*, *Aotus*, *Saimiri*, *Macaca*, *Papio*, *Cercopithecus*, *Colobus*, *Hylobates*, *Pongo*, *Gorilla*, *Pan* and *Homo*. The analysis was based on 208 characters concerning the head, neck, and upper limb muscles of these taxa, using Nona & Winclada 2002. The relationships among the taxa in the most parsimonious trees obtained ($L=382$; $RI=0.53$; $CI=0.65$) largely conform to those supported by recent molecular studies: the Primates, Strepsirrhini, Lemuriformes, New World monkeys, Old World monkeys, the subfamily Cercopithecinae and the Hominoidea are monophyletic groups, and there is strong support for the following relationships among hominoids: [*Hylobates*, [*Pongo*, [*Gorilla*, [*Pan*, *Homo*]]]]. Our study revealed that, regarding its muscles, *Tarsius* is one of the most peculiar primates, displaying some plesiomorphic (e.g., the presence of a distinct muscle spinotrapezius) and derived (e.g., the presence of two series of contrahentes in the hand and of the facial muscle zygomatico-auricularis) features that are rarely seen in other living primates. We will examine the phylogenetic and evolutionary implications of these results, and discuss the use of myological, molecular and osteological characters in phylogenetic reconstructions.

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Enamel microstructure and molar development in *Leptadapis magnus*.

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Leptadapis magnus is a large adapine primate from the Eocene of Europe with dental adaptations for folivory. We examined dental microstructural characteristics and the timing of its molar formation in histological thin sections, including M₁-M₃ from a single individual, using conventional polarized light microscopy. We used data from the Eocene notharctine species *Cantius abditus* and two extant strepsirhines as a comparison. Daily cross striations and striae of Retzius were used to determine daily secretion rate (DSR), enamel extension rate, and the timing of crown formation. We examined enamel microstructure using SEM and confocal microscopy. Enamel thickness was measured using synchrotron microtomography.

L. magnus is characterized by very thin enamel and extremely weak prism decussation, surprising considering its large body size. Mean DSR is 3.7 microns, slightly higher than in *Cantius*. A potential neonatal line was identified in the M₁, based on its similarity to the position of neonatal lines identified in the extant strepsirhines, as well as several specimens of *C. abditus*. The M₁ crown was complete at age 6.7 months and probably erupted before one year of age. Prenatal enamel extension rates in the M₁ were almost 12 microns a day, dropping abruptly to just over five microns a day at the neonatal line, then increasing again toward the cervix of the tooth. There appears to be extensive overlap in molar formation, typical of folivores, lending support to this reconstruction of dietary adaptation in *Leptadapis*. Thin enamel and weak decussation can also be interpreted as an adaptation to folivory.

This study was funded by the Royal Society and the French Ministry of Research.

Does a house full of bones equal a massacre? Testing assumptions of violence in the Texas panhandle.

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The Footprint Site in the Texas Panhandle was excavated in 1964 by F.E. Green and has become a common reference for inter-

personal violence or massacre within the Antelope Creek Focus in Texas Prehistory. The commingled remains of a minimum of thirty-two individuals were discovered within one of the three structures at this site along with a pit of ten skulls. This site is unique in that among the fifty plus sites excavated within the Texas Panhandle and western Oklahoma for the Antelope Creek Focus, this is the only one with evidence of possible extreme interpersonal violence.

Analysis consists of current osteological and forensic methods to evaluate perimortem and postmortem fracture patterns, burn pattern analysis and taphonomic alteration of the remains. Preliminary findings indicate that the assumptions of violence at this site are most likely false. Although excavation and curation problems make estimation of actual events at this site impossible, cultural associations of mortuary practice may be possible if the assumption of violence is dispelled.

In addition to the question of violence in the Antelope Creek Focus, cultural affiliation with the Southern Plains Villagers and/or the Southwestern Cultures has long been an enigma for this site. Assemblages of remains such as those found at the Footprint Site have been documented in Southwest sites, however the evidence of violence at those sites is yet to be found at Footprint. Burials within structures and subsequent abandonment have been documented in the Southern Plains, suggesting a possible cultural affinity with the Footprint Site. This study was funded by Termini Graduate Student Research Grant 2010.

Co-evolution of facial expression and brain size: a test of the visual specialization hypothesis.

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It has been suggested that primates with more specialized visual systems tend to have relatively large brains due to selection for enlarged cortical visual processing areas. This "visual specialization hypothesis" is supported by several comparative studies. However, the behavioral bases of these co-evolutionary patterns remain unclear. If the visual specialization hypothesis is correct, then variation in visually-oriented behaviors should correlate with variation in brain size. The purpose of this study is to test this prediction by examining the co-evolution of facial expression complexity and relative brain size in extant anthropoids.

Facial expression complexity is a function of facial mobility, or the number of visually distinct facial movements a species can produce. Data on facial mobility are currently available for 12 species. These data were combined with published estimates of endocranial volume and body mass. Phylogenetically-informed partial correlation analyses were used to examine the association between facial mobility and endocranial volume after controlling for body

mass. Male and female data were analyzed separately.

The results of this study provide broad support for the visual specialization hypothesis. Facial mobility is positively correlated with endocranial volume after controlling for body mass in males (partial $r = 0.65$; $p = .031$). However, females do not exhibit a significant partial correlation between facial mobility and endocranial volume (partial $r = 0.10$; $p = .396$). These findings suggest that male, but not female, brain size evolution is influenced by selection for facial expression processing.

Evidence challenging the Pleistocene origin of yaws: A reexamination of KNM-ER 1808.

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The use of paleopathology in the archaeological and paleontological record can be a way to understand the evolution of diseases as well as the behavior and culture in human and non-human primates, however it can be overlooked and possibly underreported when it comes to the human fossil record. The *Homo erectus* partial skeleton, KNM-ER 1808 is an exception because it exhibits a bone pathology not seen in other Plio-Pleistocene hominids. Walker et al. (1982) concluded that this individual suffered from chronic hypervitaminosis A, while Rothschild et al. (1995) states that KNM-ER 1808 exhibits the oldest case of the treponemal infection yaws in prehistory, which is up for debate because it may not be possible to differentiate between the treponemal infections in isolated skeletons.

Casts, x-rays, and photographs of KNM-ER 1808 were compared to the paleopathological literature to refute Rothschild et al. (1995). The treponemal diseases often show lesions on the frontal bone and anterior tibial bowing. This study compared the bowing angle of the tibia from a population of non-diseased modern humans, modern humans suffering from the treponemal diseases, and KNM-ER 1808. Examination of KNM-ER 1808 indicates that this nearly ubiquitous anterior bowing is absent. This suggests that KNM-ER 1808 probably did not suffer from a treponemal infection 1.6 MYA. Genetic evidence also supports a more recent origin for yaws. Hypervitaminosis A, does not have a large or accessible sample size to compare, therefore it cannot be excluded based on this research.

The interplay between mobility, body size and prey capture in living and extinct *Canis*.

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Limb length affects locomotor efficiency and distance traveled per step, an im-

portant component of mobility in mammals with large home ranges. Many Pleistocene and some extant mammals in cold climates have relatively short limbs, a pattern usually attributed to thermoregulation. This potentially compromises efficiency. Limb length also influences bone strength. This study considers the relationship between limb length, ambient temperature, and bone strength in living and fossil *Canis* across a range of body size and localities. We propose that limb shortening in *Canis* is a mechanism to increase bone strength by reducing bending moments in animals hunting large prey. To test this, we calculated the scaling of bone length and diameter and body mass. Results show that for extant *Canis*, there is negative allometry (femur: 0.70; tibia: 0.79) of bone length on body mass, whereas, bone strength is isometric relative to body mass. When dire wolves are included, they fall only slightly above the regression lines of bone diameter on body mass, but significantly below the line for bone length on body mass, meaning that they are increasing bone strength primarily through shorter bones. Carnivores hunting large prey may experience high forces during prey capture. Dire wolves were specialized hunters of Pleistocene megafauna living in a mild climate. Dire wolves appear to compromise locomotor efficiency in exchange for greater bone strength needed for prey capture. These data demonstrate clearly the multiple influences on limb length in mammals and argue against a simple relationship between limb length and mobility.

Secular change in the asymmetry of the human pelvis: 1842-1981.

KATHRYN DRISCOLL. Department of Anthropology, University of Tennessee.

The change that the human pelvis has experienced over time is of great interest in anthropology. In a preliminary study, the pelvic asymmetry of the William M. Bass Donated Skeletal Collection was analyzed. The current research expanded on this preliminary study and examined whether the asymmetry in the height and breadth of the ossa coxae followed a secular trend. The ossa coxae of individuals born between 1842 and 1981 were used in this study. Skeletons from the Hamann-Todd Osteological Collection and the Robert J. Terry Anatomical Skeletal Collection in addition to the Bass Donated Collection were utilized; 636 ossa coxae pairs were used in the analyses. Five birth cohorts made up of equal numbers of male and female, black and white individuals were digitized, 3D coordinates were collected, and measurements were calculated. Directional asymmetries were also calculated for each individual.

After examining each cohort for pelvic asymmetry, the black males and females exhibited the least amount of bilateral asymmetry. In each, only one cohort exhibited statistically significant asymmetry. In the white males, the later cohorts (made up of individuals from the Bass collection) were more asymmetrical than the cohorts made up of Terry and Todd skeletons. In contrast to the white males, the white females were more asymmetric in the early cohorts. When asymmetry was present, it favored the left side in both height and breadth. Secular trends do seem to be present in the white cohorts in the breadth measurement with an increase in asymmetry.

Genetic and functional variation of primate *bmp5* enhancer region.

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Reorganization of the primate bauplan (e.g. changes to thoracic cage shape, scapular relocation, vertebral column invagination) has played an integral role in locomotor adaptations. A causal genetic and developmental link is lacking between bauplan changes and bipedal locomotion, a hallmark of hominid evolution. However, a genetic and developmental link has been demonstrated specific to the shape of the thoracic cage. Guenther et al. (2008) functionally defined a cis-regulatory sequence of bone morphogenetic protein 5 (*bmp5*) that modulates the protein's expression in mouse rib anlage and influences rib curvature. We PCR amplified, cloned, and sequenced the orthologous DNA sequence in several primate taxa including gibbon, squirrel and spider monkey which were previously unavailable publicly. We aligned these to orthologous sequences of chimpanzee, orangutan, rhesus monkey, the common marmoset, and mouse. Using Match, a program that predicts transcription factor binding sites and phylogenetic analysis, we traced the progression of putatively functional nucleotide substitutions in this *bmp5* enhancer throughout primate phylogeny that potentially alter transcription factor binding sites in key taxa including human, gibbon, and spider monkey. Among many conclusions, our analysis demonstrates that while there are species-specific nucleotide differences, the human, gibbon, and chimpanzee sequences share a core of predicted binding sites that is different from that predicted in monkeys and mouse (outgroup). This study demonstrates the power of experimental and bioinformatic approaches to fundamental issues in primate and human evolution and suggests future functional studies that may help decipher critical events in the

genetic and phenotypic evolution of the primate thorax.

Searching and extracting reports from the Osteoware database.

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A relational database is a collection of data organized for easy access and management. The database itself is composed of separate tables storing different types of data. Each table contains data elements (cells) organized by horizontal rows and vertical columns, and resembles a spreadsheet to the uninitiated eye. However unlike spreadsheets relational database tables can be joined and queried so that meaningful information can be extracted and used together. The Relational Database Management System (RDBMS) used in conjunction with Osteoware, Advantage Data Architect™, offers rich and useful features for searching and extracting the osteology data stored within. Querying the Osteoware database for optimal results requires some knowledge of Structured Query Language (SQL), a computer language designed for managing relational databases. Fortunately SQL is easy to learn. This presentation will provide a basic foundation and a hands-on opportunity to compose queries that will join tables and extract data that, in turn, will generate meaningful information that can be exported to a variety of formats, including HTML, .txt, .rtf, .csv, .dif, as well as Microsoft Excel and Word for report production. Osteoware is supported by grants from the National Center for Preservation Technology and Training (NCPTT) National Park Service, and the Smithsonian Web 2.0 Fund.

Distribution of synaptic markers in chimpanzee neocortical areas across development.

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In humans, the prefrontal cortex, which is important for executive cognitive function, shows a delay in its maturation compared to other cortical areas. The purpose of this study was to examine if there is a similar humanlike developmental pattern of synaptic function in chimpanzee neocortical areas

(primary somatosensory, primary motor, prestriate visual and rostral prefrontal) by measuring the expression of the pre- or postsynaptic marker proteins synaptophysin, synapsin I, SNAP-25, syntaxin 1A, and PSD-95. Western blotting was used to assess the relative levels of synaptic markers in different neocortical regions from postmortem samples of 20 common chimpanzees, from birth to adulthood. Results indicate that early in life (0-12 months group), visual and motor areas show the highest expression level of synaptic proteins relative to the other cortical regions. However, after 2 years of age, the prefrontal cortex has among the highest levels of synapse-associated protein expression. Because there is a similar pattern (i.e. increasing levels) and a significant overall correlation during chimpanzee development with all synapse-associated protein expression, these data suggest that changes are due to a common functional developmental regulation of synapses. However, the changes observed across development, especially later in life when the expression of localized synaptic proteins become distinct, may be due to specific developmental changes in each protein occurring independently of synaptic development. These results suggest that synaptogenesis and pruning occurs asynchronously in different cortical regions and that chimpanzee prefrontal cortex matures at a slower rate than other neocortical areas as observed in humans.

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Effects of incomplete nonsyndromic squamosal craniosynostosis on cranial shape in an archaeological specimen.

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Quantification of shape changes attributable to craniosynostosis is an increasingly important component of our understanding of this condition. Most clinical cases involve the sagittal or coronal sutures, however a recent case of nonsyndromic craniosynostosis of the left squamosal and sphenofrontal sutures has been identified. The calvaria was excavated from the site of Fort King George near Darien, Georgia, and exhibits mild plagiocephaly attributable to partial coronal and squamosal synostosis and complete sphenofrontal synostosis on the left side. The scarcity of cases of nonsyndromic craniosynostosis with squamosal involvement raises questions about its relative influence of premature sutural closure and overall shape. We collected 3-dimensional landmark data from the calvaria and a series of 668 skulls

unaffected by craniosynostosis. Coordinate data were subjected to a Generalized Procrustes Analysis, a Canonical Variates Analysis, and Discriminant Function Analysis. Results suggest a unique effect of squamosal involvement. The left side porion is displaced postero-medially with compensatory expansion of the right side pterion and antero-laterally. Left pterion and frontotemporale are drawn posteriorly with the latter also demonstrating medial displacement. Right frontotemporale is displaced antero-laterally while right pterion is displaced in a similar direction but to a lesser degree. Asymmetry is also severe in the posterior occipital region as in the anterior of the vault, which is contrary to expectations based on the pattern of sutural fusion. The relevant importance of timing of fusion during growth and degree of fusion are explored.

Energetics—not pelvic constraints—determine human gestation length and altriciality.

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The classic anthropological hypothesis known as the "obstetrical dilemma" or the "obstetric dilemma" is a well-known explanation for human altriciality—a condition that has significant implications for human social and behavioral evolution. The hypothesis holds that antagonistic selection for an increasing neonatal brain and a narrow, bipedal-adapted birth canal poses a problem for the mother; the hominin "solution" is to truncate gestation, resulting in an altricial neonate. This explanation for human altriciality persists despite data linking human life history to that of other mammalian species, encephalized or not, adapted for unique locomotion or not, including cetaceans and sirenians which lack bony birth canals. Here we present evidence that challenges the importance of pelvic morphology and mechanics in the evolution of human gestation and altriciality. Instead, our analyses indicate an energetic constraint on human gestation length. Furthermore, comparative data across mammals demonstrate that human gestation length is determined by primitive mammalian energetic and metabolic constraints on gestation and fetal growth. Although pelvic remodeling during hominin evolution contributed to the present parturitional difficulty, this has not altered timing of parturition. If the human reproductive system poses a dilemma between competing needs, then fetal energy needs and maternal energy supply are the competitors, not encephalization and bipedalism. Thus human neonatal altriciality is not a solution to a

mechanical dilemma; it is simply an outcome of our constrained physiology.

CT scanning of the Willandra Lakes fossil hominids: progress and prospects.

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The human fossil sample from the Willandra Lakes, New South Wales, Australia, represents the largest collection of late Pleistocene human remains in the world. Approximately 100 individuals are represented in this sample, including the oldest known human burial in Australia, Lake Mungo 3. The Willandra Lakes Hominid (WLH) fossils are both the oldest and largest series of fossil remains that have not been repatriated to local Aboriginal groups for reburial. Thus, the WLH fossil series provides an invaluable resource for understanding the peopling of Australia and modern human origins in the region.

During May, 2010, permission was obtained from the Traditional Tribal Groups of the Willandra Lakes area for a series of CT scans to be made from the fossils. Eight of the most complete and important individuals from the collection were selected for the initial phase of the project, including Lake Mungo 3 and WLH 50.

We will discuss our progress as well as the manifold benefits and future prospects that stem from this ongoing project. First and foremost, CT scanning provides a digital archive of the fossils that can serve as a virtual "keeping place" for scientific access to the remains. We will also demonstrate how the application of "virtual anthropology" to this set of more fragmentary remains can help scientists better communicate the value of such remains to concerned indigenous communities who are often skeptical of our work.

Financial support for this project was provided by the Franklin Research Grant Program of the American Philosophical Society.

The changing role of genes in the growth and development of the skeleton.

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It is well accepted that skeletal growth and development are directed by both

genetic and environmental influences. The environmental envelope surrounding the developing skeleton obviously changes as a child is exposed to novel experiences (diet, exercise, etc.). Likewise, the genetic influences on the growth and development of the pediatric skeleton can change over the course of childhood. We examined the genetic underpinnings of measures of bone health (cortical thickness & biomechanical properties) in three cross-sectional samples of genotyped children participating in the Fels Longitudinal Study representing distinct stages of childhood development; at 3 years, 12 years, and 18 years of age. All analyses were conducted using a maximum-likelihood variance decomposition approach in SOLAR with age, sex, and skeletal age as covariates. Quantitative genetic analysis revealed significant heritability of bone measures at each of the three age groups. Heritabilities ranged from 0.47 (section modulus in the 12 year olds) to 0.82 (total cortical bone thickness in the 18 year olds). Suggestive linkages were identified for QTL on chromosomes 6q, 17q and 22p in the 3 year olds, on chromosomes 2p, 6p, 11p and 22p in the 12 year olds, and on chromosomes 1p, 6q, 7q, and 14q in the 18 year olds. Our results demonstrate that pediatric bone health is influenced by genes throughout childhood. And although some genomic regions appear to consistently influence bone health across ages, each developmental stage is also characterized by a genetic landscape unique to that time period.

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Preliminary results of activity-induced skeletal markers on proximal femora from the Bronze Age Tell Abraq tomb, U.A.E.

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Patterns of activity-induced skeletal markers within an ancient population shed light on the economic lifestyle when incorporated with archaeological findings. This study presents the preliminary results of analyses of the adult proximal femora collection from the commingled, disarticulated and fragmentary human remains from the United Arab Emirates Bronze Age Tell Abraq tomb. Archaeological evidence from the site reveals that various forms of subsistence were practiced such as fishing, farming and domestication of animals. If there was task specialization and/or division of labor to perform these tasks then activity-induced skeletal markers should reveal sub-groups within the population. The sample includes 108 femora with intact head,

neck, greater and lesser trochanter. Data on sex, age and stature were assessed using published techniques. Particular attention was paid to distinct musculoskeletal stress markers and pathologies. Preliminary results show high frequencies of posterior cervical imprint as well as increased femoral robusticity when compared to other Bronze Age populations that indicates a complex division of labor and differential access to resources from 2200 BC.-2000 B.C. These findings are supported by previous research that showed a correlation between osteoarthritis, sex, and robusticity in the adult carpals and metacarpals from Tell Abraq indicating males were habitually involved in hard physical labor using of their hands. High frequencies of osteoarthritis and fluorosis in this sample also suggest a population engaged in diverse work-related tasks.

Tolerated scrounging a foraging strategy for young juvenile capuchin *Cebus capucinus* monkeys.

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Capuchin monkeys are unique among primates in their reliance on difficult-to-acquire foods and for having large, metabolically demanding brains. This combination poses a challenge to young juveniles who lack experience in obtaining food but nevertheless must obtain enough calories to sustain their growth and daily nutrient requirements. One potential solution would be for young juveniles to capitalize on pieces of food dropped by tolerant and more proficient foragers—a behavior known as tolerated scrounging. Data on foraging behavior was collected at The Pacuare Nature Reserve in Costa Rica on three wild groups of *Cebus capucinus*. Quantity of food acquired through independent and tolerated scrounging behaviors was measured during continuous focal sampling, while behavioral frequencies were determined from instantaneous scan samples taken at thirty minute intervals. We compare the number of bites obtained through scrounging versus other means between infant, young juveniles, old juveniles and adults. Infants were found to engage in scrounging behaviors over fifty times more frequently than young juveniles, and young juveniles scrounged over four times as often as old juveniles. In addition, scrounging occurred almost exclusively with difficult-to-acquire food items. One implication of our findings is that a tolerant social structure has co-evolved with a stronger reliance on difficult-to-acquire foods. It is possible that tolerated scrounging could be the first behavioral step toward the human behavior of feeding juveniles.

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Reliability of urine test strips for measuring ketone values in Phayre's leaf monkeys.

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Energetic measures are essential in primate behavioral ecology and new methods involving C-peptides, ketones, or leptins seem to provide good estimates of energetic body condition. However, the reliability of non-invasive methods such as urine test strips is not well understood. Here, we tested whether urine test strips provided accurate measures of ketones, whether the values remained stable over the short term, and which factors possibly affected correspondence of measurements. Samples were collected for 50 individuals within three groups of Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*) at Phu Khieo Wildlife Sanctuary, Thailand (137 samples). We used test strips from different manufacturers with and without specific gravity to correct for urine concentration. Samples were collected throughout the day for the same individual at least twice. In addition, we noted the context (time since resting and feeding). Repeated testing of the same sample lead to almost perfect correlation (Spearman's rho, $P < 0.001$) and agreement (weighted kappa coefficient, $P < 0.001$), although agreement was lower comparing different brands. Samples taken several hours apart showed variable values for the same individual with weak correlation and agreement ($P_s > 0.1$). Correlation and agreement improved when specific gravity was taken into account, but neither time of the day nor the behavioral context were significant predictors. Our results show that urine test strips may estimate ketone content in urine reliably if specific gravity is taken into account. Importantly, ketone values seem to vary over the short term and, hence, single measurements may be inadequate to characterize the energetic body condition of an individual.

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Isotopic assessments of Late Miocene paleoenvironmental change in Central Europe: Implications for early hominid evolution and dispersal.

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Major cognitive and locomotor adaptations, as well as intercontinental disper-

sals, have been associated with the early hominid response to increasing seasonality during the Late Miocene. Reconstructions of paleoenvironments in Late Miocene Europe have figured prominently in these discussions, with several authors suggesting a "dietary factor", specifically the increasingly seasonal availability of ripe fruit, as the cause of decline in European hominids. Both the morphology and life history pattern of *Rudapithecus hungaricus*, a large-bodied frugivorous hominid, considered to be closely related to the last common ancestor of living African great apes and humans, suggest it would have been susceptible to increasing intra-annual ecological variability. Current paleoenvironmental reconstructions of Late Miocene Rudabánya suggest a humid, closed canopy forest ecosystem, characterized by a low degree of seasonality.

To further evaluate the environmental context of *Rudapithecus*, we employed high spatial resolution oxygen and carbon isotopic analysis in a sample of tooth enamel from six different herbivore species contemporaneous with *Rudapithecus*. To minimize attenuation of isotopic results, we employed a MicroMill system to sample tooth enamel from sectioned third molars and premolars, collecting bulk samples along the enamel-dentine junction (EDJ), as well as serial sampling at an angle to the EDJ. This sampling methodology produces a more accurate isotopic record, permitting the inference of subannual ecological conditions. Preliminary results suggest intraannual ecological variability at Rudabánya. The results of this research provide insight into the paleoecology of Rudabánya and help to evaluate the impact of environmental change on the evolution and dispersal of Late Miocene European hominids.

LB1 in comparative context: Asymmetry, microcephaly, plagiocephaly, taphonomy.

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Assessment of asymmetry in the LB1 skull from Liang Bua Cave, Flores, requires replicable quantification before arcane explication. Hypotheses concerning causes of asymmetry (normal or abnormal development, postural influences, and/or post mortem modifications) follow as matters of interpretation. So far LB1 has been compared with fossil hominids, recent hominoid

primates, and various extant human samples, normal and abnormal; techniques used are about as diverse as the specimens: anthropometric measurements on living individuals, 2-D linear measurements on photographs, 3-D landmark data, and various presentations of conventional radiographs and CT scans. Consequently, there is a large interaction effect compounding the influences of observers, samples, equipment, techniques, and standards. A further complicating factor arises because the primary specimen, as well as images and casts of it, are only selectively available.

Beyond LB1, additional skulls are known from archeological contexts on Flores (van der Plas, 2002; Lynnerup, 2010). At Naturalis, Leiden, we collected 300 3-D coordinate points on skull vaults, including both Liang Togé and Liang Momer from Flores, using a Bird electronic digitizer (Ascension Technology) plus laptop computer. Cranial shapes were quantified and asymmetries assessed as deviations of surface measurements from an inherently symmetric superquadric model (Sommer, et al., 2006). Superquadric parameters have simple geometric interpretations, are very reproducible, and capture both squareness and taper. The instruments are inexpensive (under \$10k), portable, and their blunt probes can be used safely on skulls, casts, and heads of living subjects including children, the last pertinent for the nonce given the imaginative plagiocephaly hypothesis.

Demonstrating an anthropological application of the Economides orthodontic collection: deciduous and permanent tooth size correlations in European and Hispanic Americans.

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Radiographs, intra-oral photographs, and patient records in the J.K. Economides orthodontic patient record collection are now on line and freely available for research (<http://hsc.unm.edu/programs/ocfs>). This database contains records and over 400,000 images for approximately 5,650 individuals, representing the diversity of Albuquerque, New Mexico 1972-1999, including African, Asian, European, Hispanic, and Native Americans. There are records for 600 related sets of individuals in the collections. Additionally, associated dental models are available for research at the Maxwell Museum of Anthropology.

The anthropological research potential for this database is enormous, including studies of growth and development and cranial, dental, and soft tissue studies. This potential is indicated by the present study, an intra-individual comparison of deciduous and permanent occlusal molar linear measures and areas in European (EA; n=123) and Hispanic Americans (HA; n=77). Two alternate hypotheses were considered for the relationship between correlations in HA compared to EA. First, higher overall tooth size correlations might indicate developmental stability in an admixed group (HA). Second, lower overall correlations might indicate developmental instability related to lower socioeconomic status. Correlations range from 0.00 (HA um1/UP3) to 0.72 (EA um2/UM1), within the range of correlations in the published literature. Overall, differences between EA and HA are not statistically significant at the 0.05 level, indicating that neither admixture nor socioeconomic status is affecting tooth size in this sample of HA. This study is indicative of only one of many applications available using this new research database.

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The influence of body mass and ecological similarity on dominance relationships among three sympatric primate species.

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Interspecific competition is usually explored in the context of competitive exclusion and niche segregation between ecologically-dissimilar taxa. Contrastingly, competition between ecologically-similar species is hypothesized to be mitigated by dominance relationships based on inequality in resource holding potential (RHP). I investigated the influence of ecological similarity on encounters among three sympatric primate species at Way Canguk, Sumatra: the ecologically-similar siamangs (*Symphalangus syndactylus*) and agile gibbons (*Hylobates agilis*), and the ecologically-dissimilar mitered langurs (*Presbytis melalophos*). Due to differences in body mass (and hence RHP), siamangs were predicted to dominate gibbons and langurs. Alternatively, if group size determined RHP, langurs would be dominant. Data were collected from March 2008 to October 2009 on the context and outcome of interspecific encounters (N=262) among seven siamang, three gibbon, and five langur groups. Dominance was determined from the proportion of agonistic encounters and the percentage of encounters won. Siamangs were dominant over gibbons (won 98.4%) and langurs (100%),

and gibbons were dominant over langurs (100%). However, while the majority of encounters with langurs were neutral, gibbon-siamang encounters were predominantly agonistic (Chi-Sq; p 's < 0.001), with siamangs as aggressors in all cases. Because siamang-gibbon encounters were restricted to the morning, ended by gibbons (Chi-Sq; p 's < 0.001), and shorter than those between other species (ANOVA; p < 0.001), gibbons seemed to avoid encounters with siamangs. The results support the idea that interactions among sympatric primate species are strongly influenced by ecological similarity, and that dominance relationships between ecologically-similar species, mediated by body mass, allow for coexistence.

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North American subadult body proportions: climatic adaptation or population history?

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It is generally agreed that human body proportions covary with climate in accordance with thermoregulatory predictions; body mass increases and limb length relative to trunk height decreases with greater distance from the equator. These patterns have been consistently demonstrated in both modern and pre-modern human adults in the Old World and, most recently, in modern Old World subadults. However, indigenous American body proportions among adults do not appear to conform to climatic expectations. Many correlations with mean annual temperature are low, and some morphological patterns are argued to reflect colonization history and population movements rather than ecogeographic adaptations. This study investigates whether subadult indigenous Americans follow the expected ecogeographical patterning for Old World populations. Due to a higher surface area to mass ratio, subadults are possibly more susceptible to temperature stress than adults. This results in higher correlations between anthropometric measurements and climatic variables among subadults than among adults in the Old World. If subadult North American body proportions do not exhibit the same pattern, a non-climatic explanation should be explored. Over 6,500 juveniles, originally measured as part of Franz Boas's North American anthropometric data, were used to examine the relationship between climate and morphology through ontogeny. On average, correlations between anthropometric variables and climatic variables

are lower than those of Old World subadults, are close to zero, and do not change significantly during ontogeny. These results may be considered further evidence that indigenous American proportions do not reflect climatic adaptation but rather non-climatic factors, such as population history.

Body mass estimation in Old World monkeys using long bone ends.

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Equations for estimating primate body mass often require complete long bone elements. However, complete long bone elements are rare in the fossil record rendering many published body mass estimations difficult to apply. As proximal and distal ends are far more common we developed prediction equations for estimating species-sex average body mass based on these in order to better estimate body mass in the fossil record.

Linear measurements on the proximal and distal humerus, radius, femur, and tibia, as well as the proximal ulna were collected on 34 cercopithecoid species from both subfamilies spanning a wide range of body sizes. A total of 15 predictor variables are used, with samples ranging from 102 to 258 specimens depending on the measurement. Species-sex mean body mass data were taken from Delson *et al.* (2000). Body masses were averaged by sex within species due to the large degree of sexual dimorphism in this family. Least squares regression analysis of natural log-transformed data was used to create prediction equations. All regressions show a tight correlation with body mass, R^2 values range from 0.84 to 0.95 with a mean of 0.90.

In order to test the accuracy of our predictor variables, a partial jackknife procedure was applied. For each predictor variable percent prediction error, calculated as [(actual-predicted)/predicted] x 100, was calculated for a random sample of extant species-sex samples. Average prediction error was 14% across all variables and ranged from 8% (proximal tibial breadth) to 19% (anterior-posterior diameter of tibial trochlear facet).

This study of was funded by the Leakey Foundation (SF,EG), the Wenner-Gren Foundation (SF), Geological Society of America (EG), the Paleontological Society (EG), the National Science Foundation (EG), and the University of Oregon (SF,EG).

Health and empires: implications of political development on the health of the inhabitants of Great Moravia.

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Great Moravia in the Czech Republic was arguably the first Slavic State level society in Europe during the 9th and

10th centuries. Great Moravia was located between the Byzantine Empire to the south and the Frankish Empire to the west. Despite the influences of these powerful neighbors, it retained a uniquely Slavic culture. Two populations from within Great Moravia (Mikulcice-Kostelisko, and Josefov) representing an urban and rural site respectively were studied. A contemporary rural site located outside of Great Moravia (Lahovice) was also studied. The goal of this research is preliminary documentation of the impact on population biology of the transition to a more socially stratified society. Specific questions focus on health variation between urban and rural populations and intra-site stratification and its impact on health. Linear Enamel Hypoplasia (LEH), dental asymmetry, porotic hyperostosis and cribra orbitalia were evaluated as health and nutrition indicators of general population biology. LEH and dental asymmetry data were collected on all skeletal remains with associated teeth over the age of six. Cribra orbitalia and porotic hyperostosis data were collected on all skeletal remains with associated cranium. Preliminary analysis indicates differences associated with geographic location.

Severe rickets at the Spring Street Presbyterian Church.

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Construction in New York City in 2005 unearthed four burial vaults from approximately 1811-1843 from the Spring Street Presbyterian Church. Over 300 commingled individuals were excavated, and ongoing analysis has identified at least a third of these as subadults. Although the adults from the population show relatively good health, the subadult remains are characterized by widespread pathology, including lesions and deformations consistent with rickets, scurvy, anemia, congenital syphilis, as well as pathological conditions with no clear etiology. Rickets, in particular, is widespread. From just one of the four burial vaults, 38 long bones from a minimum of 9 individuals show rickets. Additionally, 8 complete individuals exhibit rickets, 3 of them with severe cases. This poster will present these 3 cases, which were identified using both macroscopic and radiographic analyses. The extent of the bone deformation, including bowing, porosity, flaring metaphyses, and fractures, will be presented. They provide an opportunity to expand our understanding of severe subadult pathology within a specific context. Originally built in a fruit orchard in 1810, by the 1830s the church was in the center of the city. It was a radical abolitionist church that had parishioners from all social classes. One of the pastors described the church as comprised of

330 souls “who belonged to that class of person who cannot afford to purchase or hire a pew in our city churches” (Frey Family Papers 1828). This ideological community presents a unique case in which to consider the synergistic effects of social environment and biological growth.

Ecological and cultural interconnections between the Guizhou snub-nosed monkey (*Rhinopithecus brelichi*) and local communities at Fanjingshan National Nature Reserve, China.

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Ethnoprimatology is a field of study that examines human interactions with primates in ecological and cultural contexts. Using this approach, we examined the extent of overlapping resource use between the Guizhou snub-nosed monkey (*Rhinopithecus brelichi*) and human residents in Fanjingshan National Nature Reserve (FNNR), China. We also explored residents' attitudes towards *R. brelichi*, FNNR, and resource collection. According to the 2010 IUCN Redlist, *R. brelichi* is “Endangered” and the primary anthropogenic threat to their survival is the destruction of forest habitat. The methods integrated ethnographic interview techniques including structured, semi-structured questions, focal informant follows, and participant observation. The results indicate minimal overlap between humans and monkeys in terms of season, resource type, and spatial use of FNNR. The most common resources collected by residents do not overlap with the monkey's known dietary resources. Although observed locations of collection did not overlap with the monkey's altitudinal range, observed evidence of human activity did overlap with the monkey's range. Respondents reported spending more time collecting resources in the winter, which could be disruptive to the monkey during times of resource scarcity. According to interviews, respondents do not always agree with the rules of the reserve, but their attitudes towards *R. brelichi* are generally positive. Respondents expressed a feeling of connectedness with the Guizhou snub-nosed monkey because of its observable, humanlike behaviors and morphological features. Understanding local people's attitudes towards the Guizhou snub-nosed monkey and involving community participation in conservation policy development can increase local support and understanding for the objectives of FNNR.

This study was funded by the Zoological Society of San Diego and the American Society of Primatologists.

Variation in adolescent menstrual cycles, doctor-patient relationships, and why we shouldn't prescribe hormonal contraceptives to twelve year olds.

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Despite evidence that demonstrates the fundamental characteristics of adolescent menstrual cycles are variability and frequent anovulation, young girls, particularly in the United States, are regularly prescribed hormonal contraceptives to control that variability. Though it takes five years or more to achieve regular ovulatory cycles, girls as young as twelve are visiting their doctors with complaints of infrequent cycles and being diagnosed with amenorrhea. Some medical doctors suggest a more stringent determination of amenorrhea in adolescents than in adults, from six months down to only three months without menses. We suggest that the use of hormonal contraceptives in young girls can have negative health consequences related to lifetime estrogen exposure, including breast cancer.

Through a combination of literature review and pilot survey results, we propose several reasons for this phenomenon of very early hormonal contraceptive use. First, doctors and patients are largely unaware of the body of evidence showing that variation in cycle length and anovulation are normal and healthy in adolescents. Second, doctors often assume that young girls who report menstrual irregularity do so in order to secure hormonal contraceptives to have safe sex, but feel prohibited or embarrassed from asking outright. Finally, doctors are mired in a health system that can feel like a customer support model, where they are expected to resolve symptoms. We suggest that a large number of young girls may visit their doctors for these issues under duress of their parents, or to seek reassurance from an expert that they are normal, but not necessarily to secure contraception.

Food for thought: coastlines, aquatic resources, and human evolution.

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Because we live in a full interglacial period when sea levels are well above the Pleistocene average, roughly 90 percent

of hominin history in coastal settings now lies beneath the sea. This led many 20 century archaeologists to hypothesize that our ancestors only developed systematic fishing and seafaring capabilities during the past 10,000-15,000 years. New evidence from archaeology, molecular genetics, and evolutionary perspectives in human physiology suggests that fishing played a significant role in the evolution of *Homo* and the emergence and spread of anatomically modern humans (AMH; *H. sapiens sapiens*) around the globe. I test this new paradigm by reviewing current archaeological evidence for Pleistocene marine fishing and seafaring around the world, concluding that hominins practiced simple coastal foraging (marine shellfish gathering, beach scavenging, etc.) for more than several hundred thousand years. After the appearance of *Homo sapiens sapiens*—especially in the last 50,000 to 150,000 years—coastlines, fishing, and seafaring played key roles in the demographic expansion of AMH out of Africa and the colonization of Island Southeast Asia, greater Australia, and the Americas. This deeper history of hominin maritime activity challenges traditional anthropological models such as the “broad spectrum revolution” and the primacy of terrestrial adaptations.

Social and health implications of betel staining in ancient Mariana Island populations.

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The importance of betel chewing in many past and present Indo-Pacific populations is well documented, but researchers of ancient populations seldom focus on the biological and social implications of betel chewing. Clinical literature suggests that betel chewing increases susceptibility to calculus formation, oral submucous fibrosis and oral cancer. To the contrary, other studies suggest that betel staining provides a cariostatic barrier; however this relationship is not universally accepted. A better understanding of the effects of betel chewing on oral health will facilitate interpretations of caries frequencies in populations where betel chewing is common. Furthermore, implications of betel chewing are not solely biological, a point often overlooked in the clinical and archaeological literature. Dental staining caused by habitual betel chewing and intentional application can be highly visible, and therefore may serve as a marker of social identity or status. How and why betel staining reflects identity in ancient groups and social contexts is currently unknown, but is likely to have been highly variable.

The current study reviews limitations of previous research of betel nut use among past populations and introduces a new theoretical framework. The rela-

tionship between caries and betel staining is assessed using data from two sites in the Mariana Islands in Micronesia. While the data suggest there is a relationship between betel staining and the absence of caries, it is not clear that the two are correlated. The relationship between betel chewing and gender is also discussed.

The effect of infant age on infant attraction, tolerance and handling in *Ateles geoffroyi*.

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Typically other females are most interested in infants, however in black handed spider monkeys (*A. geoffroyi*) males have been observed to engage in infant handling, even though infants younger than 6 months of age spend most of their time either on or in close proximity to the mother. We examine whether the age and sex of the infant has an effect on male infant attraction, tolerance and handling in *A. geoffroyi*. All occurrence data was collected from January 2007 to July 2010 on a community of 35 wild spider monkeys at Runaway Creek Nature Reserve, Belize. During 884 hours of observation, 102 infant handling bouts, 12 infant handling attempts, and 27 infant tolerance bouts were recorded. Large juvenile, sub-adult and adult males handled infants the most [N=76, 75% of all bouts]. Male infants were handled more often than female infants [Pearson $X^2=5.263$, $df=1$, $p<0.05$] and younger infants were handled more often than older infants [Pearson $X^2=3.853$, $df=1$, $p<0.05$]. At less than 6 months, male and female infants were handled equally, but at greater than 6 months male infants were handled significantly more often [Pearson $X^2=12.448$, $df=1$, $p<0.01$]. Overall, infants appear to be more attractive to males when they are younger and the continued interaction with male infants as they age may be related to the strong bonds among closely related adult males that characterize spider monkey society. This may reflect kinship-based affiliation or bond formation.

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Diet quality, weight loss, and maternal investment in vervets.

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In wild populations, primate females face the challenge of achieving adequate

levels of nutrition to support gestation and lactation. This is in sharp contrast to the over-nutrition in modern societies where many mothers of young infants are on weight-loss diets. Yet, little is known about the consequences of diet and weight loss on maternal behavior in the overweight to normal range.

The Vervet Research Colony contains multigenerational social groups of vervets for studies of behavior and development. In 2004, the diet was changed to prevent overweight and obesity and provide a more natural level of fiber in the diet. Data on weight and mother-infant interactions were assessed for effects of the diet change. The results showed the mean body weight of breeding females declined 10% after the transition to the high-fiber diet. Behaviorally, mothers on the high-fiber diet had significantly higher rates of rejecting ventral contact and higher rates of leaving their infants. The high-fiber diet infants played a greater role in maintaining ventral contact, resulting in comparable levels of mother-infant contact for the two diets. The effects of the diet change on maternal rejection were significantly related to the mother's body weight, with lower-weight mothers scoring higher in maternal rejection. These results demonstrate that maternal behavior is responsive to changes in maternal condition, and that beneficial changes in the diet may have unintended consequences on behavior. They also demonstrate the resilience of infants in responding to variation in maternal behavior within the normal range.

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First virtual reconstructions of the frontal lobe and temporal pole of the Taung (*Australopithecus africanus*) endocast.

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The Taung type specimen for *Australopithecus africanus* includes a natural endocast that reproduces external morphology of a large portion of the right cerebral hemisphere, and a separate fragment of the fossilized face that articulates with the endocast. The natural endocast lacks the right temporal pole and rostral part of the frontal lobes, which were embedded in the back of the facial fragment. Although these structures have previously been recon-

structed manually using the external morphology of the facial fragment as a guide, we used advanced 3D-CT technology to prepare virtual reconstructions of the frontal lobes and right temporal pole. We then joined these parts of Taung's virtual endocast to a virtual image of the natural endocast, and reconstructed the remaining missing areas using mirror imaging. The resulting virtual endocast of Taung was compared with 3D geometrical models of chimpanzee and bonobo endocasts reconstructed from CT scans of dry skulls representing individuals at the same dental developmental age as Taung. We employed recently developed automated computational tools that allowed processing of 3D free-form surfaces and quantification of the mean anatomy within each species (chimpanzees and bonobos) as well as the pattern of variability around these means. These results were compared to those for Taung, and allowed us to test Raymond Dart's hypothesis that Taung's brain was advanced toward a human condition in the shape of its prefrontal as well as parieto-occipital association cortices. Our findings lend strength to Dart's suggestion that australopithecine brains evolved in a global rather than mosaic manner.

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Dental tissue allometry in modern human males and females.

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The dental crowns of modern humans are sexually dimorphic with respect to external size, and males have a greater dentine-pulp complex than females but differences in enamel quantity or thickness between the sexes are not pronounced. Allometric relationships of crown components have not been examined between the sexes, yet this information is critical for understanding how tooth crowns are assembled. We suggest two sources of variation in enamel distribution between males and females: tooth size and sex. To address this we examine sex-specific and sex-combined allometry in crown components to explore the potential effect of size and sex.

Coronal enamel and dentine-pulp volumes and surface area of the enamel-dentine junction (EDJ) were calculated from three-dimensional surface models generated from high-resolution CT

scans (0.02 to 0.04 mm voxel size). These crown components were used to calculate average and relative enamel thickness. To explore the possible effect of sex and tooth size, we performed regression analyses (reduced major axis) and correlation analyses between dental tissue volumes, EDJ surface area and enamel thickness.

Results indicate that the EDJ scales with positive allometry with respect to dentine volume and a larger dentine volume is correlated with a proportionally larger EDJ (i.e., the EDJ changes shape). Enamel scales isometrically across the sexes with total crown volume. As males tend to have larger dentine-pulp complexes and larger EDJ surface areas this explains the different previously reported patterns of sexual dimorphism in enamel thickness.

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Group structure and dispersal patterns of the socially monogamous owl monkey as revealed by mtDNA data.

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The owl monkeys (*Aotus azarai azarai*) of the Gran Chaco region of Argentina live in socially monogamous groups that include a pair of reproducing adults and a few young. However, behavioral and demographic data have shown that reproducing adults are sometimes replaced by dispersing males and females. Such events have profoundly affected group composition and relatedness among individuals. To understand the genetic consequences of male and female dispersal patterns and adult replacement, we sequenced 1099 bp of hypervariable control region (CR) of the non-recombining mtDNA genome in 121 individuals captured within a 3 km² area of study. We calculated haplotype diversity estimates to assess patterns of matrilineal relatedness among and within groups, determine sex differences in dispersal patterns, and evaluate the relatedness between partners. Our analysis revealed 52 CR mutations that defined 33 unique haplotypes belonging to three major lineages (A, B, C). Although we did not find evidence for spatial clustering of the major lineages within the study site, same-sexed individuals with identical haplotypes showed some spatial clustering. The three lineages were similarly represented among females (n=23, A=8, B=7, C=8), but less so among males (n=20, A=5, B=11, C=4). In a majority of reproducing pairs, the two adults belonged to different lineages (15/24),

but members of the remaining nine pairs showed the same haplotype (9/24), reflecting some extent of matrilineal kinship between partners. These data, in combination with demographic and behavioral data, will provide new insights into the population structure and dispersal patterns of owl monkeys.

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Bioarchaeology of a medieval Irish ecclesiastical settlement.

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Excavations of the church cemetery site at Kiltasheen, Co. Roscommon, Ireland, resulted in a wealth of bioarchaeological remains spanning over 700 years of occupation (700-1400). Preliminary analyses of skeletal and dental remains reveal a potential disproportionate (3:1) ratio of males to females at Kiltasheen. Additionally, juvenile remains account for roughly 55% of the excavated remains, which is slightly higher than the 30-40% child mortality rate expected across this time period. Thus, the population structure of the site is unique, although possibly a result of excavation bias.

The population appears to have been in general good health, as adult mean stature is on par with contemporaneous populations throughout the British Isles. Similarly, adults exhibit low rates of dental carious lesions and periodontal disease. Of particular interest, however, are the high rates of dental calculus and linear enamel hypoplasia on dental remains from Kiltasheen, and the apparent lower mean stature of Kiltasheen inhabitants than those seen among contemporary archaeological populations from continental Europe. Thus, there is a strong possibility that residents at Kiltasheen (and elsewhere in the British Isles) were subsisting on food sources that were of lower energetic and nutritional value than their contemporaries were. Understanding how dietary consistency changed through time at Kiltasheen, and how this may be related to agricultural practices, may help resolve some of these questions.

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How well do traditional stature regression formulae capture secular trends during the late 20th century?

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Secular trends in stature have been well-documented during the 20th century. However, traditional stature regression formulae such as those created by Trotter and Gleser from the Terry Collection are from individuals that achieved maximum adult height before fundamental increases in height arose. To test whether stature regression formulae from Terry Collection males (n = 1670) and mid to late 20th century individuals from collections at the University of New Mexico and the University of Tennessee (n = 81) differed, analysis of covariation was conducted for maximum femoral length, bicondylar femoral length, maximum tibial length and fibula length. The results suggest that no significant differences exist in slope values for the maximum femoral length and bicondylar femoral length. Slope and y-intercept values for both the fibula and the tibia are significantly different, the samples are smaller (n = 35). Although differences in mean stature are apparent between the two samples, differences in regression formulae are not statistically significant for femur length.

A comparative assessment of the Chen et al. and Suchey-Brooks pubic aging methods.

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Accurately assessing age-at-death of adult human skeletons is fundamental in physical anthropology. The most generally accepted methods for estimating age involve analysis of the pubic bones. Two such methods—Chen et al. (2008) and Suchey-Brooks (1990)—are the focus of this study.

The objective of this research is to evaluate the accuracy of the Chen et al. and Suchey-Brooks methods. The Chen et al. method was developed on a sample of Chinese Han males. The primary research question asked: Will the revised Chen et al. method be more accurate than the Suchey-Brooks method for aging males of European ancestry? It was hypothesized that there would be statistically significant differences between the rates of accuracy.

This research utilized a known collection of modern pubic bones curated at the Forensic Science Center in Phoenix, Arizona. A sample of 296 left male pubic bones of European ancestry,

between the ages of 18 and 70, was evaluated.

Results indicate that there are no statistically significant differences between the two methods. On average the revised Chen et al. method slightly over-ages the specimens while the Suchey-Brooks method slightly under-ages. Both methods have an average error of 8 years from actual ages.

This research demonstrates that the Suchey Brooks method is most accurate for aging young adults, while the revised Chen et al. method is most accurate for aging middle and old adults. Thus, the Chen et al. method is an important contribution to the field of physical anthropology for aging older adult skeletal remains.

A geometric morphometric study on the orientation of the lesser trochanter in humans - comparison of Upper Palaeolithic specimens with femora from a medieval skeletal assemblage.

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A conspicuous orientation of the lesser trochanter towards posterior has been reported for some femora from the Upper Paleolithic (Bonn-Oberkassel, Irlich, Dolní Věstonice), raising the question of possible differences in trochanter orientation between these specimens and femora of other origin.

To assess the variation in the orientation of the lesser trochanter we studied 65 femora originating from an early medieval skeletal assemblage (Greding, Germany) and compared the results with those for a left femur of a young adult individual from Irlich, Germany, dated to 12,500 to 11,200 BP (calibrated AMS age).

Four landmarks on the proximal femur, four on the mid-shaft and three on the distal femur were defined, recorded with a MicroScribe[®] digitizer, and analyzed using Auto-CAD[®] 2010 software. Seven angles and five distances were defined and measured. Significant differences ($P < 0.05$) between sexes were found for all linear measurements while no significant differences ($P > 0.05$) existed for angular measurements in the Greding femora.

For some angular variables related to the orientation of the lesser trochanter, the values for the Irlich femur lay outside the range of the Greding specimens. The reason for this was the more posterior orientation of the trochanter in the Irlich femur. A similar orientation of the lesser trochanter has also been reported for some other femora dating to the Upper Paleolithic (Bonn-Oberkassel, Dolní Věstonice).

The observed difference in trochanter orientation might reflect differences in activity and locomotor patterns between

medieval peasants and Upper Paleolithic hunter-gatherers.

A trauma analysis of the Morton Site skeletal series from the Central Illinois River Valley.

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The Morton Site, located within the Central Illinois River Valley was inhabited continuously from the Archaic, Red Ochre period (~1200 B.C.) to the end of the Mississippian period (~1300 A.D), and consists of 19 burial mounds. This long habitation, coupled with such a wealth of available osteological data, presents an excellent backdrop for examining biocultural change in a site-specific context. Paleopathological analyses focusing on trauma patterning contribute to a holistic interpretation of this biocultural environment and allow for a greater understanding of occupational and subsistence change, overall health status, regional warfare and violence, and concordant socio-temporal changes. However, while other sites in the region, most notably the nearby trauma-heavy site of Norris Farms 36, have been analyzed for signs of trauma, the Morton Site has never been systematically examined in this regard.

This paper provides a catalogue of skeletal trauma at Morton noting injuries related not only to interpersonal violence and captive-taking, but also highlights the extraordinary frequency of occupational and accidental injuries, as well as bone fractures secondary to other pathological conditions. This expanded analysis challenges the focus on violence-related trauma and presents a regional and population-specific interpretation of injury patterns, their variation over time, and their relationship to political, social, ecological and cultural changes in the region. The patterns of trauma in the Morton population are then used to create a model of injury that is comparable to other contemporary cemetery sites in the region such as Norris Farms 36.

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Atlantic versus Mediterranean mesolithic shell middens. An approach to the human diet from stable isotope analysis.

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We present data for the isotopic study of human and faunal remains from four

Mesolithic shell middens (Cabeço das Amoreiras, Arapouco, Cabeço do Pez and Várzea da Mó) all of them placed in the Sado Valley in the province of Alentejo, Portugal, representing the Atlantic Mesolithic communities. These sites have a timeline that ranges between 8150 - 7580 years cal. BP.

The analysis has been conducted from 18 human skeletal samples from these four sites and 11 samples of faunal remains from Cabeço das Amoreiras and Arapouco.

The initial objective of this study is to establish the diet of individuals of various Sado's shell middens. This study can contribute to find the specific weight of the harvest in the global supply of each group and therefore could reassert the hypothesis that these shell middens were stationary settlements. Moreover, we provide data on the evolution of the mollusca contribution on the diet of these individuals over time.

Finally, the comparison of our results with the data from the Mesolithic site of El Collado (Oliva, Valencia), as a representation of the Mediterranean communities, will highlight the possible differences in the paleodiet, or other resources, that both coasts had in these chronologies.

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Effects of occlusal variation on temporomandibular joint form in modern humans.

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Modern humans exhibit extensive variation in occlusal form, including occlusal discrepancies termed malocclusion. Previous studies on cadavers have linked malocclusion to deviation in TMJ shape, but it remains unclear if deviation in TMJ form results primarily from changes in the soft or hard tissues of the joint. In this study, we address the role of hard anatomy in modified TMJ shape due to occlusal variation by comparing the shape of the TMJ of individuals exhibiting different Buccal Segment Relations (BSRs) at the Hamann-Todd Osteological Collection. If the previously reported differences in TMJ shape result from changes in underlying bony anatomy, there should be observable differences in TMJ shape between individuals exhibiting different BSRs in this osteological collection.

Shape-ratios were created from metric data on the TMJ to broadly represent TMJ form. Individuals exhibiting different BSRs were then compared using ANOVA and Tukey's HSD. The results

show that there are relatively few osteological differences in TMJ shape between individuals exhibiting different BSRs. The only significant difference is the tightness of the fit between the glenoid fossa and the mandibular condyle: individuals exhibiting class 3 BSRs have a significantly looser fit than individuals exhibiting other BSRs. These data show that while there is some change to the bony anatomy of the TMJ, the previously reported deviations in TMJ form resulting from malocclusion are not due primarily to changes in the hard tissue of the TMJ. Future research should focus on the soft anatomy of the TMJ as it relates to occlusal variation.

Dental attrition does not explain occlusal discrepancies in a modern human population.

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The etiology of malocclusion has received considerable anthropological attention. A simultaneous decrease in attrition and increase in malocclusion has been noted in human populations worldwide. Some scholars have posited a causal link for this relationship: decreased wear caused increased malocclusion. However, others have suggested both of these characters relate to a common causative process independently. In this study, we test the hypothesis that occlusal attrition is causally linked to malocclusion by comparing the rates of occlusal variants on the left and right side of the dental arcade in individuals with symmetrical and asymmetrical wear. We predict that if dental wear is causally linked to malocclusion, there should be lower incidences of occlusal discrepancies on the side exhibiting greater wear in individuals exhibiting asymmetrical wear, and no difference in individuals with symmetrical wear.

We determined wear-symmetry and collected data on occlusal discrepancies on 118 individuals from the Hamman-Todd Osteological Collection. The percentages of rotated and displaced teeth on the right side of the dentition were subtracted from that on the left side to create an occlusal discrepancy index. ANOVA and Tukey's HSD (one-tailed) were used to compare indices for individuals with left, right, and unbiased dental attrition. We found no significant differences between these populations. These results suggest that a causative relationship between dental attrition and malocclusion is unlikely. Rather, both likely relate independently to an underlying causative process. We suggest that this underlying process is chewing stress. Further research

focused on interproximal wear is needed to further address this issue.

A nutritional assessment of Marshallese school children: Issues involved in applying Anthropology in order to support social change.

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Many studies have found a positive effect on growth, attendance, and exam scores of children given a meal during school hours. Having only gained independence in the last thirty years, the Republic of the Marshall Islands is still attempting to build programs like school lunch. In 2006, a local committee was formed to investigate claims that in Majuro, the capital atoll, private school children were outperforming public school children in each of the above categories. A pilot study conducted in 2006 revealed significantly lower averages in height and weight among public school children when compared to private school children. Major problems in the pilot study were the inclusion of self-reported data and a lack of repeated measures to determine measurement precision and reliability. In 2009, an updated nutritional assessment was completed to address these and other issues. Anthropometric measurements were collected from primary school children (N=588) attending public and private schools. Z-scores were calculated and compared to the CDC 2000 reference data. Both samples of school children were, on average, below the median of the reference population but the public school averages were significantly lower. In terms of body composition, no difference was found among upper arm muscle area but all skinfold Z-scores showed significant differences. The committee planned to use these results to support the need to fund school lunch programs for the public schools. Further examination of the private school sample, however, revealed issues with the findings and raised concerns about applying Bioanthropological techniques to support an agenda.

Quantification of cortisol in wild and captive nonhuman primate hair: methodological considerations and biological validation.

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Hair archives a time averaged hormonal signal and offers several advantages over traditionally collected substrates for the analysis of hormone-behavior relationships. This research explores some methodological issues associated

with hair cortisol analysis by examining 1) hair growth rates and patterns, 2) the relationship between time-averaged fecal and hair cortisol levels, and 3) the utility of the technique to track known age- and phylogeny-related patterns of cortisol variation in wild and captive nonhuman primates.

Hair growth rates, patterns and the relationship between hair and fecal cortisol levels are examined using samples derived from captive animals. Age related hair cortisol levels were determined for samples collected from wild and captive animals representing five age classes (n=73). Hair cortisol levels were compared among catarrhines and platyrrhines (n=83), and evaluated for agreement with known differences in circulating cortisol levels among these groups. Hair was subjected to a modified methanol- and sonication-based extraction method, and quantified using salivary cortisol enzyme immunoassay kits. Data were analyzed using regression models and analyses of variance.

Results suggest considerable variability in hair growth rates within and among taxa. Averaged fecal cortisol (collected over a period of weeks) and hair cortisol levels show agreement, and hair cortisol levels reflect expected age-related changes. Platyrrhines exhibit significantly elevated hair cortisol levels relative to catarrhines. In sum, our results imply that, if variation in growth rates and pattern can be accounted for, hair cortisol analysis may be a powerful and heretofore underutilized tool in field- and laboratory-based studies of the relationship between hormones and behavior.

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Mapping the distance between the brain and the inner surface of the skull: interest for the study of fossil endocasts.

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Endocranial casts are commonly used to infer the shape, size, asymmetry or overall organization of the brain of fossil species. However, endocasts are only an indirect representation of the brain. Few studies seek to assess the faithfulness of this representation, upon which is based much of our knowledge on the evolution of the brain of hominids.

The aim of this work is to automatically map in 3D the distance between the brain and the inner surface of the skull in humans and other primates to see how some morphological characteristics of the endocast (and in particular its asymmetries) relate to those of the brain.

MR images are used to automatically extract the brain and virtual endocast. Point-to-point distances are evaluated between the two surfaces to generate a distance map. Bilateral asymmetries of the brain and virtual endocast are also computed. A mean endocranial shape evaluation provides average distances and asymmetries maps.

Results show that the local distance between the brain and the virtual endocast strongly varies between anatomical regions, but symmetrically with respect to the mid-sagittal plane. It follows that global asymmetries of the brain and endocast are closely related.

These findings suggest that in paleoanthropology, the study of natural or virtual endocasts gives significant information about the morphology of the brain of fossil species. Moreover, we may use the distance map computed on extant species to infer more precise information about the potential surface of the brain of fossil species.

This work is funded by the 3D-MORPHINE project (<http://3dmorphine.inria.fr>), a collaborative research initiative of INRIA (<http://www.inria.fr>).

Analysis of kin groups using the frontal sinus.

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Frontal sinuses are generally regarded as a highly variable trait and unique to each individual, but previous studies have also demonstrated that certain characteristics of the frontal sinus are passed on from one generation to another. In this study we further explore the hypothesis of inheritance by examining the relationship between frontal sinuses and kinship groups in a population of Neolithic individuals from the cemetery of Schwetzingen (Germany). 214 individuals with an almost balanced female-male ratio have been found, with a large number of well-preserved subadults. The sample for this study is based on cranial CT-scans of 58 subadult and adult individuals, analyzed using the software Aviso 6.1. To describe and analyse characteristics of the frontal sinus, we developed a scoring scheme reflecting various attributes of sinus morphology. The traits scored

include absence of the sinus, bilateral symmetry, position (centre, left or right sides) and shape (for example, triangular) of the sinus.

Our preliminary results suggest that frontal sinuses are absent in over 20% of the total sample. This is an unusual finding because in recent European populations the ratio of absence is about 5%. Comparable results are only known from isolated historic populations like the Inuit of Greenland or Mesolithic populations from the Sudan. The results obtained from this analysis have implications for using the frontal sinus as a possible trait to examine heritable features within and between populations. In addition, the present study proposes to build a framework for future studies to examine kinship relationships based on micromorphological features.

Placing the cranial morphology of a rare endemic colobine, *Presbytis natunae*, within the phylogenetic context of its genus.

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The attributes that make SE Asian leaf monkeys appealing and informative subjects for evolutionary biologists also make them challenging to study. Because they inhabit major landmasses as well as scores of smaller islands, their biogeography is complex and mutable over geologically short time scales. Among these taxa, colobines of the genus *Presbytis* are no exception. This study investigates cranial shape and allometry in the Natuna Island leaf monkey, *Presbytis natunae*, compared to related species of *Presbytis*: *P. melalophos* and *P. femoralis*. Sumatran *Presbytis melalophos* forms the primary reference sample, and *P. femoralis* is included for additional context. Cranial metrics, including 3D landmark coordinates, were collected from museum specimens. A variety of morphometric analyses were performed to address two hypotheses: that (1) the insular species exhibits a derived cranial shape associated with its isolation and body size reduction, and (2) the various species of *Presbytis* are identifiable based on cranial form.

It was found that the major shape differences distinguishing the Natuna monkey from *P. melalophos* are unlikely to be related to its isolation and dwarfing, because *P. natunae* shares these shape characters with *P. femoralis*. Nonetheless, cranial size and shape analysis of these samples supports the hypothesis that species variants within *Presbytis* are morphometrically distinguishable, whereas skin and pelage characters currently define genus systematics. Although the success of cranial morphometrics as a tool for systematics and phylogenetic inference has proven to be limited among papionins and African colobines, this study sug-

gests that its potential in Asian colobines warrants continued exploration. This work was funded by NSF Doctoral Dissertation Improvement Grant #0824583, and by grants from the College of the Liberal Arts and the Department of Anthropology, Penn State University.

Allometry and evolution of the face in mid-Pleistocene *Homo*.

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Facial features clearly distinguish modern humans from their fossil relatives. It is unclear, however, how these features co-vary with facial size. Here we present a geometric-morphometric study of ontogenetic and static allometry in modern and archaic humans. The modern human sample (N=255) comprises growth series from four morphologically distinct human populations; their ages range from two years to adulthood. The fossil sample covers human specimens from the Pleistocene to the Upper Paleolithic, and includes several subadult Neanderthals as well as the *Homo antecessor* fossil ATD-6-69 from Atapuerca, Spain. This subadult fossil, dated to ca. 780 Ka, has been suggested to mark the earliest appearance of modern human facial features. Our objectives were to (1) assess ontogenetic and static allometry in modern and archaic humans. (2) Test to what extent ATD-6-69 exhibits a modern human facial morphology. We digitized landmarks and semilandmarks on surface and CT scans and analyzed the Procrustes shape coordinates in shape-space and form-space.

We show that the facial differences between modern and archaic humans are not exclusively allometric. The developmental trajectories of modern humans and Neanderthals are similar, but they are clearly separated. Our results indicate that the modern human facial morphology is derived, whereas the facial differences between Neanderthals and *H. heidelbergensis* are largely due to allometric scaling along an ancestral trajectory. ATD-6-69 plots along this archaic trajectory, indicating that its overall resemblance to modern humans is largely an artifact of its size. However, allometric scaling cannot account for the canine fossa of this specimen.

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Impact of global climatic change on the evolution of *Theropithecus oswaldi*.STEPHEN R. FROST¹, EMILY H. GUTHRIE¹ and ERIC DELSON^{2,3,4}.¹Department of Anthropology, University of Oregon, ²Department of Anthropology, Lehman College, ³Department of Vertebrate Paleontology, American Museum of Natural History, CUNY, ⁴NYCEP (New York Consortium in Evolutionary Primatology).

We examined the impact of global climatic change on the morphological evolution of *Theropithecus oswaldi*, which has an extensive fossil record spanning the time period from prior to 3.5 until approximately 0.25 Ma when significant changes occurred in global climate and regional African habitats. Thus *T. oswaldi* is an ideal primate for studying the relationship between climate and evolution.

Theropithecus oswaldi is recognized as a terrestrial grazer based on its limb skeleton, carbon isotopic ratios from enamel, and dental microwear. Several morphological trends are clear over its chronological range and appear to occur throughout Africa, although data are sparser for North and South compared to East Africa. These trends include an increase in body size, molar size and enamel complexity, enlargement of cranial superstructures, reduction of anterior dentition, shortening of the rostrum, and some evidence for increasing terrestrial adaptations in the postcranium. Evolution of these morphological trends is the basis for recognizing the chrono-subspecies of *T. oswaldi*: *T. o. darti*, *T. o. oswaldi*, and *T. o. leakeyi*.

While changes in *T. oswaldi*'s morphology through time generally tracked the overall increase in aridity that occurred throughout the Pliocene and Pleistocene, they did not coincide with specific major shifts in global climate, such as the global cooling event associated with the onset of major continental glaciation in the Northern Hemisphere at approximately 2.8 Ma, nor the shifts in predominant orbital cycle at approximately 1.7 and 1.0 Ma. Instead, their evolution seems to track a steady increase in adaptation to terrestrial grazing.

This study was funded by the Leakey Foundation (SF, EG), the Wenner-Gren Foundation (SF), the Geological Society of America (EG), the Paleontological Society (EG), the National Science Foundation (EG, ED), and the University of Oregon (SF, EG).

Neighbor-stranger discrimination in the Bolivian gray titi monkey *Callicebus donacophilus*.ANNA K. GABEL¹ and KIMBERLY A. DINGESS^{2,3,4}. ¹Zoologisches Institut, Universität Hamburg, Germany, ²Department of Anthropology, Indiana University, Bloomington, ³DANTA: Association for Conservation of the Tropics, ⁴Wildlife Conservation Society, Bolivia.

Territorial defense against other individuals requires a lot of time and

energy of the territory holder. One mechanism to minimize these costs is the dear-enemy effect, where neighbors show reduced aggression towards each other compared to unfamiliar intruders. Previous research has documented the existence of acoustic neighbor-stranger discrimination predominantly in birds and only a few studies have been conducted with primates. This study examined the response of the Bolivian gray titi monkey (*Callicebus donacophilus*) to playbacks of duets of strange and neighboring groups on the territory boundary. The results show a positive trend towards higher aggression in response to strangers than to neighbors, as measured in terms of latency to vocalize and approach to the speaker. Significant differences could be found in the time monkeys spent in proximity to the speaker as well as in the length of their vocal response. The results suggest that titi monkeys are able to discriminate between neighbors and strangers by their loud calls and maintain dear-enemy relationships with their neighbors avoiding unnecessary aggressive encounters. Unfamiliar groups, however, constitute a higher threat of usurping the territory, and an escalation might be worth the cost in this context. This study provides the first evidence of acoustic neighbor-stranger discrimination in a New World primate.

This study was funded by the German Academic Exchange Service (DAAD).

Genetic ancestry and indigenous heritage in a Native American descendant community living in Bermuda.JILL BENNETT GAIESKI¹, AMANDA OWINGS¹, JEAN FOGGO SIMON², RACHEL GITTLEMAN¹, JOHN LINDO¹, DAVID GAIESKI¹, and THEODORE SCHURR¹. ¹University of Pennsylvania, ²Oberlin College.

Nearly six hundred miles east of Cape Hatteras, Bermuda is a lone outpost in the middle of the Atlantic Ocean. Neither American nor Caribbean, but integrally linked to the history of both regions, this former British colony has largely escaped the attention of most anthropologists. Bermuda is one of Europe's few true discoveries in the New World, as it was uninhabited until the Virginia-bound *Sea Venture* literally crashed into its shores in 1609. Soon after, Bermuda gained the dubious distinction of being the first New World English colony to forcibly import its labor by engaging in the systematic trafficking of indigenous peoples from their homes along America's eastern seaboard. Oral traditions circulating today among contemporary Pequot, Wampanoag, and Narragansett tribes recount these same events, while, in Bermuda, residents of St. David's Island have long clung to the idea that their histories are linked to a Native Ameri-

can past. To investigate the influence of the historical past on biological ancestry and native cultural identity, we analyzed genetic variation in Bermuda's self-proclaimed St. David's Island Native Community. Our results indicate that the majority of mtDNA haplotypes present today belong to West Eurasian and African lineages. This reflects the extent of their interactions with people of European and African descent. However, Y-chromosome analysis has identified a range of Native American, West Eurasian, and African haplogroups. By comparing the genetic data with genealogical and historical information, we can reconstruct the complex history of this Bermudian community to the mid 17th century.

Something fishy in Santa Clara County: an isotopic study of dietary breadth within an ancestral Ohlone population.KAREN S. GARDNER¹, ALAN LEVENTHAL², ROSEMARY CAMBRA³, ERIC J. BARTELINK¹ and ANTOINETTE MARTINEZ¹. ¹California State University, Chico, ²San Jose State University, ³Chairwoman of the Muwekma Ohlone Tribe.

Paleodietary analysis of botanical and faunal remains has revealed the menu available to residents of California's Santa Clara Valley during the Middle and Late Periods; however, the relative contribution of dietary components cannot be accurately assessed using these methods. Stable isotope analysis of human bone from the Yukisma Mound (CA-SCL-38) provides direct evidence of the relative contributions of dietary macronutrients, as bone is built from the foods consumed during life.

This presentation explores the dietary patterns of the ancestral Muwekma Ohlone population buried in this mortuary mound, located in what is now Milpitas, California. Stable carbon and nitrogen isotope analysis of bone collagen and bioapatite is used to assess dietary patterns of 126 individuals, interred between 1700 BP and 180 BP. Results show a mean collagen $\delta^{13}\text{C}$ value of -19.0‰ , with a range from -20.3‰ and -17.3‰ . Collagen $\delta^{15}\text{N}$ values yield a mean of 8.4‰ and range 5.8‰ to 12.8‰ . Bioapatite $\delta^{13}\text{C}$ reveals a mean value of -14.1‰ , with a range of -16.2‰ to -11.9‰ . These values are compared to local foodweb isotopic values derived from archaeological and modern animal resources. The results suggest a diet primarily composed of terrestrial foods, but with a significant marine component.

Finally, consideration is made of dietary variation within this population. The ranges of values from stable isotope studies cannot be entirely explained by temporal change, age, or sex of the individuals, but may be explained by a relation-

ship between social roles, ascribed social status, and differential access to foods.

Revisiting health in Neolithic Çatalhöyük: a study of growth and development.

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Depressed skeletal growth is an expected consequence of sedentism and increased population density. Previous studies suggest that health was poor in Neolithic Çatalhöyük, one of the earliest large-settled farming communities. However, growth patterns have not been systematically examined to test these expectations. Growth of juveniles from Neolithic Çatalhöyük was evaluated from stature (n=32) and body mass (n=28), derived from femoral length and femoral head breadth, respectively. In addition, percent cortical area, a more environmentally sensitive parameter, and femoral polar section modulus, a measure of overall strength, were determined at femoral midshaft. Male and female adult means (n=20) provided growth end-points. These were compared with a proto-historic Arikara sample (Sully sites; juvenile stature n=27, body mass n=25; adult: n=20) and mid-twentieth-century US Denver Growth Study yearly averages (n=20). Within the Çatalhöyük sample, potential differences related to social status were examined through burial location. Polynomial regressions plot Çatalhöyük statural growth similar to Denver until late childhood (when Denver increases) and comparable to that of Sully. Body mass is more similar among all three samples, although the Denver sample again shows an increase during adolescence. Femoral polar section modulus and percent cortical area do not differ significantly for age from the Sully sample. Burial location does not impact growth in stature, body mass, percent cortical area, or polar section modulus. Long bone ontogenetic patterns of this sample do not support expectations of negative environmental impacts on health or growth during the Neolithic at Çatalhöyük. Rather, they suggest a relatively healthy and vigorous community. Research supported by National Geographic Society (to CSL and CBR).

Reconstructing the vomeronasal system of the earliest primates.

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Traditionally, primates have been characterized by a reduced reliance on olfac-

tion compared to other mammals. In part, this generalization is biased by absence of a functional vomeronasal organ (VNO) in catarrhines, despite its presence in strepsirhines, tarsiers, and platyrrhines. The latter taxa vary in VNO morphology, for example in neuroepithelial thickness or lumen diameter. The character state of the VNO in stem primates is unclear. In this study we used linear dimensions of the "vomeronasal groove" (VNG) to predict VNO morphology in early primates. Measurements of this osteological feature correlate highly with VNO dimensions in extant primates. Histological sections and CT scans of 54 primate crania (including 13 strepsirhine and 11 haplorhine genera) were inspected for a VNG and linear dimensions were recorded. Parsimony reconstruction was performed to predict ancestral character states of VNO functional categories and VNG linear variables. Results of parsimony analyses predict the last common ancestor of primates possessed VNO similar to strepsirhines in functional category and linear dimensions. Predicted VNG length and width, when adjusted for size, were more similar to lorisiforms. The large VNG dimensions of some cheirogaleids (especially *Microcebus*) appear to be derived, which merits consideration when they are used as an extant model for stem primates. Early primates were probably heavily reliant on olfaction like extant strepsirhines, and the vomeronasal system has experienced expansion and reduction in lineages in response to different socioecological conditions. Future research will test these interpretations by including VNG data from fossils of plesiadapiforms and early euprimates.

Quantifying sexual dimorphism in craniofacial trait morphologies using 3-D laser scanning.

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Sex differences in human craniofacial traits have been traditionally evaluated using qualitative methods. Quantification of these morphological traits, such as browridge and chin shape, typically does not extend beyond ordinal categories assigned using the illustrative scales provided in standard sources, such as *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker, 1994). This approach includes a certain degree of subjectivity, does not take into consideration population-specific variation, and drastically limits possible statistical analyses. Consequently, it is not conducive to interpopulation comparisons of sexual dimorphism in these discrete traits, and may explain the lack of such analyses in the literature.

This study describes a method using a morphometric approach to quantify sex differences in browridge and chin morphologies from 3D laser surface scans. The isolation and segmentation of these features from the remainder of the skull is described. Several characteristics are derived, including measures of bone volume and projection, as well as Principal Components following Generalized Procrustes superimposition. The methods are applied to a recent US black sample from the Terry Collection (n=30 males and 30 females). Results suggest that the proposed methods provide an objective manner to document and compare sexual variation in browridge and chin morphology. The quantification of sex differences in these trait morphologies benefits numerous anthropological disciplines. It provides a means to test for population differences in cranial trait dimorphism, determine if population-specific sex identification standards are necessary, evaluate factors contributing to variation in sexual dimorphism, and could be extended to human evolutionary studies.

They died in the Great Irish Famine. Biocultural and palaeopathological study of mass burials from Kilkenny Union Workhouse, Ireland.

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The recent development at the former union workhouse in Kilkenny City, Ireland, has revealed 63 mass burial pits containing the skeletal remains of a minimum of 970 individuals dating to the Great Irish Famine (1845-52). Although the skeletons represent the tragic inevitable end for many people during the catastrophe that was the Great Famine, the bones have the potential to offer a unique insight in understanding how the calamity struck the lowest levels of society and what the conditions in the workhouse were like. Archaeological research of historical periods has often given a contrasting conclusion with the written records, and the archaeology of the Great Famine has only recently been considered. A study on the impact of the Famine, from an osteoarchaeological and palaeopathological perspective in a multidisciplinary approach, will undoubtedly yield new information pertaining to this massive national and social catastrophe in the relatively recent history of Ireland. The biocultural and palaeopathological research in this project aims at exploring the human experience of the Great Famine by those who did not survive. The skeletal remains represent a social strata which in the Victorian society was very poorly treated, and usually only referred to as a collective – as 'paupers'. The skeletons do also give direct reflection of the impact of the Famine, by indicating a high non-adult mortality, as well as a widespread suffering of

scurvy. Furthermore, cases of craniotomies and amputations have given further insights into the management of the crisis by the workhouse institution. This research is supported by Margaret Gowen & Co. Ltd.

Does cortisol suppress testosterone under day-today conditions? Evidence from a large cohort of young adult Filipino males.

LEE T. GETTLER¹, THOMAS W. MCDADE¹ and CHRISTOPHER W. KUZAWA¹. ¹Department of Anthropology, Northwestern University.

Life history theory posits that under stressful circumstances organisms will enhance energetic investment in functions necessary for survival while reducing allocations to reproduction. Among male mammals, these trade-offs are sometimes mediated in part through the increased production of cortisol (CORT), which can lead to reduced reproductive investment via suppression of testosterone (T), a key androgenic steroid. However, less is known about the relationship between the two hormones under basal conditions when organisms are not facing potent stressors. Here we evaluate relationships between waking, pre-bed and 30-min post-waking salivary CORT and waking and pre-bed salivary T, and also with plasma total T and luteinizing hormone (LH), in a large population-based birth cohort of young adult Filipino males (20.8-22.6 years, n = 695). Data come from the Cebu Longitudinal Health and Nutrition Survey. T and CORT were significantly positively related in waking (r=0.36) and evening (r=0.31) saliva samples (both p < 0.001). These relationships were not changed after adjusting for a range of socio-demographic, anthropometric, behavioral, and health covariates. Evening CORT was also weakly positively correlated with plasma total T (r=0.08, p < 0.05) and LH (r=0.07, p < 0.10). Men reporting stress on the day of sampling also showed lower evening T and slightly higher waking CORT; however, the effects of self-reported stress on T were not mediated by CORT. We suggest that the two hormones complementarily prepare men energetically, psychologically, and behaviorally to face the challenges of the day.

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Plio-Pleistocene biogeography of the African papionins: implications for early hominin dispersals.

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Early hominin biogeography is contested and poorly understood. Depending on the analysis, two to seven Plio-Pleistocene dispersal events between

East and South Africa have been hypothesized. To better understand hominin evolutionary history and biogeography, the biogeography of contemporaneous mammals, especially primates, can be used to test different hypotheses. African papionins have long been argued to be useful adaptive and phylogenetic models for human evolution. However, while Plio-Pleistocene African papionin monkeys are found at nearly all East and South African hominin sites, their evolutionary biogeography remains unclear. The current study investigates African papionin biogeography by treating biogeography as an unordered cladistic character and African biogeographic regions as character states. To infer dispersal events, biogeographic character states for each fossil and extant African papionin taxon are mapped onto a cladogram derived from craniodental data, and the resulting biogeographic patterns are then compared to those hypothesized for contemporaneous hominin taxa during the African Plio-Pleistocene. Results indicate that African papionin dispersal patterns largely mirror those of early hominins and, in at least one case, may oppose general mammalian trends. Suggestions of unique behavioral adaptations to account for early hominin biogeography and dispersal patterns, therefore, seem unwarranted. In addition to hypothesized dispersal events between East and South Africa, African papionin monkeys appear to document a biogeographic connection between West and South Africa ~2.3 - 1.5 Ma. Future research is necessary to determine if this hypothesized faunal connection may have involved other mammalian taxa, such as hominins, as well.

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Data architecture in field paleoanthropology.

W. HENRY GILBERT. California State University, East Bay and Human Evolution Research Center, University of California, Berkeley.

Everyone agrees that data sharing is good, but considerable investment is required to build and manage large datasets. Raw data is collected, compiled, and thoroughly revised on its way to publication. Published data is generally highly refined relative to raw data. Traditionally, investigators built databases privately and 'published' contained data as printed statements, figures, or tables. Increasingly, however, permanently accessible databases are viewed as stable, citable final repositories of knowledge.

Stereotypes notwithstanding, current barriers to data access in paleoanthropology are less about cupidity than sociological logistics and a lack of standard data models and 'lookup' tables

(cross-walks). Many parameters and relationships are standard across projects, and well-designed data models radically improve the potential efficiency of data management and sharing.

Projects like RHOI (the Revealing Hominid Origins Initiative), the Middle Awash project, and the Kesem Kebena project have been actively involved in data modeling and global electronic data sharing. An RHOI survey of veteran field paleoanthropologists led to the thorough, detailed, field-tested RHOI Database Template and user manual. The Middle Awash project has developed the means to give the larger scientific community unrestricted, but efficient, access to paleontological data and serves approximately 20 fields in a quickly searchable visual paleontology database.

Information presented will include a field paleoanthropology data dictionary with field names and thoroughly-tested field definitions, a diagram of the relational databases used to manage data for RHOI and the Kesem Kebena project and a discussion of software platforms and development environments.

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Consequences of alpha male chimpanzee dominance strategies.

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Alpha male chimpanzees have been reported to exhibit distinct dominance 'styles', ranging from 'despotic' to 'cooperative'. However, given the species' long lifespan, it has not been possible until now to quantify this variation. As a result, little is known about the evolutionary consequences of dominance style. Here, I use fifty years of data on 10 alpha males in two communities of wild chimpanzees in Gombe National Park, Tanzania, to 1) document variation in alpha male behavior and 2) test the hypothesis that aggressive alpha males achieve higher reproductive success during their tenure than more peaceful alpha males. On average, the alpha male exhibited a significantly higher dominance display rate than the other adult males in the community. There was considerable inter-individual variation in the proportion of these displays that included contact aggression. However, behavioral and genetic data show no clear relationship between aggression and reproductive success. This suggests that less aggressive males

use alternative behaviors such as grooming to placate their rivals and maintain their position at the top of the hierarchy. Three distinct strategies emerged – low aggression coupled with frequent grooming; high aggression and infrequent grooming; and high rates of both aggression and grooming. This study highlights the importance of inter-individual behavioral variation for understanding the pattern of interactions and relationships in a long-lived social primate species with important implications for human evolution.

This study was funded by the Jane Goodall Institute and Duke University.

There's nothing humerus about cremation: a study of distal end humeral burn patterns.

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Color is one characteristic useful in determining the conditions under which bones were burnt. In this study, Munsell color charts and L*a*b values determined with a spectrophotometer were used to assess the color of humeral distal ends excavated from charnel house A22, located at the Early Bronze Age (2950-2200 BC) site of Bab edh-Dhra', Jordan. It was hypothesized that the bones would exhibit color patterns consistent with burn patterns from the fire that destroyed the burial structure, different from the pattern seen in intentional cremation. Two regions of the humeri, an articular surface and a non-articular surface, were examined. It was expected that if fully articulated bodies were intentionally burned the articular surface would be consistently less burnt than the other areas of the bone, due to shielding effects. The degree of burning on the humeri in relation to provenience within A22 was also examined for discernible patterns. Over 50% of both the articular surfaces (79/146) and non-articular surfaces (87/155) were burned to a temperature hot enough that they turned gray and white. There was no significant difference in burn color between the 146 articular surfaces and 155 non-articular surfaces ($\chi^2=0.30$, $p=0.86$), suggesting that intentional cremation of articulated skeletons was likely not performed in Bab edh-Dhra'. Additional results imply burning in A22 was concentrated along the periphery of the house, particularly along the east wall. These findings provide a new understanding about the mortuary practices of this site during the Bronze Age.

This study was funded by a National Science Foundation Research Experiences for Undergraduates grant (SES 1005158).

Surface and deep structure of the central sulcus in the human and chimpanzee neocortex.

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Primate brain evolution has resulted in a large increase of neocortical folding. As a result, 60% of the cerebral cortical surface is buried within sulci in humans. Positron-emission tomography (PET) studies of regional cerebral blood flow in humans suggest that cortical regions exposed on the brain surface and cortical region buried in the fundal zones at the bottom of sulci may play a distinctive role in higher cognitive processing. For a better understanding of the neural basis of human cognition in a broad comparative context, it is therefore of interest to determine whether the surface structure of sulci differs from their fundal structure across primate species.

Surface reconstructions of the central sulcus were examined together with tangential sections across the cortex. Our sample consists of MR scan data of post mortem adult brains. The composition of the sample includes 15 humans, 32 common chimpanzees (*Pan troglodytes*), 3 bonobos (*Pan paniscus*), 8 gorillas (*Gorilla gorilla*) and 8 orang utans (*Pongo pygmaeus*). Both sexes are equally represented. Data were processed for 3D reconstruction using Amira 5.3.1 (Visage Imaging). We here confirm that although the surface structure of the human central sulcus is highly variable, its deep structure is remarkably consistent. The fundus of the human central sulcus is divided in two limbs by a complex junction located between the interhemispheric and Sylvian fissures. We examine the similarities and differences between human and great apes concerning the relationships between surface and deep structure of the central sulcus.

Part of the great ape specimens used in this study was on loan to the Comparative Neurobiology of Aging Resource supported by NIH AG14308. This work was supported by the European Commission, contract number 029023.

Supernumerary vertebrae and other spinal pathology in three 17th century crypt mummies from Germany.

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A small group of mummies rest in the von Crailsheim family crypt, at Som-

mersdorf Castle, in southern Germany. All of the mummies date to the 17th century, and all are naturally preserved, due to the air flow in the crypt area. To date, the German Mummy Project has examined three of the mummies in the crypt: the Baron von Holz, Sophie von Kniestätt and the Baroness Schenck von Geyern. There is limited historical documentation related to these individuals and very little was known about the three adults. DNA analysis to determine the specific kinship relationship between all three individuals has been inconclusive so far.

Using a Siemens Definition Dual Energy Source CT scanner and medical imaging software (OsiriX and Mimics), all individuals were assessed for age-at-death, evidence of trauma or pathology and identification of potential cause of death. Analysis of the CT data indicated that all three adults had evidence of spinal pathology. All three individuals had supernumerary vertebrae: two with non-sacralized L6 and one with a non-lumbarized C8. Both women had sacral spina bifida occulta and extreme spinal curvatures, the severity of which was made clear through the 2D visualization and 3D reconstruction during the medical imaging. One of the women may have had tuberculosis; DNA testing for this is pending. The spinal pathology of these individuals is interpreted within the bioarchaeological context of the Thirty Years War in Germany (1618-1648).

Climatic and other trends in the femoral neck-shaft angle: a global study of variation among modern human groups.

IAN GILLIGAN. School of Archaeology and Anthropology, Australian National University.

The femoral neck-shaft angle (NSA) varies widely between and within modern human groups, and between modern and earlier hominin species. Debate surrounds the question of whether this NSA variation relates mainly to body shape and climate (as a morphological trend associated with Bergmann's Rule) or, instead, to population differences in habitual activity patterns (forager, agricultural and urban lifestyles, for example). Previous studies have shown inconsistent and even contradictory findings with respect to climate, lifestyle and also gender patterning in the NSA. However, these have been hampered by measurement problems (for instance, reliance on radiographs) and limited population sampling. The present study reports results from an extensive survey of the NSA (measured by hand-held goniometer) involving over 8,000 adult femora derived from 100 samples (80 countries and 20 additional groups including Ainu, Andamans, Fuegians, Inuit and Pygmies). Analyses demonstrate consistent correlations

between group NSA means and climatic indices at global and continental levels, consistent with predictions based on Bergmann's Rule. No difference between male and female NSA is found, and associations with economic categories are generally weak. However, one lifestyle variable (clothing) shows an interesting effect: a reduced NSA range with thermally-effective clothing. Also, unexpected evidence for bilateral asymmetry is revealed: a small difference between left and right NSA, attributable to right leg dominance. The unprecedented size and geographical coverage of this study allows these findings to be generalized and to resolve key questions regarding climatic and other sources of variation in the femoral NSA among modern humans.

A comparative framework for the interpretation of antemortem tooth loss in Neandertals.

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Multiple fossils of the hominin species *Homo neanderthalensis* show evidence of severe antemortem loss of teeth. Researchers have interpreted the survival of these individuals as an indication of human-like behavior—such as cooking or conspecific care—in this extinct species. One inadequately tested prediction of these interpretations, however, is that recent humans actually differ in their frequency of antemortem tooth loss (AMTL) from our closest living relatives, non-human primates.

This study investigates dental pathology in a sample of 214 individuals from *Pan troglodytes*, *Papio hamadryas*, and several populations of recent modern humans with varying diets to determine if there is a difference between humans and non-human primates. Mann-Whitney U and Kolmogorov-Smirnov two-sample tests of the data indicate that the average proportion of teeth remaining per individual in humans is significantly smaller than that of both *Pan* and *Papio* ($p=1.2 \times 10^{-5}$ and $p=9.1 \times 10^{-4}$ respectively) and the shape of the human distribution is significantly more dispersed ($p=9.4 \times 10^{-5}$ and $p=9.8 \times 10^{-4}$). The non-human primate averages ($p=0.89$) and distribution shapes ($p=0.1$) are not significantly different from each other.

These preliminary results support the hypothesis that modern humans have a higher frequency of AMTL than do non-human primates. Because there were non-significant differences between the non-human primates despite significant differences in ecology, these results further suggest that the increased frequency of AMTL observed in modern humans is not related to ecology, and therefore they tentatively support hypotheses that link increased AMTL frequency to the evolution of human-specific behaviors. Ongoing data collection will contribute further to these results.

This study was funded with generous support from the Leakey Foundation, University of California, Davis, Department of Anthropology Summer Fellowships, and the UC Davis Institute of Governmental Affairs.

Linear enamel hypoplasias and the dietary adaptations of *Cebus*.

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Linear enamel hypoplasias (LEHs) are generally accepted markers of nonspecific physiological disruption most often attributed to malnutrition or disease. Malnutrition especially has been documented in human and non-human primates as an important factor influencing development of LEHs in the permanent dentition. This study examines whether or not LEHs can be used as indicators of relative foraging success, an extension of relative levels of malnutrition, within a well-studied platyrrhine genus, *Cebus*. To test this relationship, LEH frequencies were calculated based on observations of the mandibular canines of 176 individuals of *Cebus apella*, *C. albifrons*, and *C. olivaceus*. The salient dietary differences among these species relate to alternative foraging strategies adopted during times of scarcity. *Cebus apella* fall back on hard nuts, while *C. albifrons* and *C. olivaceus*, lacking comparable craniodental adaptations, rely on other behavioral adjustments to meet their requirements. *Cebus apella*, with its specialized dentition, is predicted to show relatively lower frequencies of LEH because it can monopolize a niche unavailable to sympatric congeners lacking such specializations. The results of this study do indicate a difference in LEH frequency among species of *Cebus*, but not in the predicted direction. *Cebus albifrons* shows significantly lower frequencies of LEHs compared with its other congeners ($\chi^2=14.58$, $df=4$, $P=0.0057$). Thus the specialized dentition of *C. apella* may not reflect a nutritional advantage compared with the behavioral adaptations in other members of the genus even though it seems to allow for a wider geographical distribution and may minimize competition under sympatry.

This work was supported by the New York Consortium of Evolutionary Primatology, NSF DGE 0333415 (NYCEP IGERT).

Thermal imaging and iButtons: a novel use of two technologies to quantify the daily thermal profiles of wild howlers (*Alouatta palliata*) and their habitats at La Pacifica, Costa Rica.

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Thermoregulation is a key element of primate physiology. The significance of temperature is highlighted in on-going debates involving heat stress and thermoregulation in human evolution, particularly since our arboreal ancestors experienced body hair loss and likely increased heat load upon moving into the savanna. Despite this debate, actual body temperatures, and possible heat load, have only been measured for baboons and dwarf lemurs among wild primates. Many primate studies have recorded ambient temperatures at observer locations or nearby weather stations, but not the animal's body temperature or the ambient temperature in the animal's immediate vicinity.

To quantify the thermal profiles of howlers and their arboreal habitat, we employed thermal imaging and datalogging to record continuous ambient and body temperatures for free-ranging mantled howling monkeys (*Alouatta palliata*) at La Pacifica in Costa Rica. Thermal imaging is a noninvasive tool that measures surface infrared radiation (i.e., similar for black, brown, or white skin). iButtons are small temperature dataloggers that were attached to collars or anklets and surgically implanted subcutaneously.

Internal temperatures ranged from 41.8°C–33.3°C with corresponding ambient (i.e., ankle or collar) temperatures of 33.7°C–23.3°C for the same individuals. As expected, internal and ambient temperatures were consistently lower at night, but periods of rain also reduced both internal and external temperatures. These results demonstrate greater temperature fluctuations in a homeothermic animal than previously reported. Thermoregulation in response to rain and ambient night-time temperatures likely impacts energy budgets in terms of dumping heat or maintaining core temperatures.

The study was funded by NSF Grant (BCS-0720028/0720025).

Male homosexual behavior in *Cercopithecus mona*.

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Cercopithecus mona males living outside of family groups often coexist in small, tightly-bonded, all-male groups and regularly practice homosexual behaviors, demonstrating that male-male competition for females does not preclude male-male social bonding. Our

data indicate that homosexual sex plays a large role in male mona monkeys' daily activity patterns: more than 20% of their time is spent in direct affiliative contact and only 0.3% is spent practicing agonistic behavior. Outside of mounting behavior, sexual activity among mona monkey males shows little resemblance to heterosexual behavior: the sexual repertoire is wider, all-male sex shows little relation to dominance and no seasonal fluctuation, and the level of affiliative and sexual behaviors remains constant regardless of changing group membership. Autosexual behaviors in extra-group males are also common, suggesting that these behaviors are not a preparation or substitute for heterosexual activity. We suggest that homosexual activity benefits the participants by easing tension, reinforcing bonding, and creating pleasure.

Insights into the investigation of Late Bronze Age populations in Transylvania.

SABRINA GLOUX. ArchaeoTek – Canada.

Archaeology is well developed in Eastern Europe and helps acquire relevant information to better understanding the ways past populations lived and expanded throughout the European continent. While, in Romania, archaeology has done much in that sense, physical anthropology has been disregarded or limited to basic identification of sex and age.

The ArchaeoTek osteology workshop program is part of a wider project focusing on the study of Late Bronze Age populations from the Noua-Sabatino-Coslogeni Complex (NSCC). This project focuses on the Transylvanian component of the Noua Culture. In this area, the Noua civilization is known mostly from the study of cemeteries. As a result, the Noua population is structurally invisible due to the absence of data regarding settlement, spatial organization and social structure. The study of the Noua graves has been done almost exclusively from an archaeological perspective. The scope of the project is to investigate a sample of the Noua population in terms of advanced morphology, DNA and stable isotope studies. The goal is to achieve a better understanding of these populations by examining who they were, where they were coming from, how they lived, and their geographic and cultural radiation. The osteological material being studied (135 individuals) is stored at the National Museum of History of Transylvania (MNIT) in Cluj-Napoca.

The purpose of this paper is to present preliminary results from a 2 months investigation of 40 individuals. In regards to the first set of analysis, the preliminary conclusions are encouraging and highly promising for the future of this project.

Age at death estimation in an Italian archaeological sample: a test of the Suchey-Brooks and transition analysis methods.

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The application of aging methods in bioarchaeological contexts is problematic for several reasons, including the limiting structure of the age intervals and age mimicry of the reference sample. Boldsen et al. (2002) attempted to combat these issues by suggesting a combination of transition analysis and a Bayesian approach. In this paper, we test the accuracy of both the Suchey-Brooks method alone, and the application of transition analysis to the Suchey-Brooks method, expecting the incorporation of the statistical component will significantly increase the accuracy of estimating age at death. Pubic symphyses from 202 males and 188 females of documented age from a modern Italian collection from Sardinia were scored using the Suchey-Brooks method. Transition analysis was conducted separately on the sexes. A Gompertz model was applied to a second modern Italian sample from northern Italy to estimate a prior age at death distribution. Probability density functions were used to generate the highest posterior density regions. Finally, following the suggestion by Konigsberg et al. (2008), cumulative binomial tests were run with 50% coverage to quantify the performance of each aging approach.

The transition analysis technique performed significantly better than expected, while the Suchey-Brooks coverage yielded significantly poorer age estimates. Using an informative prior led to results that provided significantly better coverage of the stages than mere application of an aging technique. This paper demonstrates the necessity for conducting transition analysis to estimate age in archaeological samples. Moreover, the conclusions here can be extrapolated to forensic contexts.

The data collection was facilitated by a grant for Samantha M. Hens from the Office of Research and Sponsored Projects, California State University, Sacramento.

A time frame for butchery of giant lemurs and sifakas at Taolambiby, SW Madagascar.

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We compiled new and previously published ¹⁴C dates on animal bones from Taolambiby, a subfossil site that has revealed the earliest evidence of human megafaunal butchery in Madagascar. Sixty-eight dates on specimens belonging to 4 extant and 7 extinct species and ranging in age from 3270 Cal BP to modern are now available. Samples were derived from four collections representing four localities at this site, each with different percentages of extinct and extant taxa. One in particular, the Walker collection (1185 Cal BP to modern), comprises predominantly extant species. A dated microfossil record associated with the older Burney collection shows stratigraphic proxy evidence from coprophilous fungus spores for decline of the megafauna. It also documents changes in fire regime and vegetation.

Fifteen dated bones show signs of butchery, including a giant tortoise (2225 Cal BP) and a giant lemur, *Palaeopropithecus* (2250 Cal BP). Thirteen butchered *Propithecus* (sifakas) from the Walker collection range in age from 1015 Cal BP to modern. These data suggest an early presence of humans in southwest Madagascar and a megafaunal population decline prior to 1000 years ago when sifakas became primary local targets of human hunting. They also document body size reduction in the hunted sifaka population. The evidence presented shows that megafaunal population decline preceded the drought at 950 Cal BP that has been posited as triggering megafaunal extinction in Madagascar. Although climate may have played a role in subsequent ecological changes, megafaunal decline at Taolambiby seems to correlate with evidence for human arrival.

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Does breeding seasonality predict receptive synchrony and reproductive skew among non-human primates?

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Among non-human primates, male reproductive skew appears to be affected primarily by receptive synchrony and the number of males per

group. These factors have frequently been assumed to depend on breeding seasonality, with strong seasonality increasing receptive synchrony, which in turn reduces the strength of male monopolization associated with more males and lower skew. In this study, we tested the importance of breeding seasonality as a factor affecting female receptive synchrony and male reproductive skew. We obtained data from the literature on genetic paternity, number of males per group, female receptive synchrony, and seasonality of breeding (percentage of months with births and mean vector length from circular statistics on births) for 28 populations representing 19 taxa living in multi-male groups. We analyzed these data using hierarchical regression by sets and controlled for the effect of evolutionary relationships using phylogenetic generalized least squares. As expected, male reproductive skew was significantly negatively associated with the number of males per group ($P < 0.01$) as well as increasing female receptive synchrony ($P < 0.01$). Contrary to general expectations, breeding seasonality did not explain variation in reproductive skew over and above the variation explained by synchrony and the number of males per group. Seasonality alone did not explain much variation in skew and there was no significant association between breeding seasonality and synchrony. These results are consistent with limited control models for reproductive skew. At the same time they suggest that breeding seasonality is not the driving force behind receptive synchrony and hence not driving male reproductive skew.

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Potential population-specific selection on copy number variants (CNVs) in indigenous American populations.

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Copy number variants (CNVs), which are gains and losses of stretches of DNA among human genomes, constitute to a considerable fraction of the genomic variation. These variants were implicated in several evolutionary and medical phenotypes, as well as in recent, local environmental and dietary adaptations. Several high-resolution studies revealed thousands of CNVs within Asian, European and African populations. However, the distribution of these variants and their possible effect on phenotypic variation within continents is largely unknown.

In this study, we comparatively interrogated the common CNVs and their possible functional impact within three indigenous American populations. Specifically, we used a custom designed an array comparative genomic hybridization (aCGH) platform to interrogate ~20,000 copy number variable loci in a limited number of Surui (n=5), Maya (n=3), Pima (n=5) and Mongolian (n=10) samples against a European reference individual. We documented a total of 3,021 CNVs that are observed in more than one individual in our sample set. We found that 290 of these CNVs that are common (>20%) within specific indigenous American populations, absent in 10 Mongolians and rare (<5%) in African, Asian and European populations (indCNVs). This large number of indCNVs is expected due to bottleneck event that ancestors of contemporary indigenous American groups underwent during their migration into Americas. However, we observed that 147 (~50%) of the indCNVs are exonic, whereas of the overall dataset only 651 (~21%) overlap with exons. This observation may indicate an increased frequency of at least some indCNVs due to selection rather than founder effect.

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An epistemological investigation into the different theories on the rise of behavioural modernity in the hominin lineage.

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A distinction is made between the rise of anatomical and behavioural modernity.

"Anatomical modernity" is a theoretical concept defined by anthropologists (Tattersall, Schwartz, Wood, Johanson, Wolpoff, ...), that refers to a set of well-demarcated traits possessed by fossils and modern skeletons alike, such as small teeth, gracile bones, reduced prognathism, etc.

"Behavioural modernity", is an abstract notion that is introduced by archaeologists (Mellars, d'Errico, McBrearty and Brooks, Klein, Conard, Henshilwood, Zilhão, ...), but contrary to the notion of anatomical modernity, its meaning is liable to changing theories. First, I will examine the way in which "behavioural modernity" is defined by various authors. Secondly, the different theories on the rise of behavioural modernity are examined in light of the suggested time periods in which behavioural modernity arose (400,000; 250,000 or 50,000 years ago).

It will be argued that the lack of consensus within these different theories together with the lack of scientific grounding of why certain behavioural

traits are modern rather than archaic make it necessary to realize that at present adding the label "behaviourally modern" to a certain trait or species is inflicting a value judgement rather than making a scientific statement on a trait or species. Epistemological guidelines will be provided that allow one to overcome this problem.

Factors that influence the biomass of frugivorous anthropoid guilds in African communities.

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What limits primates? In Paleotropics, protein-to-fiber ratio in mature leaves (Protein/ADF ratio) is the determinant of colobine biomass, while fruit productivity was correlated with Neotropical primate biomass. As for frugivorous primate biomass, basal area and density of endozoochorous trees were the ecological correlates in the Neotropics. Major ecological correlates that could explain the variations seen in the biomass of African frugivorous primates have not been recognized to date. Here I conducted correlational analyses (Pearson $a < 0.05$) on the biomass of individual African anthropoid guilds (groups of species that exploit similar resources): apes, terrestrial mangabeys and *Mandrillus* spp., arboreal mangabeys, frugivo-folivorous guenons, frugivo-insectivorous guenons, frugivo-semivorous guenons, and colobines in relation to some ecological characteristics of ≥ 10 African communities that were obtained from published studies. Ecological characteristics examined include the number of dry months, Temperature/Precipitation (T/P) ratio (dryness index), soil pH, % of Caesalpinioideae tree basal area, and Protein/ADF ratio. This study found: (1) soil pH positively correlated with the biomass of frugivo-insectivorous guenons, but the number of dry months/yr is negatively correlated with their biomass; (2) T/P ratio is positively correlated with the biomass of frugivo-semivorous guenons; (3) no correlation with any ecological characteristics was found for the biomass of frugivo-folivorous guenons, except with the biomass of frugivo-insectivorous guenons; (4) Protein/ADF ratio is positively correlated with the biomass of apes, but sample size is small (N=5). No unifying factor determines the biomass of all anthropoid guilds, because each guild is adapted to a unique set of ecological conditions.

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The role of comparative databases in paleoanthropology research.

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Paleoanthropologists lament that they have insufficient evidence and stress the pressing need to recover more fossils. However, our community also needs information systems that allow for the best use of the fossil evidence we do have. Researchers spend an inordinate amount of time searching for basic information about the hominin fossil record; for most hominin sites only the simplest data about the fossils found there are available and even those data often have to be mined from several sources. The situation with respect to comparative data is often worse: while metric data for fossil specimens are often published, metric data for extant specimens usually are not. The dearth of databases that contain more than the most basic information about museum collections of the obvious comparator taxa means that researchers, both senior and junior, often collect data that are the same or very similar to data that have already been satisfactorily collected by others. This duplication of effort obviously wastes time and precious grant resources that could be better spent on productive, novel research. Duplicated efforts also expose collections to needless handling that gradually and inevitably degrades the sources of the data that lie at the heart of our discipline. Databases have the potential to address these issues, although in doing so new data issues arise. We will use our Human Origins Database (humanoriginsdatabase.org), which includes data from both fossil hominin and extant African ape specimens, to illustrate some of the benefits and challenges presented by comparative databases in paleoanthropology research.

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Phylogenetic and functional signals in the astragalus of cercopithecoids.

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Morphologists have long been interested in identifying musculoskeletal adaptations to locomotion in order to reconstruct locomotor habits in fossil taxa.

Cercopithecoidea is an interesting group in which to study the effects of phylogeny and function on postcrania because it is one of the most functionally diverse groups of primates, exhibiting the largest number of terrestrial species and possibly several evolutionary transitions between arboreality and terrestriality. I studied the astragalus of 45 species of cercopithecoids to determine which aspects of morphological variation are most strongly related to phylogeny or functional demands. 14 linear measurements were taken on each astragalus, raw measurements were converted to shape variables using a geometric mean, and shape variables were entered into several discriminant function analyses (DFAs). When taxa were coded by phylogeny the DFA separated cercopithecines and colobines with 87.3% correct classification and also separated taxa into a guenon group, papionin group, leaf monkey group, and *Colobus* group with 72% correct classification. When taxa were coded according to locomotor behavior (arboreal, terrestrial, or semi-terrestrial) the DFA separated groups with 63% correct classification. However, when semi-terrestrial taxa were coded as unknown, the DFA separated groups with 91% correct classification. These results show that the astragalus of cercopithecoids can successfully discriminate taxa by phylogeny and function in multivariate space. Additionally, these results indicate that although semi-terrestriality may be an appropriate behavioral category, the morphology of these species is being selected for arboreality or terrestriality rather than some intermediate position.

Morphological integration and correlated evolution in the hominin pelvis.

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The description of *Ardipithecus ramidus* posited the hypothesis that many of the morphological changes between the last common ancestor of chimps and humans and early hominins were the result of a simple pattern of selection on the developmental underpinnings of morphology with many correlated responses, using the hominin pelvis as a chief example. Because this idea focuses on developmental and correlated responses within a highly integrated structure, it can be tested using a methodology based in morphological integration. Patterns of integration (POI) describe the statistical relationships between morphological traits, and are the population level result of developmental processes that are influenced by both genetic and environmental effects. Using POIs from the pelvis of apes and other catarrhines, and applying evolutionary quantitative methods, this analysis shows that simple patterns of selec-

tion on non-human primates can produce significant correlated changes in many traits. However, human pelvises show significantly reduced levels of integration, as well as a POI divergent from all other apes, and a dramatically more complex pattern of selection is needed to produce a similar level of morphological change. These results suggest that selection broke down pre-existing patterns of pelvic integration in early hominins and allowed traits to respond to separate selection pressures with greater independence, a modification in the POI which might have been required to achieve the large morphological changes that permit habitual bipedalism. Consequently, hypotheses which advance a simple model of morphological evolution for this complicated structure may be called into question. This study was funded by a Sigma Xi Grants-in-Aid of Research grant, a Beckman Institute Cognitive Science/AI award, and a University of Illinois Summer Research Assistance award.

Ontogeny of bone stiffness in the mandibles of *Macaca fascicularis*.

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Material property variation of bone tissue is an important determinant of whole bone biomechanical behavior. Bone stiffness (i.e., elastic modulus) varies interspecifically in primates, and age-related variation in bone quality is an expected finding in studies of primate skeletal biology. Investigation of material property variation in baboons (Wang et al, *AJPA* 141:526-549) suggests that mandibular bone stiffness changes during ontogeny, and provides evidence that certain bone material properties (including stiffness) covary negatively with bone thickness. We investigated mandibular bone stiffness in a sample of *Macaca fascicularis* (N=25), representing juveniles, subadults and adults based on dental age criteria. Stiffness was determined from microindentation of coronal sections taken distal to M₁ (or dp₄ in the youngest individuals). We evaluated three hypotheses: 1) under the assumption that bone is less mineralized in juveniles, adults will have stiffer cortical bone; 2) given stereotypical patterns of cortical thickness in the mandible, bone stiffness will be highest in the lingual midcorpus, less along the buccal midcorpus and most compliant along the basal aspect; 3) assuming primacy of phylogenetic factors in determination of bone material properties, bone stiffness in macaques will resemble other papionins to the exclusion of other cercopithecoids (i.e., colobines).

The microindentation data reveal that adult macaques have significantly stiffer bone than their juvenile counterparts. However, macaque mandibles do not show a consistent relationship between stiffness and local differences in cortical thickness. The macaque data lend support to the hypothesis that colobine mandibles are materially more compliant than those of cercopithecines. Supported by National Science Foundation grants BCS-0922429, 0921770, and 0922414.

X-ray fluorescent spectroscopy and its research applications to Northern European bog bodies.

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To expand the understanding of Northern European bog bodies' contextual significance and the reason for death, this dissertation research focuses on the application of X-ray Fluorescence (XRF) Spectroscopy to both the skeletal remains and the surrounding burial environment of twelve bog bodies. This non-destructive testing method can provide a more objective contextual understanding of bog body burial sites, as well as determine geographic origin and/or disparity in environmental habitation of bog bodies early and late in life.

Currently, strontium is the most reliable element of interest in geographic origin and migration research. Strontium acts like calcium, incorporating preferentially into bone and tooth enamel at sites of increased osteogenesis. To enable the most accurate value ranges of strontium concentration as measured in parts per million (ppm), each body was repeatedly scanned at various pre-determined osteological landmarks. The skeletal areas scanned included any present/visible dentition, as well as trabecular bone regions found within the crania and postcrania. Comparable strontium concentration ratios from the bones and teeth could greatly assist in determining whether the bog body migrated between infancy and death, even possibly his/her birthplace. Subsequent data assessment strongly suggests diagenesis has occurred within the bog, affecting the bog body elemental levels. Though the strontium levels may be compromised due to environmental incorporation, additional analysis of the bog bodies' elemental composition, including Iron, Lead, Bromine, Zinc, and Zirconium, have provided a comprehensive understanding of the chemical interactions between the bog bodies and the bog itself in the form of elemental leaching and incorporation.

Patterns in ancient teeth: palimpsests of behavior.

DAVE GRANT. San Jose State University.

In analyzing burial populations from seven sites in the Santa Clara Valley patterns on teeth were found that did not conform to the flat normative wear explanation. The purpose of this study is to expand upon the seminal work of Molnar (1968) and Keiser (2001) and to propose a definitional refinement of wear patterns found on teeth from populations in Central California. Zero wear or normative flat wear was present, four additional distinct wear patterns were found. Wear patterns include slants and scoops on posterior teeth and rounding and grooving on anterior teeth. Statistically significant differences were identified between an older (4,000-2930BP) Northern population and younger populations from the Santa Clara Valley. Analysis of the Southern population suggests that these individuals were not utilizing their teeth as frequently to produce patterned wear and may possibly suggest an elite class that was exempt from normal processing activities. The percentage of slants, rounding and scoops all increased through time from the earlier, older, northern population to the younger, southern populations. Northern males exhibited more slant and rounding wear than females in that population. Southern males had more slant wear than females and were evenly split on the rounding pattern. Scoops, which may be related to arrow shaft processing or peeling, are overwhelmingly found in the southern population after the adoption of the bow and arrow in this area. Further research is called for to further refine and define these processes.

A bioarchaeological study of cranial trauma in the William M. Bass and Hamann-Todd collections: interpersonal aggression in America.

KATY D. GRANT and JACQUELINE T. ENG. Department of Anthropology, Western Michigan University.

This study on the patterns of interpersonal violence in America compared cranial trauma found in samples from the William M. Bass Osteological Collection (BOC) held at the University of Tennessee-Knoxville with samples from the Hamann-Todd Osteological Collection (HTOC). Individuals in the HTOC had been primarily of low socioeconomic status and had lived in Cleveland, Ohio during a time of social, economic, and political instability. Many of the individuals in the BOC had been college educated and had lived during a time when Tennessee and surrounding states were under relatively stable conditions. Because of these differences, it was

hypothesized that the BOC would have a lower rate of traumatic lesions than the HTOC.

The sample used in this study included 297 adult crania from BOC (n=152) and HTOC (n=145), including 183 males and 114 females. All crania were examined macroscopically and with the help of a hand lens. The total frequency of traumatic lesions found in all crania observed was 22.6 % (67/297). Although the BOC was found to have a higher frequency (24.3%) of cranial trauma than in the HTOC (20.7%), it was not found to be statistically significant. When testing BOC against HTOC for sex, age, and ethnic identity, no significance was found for all comparisons. Additionally, when testing for location and type of fractures (blunt, sharp, and gunshot wounds), no significance was found, with the exception of gunshot wounds (p=0.036). Implications of the results will be discussed in our poster. This study was funded by the Undergraduate and Creative Activities Award from the College of Arts and Sciences at Western Michigan University.

Effects of social cohesion, pair-bonding and monogamy on primate brain evolution.

JESSICA GRAVES, E. CHRISTOPHER KIRK and REBECCA J. LEWIS. Department of Anthropology, University of Texas, Austin.

The social brain hypothesis suggests that the cognitive demands of living in large, complex social groups were the primary selective factors favoring increased encephalization in primates. Recent studies suggest that it is the quality and complexity of social relationships rather than large group size that has selected for increased encephalization. Pair-bonded social systems and monogamous mating systems have been proposed to provide the social complexity favoring increased brain size. The goal of this study was to evaluate the importance of group size, group cohesiveness, pair-bonding and monogamy on primate brain evolution. Data on endocranial volume (ECV), body mass, social systems and mating systems were collected for 212 primate species from the literature. These data reveal that, across all primate taxa, group size is positively correlated with ECV. Furthermore, species with cohesive social systems have significantly larger ECVs than species with dispersed social systems. Species grouped by mating system and social system did not significantly differ in ECV. When these relationships were examined within infraorders, we obtained different results. Only platyrrhines showed a significant correlation between ECV and group size. Monogamous and pair-bonded catarrhine species showed significantly larger ECVs than other catarrhines. Mating and social system

showed no significant effect on ECV for all other infraorders. Our results suggest that although group size is positively correlated with ECV across all primates, the evolutionary forces acting on primate encephalization may vary among clades and the complexity of social relationships in pair-bonded and monogamous systems may not be uniform across all primates.

This study was funded by the Undergraduate Research Foundation.

The effect of auditory enrichment on the expression of abnormal behaviors in laboratory-housed infant rhesus macaques (*Macaca mulatta*).

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Environmental enrichment can reduce the expression of abnormal behaviors in captive primates. However, auditory enrichment has generated mixed results, possibly due to music choice, volume levels, or species differences. With these factors in mind, the purpose of this study was to test the effect of two different types of music on captive primates. Forty laboratory-housed rhesus macaque (*Macaca mulatta*) infants at the Oregon National Primate Research Center were observed for 19 days over a 4 week period. During Week 1, subjects were observed with no music to acquire a baseline level of behaviors (Phase 1). During week 2 subjects were exposed to white noise for 3 hours a day (Phase WN). During week 3, designer music was played for 3 hours a day (Phase DS). White noise and the designer music were played at ~72 decibels. Observations continued into week 4 to determine if changes in behavior were residual (Phase 4). Results show that exhibition of abnormal behaviors were at their highest during Phase 1, with an average of 90.5 abnormal behaviors exhibited daily. Abnormal behaviors significantly decreased over the course of the study with subjects and were lowest, at 48.6 per day, during Phase DS (X^2 : 39.3, DF: 3, $p < .001$). This research demonstrates that auditory enrichment decreases the exhibition of abnormal behaviors in captive primates. It should be noted however, that some behavioral changes could be due to increased familiarity with the researcher. Future directions should aim to address this factor, in addition to introducing other music genres.

Hominoid behavior in ecological and phylogenetic context: is it all in the (super) family?

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Selective forces play an important evolutionary role, reinforcing the preservation of adaptive qualities and diminish-

ing the frequency of maladaptive traits. In turn, the shared evolutionary history of closely related taxa may act as a constraint, effectively limiting natural selection in driving adaptation. This study evaluated the variability of behaviors exhibited by closely related taxa in different ecological contexts to identify the extent to which phylogeny affects behavioral adaptation among extant hominoids. Fourteen longitudinal studies of gorillas, chimpanzees, bonobos, orangutans, gibbons, and siamangs functioned as ingroup operational taxonomic units (OTUs). Outgroup taxa consisted of rhesus macaques and yellow baboons. Character states were coded for 74 social characters, 32 ecological characters, and four demographic characters. Phylogenetic analyses of the complete dataset and data subsets suggest that behavioral repertoires reflect the evolutionary history of the populations to some degree, but also demonstrate plasticity. Demography and life history more closely track phylogeny, while cognitive and social behaviors demonstrate greater flexibility. Sociosexual behaviors varied widely across taxa, and when analyzed as a data subset, demonstrated high levels of autapomorphy. Overall, the social behaviors of chimpanzees, bonobos, and gorillas were more similar to those of macaques and baboons, with Asian apes demonstrating behaviors that were less similar to their closest genetic relatives. Chimpanzees and bonobos from similar environments displayed behavioral adaptations that were more comparable to each other than to geographically distant populations of their own subspecies. These results suggest that behavior may be less constrained by phylogeny than suggested in previous reports.

Peripartum shifts in female sociosexuality: adaptive or pathological?

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This presentation reviews human female peripartum shifts in sociosexuality within an integrative evolutionary, comparative, mechanistic, and cross-cultural framework. An evolutionary perspective indicates that ancestral females spent the bulk of their reproductive years pregnant or subject to lactational amenorrhea. Across the peripartum period, females face life history allocation challenges between current and future reproduction. Hormones and other features of women's physiology help coordinate the increased investment in maternal behavior at expense to sexuality. Comparative nonhuman primate data indicate that females may maintain sexual behavior during pregnancy at variable rates, but these tend to plummet postpartum when females are focused on caring for a new offspring. In

humans, data from international behavioral studies and cross-cultural attitudinal surveys indicate that reductions in peripartum female sociosexuality are common, but also subject to variation due to factors including marital dynamics (e.g., reduced gestational sex and extended postpartum sex taboos in more polygynous societies) and breastfeeding (e.g., lactation tends to inhibit female proceptivity). The human and nonhuman primate data suggest both adaptive (e.g., elevated prolactin associated with lactating facilitates maternal investment at expense to resumption of ovarian cycling) and byproduct (e.g., elevated mid-gestational sex steroid levels promoting pregnancy outcomes, but incidentally enhancing libido) interpretations of these peripartum transitions in female sociosexuality. Further, human females may negotiate continued partner investment through greater expression of peripartum sexuality than would otherwise be expected. Overall, peripartum shifts in female sociosexuality are more consistent with adaptive life history allocation interpretations than some recent biomedical views of these as "pathological".

Developmental variation in great ape molar crowns.

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Investigations of tooth development have become increasingly common in characterizations of fossil ape and human dentitions. Despite this, relatively few studies report comparative data for living great apes, which are often assumed to show similar patterns of dental development. Here we quantify incremental development, including cuspal enamel thickness, daily secretion rate, Retzius line number and periodicity, crown formation time, and coronal extension rate in histological sections of great ape molars. We find that cuspal enamel thickness increases from *Pan* to *Gorilla* to *Pongo*, ranging from ~0.5-2.0 mm, depending on tooth and cusp type. Daily secretion rates are broadly similar among great apes, ranging from ~3-5 microns/day in the inner to outer cuspal enamel. These variables lead to relatively short cuspal enamel formation times in *Pan* and longer formation times in *Pongo*. Retzius line number is highest in *Pan*, while average Retzius line periodicity is highest in *Pongo*. Although there is a good degree of overlap, average molar crown formation

times increase from *Pan* to *Gorilla* to *Pongo*. Differences in coronal extension rates are particularly marked; *Gorilla* rates are higher than both *Pan* and *Pongo*. Accelerated cellular extension in *Gorilla* facilitates the formation of large tooth crowns over a period comparable to other great apes. Variation in dental development among great apes may reflect differences in life history and related variables such as body size. Future studies on individuals of known-sex and subspecies are needed to assess finer-scale aspects of great ape developmental variation.

This study was funded by Harvard University and the Institute of Human Origins, Arizona State University.

A new ~1.5 Ma hominin scapula from Koobi Fora, Kenya.

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The KNM-WT 15000 skeleton preserves the only known Early Pleistocene scapula from East Africa. As a result, it has not been possible to characterize shoulder and upper limb variation from this critical period of hominin evolutionary history. Here, we describe a new 1.51-1.53 Ma hominin shoulder fossil, KNM-ER 47000, from the Koobi Fora Formation, Kenya (FwJ 14E, Area 1A). KNM-ER 47000 is an associated right arm skeleton, including portions of the scapula, humerus, ulna, wrist, and several hand bones. The scapula consists of a complete glenoid cavity preserving a small portion of the scapula spine and neck, the proximal half of the acromion process, and the medial aspect of the axillary border.

Though fragmentary, a sufficient amount of the scapula is available to make meaningful comparisons with *Australopithecus*, early *Homo*, and a large sample of living hominoids. The orientation of KNM-ER 47000's glenohumeral joint is similar to KNM-WT 15000 in being marginally more cranially oriented than modern humans, but is considerably more laterally oriented with respect to the great apes. In contrast, the angle used to measure scapula spine orientation relative to the axillary border is more acute than in mod-

ern humans and falls within the gorilla confidence limit. Such a spine orientation is suggestive of a narrow, yet long infraspinous region, resembling that of extant apes and *Australopithecus*. This mosaic pattern is unique among fossil and extant hominoid scapulae, and suggests that some shoulder characteristics may not necessarily be developmentally or functionally linked.

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MNI and MLNI in the quantification of commingled skeletal remains: application to a large-scale Bronze Age skeletal collection.

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Minimum likely number of individuals (MLNI) represents a quantification technique rarely taken advantage of despite the potential for underestimation when calculating MNI, particularly when applied to fragmentary, commingled remains. Both MNI and MLNI were determined using the best-preserved skeletal elements from Early Bronze Age II-III (2900-2300 BCE) Bab edh-Dhra', Jordan. While MLNI has previously been applied only to small-scale circumstances of commingling, we tested the hypothesis that it is a useful method for evaluating larger commingled collections. This hypothesis was tested by osteometric sorting and pair matching of the calcanei, tali, and proximal femora.

MNI was similar for tali (n=224) and calcanei (n=215), although fewer femoral fragments gave a relatively low MNI (n=142). This indicates that in the recovered assemblage, <250 individuals are represented. Conversely, MLNI calculations display significantly elevated estimates for tali (n=1,129), calcanei (n=2,363), and femora (n=1,633), suggesting that the original number of individuals represented was substantially larger than indicated by MNI. However, MLNI results are likely exaggerated because so few pair matches could be made relative to the number of bones present; this is confirmed by extremely low recovery probabilities for all elements (r=0.184, 0.083, 0.086, respectively). Such artificial inflation is a product of taphonomic processes, including burning, that have altered the bones (e.g., warping, heat fractures) to the extent that they may no longer be visibly pair-matched. Consequently, while MLNI is a useful method when applied to well-

preserved, small-scale collections, taphonomic alteration and ability to pair match must be considered when dealing with larger archaeological assemblages.

Behavioral responses to seasonal changes in Guianan bearded sakis (*Chiropotes sagulatus*): Brownsberg Nature Park, Suriname.

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Behavioral responses to seasonal changes in resource availability have been well documented in many primate species, but little is known about how bearded sakis (*Chiropotes* spp.) adjust to seasonal variation in fruit availability. As unripe seed predators, the pitheciines are thought to be removed from intra-specific competition experienced by ripe fruit eaters. However, observations that group sizes are flexible and sub-grouping is common in both genera of larger-bodied pitheciines (*Chiropotes* up to 56-member groups and *Cacajao* > 100-member groups) suggest that feeding competition may influence group stability. In this study, conducted in Brownsberg Nature Park, Suriname from March 2008 to April 2009, we predicted that bearded sakis (*Chiropotes sagulatus*) would adjust group size, activity patterns, travel patterns, and feeding habits seasonally. Indeed, we found that during the long dry season group size decreased ($K = 12.2$, $p < 0.01$), and activity patterns ($\chi^2 = 907.9$, $p < 0.001$) and diet composition changed ($\chi^2 = 288.7$, $p < 0.001$). Group size interacted with travel distance during the dry season resulting in smaller groups and shorter travel distances ($r^2 = 0.42$, $t = 4.54$, $p < 0.001$). While other primate species use some of these strategies to withstand periods of lower resource production in the forest, this study demonstrates that, similar to fission-fusion in *Ateles* and *Pan*, flexibility in group size is also used frequently by *Chiropotes*.

Take a load off - intrinsic foot joint kinematics responding to load.

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Humans share a pedal anatomy that is fairly uniform among primates and different from other mammals. Yet, the foot is frequently cited as one of the more distinctively human features. This research asks: are the uniquely human features of the foot primarily artifacts of functional application, or are they rooted in anatomy? This study

addresses that question by comparing how the primate foot responds to load under experimental conditions.

Data are derived from feet of human, chimpanzee, and baboon cadavers. Each specimen was subjected to a vertical load via the tibial shaft while monitoring positions of the calcaneus, talus, cuboid and navicular. Functional alignment movement analysis was used to derive 6 DOF movement patterns as well as the orientation of rotational axes for the joints formed between adjacent pairs of these bones.

Conventional kinematic analyses report joint rotations as if they occur about the orthogonal axes of the anatomical reference frame. When presented in this fashion results suggest a strong functional similarity between humans and chimps, to the exclusion of baboons. However, when the orientation of the rotational axis is considered the human foot is shown to be unique, while chimps and baboons are more similar. These findings suggest a functional progression from monkey to ape to human. In this fashion, the human foot can be viewed as an extension of the primate pedal condition. Consequently, the foot of the stem hominine may not have been recognizably distinct from that of the ancestral hominid condition.

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First examinations on neolithic human bones from Göbekli Tepe, Turkey.

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Göbekli Tepe is the earliest known temple complex, located in the eastern part of Turkey. Until now, no graveyards or burials inside the buildings had been found. But as the structures were filled up with soil in Neolithic times, people took the soil from the surroundings. In this soil, 129 human bone fragments were found, the most common type being skull fragments (81). Age distribution shows 15 fragments belonging to subadults and 114 to adults. Males were represented by 18 fragments, females by 13, and in 98 fragments no statement about the sex could be made. Mostly inflammatory but also hemorrhagic diseases of the external lamina of the skull vault were found in 14/58 fragments, in the internal lamina in 8/52. The joints showed degenerative changes in 1/13 extremity joints and in 1/2 vertebral joints. Diseases of the teeth could be examined in 13 teeth. Out of the 13 teeth one had caries, six showed calculus, three had transversal enamel hypoplasias and three showed

severe attrition. There were no signs of abscesses in any of the mandibles or maxillas. In one case a severe inflammatory process of the nasal cavity had occurred. Two fragments had signs of burning, three showed cut marks and one frontal fragment had geometric carvings on it. Even if the burials were not inside the cult-place, they had different kinds of artificial treatment though they possibly belong to this place.

Population biodistance in ancient central California.

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The Vineyards site (4-CCO-548) is a central California multi-use site which dates to the Middle Archaic (4350 and 550 BC). The remains of nearly five-hundred individuals were recovered from 4-CCO-548. Mean measures of divergence were derived from frequencies of nonmetric cranial data. The MMD's were used to place the Vineyards sample in a taxonomic context with other contemporaneous regional samples. Tremendous biological variability has long been attributed to the early Native American inhabitants of the Central Valley of California. Some researchers have attributed the distinctive dissimilarity between samples to in-migrations of new people to the area. Others have found marked diversity not only between cultural horizons but also between sites attributed to the same horizon. This diversity has been attributed to isolation by distance due in part to the sedentary life style of Central California populations. The results of the present biological distance analysis in large part mirrors results found in previous ones. That is, the estimated distances between populations is quite large and taxonomic diagrams based on those distances reveal very few close relationships. This may lend further support to the contention that precontact California Native American groups practiced a relatively strict form of endogamy. However, another possibility must also be considered. Genetic drift is not just a phenomenon of geographic separation but also can be due to temporal separation. The difficulties presented by the inadequate California chronologies force researchers to place population samples in extremely long time sequences with little meaningful internal separation of those large temporal associations.

Who is more bipedal? Positional behaviour in captive bonobos and chimpanzees.

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Although bonobos are often considered to be more bipedal than chimpanzees in the wild, previous research as shown that this is not the case in captivity and that both species are equally bipedal. We provide a further test of this incongruity through an analysis of positional behaviour in captive bonobos (*Pan paniscus*) and chimpanzees (*P. troglodytes*) at the Leipzig Zoo, Germany. We analyzed video data collected over a period of nine years on bonobos ($n=8$) and chimpanzees ($n=8$) paired to the same sex and similar age. Locomotor behaviours were quantified using a step sampling method, postural positions were measured in time and the substrate used was noted for each. Chi-square tests of variation in the frequency of each positional behaviour were conducted both between interspecific pairs and across age-classes within and between species.

Results revealed that bonobos engaged in significantly more bipedalism and suspensory behaviour than chimpanzees. Infant and adult chimpanzees exhibited more quadrupedal fist-walking and knuckle-walking, respectively, than bonobos. Chimpanzees were altogether more terrestrial than bonobos, although mean frequencies of positional behaviours varied widely across individuals and age-classes. Intraspecific comparisons showed significant changes in locomotor behaviour throughout ontogeny in both species. These results support previous locomotor research in the wild that documents similar ontogenetic changes in locomotion and significant variation in the frequency of bipedalism versus quadrupedalism between bonobos and chimpanzees.

This study was funded by the Max Planck Society.

Population density and group composition in *Tarsius pumilus*.

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Between June and September 2010, I conducted a population and group census of pygmy tarsiers, *Tarsius pumilus*, as part of a study of their high-altitude behavioral ecology. Sampling took place within a 1 km² area encompassing altitudes of 2100-2300 m on Mt. Rore Katimbu in Lore Lindu National Park, Central Sulawesi, Indonesia. Over the course of 60 nights, an average of 12 mist nets were positioned and checked nightly for a total of 5,600 net-hours. Within 20 one-hectare plots, I observed five groups containing a total of 18 individuals. The mean number of groups per hectare was .25, with a mean of .9 individuals per hectare. The average distance between sleeping sites of

neighboring groups was approximately 165 m. The number of groups within the 100 ha area that was sampled is estimated to be 25, with an estimated population density of 90 individuals per 100 ha. Results suggest that in secondary moss forest, pygmy tarsiers live at a density higher than previously thought, although at a lower density than lowland Sulawesi tarsier species.

Group composition was variable. The mean group size was 3.6 individuals, and group size ranged from 2 to 5 individuals. The presence of multiple adult males and females in some groups suggests they may have multi-male/multi-female social groups. These results may be influenced by the time of the study; all groups contained an infant, a juvenile, or a lactating or pregnant female, indicating that the study occurred during a birthing season for pygmy tarsiers.

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Relationships among extension rates, crown formation time, and perikymata distribution: implications for Neandertals.

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The enamel extension rate, the rate at which enamel-forming cells differentiate along the enamel-dentine junction (EDJ), reflects how fast a tooth grows in height. Here we analyze how enamel extension rates change along the EDJ in teeth from diverse modern human populations. We also ask whether that change is related to variation in the way perikymata, growth increments on the surface of lateral enamel, are distributed along the crown. As surface structures, perikymata are an important source of information about crown growth in fossil hominins. Modern humans have been shown to share a pattern of perikymata distribution different from that of Neandertals, suggesting differences in the way their lateral enamel grew. In our modern human samples, we find that enamel extension rates in the first-formed enamel are often 10x greater than they are in the last-formed enamel, such that much of a tooth's crown height is established in a relatively short time

period. Statistically significant declines in extension rates are also found in the lateral enamel, and the degree of decline is related to the distribution of perikymata on the tooth crown. While this finding provides insight into the causes of modern human variation in perikymata distribution, it does not reveal the causes of the Neandertal perikymata distribution pattern, as other enamel growth variables can affect how perikymata are distributed. Indeed, previously published data on extension rates in the Neandertal permanent molar from La Chaise fall within the bounds of changes in modern human extension rates along the EDJ.

The *Homo erectus* from Kocabas in Turkey and the first settlements in Eurasia.

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Few fossil hominids are known in Turkey. Among them, a partial skull was discovered in 2002 by one of us (M.C.A.) in the Basin of Denizli, near Kocabas, South-West of Turkey. Dated to 500 to 330 Ka, it constitutes an opportunity to assess the modalities of the settlements in this region and, in a broader context, through Eurasia. The preserved frontal and parietal bones fragments were attributed to *Homo erectus* (Kappelman et al., 2008). Although a first 3D-reconstruction of the fossil was done, the main part of the frontal bone was still missing.

We present a new reconstruction. CT data were obtained in the Pammukkale University Hospital (Philips Scanner, 0.8 mm thickness, 120 Kv, 175 mA) and they were exported as DICOM files (512*512) and postprocessed using Mimics 13.1 (Materialise©) and Rapid-Form 2006 Inus Technology®.

Cutting planes and anatomical landmarks were used to connect the bone fragments. The left part of the supra-orbital torus was completed by mirroring the right one. Early, Middle and Late Pleistocene hominids from Europe, Africa, and Asia were used as comparisons to test a reconstruction of the damaged frontal scale of Kocabas.

Results show morphological and anatomical similarities with the Asian *Homo erectus* such as: a flatness of the biparietal vault, a strong post-orbital constriction, an cephalic rostrum. Specifically, the Kocabas fossil is closer to these from Zhoukoudian in China showing a strong sagittal convexity of the frontal scale, a marked prominence of the lateral part of the supra-orbital torus and a supratral depression.

The mediation of increased energetic demands by lactating wild chimpanzees: behavioral and hormonal considerations.

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In general, lactating females have higher energetic demands than their non-lactating counterparts. Females can meet the demands of rising energetic costs, without mobilizing stored energy, by reducing energy expenditure and by increasing energy intake. Elevated glucose metabolism as a result of both increased energy intake and demand should result in elevated levels of urinary c-peptide in lactating females.

To test for changes in behavioral patterns and urinary c-peptide in response to the elevated energetic demands of lactation, we collected behavioral and hormonal data from 24 lactating and 18 cycling, non-lactating female chimpanzees over a 12 month period at Ngogo, Kibale National Park, Uganda. A comparison of the two groups demonstrated that lactating females decrease their energy expenditure by spending significantly more time resting and less time traveling than non-lactating females. Lactating females also increase their energy intake by feeding significantly longer than non-lactating females. However, the difference in mean urinary c-peptide levels between the two groups was not significant. The lack of elevated c-peptide levels among lactating females may be due to reduced diet quality or, more likely, increased insulin sensitivity during lactation. Variation in insulin sensitivity, which is affected by factors such as body mass and reproductive status, should be considered when using c-peptide as a biomarker in field studies. Additionally, our assessment is that c-peptide is best used as an indicator of energetic intake or metabolic glucose demand, not overall energetic status.

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The effect of substrate compliance on gibbon leap biomechanics.

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The storage and recovery of elastic strain energy in the musculoskeletal systems of animals has been studied extensively, but the external environment represents a second potentially useful energy store which is often neglected. To date no such energy recovery mechanisms have been demonstrated in leapers, despite indications of energy recovery by tree swaying orangutans.

We used a forceplate and two high-speed video cameras to conduct a biomechanical analysis of captive gibbons leaping from stiff and compliant poles. We found that the gibbons minimised pole deflection by using different strategies. Two leap types were used: slower orthograde leaps used a wider hip joint excursion to negate the downward movement of the pole with no increase in work done on the centre of mass. Greater hip excursion also minimised the effective leap distance during orthograde leaps. More rapid, pronograde leaps conversely applied force earlier in stance where the pole was effectively stiffer, minimising deflection and potential energy loss. Neither leap type appeared to usefully recover energy from the pole to increase leap performance, but the gibbons demonstrated an ability to adapt their leap biomechanics best to counter the negative effects of the compliant pole.

A uniquely modern human pattern of early brain development and its implications for middle-late Pleistocene cranial diversity and cognition.

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Modern humans are significantly more variable in neurocranial shape than Neanderthals and chimpanzees. High levels of shape variability can already be observed near the emergence of our species in Pleistocene Africa. Here we study the developmental processes that underlie this pattern of cranial diversity using geometric morphometrics. Comparing adult and subadult modern humans (N=57), Neanderthals (N=10) specimens and chimpanzees (N=61), we show that many aspects of the endocranial developmental pattern are shared by the three species. However, in the first year of life modern humans depart from this presumably ancestral pattern. The characteristic globular braincase of adult modern humans is largely the result of a developmental phase that is unique to *Homo sapiens* and not present in our closest living and fossil relatives. During this "globularization-phase" directly after birth, the cranial bones are thin and the sutures are open. The species differences of the perinatal developmental trajectories therefore most

likely reflect underlying differences in the tempo and mode of early brain development.

In modern humans the largest variation of neurocranial shape within and between populations corresponds to a contrast between more globular and more elongated crania. We therefore suggest that the evolution of the postnatal "globularization-phase" contributes to the high levels of neurocranial variability among modern humans. We speculate that a shift away from the ancestral pattern of brain development occurring in early *Homo sapiens* underlies brain reorganization and that the associated cognitive differences made this growth pattern a target for positive selection in modern humans.

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Inferences from variation in linear enamel hypoplasias in overall frequencies, presence or absence of sexual dimorphism, and in the location of the lesion in the central incisors in different generations of three agricultural populations from the state of Yucatan, Mexico.

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Linear enamel hypoplasia (LEH) variation responds to living conditions. Because females are more ecosensitive than males and not all areas of a tooth are equally sensitive to LEH formation, it was expected that LEH frequency thresholds associated to presence or absence of sexual dimorphism and to particular LEH distributions within the surface of a tooth could be found.

Frequencies, presence or absence of significant sexual dimorphism and lesion location in the central incisors were compared between generations and between living agricultural populations that differed in their degree of exposure to infectious diseases, sanitary installations and access to food and medicine during early childhood. Significant sexual dimorphism was found only in our populations with overall frequencies between .65 and .64. The lesions in the central incisors of these pre-vaccination campaign populations were more evenly distributed as shown by significantly more platicurtic distributions than those of the younger and better off populations with overall LEH frequencies below .6 and above .27. Finally, overall LEH frequencies were .06 in the most affluent modern peasants with access to modern day health care. A table is presented that associates population LEH frequency with sexual dimorphism and LEH distribution in the central incisors in different published samples and proposes a scale that may be used to infer living conditions and interpret genera-

tional change in archaeological populations.

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Functional morphology of the *Theropithecus brumpti* forelimb.

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To better understand forelimb functional morphology and locomotor mode of the putatively forest adapted fossil baboon *Theropithecus brumpti*, linear measurements were collected from all available associated postcranial material as well as an extensive cercopithecoid comparative sample. Additional aspects of behavior (e.g. feeding traits, habitat preferences) were compiled for each comparative species from the literature in an attempt to identify behaviors beyond the arboreal/terrestrial dichotomy and identify postcranial features that may be related to feeding or other behaviors.

Although sometimes described as the arboreal theropithecine, when *T. brumpti* forelimb morphology is compared to 1) the comparative sample and 2) other fossil and extant *Theropithecus*, it becomes clear that *T. brumpti* was not an arboreal quadruped. *T. brumpti*'s forelimb exhibits signals of terrestriality including relatively narrow scapular infraspinous fossa, significant retroflexion of the humeral medial epicondyle and olecranon process. This is concordant with signals of terrestriality exhibited in the *T. brumpti* hand (Guthrie and Frost, 2010).

Features historically used to reconstruct *T. brumpti* as more arboreal than other members of the genus are interpreted here as part of a suite of traits that characterize early *Theropithecus* including early *T. oswaldi* (e.g. moderate indentation of the scapular glenoid fossa, humeral head that is even with greater tuberosity). Furthermore, this suite of traits is better interpreted as foraging adaptations perhaps related to forest floor locomotion and gleaning which may be primitive for *Theropithecus* and possibly for papionins (Fleagle and McGraw 2002).

This study of was funded by the Geological Society of America, the Paleontological Society, the National Science Foundation, the Leakey Foundation and the University of Oregon.

A model for evaluating trauma patterns in the context of the Colombian conflict.

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Since the 1960s, Colombia has supported a complex armed conflict, in

which different actors such as guerrilla and paramilitary groups have operated through several interests, criminal activities and human rights violations. In 2003 the Government signed a peace accord which provided a demobilization program to armed groups combatants. This transitional justice model has confronted the victims demands for reparation, requiring a proper clarifying of the fate of the missings.

In this context of strengthening the strategies in the search, recovery and identification of the missing persons in Colombia, this research systematizes the physical evidence and information related to the circumstances of death of the 3407 exhumated victims analyzed by forensic experts from state institutions, into a Geographical Information System (GIS) to characterize and differentiate the patterns of homicide and intentionality among the different armed actors.

The analysis suggest four possible scenarios that explain the variation in skeletal wounding patterns: 1) Multiple gunshot wounds will be expected in combat casualties; 2) Gunshot wounds in the skull, sometimes associated to blindfolds and/or ligatures, as evidence of executions; 3) Fatal injuries in association to dismemberment, as an intention to hide the corpse; and 4) Dismemberment without fatal injuries, as evidence of torture.

This analysis provides a synthesis of the wounding patterns, constructing an epidemiological framework in the Colombian armed conflict, that contributes to the interpretation of the circumstances of death of the victims to ensure not only the accountability of perpetrators but to fulfil the needs of truth that demand their families.

Comparative and quantitative myology of the prosimian forearm and hand.

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Several observations reported in the literature, namely the relative development of digital flexors and some intrinsic hand muscles in lorises and the dominance of the ulnar deviators in vertical clingers, are based purely on qualitative evidence. We aim to substantiate these observations through analysis of quantitative muscle data from a broad sample of strepsirrhine and tarsier species. The forearm and hand of 17 fresh-frozen specimens representing six families and 12 species were dissected. Selected muscles without their tendon(s) were weighed fresh and wet (48 hours in 10% formalin solution) to the nearest 0.01 g. Muscle weights were compared by limb compartment and functional group, as well as with the actual body mass of the specimens. Forearm muscle and body masses are highly correlated ($r = 0.98$)

and scale with a slope of 1.18, which is slightly lower than the 1.23 slope reported by Demes et al. (1998) for hind-limb muscles of prosimians. The digital flexors and flexor muscle compartment of *Nycticebus* represent 46% and 55% of total forearm muscle mass, well within the range of other prosimians. Relative mass of the ulnar deviators of vertical clingers is lower than that of pronograde quadrupeds of similar size. In contrast, the mass of adductor pollicis of *Nycticebus* is greater compared to other taxa (52% of hand muscle mass), which correlates with the extreme thumb divergence of lorises. Despite lacking predictable quantitative variation, the deep flexor muscles of prosimians show important differences in tendinous arrangement that parallel differences in grasping behavior.

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Computer-assisted detection of dental incremental growth structures.

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Histological analyses of dental thin sections are conducted to obtain various developmental data, ranging from enamel deposition rates and crown/root extension rates to estimates of an individual's age at death. Conventional methods rely on manual counting and measurement of incremental growth structures found in dental hard tissues. However, these analyses are tedious to perform and are prone to observer errors, hence computational tools and algorithms are needed to facilitate the identification of growth structures, and to increase measurement reliability.

Here we present an interactive software tool that supports researchers in annotating and counting incremental growth structures on digital images of dental cross sections. The software makes use of line-detection algorithms for fast automated identification of growth lines. These algorithms can be tuned to specific incremental structures such as daily increments and Retzius lines. Software-based feature detection yields a preliminary set of incremental lines, the position and orientation of which can be verified and/or adjusted via user interaction. The software comprises additional modules for metric analyses and for the management and permanent storage of structural annotations. The proposed semi-automated approach has been validated for daily incremental and Retzius line counts on human tooth crowns.

The software tool is platform-independent and freely available to interested researchers.

Does treating intestinal helminth infections reduce smoking behavior? Results of a double-blind, placebo-controlled, randomized control trial among Central African foragers.

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Humans, like other animals, might have an evolved propensity to consume plant neurotoxins as a defense against pathogens. Nicotine is a potent neurotoxin with proven efficacy against intestinal helminths. Hence, 'recreational' tobacco use might protect against helminth infections. Moreover, as a form of self-medication, individuals regularly exposed to soil-transmitted helminths might (unconsciously) increase tobacco consumption in response to infection, reducing consumption when the infection abates.

To test this hypothesis, we conducted a double-blind, placebo-controlled, randomized control trial among Aka foragers of the Central African Republic, a tobacco-using population with a high prevalence of helminth infection yet little access to Western anti-worm medicines. Because most Aka men smoke and most Aka women do not, the study was restricted to men. Upon entrance in to the study, participants provided one stool sample and one saliva sample each day for three days. Worm burden was determined by estimating helminth eggs per gram of stool. Smoking levels were estimated by assaying salivary cotinine, a nicotine metabolite. Participants were then randomized in to two groups. The treatment group received a single, 400 mg dose of albendazole, a commercial drug effective against the most common species of intestinal helminths. The control group received a placebo of identical appearance. Participants and researchers were blind to group assignment. After one-to-two weeks, participants provided another set of stool and saliva samples. We predicted that, compared to the control group, the treatment group would exhibit reduced smoking behavior.

This study was funded by the Washington State University Alcohol and Drug Abuse Research Program.

Testing the Neolithic demographic transition: a case study from Southeast Asia.

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Recent excavations at Ban Non Wat in Northeast Thailand provide a large

sample (n=636) of human skeletal remains and long occupation covering two millennia from c1700BC. This offers a unique opportunity to assess the relationship between agricultural development and demography in Mainland Southeast Asia. Paleodemography has as one of its research foci the effects of the origin and intensification of agriculture. The general model of demographic change is one of dramatic population increase, identified as the 'Neolithic demographic transition'. This is based on the premise that constraints on fertility were removed by the availability of a reliable food supply. We present paleodemographic data from Ban Non Wat to test the hypothesis that the early agriculturalists in this environment did not experience a 'demographic transition'. Our data support this hypothesis, and instead we argue, on the basis of an increase in infant mortality during the latest phase of Ban Non Wat and at the nearby contemporary site of Noen U-Loke, for a population increase occurring later in prehistory, during the 'Iron Age'. This is consistent with archaeological evidence of major socio-political changes and geoarchaeological evidence of agriculture intensification in the region at that time.

Evaluation of methods for preserving fecal microbial DNA from the spider monkey.

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Gut microbes play a critical role in the health of humans and animals. However, few studies have examined the host-microbe relationship in wildlife. Gut microbe populations can be obtained non-invasively via fecal samples and analyzed to assess the health of wildlife species. This study was undertaken to determine a practical approach to preserve monkey feces for microbial DNA extraction. Fecal samples were collected from spider monkeys (genus *Ateles*) at the Columbian Park Zoo, Lafayette, Indiana. Samples were stored at -80°C, -20°C, 4°C, in RNA-later at room temperature, and on Whatman FTA cards for a period of time prior to DNA extraction. Fecal DNA was extracted using the Qiagen QIAamp DNA Stool Mini Kit. Samples frozen at -80°C and -20°C and samples stored in RNA-later produced a high DNA yield (20-60µg) but were subject to significant reductions in DNA recovery over two months (p<0.01). Refrigerated fecal samples showed no significant difference (p>0.01) in DNA yield (average = 28.6 µg) over two months, but the sample molded after three

weeks. DNA yield from FTA cards was low but consistent (average = 11.3µg) with little reduction in DNA recovery over two months. The amount of DNA extracted from the FTA cards was sufficient for 16s rRNA PCR and sequencing. The results indicated that FTA cards are a convenient and effective tool for preserving microbial DNA in monkey feces – particularly if fecal samples cannot be processed immediately. This study was funded by Morris Animal Foundation and Purdue University School of Veterinary Medicine.

How big is "giant"? New body size estimates for *Protopithecus brasiliensis*.

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The purpose of this study is two-fold: First, to create statistically robust predictive regression equations for body mass, total body length, and head and body length from postcranial elements using a platyrrhine reference sample, data that does not exist elsewhere in the literature. Second, to apply those regression equations to the "giant" subfossil platyrrhine *Protopithecus brasiliensis*, a little-studied taxon represented by a nearly complete skeleton. Care was taken in selecting the reference sample and method of regression. Building on results of previous work with other primate groups, different skeletal elements, different subgroups of the reference sample, and different regression models lead to different body size estimates with different standard errors and prediction errors. However, relatively tight clusters of estimates around 20 kg, total length of 1675 mm, and head and body length of 710 mm are obtained, placing the fossil in the size range of a large male baboon. While not quite as large as the original 25 kg body mass estimate for the fossil, this new estimate is still approximately 150% larger than the largest living platyrrhines. Confirmation of its place in a "giant" size class should have a profound effect on reconstructions of various aspects of the paleobiology of *Protopithecus*. This research was made possible by NSF DDIG #0925704.

Mercury in bone protein vs. bone mineral as a biomarker of marine diet.

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Mercury is a toxic heavy metal that accumulates to high levels in marine organisms, but not in terrestrial organisms. Since mercury may be released into the environment by both industrial and natural processes, preindustrial populations with marine-based diets likely consumed large quantities of mercury, which previ-

ous studies have shown accumulates in bone in an exposure-related fashion. Many bone metals, such as lead, occur in the bone mineral, substituting for the divalent calcium ion in the mineral crystal. However, some metals may occur mainly in the bone protein. In soft tissues, such as muscle, organs, and hair, mercury is tightly bound to the protein component of the tissue, with a particularly high affinity for the sulfur-containing amino acid cysteine. This research focused on revealing the location of mercury in bone by comparing bulk bone mercury concentrations to measures of protein content, including bulk bone nitrogen and sulfur concentrations. Linear regression analyses of archaeological bone revealed significant positive relationships between whole bone mercury concentration and whole bone nitrogen and sulfur content. These results indicate that bone mercury is associated with the protein phase of bone, possibly with the cysteine-containing proteins, such as procollagen and the noncollagenous proteins. Analysis of mercury on bone protein, rather than on whole bone, may provide a novel method of assessing the importance of marine vs. terrestrial resources in past populations.

Cross-species parallels in parental investment: it's me and the dog.

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Evolutionary theory suggests that biological parents will exhibit greater attachment and investment in their offspring than step-parents, with considerable previous research in humans consistent with this expectation. Here, we ask whether similar patterns hold among dog owners: will "biological" dog owners (who acquire a dog) exhibit differential involvement with their dogs compared with "step" dog owners (for whom someone else such as a spouse acquired the dog)? To address this question, we recruited 895 dog owners (711 women) aged 18-79 to complete a survey administered either in person or online. The survey contained basic sociodemographic information and items tapping five dimensions of human-dog dynamics: attachment, investment, punishment, anthropomorphism and general attitudes toward dogs. Preliminary results indicate that "biological" dog owners exhibit significantly greater attachment, investment, and more positive attitudes toward dogs than their "step" dog owner counterparts. No differences in punishment or anthropomorphism appeared between groups. These patterns remained even after adjusting for potential confounding variables such as owner's age, dog's age, and dog size. We discuss these findings with respect to the ways in which dogs increasingly serve a role as human "family members",

the proximate processes shaping these patterns of human-dog dynamics, and the significance of such cross-species behavioral investment for evolutionary theory.

Fluvial transport of human remains at Actun Tunichil Muknal, Belize.

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The Mayan cave site of Actun Tunichil Muknal in Belize contains human remains that have been affected by complex geological and cultural processes. Previous examinations of ATM have provided detailed analyses of the skeletons and produced GIS-based maps, permitting spatial interpretations of artifact and bone distribution patterns. Underestimated until now is the degree to which water flow may have affected the current locations and distribution of the individuals independently of cultural factors. This study investigates taphonomic effects within ATM and their impact on the distribution of the human remains, particularly those effects related to water flow and sedimentation. Patterns of bone orientation, placement with respect to running water channels and pools, and non-random clustering suggest that fluvial transport has been and continues to be a significant complicating factor throughout the cave. Additionally, some individuals are located at low points or in basins that are positioned downstream in the direct line of water flow, demonstrating a characteristic pattern of bone orientation and compaction that is not consistent with a bundle burial or other deliberate placement by humans. In summary, it is clear that many bones have been displaced not by human action but by water action, potentially forcing us to re-examine our interpretations of Mayan rituals and death-related practices. Both human behavior and the physical environment affect the distributional characteristics of the artifact assemblage. The effects of relevant taphonomic processes must be acknowledged and subtracted before we can hope to interpret the cultural meaning that may be embedded within the site.

Monkey census by vocalization: an effective approach.

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Halloran *et al* (2010) detailed a census methodology for *Cebus capucinus* by analyzing the prosodic features of each individual's alarm call and statistically grouping the calls together by variance. A cluster analysis gave the precise number of callers in each sample tested. In order to study the effectiveness of

such an approach, this methodology was performed and compared with a concurrent traditional grid sampling methodology in the same area and over the same period of time. For our census, alarm calls were collected from a site at Ometepe, Nicaragua. These calls were analyzed for prosodic features such as duration, onset abruptness, and the first three spectral peaks. These results were standardized to euclidean distance units and then clustered by using Ward's minimum variance cluster analysis. At this point a ratio was calculated, based on neighboring populations, to determine the number of callers to the number of group members. The ratio revealed the same number of monkeys in the area as the traditional censusing method. Since the census by vocal analysis revealed the same number of monkeys as the traditional sampling method, we feel that vocal analysis could be a convenient, effective, and efficient means in counting an arboreal and transient primate species such as *cebus capucinus*.

Patterns of variation in development of the deciduous dentition of *Macaca nemestrina*.

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Permanent dental development is frequently used as a proxy for somatic growth and development as well as in estimation of the pace of life in extinct species. Schedules of permanent tooth development are available for some primate species, but those of the deciduous teeth are few and far between. We know that later occurring developmental events are more variable and several authors have given convincing evidence that they are more informative regarding species-level evolutionary diversity. In light of this, this research considers the pattern and timing of variation in the growth of the deciduous dentition in *Macaca nemestrina* (pigtailed macaque). Standardized lateral cephalograms were taken on a total of 144 male and female fetal and neonatal *M. nemestrina* ranging in age from 60 to 209 gestational days. The specimens in this sample were a result of timed matings and ages are known within ± 1 post-ovulatory day. A stage-based scoring system based on the Demirjian method was used to assess development of both maxillary and mandibular developing deciduous teeth. Summary statistics are generated to describe the overall pace of development. Patterns of variation are characterized by both a significant increase in the standard deviation of tooth development scores in the last third of fetal development as well as an increase in the spread of ages associated with individual tooth development stages including crown completion and root extension. Discriminant analysis shows sexual differences in development of

dm¹ from 130 to 140 gestational days, Wilks' Lambda of 0.845 and $p = .006$. This research was supported in part by National Institutes of Health grants DE-02918 and RR-00166.

Hindlimb morphology and hip postures in catarrhine primates.

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Apes use more varied hindlimb positions than monkeys, particularly terrestrial species, in order to negotiate a complex 3D environment. Femoral and pelvic morphology both affect and reflect hindlimb positional adaptations, but the relative influence of particular aspects of hip and thigh morphologies on hindlimb postures is unknown, affecting our ability to use these features to interpret locomotor behavior in fossil taxa.

This study uses articulated 3D polygonal models of the pelvis and femur to simulate range of abduction during loading, and evaluates effects of different aspects of morphology on femoral postures. Continuous laser scan data of the pelvis and femur were collected for a large sample of extant primates, as well as fossil apes and hominins. Microscribe landmark data of intact pelvises were used to orient innominate scans in 3D virtual space. Morphological variation and range of thigh abduction were quantified with PolyWorks software.

Our results show significant variation in femoral postures, and thus knee position, among species for any given hip position. In particular, more suspensory apes have femora that are inherently more abducted in neutral hip positions than cercopithecids. Features most influential on femoral postures include neck-shaft angle, neck length, femoral head and acetabular orientation, fovea capitis position, and bicondylar angle. Acetabular fossa size and greater trochanter height were less significant. Results of our study provide a basis with which to evaluate locomotor adaptations in extinct primates.

This study was funded by NSF, Wenner Gren Foundation, LSB Leakey Foundation.

Loris locomotor behavior in relation to skeletal morphology: disjunction between assumed mobility and utilized range of motion.

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An underlying assumption of many studies of primate functional anatomy

is that skeletal morphology directly reflects an animal's movement patterns. For example, expansion of humeral head is assumed to relate to greater shoulder mobility, but Chan (2008) found that passive shoulder mobility of lorises with a relative expanded humeral head is the same or less than that of lemurs. This project explores this disjunct between anatomy and range of motion by quantifying active 3D shoulder motion during slow climbing and bridging in lorises. These data are used to test the hypothesis that active, rather than passive, shoulder mobility influences shoulder morphology of lorises. We videorecorded two subjects each of *Loris tardigradus* (LT) (0.175-0.205kg) and *Nycticebus pygmaeus* (NP) (0.420-0.515kg), bridging across substrate gaps of several widths and orientations. Three-dimensional joint angles and limb positions were digitized using Innovision Systems, Inc[©] software to calculate excursion (flexion and abduction) of the humerus with respect to the trunk. These data were plotted on a polar coordinate system and compared to the passive range of motion reported by Chan (2008). The results showed that the excursion of the arm in both species is comparable to those used during arboreal quadrupedalism (LT mean=100°; NP mean=123°) which is less than the range of motion predicted lorised skeletal morphology (LT mean=228°; NP mean=171°). These results suggest that previous methods of extrapolating mobility from various shoulder features, including glenohumeral skeletal morphology, are problematic and argue for cautious functional interpretation of primate fossil skeletal material. This study was funded by NSF BCS-0749314.

Teaching evolution in the anthropology classroom: the importance of examples relevant to human and non-human primate evolution.

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Evolution by means of natural selection is the foundational theory linking all life sciences, and one of the few paradigms consistently represented in all four sub-disciplines of anthropology. It is essential, therefore, that students in any life science course attain a basic understanding of evolutionary theory, particularly as it pertains to humans. However, research indicates that many undergraduate students do not understand evolutionary theory any better at the end of a course than they did at the beginning. Students often continue to hold to various misconceptions of evolutionary theory which potentially contribute to the misuse of an inaccurate version of evolutionary theory and con-

tribute to erosion of science literacy. While many instructors bemoan students who refuse to accept evolutionary theory, those who accept evolutionary theory, but do not realize that they misunderstand it, present a greater challenge. We test the use of a teaching method designed to address student misconceptions of evolution. We designed and administered an experimental lab to address misconceptions of evolution and matched pretest and posttest surveys to assess students' misconceptions prior to and following the experimental lab. Unlike previous studies, the lab and surveys are specific to primate and human evolution for use in an anthropology course. Matched pretests and posttest surveys completed by 89 undergraduate study subjects were scored and analyzed using the paired sample *t* test procedure. Compared to previous studies, a greater percentage of students show improved scores between the pretest and posttest. The difference between the pretest and posttest scores, however, is modest.

Non-metric trait variability expressed in the deciduous molars of chimpanzees and gorillas.

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Non-metric dental traits are a well established tool for anthropologists investigating population affiliation and movement in humans. Nonetheless, similar traits in the great apes have received considerably less attention. The present study provides data on non-metric trait variability in the deciduous molars of great apes from museum context. Twenty-two traits are observed in the upper and lower deciduous molars in specimens of *Pan troglodytes*, *Pan paniscus*, *Gorilla gorilla*, and *Gorilla beringei*. Overall trait variability is assessed across the species. *Pan troglodytes* demonstrates the greatest number of variable traits (74.1%), whereas *Pan paniscus* has the fewest (51.9%). Five traits were found to be fixed as either always present or always absent across the study group.

This study demonstrates the variability of non-metric traits in the deciduous molars of chimpanzees and gorillas. These traits could potentially be used in the same way that similar traits are in humans, namely group affiliation and population movements through time. Further, this study establishes scoring guidelines and methodology relevant to deciduous dental morphological characteristics found in the great apes, but not necessarily in humans.

This study was funded by a grant from the Paul Anderson Interdisciplinary Summer Research Fund and Macalester College.

Bio-social factors and cranial modification in late Bronze Age Cyprus.

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Cultural cranial modification (or artificial cranial deformation), is a commonly discussed topic in the prehistory of Cyprus. Occipital forms of cranial modification are seen from the Cypro-PPNB. The "Cypriot" or post-bregmatic form of cranial modification is first identified for the Late Cypriot I (1650-1450 BC) period and most common in the Late Cypriot II (1450-1200 BC) period. A "banded", circumferential elongation of the cranial vault has also been identified in two individuals from the same tomb (French Tomb 5, 1949) at Enkomi. Cranial modification has been considered to be a marker of gender, status, kinship or ethnicity. Past studies of bio-distance in Cyprus have excluded modified crania for obvious reasons. This study investigates the biological relationships between individuals with modified and unmodified crania through dental measurements using quantitative population genetics. At Enkomi, males of both the modified and unmodified groups are closely related. Unmodified females show an affinity for the male groups, while females exhibiting modification seem to be unrelated to the males. The two individuals exhibiting circumferential modification are distinct from the other groups. The results suggest that cultural cranial modification in the LC seems to be an expression of status rather than gender or kinship. Individuals from Enkomi are then compared to individuals from Kalavassos – Ayios Dhimitrios and Episkopi – Bamboula, to better understand this phenomenon throughout the island.

Estimating the distribution of probable age-at-death from the dental remains of immature human fossils.

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Moorrees, Fanning, and Hunt presented graphs of "mean attainment age" for ten permanent teeth (maxillary incisors and all mandibular teeth) and three deciduous teeth (mandibular canine and molars). The graphs presented in these articles have been widely cited, but often erroneously implemented to estimate age or to infer correlations in development between teeth. Since individual probit models using the logarithm of conception-corrected ages were used to create these attainment stages, this graphical information can be back-transformed into parameters for estimating age-at-death for dental remains from immature fossils.

For the current analysis, 358 points from tooth formation graphs in Moorrees, Fanning and Hunt were digitized using DataThief III, version 1.5. Specifically, the digitized points for each transition were conception-corrected and converted to the logarithmic scale. The sum of squares for the predicted points around the digitized points was minimized, resulting in median ages of attainment on a base 10 logarithmic scale at each formation stage for the teeth evaluated. These derived median ages of attainment can subsequently be used to estimate a probable age-at-death distribution for immature fossil specimens. These distributions are calculated two different ways: 1) using only a within-tooth variance and 2) using a total variance that includes a between tooth component. For this study, probable age-at-death distributions are presented using the parameters derived from the Moorrees, Fanning and Hunt studies and tooth formation is scored for 47 immature early modern humans and 19 immature Neandertals.

Variation in sexual strategies and paternity skew in wild black and white colobus monkeys (*Colobus guereza*).

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For most primates, little is known about the extent to which both male and female sexual strategies vary within populations, and how they interact to influence patterns of reproductive success. We combined observational, hormonal, and paternity data to examine female and male sexual strategies and paternity skew in multiple neighboring groups of wild guerezas (*Colobus guereza*) in Kibale National Park, Uganda. Female guerezas lack sexual swellings and, like many anthropoid primates, mate flexibly both during and outside of fertile periods, including well into pregnancy. We observed a wide range of variation in the reliability with which female sexual behaviors indicated the peri-ovulatory period, the extent to which females displayed sexual behavior outside these fertile periods, and the extent to which they solicited and mated with multiple males. In most groups, though, primary males (i.e., the sole or highest-ranking adult males) had the greatest access to females and largely monopolized copulation. In accordance with these observations, the vast majority of infants we genotyped across eight uni- and multi-male study groups were sired by their groups' primary males. By combining inferences from behavioral, hormonal, and paternity data, we conclude that interactions

between differing female and male sexual strategies in guerezas may ultimately result in similar patterns of paternity skew. However, much sexual behavior in guerezas apparently has nonreproductive functions.

Seasonal variation in sexual segregation in spider monkeys (*Ateles geoffroyi yucatanensis*).

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Sexual segregation, the separation of males and females socially, spatially, or by habitat, has been documented and recognized as an important part of the socioecology of many vertebrates (i.e. ungulates, bats, whales, and fish). However, it has not been quantified or systematically examined in any primate species. We investigated temporal patterns of sexual segregation in a population of spider monkeys in Belize. Using data collected over a 23 month study, we used the Sexual Segregation and Aggregation Statistic to test three hypotheses: *i*) the sexes segregate, *ii*) the sexes aggregate, or *iii*) the sexes group at levels expected by random association. Spider monkeys live primarily in sexual segregated societies. We found that aggregation never occurred in this population. Significant segregation accounted for 65% of all months; however the degree of segregation varied monthly and between the two study years. Males and females associated at random during two periods of the year: May-June and December-January. We examined two possible ecological factors contributing to sex segregation and suggest that variation in monthly food availability and seasonal birthing peaks may contribute to these patterns. The separation of males and females is not yet identified as a factor underlying fission-fusion dynamics. Sexual segregation might reveal an important new source of variation in primate social grouping patterns. This study was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) and research funds from Athabasca University.

Three dimensional evaluation of Neanderthal craniofacial features in the European and African Middle Pleistocene human fossil record.

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The classification and phylogenetic relationships of the Middle Pleistocene human fossil record remains an intrac-

table problem in paleoanthropology. Researchers have noted broad resemblances between European and African fossils from this period, suggesting a single taxon ancestral to both modern humans and Neanderthals. Others point out 'incipient' Neanderthal features in the European sample, and argue for their inclusion in the Neanderthal lineage exclusively, following a model of accretionary evolution.

We evaluated eight proposed 'incipient' Neanderthal facial, neurocranial and basicranial traits: infraorbital shape / orientation; glabellar projection relative to the browridge; forward position and sagittal orientation of the face; juxta-mastoid eminence size; occipital plane convexity; mastoid process reduction; mid-facial prognathism; and piriform aperture size. These features were captured using 3-D landmark and semi-landmark coordinates and analyzed as three separate datasets to maximize samples. A large number (n = 66) of Pleistocene hominins from Europe and Africa, and a comparative sample of seven widely defined modern human geographic populations was included in the analysis. The coordinates were superimposed using Generalized Procrustes Analysis and analyzed using mean configuration comparisons, principal components analysis and Procrustes distances.

Results show that a few of the traits examined follow the predictions of the Accretion Model and relate the mid Middle Pleistocene European material to the later Neanderthals. However, most showed Middle Pleistocene Europeans to be nearly identical to the African Middle Pleistocene samples until the Holstein period. We suggest that some commonly cited 'incipient' Neanderthal features might instead represent plesiomorphic traits.

This study was funded by the Marie Curie Actions grant MRTN-CT-2005-019564 'EVAN' and the Max Planck Society.

Consequences of contact: evaluation of health patterns using enamel hypoplasias among the Colonial Maya of Tipu.

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The Colonial Maya population from Tipu was analyzed to investigate health changes associated with European contact. Located in western Belize, Tipu was occupied from 1541-1704, and consists of a Spanish mission church with 588 interments. Enamel hypoplasias are used to explore growth disruptions resulting from nonspecific physiological stress. Standard methods of scoring (Buikstra and Ubelaker 1994) were employed to assess frequency, severity, color, and type of episode in the permanent anterior dentition. For analysis,

individuals were placed into age groups of 6-17, 18-35, 36-50, and 51+ years. The population was also considered for differences by sex and tooth type.

Results showed a mean of 1.28 hypoplasias per tooth with canines averaging more episodes than incisors and maxillary teeth more than mandibular. Females displayed approximately 0.33 more lesions per tooth than did males, and those dying as juveniles had only slightly more episodes than those surviving to adulthood. Over 90% of the episodes recorded were of mild severity. No differences in patterns of severity by sex were found. However, juveniles demonstrated a higher frequency of moderate and severe hypoplasias. Mean age at formation was consistent across sex and age groups with most forming from 0-3 years on incisors and 4-6 years on canines. These data suggest that overall the population at Tipu was relatively healthy despite European contact, which is also reflected in low frequencies of other indicators, such as anemia and infection. Similarly, they do not reflect extensive presence of epidemic disease, instead showing adaptation despite notable culture change.

Early modern human footprints from Engare Sero, Tanzania.

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Fossil hominin footprints provide a rare but exciting opportunity to directly observe the fossilized locomotor behavior of our extinct ancestors. In this paper we report on a new fossil hominin footprint site dating to approximately 120 Ka (thousand years ago) at Engare Sero, Tanzania, near the southern shore of Lake Natron. Over 350 footprints have been uncovered at the site, making it one of the most numerous Pleistocene hominin footprint sites known to date. We compared these footprints to a sample of footprints made at various

speeds by minimally-shod and habitually unshod adult Dassenach females (N=10) and males (N=10) from the northeastern region of Lake Turkana. The Engare Sero footprint assemblage contains trails and some isolated prints of multiple individuals walking on a surface of wet volcanic ash close to 150 m² in area over a relatively short period of time. Preliminary analyses of the footprints show that the foot morphology reflected in the prints is anatomically modern in form, and that some of these individuals were moving at a comfortable walking pace, while others were almost certainly running. The walking footprints show stride lengths that fit well within those of the Dassenach experimental group. Based on their sizes, the footprints were likely made by individuals ranging from adults to children and provide new data on group composition in early modern humans.

This study was funded by National Geographic, grant number 8748-10, and the National Science Foundation, grants BCS-0924476 and DGE-0801634.

Comparative evidence for the evolution of aging in our lineage: humans vs. chimpanzees.

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As products of a common evolutionary history we share many aspects of our age-specific schedules of development, reproduction, and senescent decline with the other great apes. But some aspects of these schedules clearly distinguish humans. Hypotheses about what happened in our evolution benefit from attention to both similarities and differences between the life histories of humans and the other apes. Here I review results from continuing comparisons of aging rates in humans and chimpanzees, including mortality and fertility schedules, ovarian follicular stocks, and circulating levels of adrenal steroids. The comparisons focus on females because life history tradeoffs differ between the sexes, and menopause has been of particular interest, drawing explicit consideration in classic contributions to evolutionary theories of senescence. In addition, conflicts of interest that arise from female tradeoffs have been persuasively linked to the evolution of distinctively human cognitive and social capacities.

Deep genealogy, Neandertal ancestors, and our accelerating evolution.

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Anthropologists have long confused genealogical and behavioral definitions of humanity. At least five out of six liv-

ing humans have Neandertal ancestors, which comprise an estimated 1 to 4% of their ancestry. Human genes have divergent genealogical histories, representing multiple "archaic" populations inside and outside of Africa. Late Pleistocene populations show comparable technical and symbolic abilities within and outside of Africa. A humanlike vocal-auditory channel had appeared before 600,000 years ago. Yet humans of the last 40,000 years have evolved extremely rapidly, in some instances diversifying; in others paralleling each other.

Using new visualization methods, I examine the genealogical patterns of human genes. The impact of our rapid Holocene evolution simplifies some genealogical relationships while partially obscuring earlier ones. The genetic echoes of Neandertals and other archaic populations emerge against a slim network binding all living people. These networks show the impact of adaptive potential in ancient human populations. A broad view of human cultural and technical records suggests that gene-culture interaction may be a fundamental aspect of Pleistocene human evolution.

Continuing trends toward obesity, diabetes, and hypertension in Samoa: the role of nutritional transition.

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Samoa is experiencing nutritional transition from subsistence agriculture to increased reliance on imported, processed, and purchased foods, and reductions in physical activity. This study examines temporal trends in obesity, diabetes, and hypertension and in dietary intake over the past 30 years in order to assess the contribution of changing diet to the rising burden of non-communicable disease (NCD). Data from four surveys undertaken between 1979 and 2010 in Samoan adults (age 25-64 years) are used to describe temporal trends in obesity and related risk factors. Data from WHO/FAO food balance sheets are used to describe changes in daily total energy, protein, and fat intake over the same period. In 1979-1982, 11.7% of males were obese based on Polynesian standards for BMI. By 2010, male obesity had risen to 41.7% and female obesity from 32.3% to 62.1% over the same period. The prevalence of hypertension increased by 2.9% in males and 8.2% in females. In 2010, 12.5% of females and 7.7% of males had elevated blood glucose, indicative of diabetes. Total energy intake in 1979 was less than 2500 calories per day. Recent estimates suggest intake to be greater than 3000 calories per day, a 20%

increase. Fat and protein intakes increased by more than 65% and 75% respectively.

The prevalence of NCDs has risen substantially in Samoa over the last 30 years. Modernisation of the traditional diet and a concurrent decrease in physical activity resulted in chronic positive energy balance and a greatly increased risk of obesity and other NCDs.

This study was supported by the U.S. National Institutes of Health Grant R01-HL093093.

Eye size and locomotion: A test of Leuckart's Law in mammals.

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Leuckart's Law proposes that animals capable of achieving fast locomotor speeds require large eyes in order to enhance visual acuity and avoid collisions. Leuckart's Law is commonly invoked to explain the relatively large eyes of some birds, but remains untested in non-avian vertebrates. The goal of this study is to test the relationship between eye size, locomotor speed, and locomotor agility in mammals.

Data on axial eye diameter (AD), maximum running speed (MRS), and locomotor agility (LA) were collected from the published literature for 86 species from 10 mammalian orders. In mammals generally ($n=50$ species), AD is significantly positively correlated with MRS (Pearson's $r=0.81$, $p<0.01$). Partial correlations further show that MRS explains 36% of the variance in residual AD when body mass is held constant. Speed data are limited for primates, but ranks of LA are available for 36 primate species. Although mean AD is shortest for "slow" and longest for "fast" primates, we found no significant difference in AD between LA categories (Kruskal-Wallis $H=0.33$, NS).

Our analysis supports the expectations of Leuckart's Law by demonstrating that faster-moving mammals tend to have larger eyes than slower-moving mammals. However, we found no significant relationship between eye size and locomotor agility in primates. This latter result does not necessarily contradict Leuckart's Law. We therefore conclude that maximum speed of locomotion is one of several factors (e.g. activity pattern, diet) influencing the evolution of eye size in mammals.

A study of modified teeth from archaeological sites in Illinois: recent and archival examples.

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The intentional modification of dentition (unlike tattoos, scarification, piercings,

hairstyles, and clothing) leaves tangible evidence of cultural behavior observable by bioarchaeologists. The meaning behind these modifications remains elusive, whether an enhancement of beauty, a mark of status or ethnicity, or of social or religious importance marking a rite of passage or of office. The majority of known culturally modified teeth in North America are from Mississippian sites located in the American Bottom region of Illinois near Cahokia, the preeminent Mississippian cultural center in eastern North America. A number of additional examples have recently been identified from current archaeological work and curated museum collections. Good temporal and contextual control for these teeth provides much needed new information on the frequency and geographical distribution of modified teeth in Illinois. This poster describes variations in style and considers the temporal and geographic distribution of modified teeth, as well as bioarchaeological evidence of age, sex, and status of the individuals. We compare examples from Illinois to those from Mexico and Central America, and consider the applicability of Romero's (1970) classification system to Illinois/North American examples. Do Illinois examples show stylistic preferences by region or by sex? Do the small number of culturally modified teeth found outside the American Bottom reflect social interactions between regions? This expanded dataset brings us one step closer to answering these questions.

Convergent evolution of diurnal amniote eye design and visual acuity in anthropoid primates.

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Many diurnal amniote taxa possess an eye design hypothesized to be optimized for high visual acuity. This design includes a relatively long axial diameter of the eye, which correlates with increased focal length, relative to a smaller corneal diameter. However, non-anthropoid mammals, regardless of activity pattern, appear to differ from other amniotes in retaining an eye design optimized for high visual sensitivity, with a shorter axial length of the eye relative to the corneal diameter, an eye shape that reduces visual acuity and is typically restricted to scotopically adapted amniotes. Only anthropoid primates are known among mammals to have evolved proportions of the eye similar to non-mammal diurnal amniotes. However, the relationship between eye shape and visual acuity has yet to be evaluated within non-primate mammals. Also, the degree to which anthropoids have converged on the typical diurnal amniote eye design and visual acuity requires evaluation.

Data were compiled on corneal diameter and axial eye length as well as on be-

havioral and anatomical estimates of visual acuity in mammals and birds. Both anthropoids and birds are statistically separated into nocturnal and diurnal groups by measurements of axial diameter and estimates of visual acuity. Non-anthropoid mammals (including strepsirhines) of various activity patterns are not distinguished by eye morphology or visual acuity, and are most similar to nocturnal birds and *Aotus*. Only anthropoid primates notably differ from general mammalian patterns of eye morphology and high visual acuity, and possibly have re-evolved an eye shape more typical of the general amniote pattern.

Cranial non-metrics and macromorphoscops in OsteoWare.

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Non-metric and macromorphoscopic trait data is often fraught with error introduced during the data collection process. One of the unique aspects of OsteoWare is a suite of traditional cranial non-metric traits, in addition to a series of novel macromorphoscopic traits used by forensic anthropologists assessing ancestry. Collecting cranial non-metric data in OsteoWare is an intuitive, menu-driven process, a feature designed to decrease observer error and idiosyncratic interpretation of trait states. Individual character states for each macromorphoscopic trait are clearly defined and illustrated with line drawings focusing on the region of interest. The end user of OsteoWare will find each of these features to be a convenient and practical method for collecting cranial non-metric and macromorphoscopic trait data. This presentation outlines the criteria for collecting cranial non-metric and macromorphoscopic trait data. Case studies and example material will be presented from the Smithsonian Institution collections to demonstrate the efficiency and effectiveness of these two modules.

Exploring integration and modularity of the *Papio hamadryas ursinus* cranium.

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Integration and modularity are developmental concepts key to understanding morphological evolution and taxonomic diversification. As skeletal morphology forms the basis for systematic description and the phylogenetic appraisal of extinct taxa, there has been an increased interest in these concepts within the paleoanthropological community. In the current study, geometric morphometric methods were used to

investigate modularity in an ontogenetic sample of *Papio hamadryas ursinus* crania without their *a priori* designation. Forty-three 3D landmarks were obtained from each specimen. After superimposing the landmark configurations using a generalized partial procrustes analysis, orthogonally projected to the tangent plane, the effects of allometry and sexual dimorphism on craniofacial variation were removed by multivariate regression. As modules are internally integrated regions that are relatively independent from each other, covariation between cranial modules should be significantly weaker than other random partitions of the cranium. The 2-block partial least squares RV coefficients for all possible pairs of spatially-contiguous landmark subsets were then calculated and significance determined using permutation tests. The nasal-premaxillary-maxillary region and posterior cranial vault were found to be modular in nature and, with the exception of areas of contact, statistically independent from one another. The same can be said of the cranial vault and anterior occiput. The maxillary portion of the face and anterior occiput, on the other hand, displayed a strong degree of integration likely reflecting the involvement of the latter in lower facial development and positioning. This study was funded by the NRF and the Palaeontological Scientific Trust.

To the West! A dental morphology investigation of gene flow between populations of the Iranian Plateau and the macro-Mesopotamian interaction sphere during the last three millennia B.C.

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Despite archaeological evidence at the Bronze Age site of Tepe Hissar in north-eastern Iran of contact with populations of south Central Asia and the Indus Valley, biological evidence of gene flow between populations of these regions was found to be starkly absent (Hemphill 2010). Such results suggest either inter-regional gene flow was absent, or that the Tepe Hissar population experienced gene flow with commercial partners of other regions. Hasanlu, located in northwestern Iran astride a crossroads leading to Mesopotamia, contains archaeological evidence of extensive contact with Mesopotamian populations. This research tests whether the inhabitants of Tepe Hissar experienced gene flow with populations involved in the macro-Mesopotamian interaction sphere found in northwestern Iran. This investigation is based on assessment of 17 tooth-trait variations scored in accordance with the Arizona State University Dental Morphology System in a sample of 136

individuals recovered from Tepe Hissar, 70 individuals recovered from Hasanlu, and 2,241 individuals of 22 samples of prehistoric and living Central Asians, Pakistanis, and peninsular Indians. Intersample differences were examined with hierarchical cluster analysis, neighbor-joining cluster analysis, multidimensional scaling and principal coordinates analysis. Results consistently identify Tepe Hissar individuals as possessing closest affinities to inhabitants of Hasanlu. By contrast, Tepe Hissar individuals exhibit little to no affinities to prehistoric Central Asians or to prehistoric or living individuals from the Indus Valley and peninsular India. Hence, it appears commercial contacts between Tepe Hissar and populations to the west *did* result in significant gene flow, while trade contacts across the Iranian Plateau did not.

Dental evidence bearing on morphological dating of the LB1 specimen.

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The dating of the skeleton LB1 from Flores, Indonesia, is less certain than suggested in the literature. Dates from the surrounding deposits are contradictory. Direct dating of the bones has not been performed. Thus, the age of LB1 should be considered by other dating techniques. Morphological dating has been applied in palaeoanthropology and is commonly used in archaeology.

The aim of the present study was to test whether the condition of the LB1 dentition compels the view that the individual represents a member of a new species, or is more consistent with membership in a regional population of extant *Homo sapiens*. The new evidence provided here comprises observations on the original specimens and photographs of the dentition.

Tooth dimensions are consistent with modern humans. Tooth morphology exhibits numerous concordances with the extant Rampasasa. The presence of dental caries in LB1 (lower premolars and a canine) indicates a low probability of belonging to a hunter-gatherer society. Dental attrition of LB1 is of a type more common in agricultural societies than among hunter-gatherers, the differences in attrition between molars are small. The *ante mortem* loss of lower right P4 without alterations of the adjacent structures suggests a surgical extraction. Evi-

dence of a Class II restoration with radiolucent material in the lower left M1 has been disputed, but not refuted by an independent examination that until now has been precluded by selectively restricted access to the specimen. Dental modifications would strongly favor an affiliation to a modern society with dental surgery techniques.

The relation between standard error of the estimate and sample size of histomorphometric ageing methods.

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Histomorphometric ageing methods report varying degrees of precision (measured through standard error of the estimate or SEE). These techniques have often been developed on variable samples sizes (n) and the impact of this parameter on SEE is poorly understood. This paper explores the relationship between n and reported SEE through a review of the literature (abstracts, articles, book chapters, theses, and dissertations) and a mathematical simulation. Thirty-eight studies reporting n and SEE in years were included in the current study. Reported SEE values were highly variable ranging from 2.58 to 16.00 years (Mean: 8.51; Stdev: 3.56). To examine the probabilistic relationship between n and SEE we generated a simulated population of 50,000 individuals where histomorphometric 'ages' were assumed to reflect normally distributed random error about chronological age. SEE values were calculated for randomly selected subsamples of varying size. This simulation revealed that in large samples (>100) SEE converges on the level of variation present in the population; however, in smaller samples SEE becomes increasingly variable. In general, this pattern matched the observed pattern of published SEE values. While numerous sources of variation exist between different methods, the impact of insufficient sample size should not be overlooked. Notably, while SEE values as low as 2.58 years have been reported, studies which exceed 150 individuals report a mean SEE value of 11.05 years (Stdev: 1.91). Meaningful comparison of the precision of different approaches requires larger samples than are frequently used and would ideally be based upon standardized samples.

Plant foods and the dietary ecology of Neanderthals.

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Previous research has suggested that Neanderthals had a narrower diet than

did early modern humans, and lacked social and technological advances (like sexual division of labor, and use of projectile weapons) that would have permitted a wider diet. These dietary differences are thought to have contributed to their disappearance. However, this model for Neanderthal behavior is based primarily on data from animal foods. Plant foods are known to be vital parts of modern forager diets, and usually represent women's contribution to diet. I have examined plant foods in the diets of Neanderthals and early modern humans by identifying the plant microfossils (starch grains and phytoliths) recovered from the dental calculus and stone tools from several populations in Europe, the Near East, and Africa. The results suggest that these two species consumed plant foods in similar numbers and varieties, including usually-low-ranked foods like USOs and grass seeds. Environmental differences affected plant food consumption more than species allocation did. There appears to be some intensification of Neanderthal plant use after 50ka. These data suggest a more complex picture of Neanderthal dietary ecology than previously drawn, and that the complex relationship between technology, social behavior and food acquisition strategies among Neanderthals must be better explored.

This study was funded in part by NSF IGERT grants, a Wenner-Gren Dissertation Fieldwork grant and a Smithsonian Predoctoral Fellowship.

Maxillary suture aging: a revision of the visual method for estimating skeletal age of adults.

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Age determination from human skeletal remains is an important biological parameter in both forensic and paleodemographic contexts. Cranial sutures, while frequently applied, show low reliability for estimating age at death of adults. Maxillary sutures have seldom been tested after their original introduction by Mann and coworkers (*J Forensic Sci* [1991] 36:781-791). This study presents the results of a revision of the original maxillary suture method on a large sample (n=483) of known sex and age from the Human Osteological Collection at the Department of Human Anatomy, University of Torino, Italy. Palate sutures were scored in five regions that were combined to form a summary score from which an age at death estimate was obtained. Results indicate significant differences in suture closure between males and females. Males exhibit stronger correlations with age for all indicators. Correlations are similar to, or stronger than, those reported for other age estimation methods from the pelvis. However, age ranges are wide in both sexes. Several

summary scores were found to have similar mean ages, ranges and distributions. These were grouped together to produce four palatal suture stages that show highly significant age differences. Although the results generally indicate only broad stages of life, they contribute helpful information to age-at-death estimation, especially for older individuals where other methods are less effective. The research was funded in part by a grant to the author from the Office of Research and Sponsored Projects, California State University Sacramento.

A revised method for sex identification and age estimation at death. Indicators for the study of immature skeletal remains.

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The study of past populations emphasizes the need to recover information on living conditions of children given their vulnerability under poor hygienic and health environments that characterized most of the earlier populations which results in differential mortality among groups. However, the study of that segment of the skeletal samples was prevented by technical and methodological difficulties faced on assigning sex in children and making an accurate estimate of age at death among for ages under seven or eight years. The purpose of this paper is to show the application of a methodology recently developed at ENAH (México) to identify sex based in morphological features from ilion, skull and mandible. The metric results were confirmed both by a statistical procedure, as discriminant functions and DNA analysis. The age estimate was done by dental and cervical vertebrae indicators, the latter developed from a sample of contemporary groups and adjusted to skeletal remains. The study sample includes 184 subadult skeletons from San Gregorio Atlapulco, Xochimilco osteological series, dated for the beginning of the Colonial period.

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Use of auditory and olfactory signals in night monkeys (*Aotus nancymae*).

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Communication is a key element in social behavior, and theory suggests sig-

nals modify the behavior of other individuals. Some primates are reported to emit distinct communicative signals in well defined behavioral contexts. Night monkeys (*Aotus* sp.) are secondarily nocturnal, having evolved from a diurnal ancestor. In contrast to most other nocturnal primates, night monkeys travel and forage as cohesive family groups. We predict that night monkeys use vocal and olfactory signals in specific behavioral contexts to communicate clearly with group members in the dark. We collected data on the frequency of vocalizing and scent-marking on captive night monkeys (*A. nancymae*) at the DuMond Conservancy. We recorded continuous focal animal behavioral data on 20 males and 13 females. We analyzed the behavioral contexts in which signals were produced (n=1050) and tested the hypothesis that signals were given in specific contexts more frequently than predicted by chance (χ^2 tests). Individuals peep, chuck and scent mark while moving around the enclosure and during affiliative interactions with group members (71-93% of occurrences, $p < 0.001$). Trills were emitted while feeding (81-87%, $p < 0.001$). Males hooted while perched and scanning their surroundings, followed by affiliative interactions with group members (70%). Night monkeys also concatenate vocal signals and emit combinations in specific contexts. Our results suggest that night monkeys have specific vocal and olfactory signals that may facilitate group travel, cohesion and feeding. Having non-visual signals for such information is prevalent in other primates, but may be especially important for communication at night.

This research was supported in part by an NSF GRF, Turner Fellowship and AGEP Scholarship (JPH).

Reconstructing hominin and mammalian evolution by combining palaeomagnetic, uranium-lead and stable isotope analyses on speleothem from cave deposits; examples from the Plio-Pleistocene of South Africa.

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The recent cross-correlation of multiple geochronological techniques, including

palaeomagnetism, uranium-lead, electron spin resonance and biochronology has led to the ability to accurately date the southern African early hominin bearing palaeocave deposits. This has allowed the first accurate seriation of the southern African sites and hominin species for cross-correlation with eastern Africa. In many of the palaeocaves there are thick speleothem sequences ideal for stable-isotope analysis used for reconstructing palaeoclimate and palaeovegetational changes during the period when they formed. These deposits can now be directly dated using a combination of uranium-lead and palaeomagnetism. This work has also enabled the identification and direct dating of short geomagnetic field events that can be used in the future to more precisely confine the age ranges for the palaeocaves and hominin fossils. Examples of current multi-disciplinary work are presented from the sites of Makapansgat, Sterkfontein, Malapa and Hoogland.

Bioarchaeological investigations of Bronze and Iron Age burials from Mitrou and Tragana Agia Triada in central Greece.

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Recent bioarchaeological studies in central Greece have attempted to synthesize paleodemographic and health indicators from Bronze Age human skeletal samples. Archaeological excavations under the direction of Drs. Aleydis Van de Moortel (University of Tennessee) and Eleni Zahou (14th Ephorate of Prehistoric and Classical Antiquities, Lamia, Greece) at the site of Mitrou, located in East Lokris of central Greece, have produced a diverse burial sample dating from the Early Helladic to Proto-geometric periods. Graves from Mitrou represent one of the largest burial samples from a single site in East Lokris (n = 75).

As part of the Mitrou Archaeological Project, the skeletal material from Mitrou and Tragana Agia Triada, a series of Mycenaean chamber tombs located approximately 3 km south of Mitrou, have been the focus of bioarchaeological research. The two burial samples complement each other temporally with the Tragana Agia Triada tombs representing the Late Helladic periods and the graves at Mitrou representing Early to early Late Helladic and Proto-geometric periods. The osteological remains from Tragana Agia Triada have been the focus of prior bioarchaeological research, but the remains examined for this study represent burial loci not examined in the original study. The two burial samples combined provide new insight into the overall health of Late

Bronze to Early Iron Age populations in central Greece. Data presented from Mitrou and Agia Triada focuses on demography, oral health, and paleopathology. Results are compared to earlier osteological studies in the region as well as findings from numerous contemporaneous burial samples from across Greece.

Dietary and funerary practices of French Roman population: first isotopic evidence.

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Excavation of the Roman suburban necropolis of Evreux (Ist-IVth c. AD) revealed two distinct funerary practices: (1) bodies buried in *decubitus dorsal* as expected and well known for the period, and (2) bodies buried in various positions, associated with equid remains. Using stable isotope analyses on bone collagen ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$), this study aims to assess the relationships between dietary and funerary practices. In order to answer to this issue, 91 human were analyzed. Moreover, to define the local environment, analyses were also performed on 68 animal remains (fishes, bovids, caprids, canids and foal). Results highlighted (1) the consumption of terrestrial local food resources, and (2) the lack of regular consumption of fishes and C4-plants ($\delta^{13}\text{C}$: -20.4 to -19.3‰; $\delta^{15}\text{N}$: 6.5 to 10.6‰; N=91). Therefore, this study revealed differences between the two funerary groups. The group (2) exhibits a wider isotopic variability and lower nitrogen values than the group (1), which could indicate a more opportunistic access to food items by the group (2). If one accepts that a limited access to animal proteins is linked to low social status, thus the funerary group (2) could be considered as the less wealthy people buried in the dedicated horse remains area. Social and/or cultural factors might be involved in the dietary distinctions observed between both funerary groups. This work was funded by INRAP.

The effects of infant presence on the rate of olfactory communication in female ring-tailed lemurs.

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Scent marking is a form of olfactory communication seen as individual advertisement. Chemical profiles are em-

bedded with information that identifies the individual, her physical condition, including fertility status, and may be used to advertise (or conceal) the presence of an infant. As the profiles do not remain constant over time this study aims to investigate the effect infant presence has on the rate of female marking to better understand the role olfactory communication in this social species.

Data were collected on seven social groups of ring-tailed lemurs at the Beza Mahafaly Special reserve, Madagascar from June 2009 through March 2010. In females where the infant survived the length of the study, females showed higher marking post-birth marking rates than during the pre-birth period. The marking rates of the individuals whose infants died during the study also varied significantly between pre-birth, post-birth and post-mortality periods, with a peak in post-birth rates and a decline post-mortality.

These results demonstrate a significant relationship between infant presence on marking rates of adult females. This may be due to a hormonal response associated with the presence of an infant and or a time where social change within a troop is observed. This study gives us a better understanding into the role of olfactory communication, a method that is heavily depended upon in this species. Future work will examine mechanisms that alter scent marking to understand how genotype, pheromones and social environment interact in female olfactory communication.

Long bone cross-sectional shape and robusticity in mountainous and flat terrain bovids: implications for Neandertal locomotor behavior.

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Neandertal tibiae are mediolaterally robust compared to those of anatomically modern *H. sapiens*. It has been suggested that their mediolateral (M-L) hypertrophy may result from higher levels of habitual M-L loading introduced by locomotion on rugged terrain. To investigate the effects of terrain type on bone cross-sectional geometry, this study uses a large comparative sample of flat terrain (73 species) and mountainous (24 species) bovids to see to what extent terrain affects relative anteroposterior to M-L rigidity and strength of the forelimb cannon bone (metacarpus). Linear bone dimensions at midshaft were obtained from the literature and used to estimate section moduli and second moments of area using a solid beam model. Average species body mass and bone length data were also taken from the literature. Results indicate that mountainous bovid cannon bones are overall more robust than those of flat

terrain bovids, but with more pronounced increases in M-L rigidity and strength. Furthermore, using a specific test case, it was predicted that the only mountainous member of a flat terrain clade (*Gazella*) would have comparatively mediolaterally robust cannon bones. The prediction was confirmed. These findings suggest that M-L hypertrophy may be a morphological signal of mountainous environment inhabitation and that Neandertals may on average have spent more time on rugged, mountainous terrain than anatomically modern *H. sapiens*. Elevated habitual M-L bending stresses may be introduced on uneven terrain by an increase in laterally angled stepping motions and/or more variation in orientation of ground reaction forces on the feet during locomotion.

A comparative analysis of long bone diaphyseal robusticity in the Lake Mungo 3 skeleton.

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Lake Mungo 3 (LM 3) holds considerable potential for our understanding of the earliest inhabitants of Australia. LM 3 was found in the Willandra Lakes system, an environment that has changed dramatically since the late Pleistocene. As such, LM 3 can provide information about skeletal adaptations to an ancient ecosystem. Further, LM 3 has been described as gracile based on cranial morphology but postcranial analyses of this skeleton indicate relatively high levels of robusticity. This morphological discrepancy has made a diagnosis of sex for LM 3 difficult. The present study will use cross-sectional measurements of the humerus, femur, and tibia from CT scans to address questions of robusticity that can help inform diagnoses of sex as well as patterns of mobility. Properties of mechanical loading that were calculated include: cortical area, maximum and minimum second moments of area, and the polar second moment of area. These properties, standardized to bone length and body mass, measure compressional, tensile, bending, and torsional strength of long bone diaphyses. There are two purposes for carrying out this study. First, long bone robusticity generally adheres to a gradient of sexual dimorphism. If it can be shown that LM 3 falls higher on this gradient then a diagnosis of male sex for this skeleton would be supported. Secondly, long bone robusticity can provide a unique insight into foraging strategies used by inhabitants of ancient ecosystems. Through the examination of populations which differ in their subsistence strategies, patterns in diaphyseal robusticity emerge that can indicate different mobility patterns and subsistence strategies. Results indicate

that LM 3 falls well within the male range of long bone robusticity in both the upper and lower limb. The lower limbs of LM 3 also exhibit high relative robusticity, which indicates that this individual engaged in mobile, long distance foraging.

This research was funded by the Franklin Grant program of the American Philosophical Society.

Sex assessment of non-adult skeletal remains: which sexually dimorphic features are more reliable?

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Sex estimation is a regular component of the examination of human skeletal remains in archaeological, anatomical, and forensic investigations. Morphological differences between the sexes in non-adult skeletons are subtle, so sex determination is challenging. The goal of this project was to determine the efficacy of previously suggested metric and non-metric assessment standards as sex indicators for non-adult skeletal material. Data was collected from 233 individuals from five identified osteological collections, broadly grouped based on historical records as ethnically European, African, or of mixed ancestry. Non-metric visual assessment of the orbit and mandible was scored with methods from Molleson et al. (1998). The obtained sex estimation was compared with the known sex of each specimen. The proportion of correctly inferred sex was not better than expected by chance in any analysis.

Metric assessments included measurements of the os coxae based on Schutowski (1993) and Rissech et al. (2003) and canine teeth based on Duncan (1995). Discriminant function analyses were employed to statistically distinguish the sexes on the basis of measurements. All measurements except greater ischial depth and breadth could be used to significantly successfully infer sex only in the 12-16 age group, and these could only be performed on European individuals in the sample. Canine measurements for deciduous teeth could not infer sex more accurately than expected by chance for any ethnic group, but canine measurements for permanent teeth were found effective for Europeans. Flaws in sampling in this and previous studies and implications for future methods are discussed.

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Miami University College of Arts and Sciences.

The mechanisms that produce the defects of enamel hypoplasia.

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Enamel hypoplasia is the term used to describe defective formation of enamel which results from disruption of enamel matrix secretion during development of the tooth crown. Such defects range continuously from a microscopic accentuation of matrix layering up to deep furrows in which the enamel covering of the crown may be missing altogether. Epidemiological studies of living people have matched the defects to episodes of poor health during childhood and laboratory studies have shown that they occur in association with infection, fever and nutritional deficiency. The age at which the growth disruption took place can be established from the position of the defect in the development sequence of the teeth. In bioarchaeology, the defects are seen as useful indicators of poor health in childhood but they are difficult to interpret because the mechanisms by which the different defect morphologies are produced are little understood.

Specimens from the Post-Medieval crypt at Christ Church, Spitalfields, in London display a range of hypoplastic defects in teeth from children which are little affected by wear and have very good preservation of microscopic incremental features in enamel. This provides an opportunity to study in detail the sequence of matrix secretion events shown by enamel increments during the formation of different types of defects. Prism cross striation counts and brown stria of Retzius morphology in examples from this assemblage demonstrate the mechanism by which the more common furrow-form defects are formed and show how this contrasts with formation of pit-form and plane-form defects. This study was funded by the Wellcome Trust (067257/Z/02/Z).

Mother's milk and commensal gut bacteria: what we know and what we need to find out.

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Mother's milk not only provides the energy for infant somatic growth and behavioral activity, but also supplies constituents, such as oligosaccharides, that influence the establishment of com-

mensal gut bacteria in the infant. Recent advances have revealed that these symbiotic bacteria serve essential digestive and immunological functions throughout an individual's life and are sensitive to critical periods during early development. Here we additionally show that beneficial bacteria themselves are present in milk. Milk samples were aseptically collected at peak lactation from 54 rhesus macaques (*Macaca mulatta*) at the CNPRC. Following GM17 and MRS agar plating, single bacterial colonies were isolated based on difference in morphotypes, then grouped based on whole-cell protein profiles on SDS-PAGE. Bacterial DNA was isolated and the sequence of the 16S rRNA gene was analyzed revealing 106 strains of 19 distinct bacterial species belonging to five genera: *Bacillus*, *Enterococcus*, *Lactobacillus*, *Pediococcus*, and *Streptococcus*. Some of these species, particularly lactic acid bacteria, inhibit the growth of pathogenic bacteria by competitive exclusion and/or through the production of antimicrobial compounds. The presence of these bacteria in milk indicate an as yet unknown mechanism by which maternal gut bacteria are translocated to the mammary gland and provided to the developing neonate via ingestion of milk. In this way, bacteria in milk may be a protective mechanism to promote infant health by improving the establishment of their commensal gut bacteria and reducing infection. This is the first such study in a non-human primate and highlights the multitude of questions that remain.

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Photographs, radiographs, PENDING, and summary paragraphs in Osteoware.

JANINE HINTON. Repatriation Osteology Lab, National Museum of Natural History, Smithsonian Institution, Washington D.C.

Documentation of human remains should include photography and radiographs of the bones and teeth. The Smithsonian Institution data entry and management system, Osteoware, both keeps track of photograph and radiograph requests and allows the option to place a current case onto a hold or "PENDING" list until these requests and the entire documentation process is complete.

The photograph and radiograph request modules allow the researcher to make requests specific to bone(s) and view(s), and provide a searchable text field for relevant notes. The researcher can click the PENDING button to place the case on hold. When documentation is complete the researcher can then remove the PENDING status.

The final step of osteological documentation includes the composition of a summary report, or paragraph. The Osteoware Summary Paragraph module contains selectable buttons to import comments from the following modules: Skeletal Inventory, Age and Sex, Taphonomy, Pathology descriptions, Dental observations, and Cranial Modification, and provides the ability to edit and spell-check the overall composition. This presentation will demonstrate how to use Osteoware to request and manage photographic and radiographic documentation, how to use the PENDING option, and how to compose a summary paragraph. Case studies will be included from the National Museum of Natural History collections.

Osteoware is supported by grants from the National Center for Preservation Technology and Training (NCPTT) National Park Service, and the Smithsonian Web 2.0 grant.

A preliminary study on locomotor kinematics of the semi-wild Assamese macaques (*Macaca assamensis*) in northern Thailand.

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The global goal of this project is to non-invasively study primate locomotion in wild environment using the advanced apparatus and techniques. In this preliminary study, as the first step, we tried to develop the methods for such measurements in a half-wild environment. The Assamese macaques (*Macaca assamensis*) at Wat Tham Pla (Tham Pla temple) in northern Thailand were chosen as the subjects because they are originally wild, but are living around the temple, being provisioned by tourists. We recorded their positional behavior by using two video cameras, and estimated the kinematic parameters during terrestrial locomotion in this study. Preliminary results revealed that the Assamese macaques walked with more retracted hind limbs and more protracted forelimbs as compared with the Japanese macaques. Consequently, duty factor, which is a measure of stability, were significantly larger in the former species. The Assamese macaques mostly used diagonal sequence gait, but sometimes showed lateral sequence gait. The hands were used in both digitigrade and semi-palmigrade postures, and were more abducted than those of the Japanese macaques. We hypothesize that these features may be related to their unique locomotor behavior, cliff-climbing. Kinematic analysis in a semi-wild environments still has some difficulties that have to be addressed (e.g., relatively low accuracy, difficulty in calibrations etc.), but constitutes one future direction in the field of primate

locomotion studies, given its tremendous potential. Such studies do not produce immediate results, but are still worth doing, and it is necessary to accumulate data steadily.

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GIS Spatial Analysis of an Oldowan "living floor" site, FxJj 20 AB.

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GIS Spatial analysis of the FxJj20 AB site, on the Karari Escarpment in Koobi Fora, Kenya, suggests clustering of stone artifacts and bone indicative of activity loci within a much larger site, consistent with the idea of a "living floor". The 2010 excavation season yielded a high density of artifacts and bone fragments, as well as numerous samples of discolored earth. Included in these finds were small microdebitage artifact, with maximum dimensions of 5 mm or less, which display no observable orientation, and indicate that the site, is in primary context, and was subject to little, if any disturbance. The presence of microdebitage is unique to sites of this age and allows for intrasite analysis of activity areas. Discolored earth has been used by some researchers to indicate the presence of fire on ancient sites and samples from this year's excavation will be analyzed and we will report on preliminary results of the results. GIS analysis has been used by other researchers to indicate the presence of 'phantom hearths' by identifying loci of activity around central areas where few to no artifacts are found. Analysis of the original 1973 excavation and current excavation together will provide the opportunity to evaluate FxJj20 AB for the presence of these anomalies in the record. This site will provide insight into the activities associated with tool manufacture, butchery, food procurement and occupation and use of the landscape over time.

This research was funded in part by the Center for Human Evolutionary Studies, Rutgers.

"On the Same Page" at UC Berkeley, genetic testing our incoming students.

LESLEA J. HLUSKO. Human Evolution Research Center, University of California Berkeley.

The "On the Same Page" program at the University of California Berkeley is designed to provide all incoming students with a common experience. For the fall of 2010 the common experience was "Bring Your Genes to Cal," an opportunity to explore the theme of personalized medicine through a program designed by the Dean of Biological Sciences and Professor Jasper Rine. Each incoming student received a saliva kit and a consent form; over 700 of the

5,000 new students mailed in a sample of their genetic material. Each sample was tested for allelic variation of genes that influence how the body uses folic acid and metabolizes lactose and alcohol.

Controversy over this program was immediate and extensive. The program was designed and implemented by faculty from the Department of Molecular and Cell Biology with no input from faculty in other departments. Much of the controversy centered on ethical issues, as students were asked to provide genetic material prior to being given a chance to learn about genetic testing, the ethical and psychological implications, or the evolutionary context in which such variants evolved. In August, the California Department of Public Health ruled that the project amounted to medical research and required that the University use a licensed clinical laboratory rather than process the genetic data on campus. Due to financial concerns the University decided to only provide the results in aggregate rather than individually. During this symposium I will report on how this program unfolded over the fall semester.

Metabolic rhythms in haplorhine and strepsirrhine primates.

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Microstructural evidence from teeth and bone has recently been used to support the hypothesis that growth, metabolism, and reproduction – i.e., life history – are centrally regulated by a neuroendocrine rhythm known as the Havers-Halberg Oscillation (HHO). Many questions about HHO biology and its relationship to life history evolution remain. For example, studies have shown that body mass is a strong predictor of HHO for anthropoid primates, but it cannot explain the unusual HHO patterns of strepsirrhine primates. It is uncertain whether this results from phylogenetic differences in HHO regulation across major primate clades, or whether such differences are eliminated by application of more physiologically relevant predictor variables.

This study examines Retzius line periodicity (a proxy for HHO) gathered from histological sections of haplorhine and strepsirrhine teeth to provide insight into this question. Results for regressions of Retzius periodicity against body mass, brain mass, encephalization, and

basal metabolic rate (BMR) show that for all primates, brain mass and BMR are the best predictor variables. However, strepsirrhines still differ in these two relationships with respect to haplorhines. This suggests that while brain mass and BMR are more physiologically appropriate variables for assessing patterns in HHO variation, phylogeny may still play a major role in governing how HHOs of specific taxa respond to ecological forces. Results also suggest that relatively longer HHOs seen in larger-brained subfossil lemurs correspond with their relatively “slower” life history schedules, reinforcing the idea that HHO can influence the evolution of life history in response to specific ecological selection regimes.

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Investigating early diagenesis: The qualitative preservation of collagen in bones after short interment periods.

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Shortly after death, all body tissues, including bone and its components, inevitably undergo taphonomic changes that consequently lead to total dissolution of the dead body. Depending on multiple factors, such as burial context, temperature, soil pH, water balance etc., decomposition is either favoured, causing faster alteration and loss of tissue, or delayed, resulting in a better preservation. Due to the complexity of factors contributing to the taphonomic fate of skeletal tissue in particular, diagenetic pathways are still not fully characterized and understood. Despite the fact that many authors emphasize the crucial role of the first years post-mortem in setting the course for long-term preservation or decay, little systematic research has been conducted in this field.

The aim of this study was to trace the initial bone collagen breakdown from the first years of interment up to later burial periods in order to investigate the mechanism of mineralized peptide degradation under varying soil conditions and the influence of inhumation time. Assessing the integrity of bone collagen is essential for various archaeometric analyses, focusing on radiocarbon dating and stable isotope analysis to reconstruct dietary patterns of past populations.

We analyzed a set of long bones from two different cemeteries with burial times ranging from 8 to 60 and 90 to 150 years. Comparative amino acid analysis (HPLC) revealed a selective

loss of certain amino acids, showing stronger coherence with soil properties than inhumation time. Histological features and collagen quantity proved to be unreliable markers for collagen quality.

Evolution of tuberculosis: a meta-analysis of paleopathological evidence.

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Tuberculosis is a re-emerging disease and is a major problem in both developing and developed countries today. An estimated one third of the world's population are infected and almost two million people die from the disease each year. Bone lesions occur in 3-5% of active tuberculosis cases and can be used to diagnose the disease in ancient skeletal remains. A meta-analysis was conducted on 394 paleopathological tuberculosis cases from 180 sites (9000-200 years BP) on all continents for the purpose of testing two hypotheses; 1) the prevalence of bone lesions does not change through time and 2) the distribution of lesions throughout the skeleton does not change over time.

The prevalence of bone lesions was found to significantly decrease over time ($P < 0.05$). The distribution of bone lesions was found to change from mainly spinal in earlier time periods to include more cases in other regions of the skeleton (long bones, joints, hands, feet) in later time periods. This difference in distribution was evaluated using a Chi-squared test and found to be significant ($P < 0.01$). These findings may represent the evolution of the relationship of host and pathogen over time, with the pathogen becoming less virulent but using more of the host's tissues to survive.

The LB1 endocast: un-adorned, un-smoothed, a replication study based on the original CT scan data.

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An essential part of science is the process of replication. Thanks to our colleagues listed below and their Indonesian colleagues at ARKENAS in Jakarta, it has been possible for the authors to independently analyze the original CT scan data for the LB1 cra-

nium. Using ITK-SNAP and Analyse software programs, we have independently segmented the data to produce an endocasts in their original form, without smoothing, or correcting for broken cranial elements or distortion, and to compare these with the "virtual" endocast created by Falk et al (2005). While agreeing with this earlier effort in most regards, particularly the strong gyri recti of the prefrontal lobe, we regard other aspects of their reconstruction as problematic, such as the left and right temporal lobes, the juncture between occipital and cerebellar lobes, and presence of a lunate sulcus. Our initial volume estimates bracket those reported by Falk et al (2005), though we expect the original undistorted endocast to be somewhat smaller. It will be interesting to see any future independent analyses done on the newer micro-CT scan data which might become available in the future. Acknowledgements: We are grateful to Drs. Michael Morwood, Peter Brown, Bill Jungers, Thomas Sutikna, Rokus Dun Awe, Wahyu Saptomo, Jatmiko, and Tony Djubiatomo, Director of the Indonesian Research and Development Centre for Archaeology for giving us access to the CT scan data.

A zoologist's perspective on the evolution of human ovarian aging: implications for women's health in the postmenopausal age.

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Life expectancy has increased gradually over the course of human evolution—but it has doubled in industrialized societies since the early 1900s, resulting in much longer postmenopausal life spans for modern women. From a comparative biological perspective, human menopause may not require special evolutionary explanation. Midlife fertility loss followed by extended postreproductive life spans occurs in a wide range of other female vertebrates, and is an expected outcome of a finite ovarian reserve produced under particular developmental constraints. In industrialized societies, reproductive aging in women correlates clearly with other clinical aging syndromes, including increasing rates of cardiovascular disease, some cancers, osteoarthritis, and sensory deficits. Intriguing questions remain concerning whether the postmenopausal life span is a human ancestral trait, an adaptation for life in extended kin networks, an artifact of cultural protections against ancestral mortality pressures, or a complex combination of these. These questions can be addressed more incisively as anthropologists and biogerontologists begin a coordinated effort to obtain more extensive comparative clinical data, particularly a variety of traditional people. These data would ideally

include functional measures and clinical predictors of disease, as well as reproductive measures, from midlife, older, and very old age classes. A refinement of scientists' view of the menopausal transition, and a working knowledge of the ancestral physiological trade-offs inherent in our reproductive health, are both essential for addressing women's health concerns over the course of the life span.

This work was supported by the Center for Reproductive Biology of Washington State University.

Diet and ontogenetic changes in human mandibular strength.

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Mandibular size and shape are commonly used to infer masticatory load history in archaeological human populations and fossil hominids. However, several factors, including genetic programming and functional demands, influence growth and development of the human mandible into its resultant adult form. The degree to which these separate factors drive mandibular morphology is not yet clear. The goal of this study was to quantify and compare ontogenetic trends in mandibular corpus cross-sectional properties between two archeological populations representing distinct dietary habits.

Using bi-planar radiographs and a hollow asymmetrical beam model, strength and rigidity properties were determined in the mandibular corpus in Arikara (n=42) and Tigara (n=63) population samples. The Tigara sample represents an arctic population with a demanding dietary regime and robust adult mandibles compared to the Arikara. Ages, determined from dental eruption, tooth development, and epiphyseal closure, ranged from infancy to adulthood. To assess developmental patterns in mandibular strength between populations, residual values from polynomial lines fit through the pooled data set were compared using ANCOVA and independent t-tests.

If differential mechanical environments associated with population-specific masticatory forces drive mandibular form, then divergent growth trajectories should be present between the two populations analyzed here. Results of this study indicate that this is in fact the case for the majority of properties examined. This suggests that while certain morphological characters possess population-specific genetic predispositions, most differences are evident only after the initiation of masticatory demands, supporting developmental plasticity as a major factor in determination of adult mandibular form.

A comparative study of the anatomical mechanical advantage of the elbow flexor and extensor muscles in anthropoid primates.

NICHOLAS HOLOWKA. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

Previous studies of the mechanical advantage of the muscles controlling flexion and extension of the elbow have generally focused on either the *biceps brachii muscle* (BBM), or the *triceps brachii muscle* (TBM). The anatomical mechanical advantage (AMA) of these muscles, which is an approximation of their effective mechanical advantage, can be calculated from landmarks on the radius and ulna as the ratio of lever arm length to forearm length. Studies have suggested that elbow AMA can be used to distinguish between primates with different locomotor behaviors, making it potentially informative in behavioral reconstructions of fossil primates, but some contest its usefulness. This study examines the *brachialis muscle* (BM), an elbow flexor that has received little attention in AMA studies, along with the TBM and BBM. Lever arms of these muscles and forearm lengths were measured in a sample of anthropoid primates representing a broad range of locomotor behaviors. For the BBM and BM, the relationship between lever arm and forearm length was assessed. Results indicate that relative BM lever arm length consistently distinguishes "slow" suspensory species from brachiators and quadrupeds, but relative BBM lever arm length does not. Mean AMA scores were also calculated for all three muscles, and these scores were compared on scatter plots. These data show that, when considered together, AMA scores from multiple muscles reliably discriminate suspensory taxa from primarily quadrupedal primates. Hence, BM and TBM AMA calculations from entirely preserved ulnae can be used to inform fossil primate behavioral reconstructions.

Variation in rates of enamel deposition in two samples of deciduous dentition.

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Enamel deposition taking place during dental development leaves a visible record of rates of growth through enamel microstructures in the tooth crown. Research addressing the variation in dental development between human populations has resulted in an accepted range of enamel growth for human secondary dentition (Reid and Dean 2006), allowing comparisons to both non-human primates and hominin species. The range of daily rates of enamel growth and periodicity has not yet been established for human deciduous teeth, however. In this research, histological thin-sections showing daily cross-striae counts and long-period striae markers are used to determine the rates of deposi-

tion and periodicity of deciduous enamel in Italian samples from both modern school-children (Fatina) and a Roman archaeological site (Isola Sacra). Data from maxillary incisors and canines show no significant differences in deposition rates between enamel zones within a single tooth designation. Significant variation in individual daily enamel formation is shown (Fatina $p=0.047$, Isola Sacra $p=0.000$); Population variation is also discussed.

An assessment of nasal septal deviation and facial form in European- and African-derived populations.

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An integrated nasal septal-premaxillary complex is likely an important determinant in prenatal and early postnatal facial development. The role of the septum in later facial ontogeny, however, is unclear. The presence of septal deviation would suggest a disjunction between septal and facial growth, although this does not necessarily preclude the septum from influencing postnatal ontogenetic development. To understand the septum's role in later postnatal facial growth, we must determine if a relationship exists between the nasal septum and facial morphology. In this study, we assessed these variables in European- and African-derived populations that exhibit early ontogenetic variation associated with the nasal septal-premaxillary complex. We tested two hypotheses: 1) There is a significant difference in nasal septal deviation between populations; 2) Population variation in facial form is correlated with septal deviation. Our hypotheses were tested using data from CT scans of living humans ($n=70$). Septal deviation was measured as the greatest difference between the absolute and superior-inferior height of the septum in the coronal plane. Facial morphology was assessed via principal components analysis of Procrustes-scaled landmarks. Our European-derived sample exhibited greater septal deviation compared to our African-derived sample ($P<0.0001$). Furthermore, septal deviation was correlated with PC1, which described population variation in facial form ($r=0.71$, $P<0.0001$). Thus, increased septal deviation was associated with a relative reduction in facial length and an increase in nasal projection. This suggests that while the nasal septum may have little influence on later ontogenetic variation in facial length, it may influence population variation in external nasal morphology.

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The metabolic cost of walking in Neandertals and Upper Paleolithic Europeans.

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It was assumed that because of their shorter lower limbs and greater body mass Neandertals walked markedly less efficiently and economically than Upper Paleolithic Europeans which in certain conditions might play a role in Neandertal extinction. However, other morphological characteristics of Neandertals were proposed to possibly affect locomotor efficiency and economy such as relatively short tibia, posteriorly displaced tibial condyles, thick patella and long calcaneus besides lower limb length and body mass. In this study we aim to utilize all these morphological characteristics to estimate differences in locomotor efficiency and economy between Neandertals and Upper Paleolithic Europeans.

We used a recent biomechanical model of Pontzer et al. (2009) to estimate locomotor efficiency and economy of Neandertal and Upper Paleolithic European expectations. Being aware of the effect of posture on some variables employed in the model (moment arms of the ground reaction force) we developed a trigonometric model that determines the behavior of the moment arms of the ground reaction force during stance phase when given the body segments lengths and the joint angles which allowed us to control the effect of posture.

Our results suggest that Neandertals might use 4 percent less mass-specific energy (were more efficient) and 9 percent more absolute energy (were less economical) to walk a unit distance than Upper Paleolithic Europeans. Furthermore, assuming the same joint angles Neandertals would have shorter moment arms of the ground reaction force especially at the knee and ankle. This study was funded by the Charles University Grant Agency, grant number 169310.

Intra-specific scaling of hind limb posture in wild chacma baboons (*Papio hamadryas ursinus*): using field data to address typical lab-based questions.

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Biewener's (1989, *Science*) experimental data in non-primate mammals (0.04-280 kg) show that as size increases, mammals adopt more extended hind limb joints. An extended limb increases the

effective mechanical advantage of anti-gravity muscles (e.g., quadriceps) thereby requiring less muscle force to maintain posture. Although some experimental data supports Biewener's findings for primates, there are some inconsistencies. For example, Polk (2002, *J. Exp. Biol.*) and Young (2009, *J. Exp. Biol.*) found no significant correlation between body size and knee angle in adult cercopithecine monkeys (three species, six individuals, 4.1-24.2 kg), or in squirrel monkeys (six individuals; 0.218-0.535 kg; ontogenetic sample), respectively. These results may be related in part to the small body size ranges and/or too few individuals sampled in both studies. Unfortunately, both issues are often inherent in lab-based primate locomotion research. To clarify this, we examined the relationship between body size and knee angle in a troop of wild chacma baboons (*Papio hamadryas ursinus*) living in the De Hoop Nature Reserve, South Africa. We obtained video of 33 individuals (1-9 years; 2-29.5 kg) as they walked (duty factor <50) perpendicular to a tripod-mounted camcorder. We measured angle at mid-support for 228 steps and performed regressions using individual means. We found that heavier, older baboons indeed have more extended knee joints ($r=0.477$, $p<0.01$). Our results for this single species support Biewener's general biomechanical hypothesis that larger individuals adopt more extended limbs. Moreover, this study demonstrates the utility of field-acquired kinematics to supplement conventionally acquired lab-based data for answering biomechanical questions.

Isolated hominid cranial fragments from the Omo River Basin: 1969-1975 collections.

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The hominid-bearing Shungura and Usno formations in the lower Omo Basin date to between ≈ 3.4 -1.4 my. This long temporal span makes the Omo record one of the longest continuous records of hominid evolution. Taxa represented include multiple species of *Australopithecus* and *Homo*. Here we provide the first descriptions and interpretations of fragmentary cranial remains attributable to two hominids from the 1969-1975 collections. Specimen L345-11 derives from Submember C9 of the Shungura formation (≈ 2.51 my). This immature specimen is a frag-

mentary right parietal that retains ≈ 38.5 mm of the coronal and 32.0 mm of the sagittal suture. Cranial thickness at bregma is 7.5 mm but the vault thins to ≈ 4.0 mm laterally. A low ridge of bone parallels the sagittal suture, indicating the presence of a developing crest. Specimen P996-17a-b derives from Shungura Member K (≈ 1.45 my) and comprises a fragment of frontoparietal, preserving the bregmatic region and portions of the coronal suture, and a fragment of the left pterygion region. Vault thickness at bregma is 11.0 mm and, while thinner at sphenion/krota-phion, it remains as thick as ≈ 7.5 mm in this region. These specimens are compared to a sample of East African hominid crania.

While the remains are fragmentary, reconstructions based on CT scans and mirror imaging provide further information. Taxonomically relevant features include vault thickness, sagittal crest development, external and internal vault curvatures, and vascular patterns. Given these data we assign L345-11 to *Australopithecus cf. aethiopicus* and P996-17a-b to *Homo cf. erectus*.

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Gene discovery in a hibernating primate.

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Primate sequencing efforts have expanded our ability to address difficult research questions relating to evolution and disease. The gray mouse lemur, *Microcebus murinus*, is one of the few lemurs to undergo torpor (hibernation). By identifying genes involved in torpor, we can begin to understand processes associated with metabolic regulation such as diabetes and obesity. In order to investigate the genes involved in torpor in the gray mouse lemur, targeted sequencing was conducted on a cDNA library created from polyA selected RNA from a mouse lemur liver using a Roche GS-FLX (454) instrument. These cDNA sequence data were compared to the human genome and combined with the current 2X gray mouse lemur genome sequence to offer clues into the evolution of genes in the primate lineage as well as to offer insight into the genes critical for hibernation. Of the 1.8 million sequence reads obtained, nearly 70% mapped to known human genes while 30% were unmapped. These unmapped reads may provide insight into mouse lemur specific genes. Several

genes known to be important in other hibernating mammals, such as *PDK4*, *SIRT1*, *FGF21*, *CLOCK* and *PER*, were identified in this study. The data are currently being evaluated to identify genes under positive selection. This cDNA sequence resource will provide a basis for further research on metabolic regulation in primates, as well as offer an important evolutionary perspective on lemur biology and genome evolution.

This study was funded by the Primate Genomics Initiative at Duke University.

Dental anomalies in the deciduous dentition of a C-Group Nubian child from Hierakonpolis, Egypt.

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The purpose of this study is to describe and discuss a case of "twinned" incisor with an associated talon cusp in a sub-adult from a cemetery at Hierakonpolis. Excavations at the site's C-Group Nubian cemetery (HK27C) unearthed approximately 60 individuals dated from the 11th Dynasty through the 2nd Intermediate period. Of these, the remains of a 3-4 year old child, age determined by dental eruption, were recovered from Tomb 37b; they were associated with a more recent "Egyptianized" section of the cemetery. The incisor twinning, i.e., gemination event, and the talon cusp, are present in the right deciduous maxillary lateral incisor; both are unilateral in their expression. Gemination in deciduous teeth occurs at a very low rate; previous studies reported an incidence of 0.4 to 0.9 percent. Talon cusp occurs from 0.6 to 7.7 percent in deciduous teeth. These two anomalies combined make the discovery rare, as only three case studies have been described in modern dentistry. Twinned incisors and talons cusps, respectively, have been documented in multiple regions of the world -- from Peru to Portugal. The present discovery at Hierakonpolis is the first example in North Africa of either anomaly in a juvenile, and contributes to an ever increasing data set of dental anomalies in the region.

Dr. Renee Friedman kindly facilitated analysis. Funding for the excavation in 2007 was provided by National Geographic Society and Wenner-Gren Foundation; granted to the second author and the Hierakonpolis Expedition.

A case of metastasized prostate cancer from the historic Spring Street Presbyterian Church in Manhattan.

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In 2005, construction crews in New York City unearthed human skeletal

remains from what was determined to be burial vaults of the Spring Street Presbyterian Church. This radical abolitionist church, active from approximately 1811-1843, was comprised of a mixed-race congregation that was predominantly working class. Of the some 300 individuals recovered from the site, many of the subadults exhibited pathological conditions, while most of the adults revealed few. Tuberculosis and venereal syphilis was present in a small number of the adults. One individual, in particular, exhibited lesions consistent with prostate cancer. The incomplete skeletal remains of an adult male, 40-44 years of age, designated as Burial 9 in Vault II, has proliferative and lytic lesions on the os coxae, sacrum, and proximal third of the femora diaphyses. This poster will present the case of the suspected neoplasm in Burial 9, as identified by micro- and macroscopic observation as well as radiographic analysis. When interpreting these lesions, it is important to consider the social and physical environment this individual lived in, so as to understand the morbidity and mortality of persons with such a condition. Burial 9 provides a unique opportunity to study a relatively rare case of prostate cancer in an archaeological specimen and to better understand the effects of genetic and environmental factors on the development of prostate cancer.

Skeletal tissue properties: the utility of using indentation modulus and density as proxies for elastic modulus.

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An important aspect of modeling mechanical behaviors of structures is determining the correct material properties. Two material properties that greatly influence skeletal tissue mechanical behavior are elastic modulus and density. The purpose of this study is to examine the relationship of these material properties using a female *Macaca fascicularis* skull. Density and elastic modulus are expected to exhibit a very strong correlation.

The female *Macaca fascicularis* skull underwent micro-computed tomography scanning. The scans yielded grayscale values that were used to calculate cortical bone density. After the skull was scanned, the hard palate was sectioned for microindentation. A total of 7 samples underwent microindentation to determine the hardness of the cortical bone. The hardness values were then used to calculate the elastic modulus of the skeletal tissue. Density and elastic modulus values were determined in the same locations in the palate. Linear regressions of these variables were performed to determine their relationship. Both specific, localized areas of bone and larger, regional areas of bone were

examined to determine the relationship between density and elastic modulus. All of the regressions showed a poor correlation; however, it is highly unlikely that these 2 variables are truly uncorrelated. A more likely explanation for this lack of correlation is that indentation and density are relying on different factors to estimate elastic modulus. In this study both variables of interest were determined indirectly which is likely a contributing factor to the demonstrated lack of relationship.

An examination of biological distance and population structure among four coastal Kenyan populations.

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This study examines biological distance (biodistance) and population structure among four coastal Kenyan populations, and is part of a larger project investigating the concordance between estimates of population structure based, independently, on genetic data and dental data from the same individuals. The aim of the current project is to determine if structure and distance estimates for the selected populations conform to expectations based on these populations' histories.

Presence and absence of twenty-seven dental non-metric traits were scored on 388 impressions collected from four populations (representing two ethnic groups): Dawida and Kasigau (Taita), and Mombasa and Lamu (Swahili). Next, biodistance estimates were calculated using Konigsberg's modified Mahalanobis distance program. The resultant distance matrix was then used to calculate the r -matrix, which yielded corresponding F_{ST} values (a measure of inbreeding within (sub)populations).

The following hypotheses were tested: 1) Taita populations will exhibit higher F_{ST} values than Swahili populations because the Taita are more geographically and culturally isolated than the Swahili, and 2) following a model of isolation by distance, the biodistance between the furthest locations (Mombasa and Lamu; Lamu and Dawida/Kasigau) will be largest, while smaller biodistances will be between closely-spaced locations (Mombasa, Kasigau, Dawida).

Preliminary results from a sub-sample of the 388 individuals indicate that some expectations have been met. F_{ST} values were higher in the Taita samples and low in the Swahili samples. Unexpectedly, none of the predictions based on the isolation by distance model were met. Explanations for such deviations will be further explored in this poster.

This study was generously funded by the U.S. Department of Education through a Fulbright-Hays Doctoral Dissertation Research Abroad Grant (P022A090029), a Wenner-Gren Foun-

ation Dissertation Improvement Grant (7962) and the Ohio State University Graduate School.

Understanding Fst and Discriminant Analysis Classifications by means of resampled datasets: the influence of different variables and the extent to which they actually reflect sub-population divergence.

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Classification through Discriminant Functions and F_{ST} are common means of studying the apportionment of global human cranial morphological variation. However, the power of each method in reflecting real population structure is rarely discussed in the literature. In this work we assess the relative capacity of each method in real populations (Asia, Africa and Europe) and in randomly generated ones. Our goals were 1) to investigate the effect of different sets of numbers of variables in each statistic; and 2) to measure their capacity of reflecting the original structure of the populations. F_{ST} and frequency of correct classification (FCC) were calculated for thousand randomly chosen datasets considering progressive numbers of variables for the original and random (mixed) populations. The results for the real populations indicate that both statistics vary considerably when different sets of variables are used, especially when the number of variables employed is small. Besides, both indexes are influenced by the total number of metric traits included in the analysis, although in different ways: FCC increases when more variables are used while F_{ST} reach its higher values with an intermediate number of variables. The results for the random populations show that F_{ST} is close to zero, as expected. On the other hand, FCC can reach 64% of correct classifications even when dealing with populations that are not real. We conclude that both number and type of variables can affect drastically statistics that describe population structure and care must be taken when comparing results obtained from different sets of variables.

Testing evolutionary and dispersion scenarios for the settlement of the New World.

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tiva, Universidade de São Paulo, ³Senckenberg Center for Human Evolution and Paleoecology, University of Tübingen.

Recent evidence regarding the settlement of the Americas from diverse fields is found to support different colonization scenarios. The currently available genetic evidence suggests a "single migration" model, in which both early and later Native American groups derive from one expansion event into the continent. In contrast, the pronounced anatomical differences between early and late Native American populations have led others to propose more complex scenarios, involving separate colonization events of the New World. Using large samples of Early American crania, we: 1) calculated the rate of morphological differentiation between Early and Late American samples under three different time divergence assumptions, and compared them to the morphological differentiation expected under neutral conditions; and 2) tested the goodness of fit of three geographic dispersal scenarios for the colonization of the New World by comparing them to the morphological distances among early and late Amerindians, early and late East Asians and Australo-Melanesians. Results indicate that the assumption of a last shared common ancestor outside the continent better explains the observed morphological differences between early and late American groups. Also, a model comprising two Asian waves of migration coming through Bering into the Americas fits the cranial anatomical evidence best, especially when the effects of diversifying selection to climate are taken into account. We conclude that the morphological diversity documented through time in the New World is best accounted for by a model postulating two waves of human expansion into the continent originating in East Asia and entering through Beringia. This study was funded by FONDECYT (11070091), FAPESP (04/01321-6 and 08/58729-8), CNPq (301126-04.6), the Max Planck Gesellschaft and the EVAN MRTN-CT-019564.

Characteristics of bone structure during growth: a comparison of the age-associated patterns of change in cortical bone geometry and trabecular bone microarchitecture in the human tibia.

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Human long bone trabecular microarchitecture has been demonstrated to reach its essential adult configuration by the

time an individual reaches late childhood, whereas the geometric properties of cortical bone continue to change past adolescence. The objective of this research is to examine the differing developmental trajectories of trabecular and cortical bone with regard to shape differentiation and strength maturation. Here, we test the hypothesis that the cross-sectional shape of the tibia initially transforms from rounded to triangular in association with the acquisition of bipedal walking and continues to differentiate in shape well into skeletal maturity, in contrast to trabecular bone developmental patterns. High resolution x-ray CT images of the tibial midshaft were taken from 30 individuals ranging developmentally from neonate to skeletally mature from the SunWatch Village skeletal collection, an Ohio Valley maize-dependent agricultural village (AD 1200-1300). Cortical geometric properties (I_{max} , I_{min} , and J) were calculated using a custom code written in IDL. Polar plots of multiple centroid radii were developed to visualize and compare the age-associated cortical geometric shapes. Results demonstrate a dramatic differentiation in tibial midshaft shape from birth to late adolescence; increasing I_{max}/I_{min} ratios correlate with increasing age (Pearson correlation of 0.847, p -value=0.000), showing that tibial cross-sectional shape becomes more heterogeneous (from more to less rounded) throughout ontogeny. This study demonstrates that by late adolescence, the geometries of trabecular and cortical bone have stabilized into adult patterns, but have arrived there via differing trajectories. Grant Sponsors: National Science Foundation Dissertation Improvement; Grant number: BCS-0650727 (JHG); National Science Foundation; Grant number: EAR-0646848, (RAK).

Anterior dental microwear of Middle and early Late Pleistocene hominins from Morocco.

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Pleistocene hominin fossils from northwestern Africa, especially Morocco, hold great potential for providing clues regarding the evolution and dispersion of *Homo*. For example, early Middle Pleistocene fossils can offer a rich source of data concerning the transition from *erectus* to *sapiens*. Furthermore, while focus has centered on Middle Pleistocene populations in Europe, contemporaneous hominins from northwestern Africa can present a more comprehensive picture of dietary and behavioral breadth. Consequently, this study seeks to better understand the dietary and behavioral milieu of these

hominins through dental microwear texture analysis.

High-resolution casts of four individuals were used in this study. The Salé and Thomas Quarry III individuals are dated to the early Middle Pleistocene, whereas those from Dar es-Soltane II and Grotte des Contrebandiers are from the early Late Pleistocene. Anterior teeth were scanned using a white-light confocal profiler using a 100x objective lens. The resultant scans measured a total area of 204 x 276 μ m, and were analyzed using Toothfrax and SFrax software packages. Modern human samples were used as a comparison baseline.

Results indicate high anisotropy and moderate textural fill volume values for the earlier Pleistocene hominins, whereas the later individuals show low anisotropy and high textural fill volume values. Anterior dental microwear signatures for the later hominins are most similar to those of modern humans from the arctic. This pattern suggests the early Late Pleistocene hominins from Morocco may have participated in more high magnitude or repetitive loading associated with non-dietary anterior tooth use than did the earlier hominins. This study was funded by the National Science Foundation DDIG (BCS 0925818).

Children of divorce: effects of adult replacements on survival and dispersal of young owl monkeys in the Argentinean Chaco.

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Although owl monkeys (*Aotus azarai*) of the Argentinean Chaco are socially monogamous Neotropical primates, male and female partners are sometimes replaced by intruders from outside the group. The consequences of those replacements on the pair's offspring have not been evaluated. Here we tested the prediction derived from parental investment theory that juveniles would disappear (as a proxy for death) at younger ages in groups with replacement than in stable groups. We also predicted, as derived from the evolutionary theory of the family, that subadults would disperse at older ages after the replacement of the opposite-sex parent than in stable groups or after replacement of same-sex parents. To test the predictions we compared, taking the immature's sex into account, the survival and dispersal of owl monkeys ($n=19$ males, 15 females, 48 unknown sex) from stable groups and from groups with replacements. Contrary to expectation, we found that juvenile survival was not negatively affected by replacements (G -test, $p=0.36$), suggesting that infants and juveniles may be cared for

similarly by step- parents and biological ones. On the other hand, and in support of the evolutionary theory of the family, young males dispersed later when the mother had been replaced than in stable groups (x^2 test, $p=0.016$), but the replacement of the adult male had no significant effect on the dispersal of young females. Our results stress the importance of detailed and sex-specific dispersal/survival analyses as part of any investigation of mating systems and paternal care in primatology.

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Sex differences in cognition in rhesus macaques: a model for understanding human variation in cognition?

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There is still much controversy regarding the origins of sex differences in human cognition. Some researchers support at least some influence of biology, citing the consistency of sex differences and biological correlates of variation in cognition. These researchers are divided though, on whether such biological influences arise from mechanisms shared with other mammals, or rather, from unique pressures during human evolution. Contrary to all of these ideas, a growing contingent supports a completely cultural explanation for the existence of cognitive sex differences in humans. Such researchers cite findings that show how the priming of gender and stereotypes can strongly influence the strength of sex as a factor in cognitive task performance. These different perspectives have not been resolved with human research, so to take a different approach, we turned to a nonhuman primate model (*Macaca mulatta*), in which the effects of enculturation are much reduced, to test these hypotheses. To do so, we adapted the mental rotation task for nonhuman subjects; this task regularly obtains the largest sex differences of any cognitive task. In this task, subjects must discriminate between two sets of images: either the set represents the same object viewed from different angles or two different objects. We observed a significant effect of condition, showing that some monkeys successfully discriminated between same-but-rotated and different sets. We also observed a marginally significant effect of sex, with females showing less discrimination than males. The impact

of this finding on current hypotheses is examined.

This study was funded by Yale University and International Primatological Society Research Grant.

Biological anthropology in the genomics era.

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This study explores the current and future impact of the "genomic era" on biological anthropology. Whereas *genetics* refers to the detailed study of one or few genes in isolation, *genomics* is the study of organisms using the entirety of their genome and their environments. The term "genomics era" alludes to the seemingly endless research potential released by an arsenal of technological advances of the last decade. The challenges posed by the genomic era to biological anthropologists are significant, and our ultimate goal is to understand how biological anthropologists in general, and anthropological geneticists in particular, can reposition themselves to face these challenges.

We collected interview data and qualitative data based on an online survey from professionals on the ways in which challenges posed by the genomic era may affect their practice of biological anthropology. Questions were structured around teaching, research, and advising. Preliminary results based on interview data alone indicate that, in general, biological anthropologists in anthropology departments suffer from a lack of resources relative to colleagues in other academic departments. Furthermore, results indicate that *both* an increase in funding *and* institutional change (at the departmental and university-wide level) is needed. Using the new technologies and methodologies of the genomic era requires time, money, accessibility, new laboratory skills, and bioinformatic training. Anthropological geneticists are struggling to remain competitive in these five areas as the pace of change in genomic technology increases. These results provide a potential roadmap for change for biological anthropologists to remain competitive in the genomic era.

Comparative skeletal maturation of the elbow.

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Skeletal maturation involves the appearance of ossification centres and fusion of secondary centres with each other and with a primary centre to form a consolidated skeletal element. Skeletal maturation in humans and African apes proceeds through a series of well

defined steps, but the timing of these stages relative to chronological age, dental development and the maturation of other skeletal elements is variable.

This paper examines species differences in the sequence and relative timing of skeletal maturation of the elbow in humans, chimpanzees and gorillas. Skeletal maturation of the elbow involves several distinct events: coalescence of the ossification centres of the distal epiphysis of the humerus to form a composite epiphysis; fusion of the separate or partly fused ossification centres of the distal epiphysis or of a composite distal epiphysis to the metaphysis of the humerus; fusion of the proximal radius and proximal ulna. Each potential point of fusion was scored as unfused, partially fused, or completely fused.

An age-independent seriation of successive and/or overlapping stages of fusion reveals species differences in the sequence of maturation events within the elbow. Ordering of individuals according to sequential stages of tooth emergence or (non-elbow) skeletal maturation reveals species differences in the relative timing of elbow maturation. The sequence and timing of elbow maturation of fossil hominins is evaluated in the context of differences between extant species.

What is the relationship between mandibular corpus cross-sectional geometry and molar microwear enamel surface texture?

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The vertebrate fossil record is heavily represented by craniodental remains, offering the potential to elucidate patterns of evolution in diet across a broad range of taxa. Because the ability to reconstruct feeding (or any) behavior of extinct animals depends on the use of many independent lines of evidence, understanding the relationship between multiple lines of evidence is critical. This study tests the relationship of mandibular corpus cross-sectional parameters to molar occlusal enamel surface texture in two New World monkey taxa with known natural dietary consistencies: *Alouatta* (n=11), whose diet is considered "tough" (with high levels of enamel surface anisotropy - *epLsar*), and *Cebus* (n=12) whose diet is consid-

ered "hard" (with high levels of enamel surface feature complexity - *Asfc*). The two methods compared here have established records of use in inferring feeding behavior of extinct taxa, especially primates.

Mandibular cross-sectional geometry was obtained via computed tomography, and microwear data were collected from the literature. Results of the mandibular cross-sectional geometric analysis indicate that the corpus of *Alouatta* is both stronger and more rigid in bending and torsion than that of *Cebus*. With these results, we expected *Asfc* to positively correlate and *epLsar* to negatively correlate with mandibular cross-sectional geometry. However, Spearman's Rho correlation results were mixed: expected significant correlations were observed in *Cebus*, but not for *Alouatta*. Thus, there appears to be a complex relationship between results of these analyses that must be considered when using either one in isolation to reconstruct feeding behavior of extinct animals.

Race and genetics: concepts and practice in primary care.

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While the time-worn idea that the human species can be reasonably divided into four or five biologically distinct races has long been rejected by anthropologists and many biologists, it keeps reemerging in nearly its original form. In the prodigious wave of genetics research following the Human Genome Project, the concept of biological races has been experiencing something of a reinvigoration. Racial/ethnic labels are being used routinely in this context, which promotes the illusion that these labels have the status of legitimate scientific categories. At the same time, racial classifications are increasingly ubiquitous in current clinical research, and permeate the medical literature; most often in the absence of a consideration of whether observed group differences are biological or socioeconomic in origin. Little is known about the uptake of these concepts by clinicians, and the consequences of these questionable practices for the care provided to racially labeled patients. In this paper we report on a study examining the management of chronic illness in primary care clinics in a Midwestern U.S. state. We have conducted clinical observations and interviews with 60 primary care clinicians, focusing on their concepts of race and genetics and how they apply them in their care of minority patients. We will argue that genetics is becoming a euphemism for race, and is used to rationalize racial profiling in the selection of diagnostic and treatment options.

A differential diagnosis of Diffuse Idiopathic Skeletal Hyperostosis (DISH) in a *Gorilla gorilla gorilla* skeleton.

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Diffuse Idiopathic Skeletal Hyperostosis (DISH), a pathological condition prevalent in modern human populations, has rarely been documented in other hominoids. Although its antiquity has been established, the diagnostic standards are inconsistent, and only one case of DISH in a non-human primate has been reported in the literature. This investigation provides the first postmortem differential diagnosis of the condition in a *Gorilla gorilla gorilla* specimen. Antemortem medical records from captivity, macroscopic diagnostic criteria, computed tomography (CT), and histological data are used here to document DISH in a captive female *Gorilla gorilla gorilla* as a proxy for archaeological context. Furthering our understanding and interpretation of the process this disease takes through three dimensional CT reconstruction and accompanying descriptions of histological analysis of ectopic growth, this paper builds knowledge of diagnostic signatures of the disease. This skeleton shows diagnostic characteristics of DISH including "candle wax" vertebral ossification, preservation of intervertebral disc space, uninvolved interarticular facets, and histological appearance consistent with the ossification of the anterior longitudinal ligament. However, vertebral patterning and the histological presence of appositional bone growth vary from traditional diagnostic standards supporting a multi-methodological approach to differentially diagnosing DISH. Captive lifestyle conditions for a non-human primate are analogous to the clinically correlated behavioral risk factors. Combining clinical data with human and captive non-human primate skeletal and lifestyle data will aid in further clarification of behavioral reconstructions of past populations. Increasing awareness in human and non-human primates will lead to a more accurate paleopathological differential diagnosis and lifestyle interpretation.

This project was funded by the Department of Anthropology at The Ohio State University.

A preliminary comparison of spinal extensor-muscle fiber architecture in *Galago senegalensis* and *Nycticebus coucang*.

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Leaping is generally considered a hind-limb-driven locomotor behavior that

requires enhanced maximum shortening velocity and excursion of muscles to facilitate acceleration during take-off. However, some investigators have noted that spinal extension is also an important component of leaping, as this movement increases the leap length by extending the spine from a flexed position at the beginning of the take-off phase. We compared absolute and relative measures of fiber architecture (mass, pinnation angle, fiber length [Lf], and physiological cross-sectional area [PCSA]) of selected spinal extensors (thoracic and lumbar segments of mm. iliocostalis, longissimus, multifidus) between one *Galago senegalensis*, a habitual leaper, and one *Nycticebus coucang*, a slow-moving arboreal quadruped. We hypothesized that since *G. senegalensis* engages in rapid spinal extension during leaping, it should exhibit extensors that are relatively long-fibered and thus well-suited for generating relatively high shortening velocities and excursions compared to those of *N. coucang*.

Relative to the thoraco-lumbar spine length, *G. senegalensis* has longer, more parallel-fibered extensors compared to *N. coucang*. As Lf is proportional to maximum shortening velocity/excursion, the relatively long fibers of the spinal extensors indicate that *G. senegalensis* has the capacity to generate relatively high shortening velocity and greater excursion compared to *N. coucang*, which would facilitate the rapid back extension during leaping. As an architectural trade-off between maximizing muscle excursion/contraction velocity and force, *G. senegalensis* also exhibits relatively smaller muscle PCSAs. These results highlight the potential trade-off between maximizing muscle force- and velocity/excursion, and add an important dimension to the study of leaping behavior.

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Acoustic communities: an amendment to the social brain hypothesis.

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The social brain hypothesis states that large primate brains evolved to successfully navigate within complex social systems. Previous research on the subject has restricted group size to visual contact with other individuals. Visual signals convey information such as: behavior, social status, reproductive status, location, sex/age class or winner/loser statuses; however, vocal communication also transmits these types of social information for many primate species. Furthermore, in densely forested habitats, acoustic signals may propagate further than visual signals. Therefore, a multimodal viewpoint is relevant to how social information is processed and the scale of individuals that could be considered part of a "group". This project postulates that both visual and

acoustic cues are relevant to social communication and thus could contribute to the social brain hypothesis. The goal of this study was to assess if vocal complexity positively correlates with Encephalization Quotients (EQ) in primates. Data for complexity and brain body weights were compiled from previous studies for 151 primate species. Complexity was assigned to species satisfying one or more of 4 categories: (1) repertoire size (2) song complexity (3) individual recognition or age/sex specific calls and (4) acoustic subgroup monitoring. After controlling for group size, this study shows a highly significant correlation between vocal complexity and brain size. These data suggest both acoustic and visual social cues contributed to the social brain and acoustic communities might more accurately define "group" for some species of primates.

First Peruvian Christian mummies? A bioarchaeological analysis of the transitional funerary site of Marcajirca, Huari -Peru.

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Marcajirca is a prehispanic funerary site (AD.1040-1640), located 600 km northeast of Lima, that has been continuously explored since 2007 as part of a bioarchaeological field school. One of the objectives is to understand how mortuary rites are implemented according to local rituals. Traditionally, mummified bodies tied in fetal position with ropes and wrapped in blankets (bundles) are placed in either caves or burial houses (*chullpas*). However, recent discovery of two unexpected burial pits, initially interpreted as ossuaries, prompted further examinations. Careful bioarchaeological excavations and analyses in addition to 14C dating placing both structures in the timing around the arrival of the Christians (A.D. 1480- 1640), revealed that the bones were in fact individual mummies sequentially buried underground.

Our on-going working hypothesis proposes that despite ancestral prohibition of body inhumation, when the Extirpation of Idolatries was imposed, as presented in historical documents, forcing the population to bury their dead in designated cemeteries, local "priests" managed to adapt their rituals by "hiding" mummy bundles underground to satisfy both Christian standards of inhumation and traditional body treatment, effectively creating a transitional ritual of Christian mummies.

Despite regular looting of the bundles and disruptions of the site by neighboring farmers, cautious excavations by field anthropologists and contextual approach of the burials was crucial to generate precise data and help shed light on potential original transitional burial practices.

Bony criteria for differentiating osteochondrodystrophies: applications in prehistory.

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Prehistoric and recent skeletal evidence shows instances of gene expression errors that affect skeletal development. One of the more common classes of defects is the osteochondrodystrophies. Errors in development in the osteochondrodystrophies are related to multiple genetic mutations. Here we compare the skeletal morphology of an individual with mutations in the COMP gene (multiple epiphyseal dysplasia/pseudoachondroplasia) to that expressed in individuals with mutations of the FGFR3 gene (achondroplasia).

We compiled diagnostic criteria for the above conditions and evaluated them on a sample of individuals with COMP and FGFR3 mutations. The sample of malformed individuals comprises one complete skeleton with a COMP mutation and a skeleton and cranium from two individuals with an FGFR3 mutation. These malformed individuals were compared to a sample of 30 normal individuals. A series of nonmetric criteria for the differentiation of these two genetic conditions was established.

Our comparisons allow us to establish a range of bony criteria for the differentiation of COMP and FGFR3 expression. These criteria include 5 differences in the skull, 5 differences in the thoracic cavity, 25 long bone differences, 8 pelvic differences (os coxae and sacrum), and 2 differences in the feet. Multiple epiphyseal dysplasia and pseudoachondroplasia represent a developmental continuum differentiated by variation in COMP gene expression. Alternatively, FGFR3 gene expression related to achondroplasia does not form such a continuum. Because in life these conditions mimic one another morphologically, having a set of standard skeletal criteria to differentiate them should clarify diagnoses in prehistoric remains.

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Anatomy and isolation in mid/late Pleistocene Indonesia: New insights on the age and anatomy of the hominins from the Solo River Valley.

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The last surviving *Homo erectus* populations have long been considered to come from the Solo River Valley, Java, Indonesia. Both Ngandong and Sambungmacan yield well preserved fossil calvariae that have been considered of either late (< 50-100 ka) or middle (200-500 ka) Pleistocene age. The relationship between these remains, those from *H. erectus* in mainland Asia, and other middle Pleistocene species such as *H. heidelbergensis*, remains obscure, however, in part because of uncertainties regarding the geological age of the Indonesian populations.

We review the results of our Solo River Terrace (SoRT) project whose recent radiometric (⁴⁰Ar/³⁹Ar) and taphonomic work provides strong evidence of a middle Pleistocene component in the Solo River Valley. We describe previously undescribed remains from Ngandong. Using morphometric data, we consider the relationship between the Ngandong and Sambungmacan hominins, other *H. erectus*, and other *Homo* species. And, finally, we consider the implications of the differing geological age estimates for interpretations of brain size increase, biogeography, isolation, and relatedness within later genus *Homo*.

The anatomy of the specimens coupled with a late Pleistocene age suggests refugial populations of *H. erectus* in island Southeast Asia. On the other hand, if the Solo River hominins are the contemporaries of fossils from other middle Pleistocene localities, then our morphological results suggest a strong signal of regional isolation (local evolution) amongst *H. erectus* populations in both mainland China and Southeast Asia. In either case, the morphological signal is one that is distinct from other *Homo* taxa.

Social behavior and proximity to group members in a captive chimpanzee (*Pan troglodytes*) identified with sensory integration difficulties.

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A young adult female chimpanzee (*Pan troglodytes*) at the Saint Louis Zoo has been identified with sensory integration and processing difficulties. Holly's behavior manifests through increased levels of stereotypies, problems with social relations and poor occupational

performance in routine daily activities. As part of a plan of therapy to improve Holly's situation, baseline frequencies of behavioral activity and social interactions have been assessed using one-minute interval sampling of focal individuals. This study describes social activity and proximity to group members for Holly and her peers during July 2009 and January 2010, in both outdoor and indoor enclosures.

Holly's social behavior and proximity to group members differed from her peers and between enclosures. Irrespective of enclosure, Holly spent more time in close proximity (1m) to other individuals and less time at a distance greater than 4m from all individuals. However, her behaviors when near other individuals were largely self-directed and her attempts at interaction (e.g. grooming) were often not reciprocated. Close proximity to others for both Holly and her peers was unevenly distributed across group members, but target individuals differed. Some individuals were observed actively avoiding proximity and contact to Holly, but not with her peers.

Holly's sensory integration problems isolate her and have multiple effects on the social dynamics of the entire chimpanzee group. Occupational therapy is focusing on alleviating Holly's abnormal behavior, with a goal of improving the social environment in the group. Widespread application of occupational therapy and sensory integration theory to zoological management may be possible.

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Path analysis of vocally-mediated intergroup spacing strategies in mantled howling monkeys.

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The long-distance calls of mantled howling monkeys have been hypothesized to serve the primary purpose of mediating intergroup spacing. Experimental and observational studies have confirmed coordination of vocalizations and movement patterns, but interpretations have produced conflicting models of mutual avoidance, tit-for-tat reciprocation, and boundary marking. To assess the movement patterns in a more general framework, we employ a random walk analysis of male mantled howling monkey vocalizations and movement paths at Ometepe Biological Field Station, Nicaragua in August 2010. Specifically, we predict that howling monkey movement paths will have speed and angle distributions that show biased relationships

with the angle and frequency of extragroup vocalizations: males will exhibit angular bias either towards or away from out-of-group vocalizations and speed bias in the form of periods of increasing movement that follow periods of increased frequency of audible vocalizations.

We calculated arboreal movement paths via compass angle intersections from paced reference points and we quantified frequency of male vocalizations via interval-based counting methodology. By constructing an angular histogram representing directional biases of movement with regards to the vocalizations of extragroup males, we find an alternative pattern to the tit-for-tat model of spacing that includes increased specific avoidance, increased withdrawing lateral searches, and occasional direct approach. We interpret the angular distribution of movement responses as a budgeting process that minimizes intergroup encounters and increases available time and space for foraging. In addition, we find synchronization of male vocalizations and movement speeds that confirms existing hypotheses regarding the initiation and maintenance of intergroup spacing.

Afridonty: the "Sub-Saharan African Dental Complex" revisited.

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Prior research revealed that, compared to other world populations, Africans south of the Sahara Desert are distinct dentally -- especially in their expression of nine high- and two low-frequency morphological features. This suite of traits was termed the "Sub-Saharan African Dental Complex" (SSADC); it includes the world's highest occurrences of Bushman canine, two-rooted UP1, UM1 Carabelli's trait, three-rooted UM2, LM2 Y-groove, LM1 cusp 7, LP1 Tome's root, two-rooted LM2, and UM3 presence, and among the lowest occurrences of U11 double shoveling and UM1 enamel extension. The SSADC is based on the pooling of several spatially disparate samples and is largely synchronous (i.e., 19th-early 20th centuries); it was, thus, intended as a preliminary characterization. Still, the SSADC helped 'place' sub-Saharan peoples on a global scale, and proved useful in better understanding human origins.

Recent research on movement of west African Iron Age agriculturalists across the subcontinent, sometimes called the "Bantu Expansion," allowed study of many hundreds more dentitions; samples come from throughout west, central, east, and south Africa, and date between the late Pleistocene through mid-1950s AD. Although some spatial and temporal trends are now evident relative to the SSADC including, for example, slightly lower dental complexity in early Holocene Kenyans and Tan-

zanians, the SSADC stands the test of space and time, as it remains useful in characterizing sub-Saharan Africans globally. Therefore, the SSADC should be moved out of the "preliminary" category and, following standard nomenclature (i.e., Turner's Sinodonty and Sundadonty) it is suggested that the complex now be termed "Afridonty." Funding was provided by the National Science Foundation (BNS-9013942, BNS-0104731, BCS-0840674), the ASU Research Development Program, and the American Museum of Natural History.

The Mio-Pliocene colobine monkey, *Mesopithecus*, in China.

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The colobine monkey, *Mesopithecus*, from very late Miocene and very early Pliocene deposits of southern and eastern Europe, Russia, Iran, Afghanistan, and the Pakistani Siwaliks is best known from the Turolian site of Pikermi in Greece where *M. pentelicus* is recognized as a large, unspecialized, semi-terrestrial monkey.

We report here on new finds of *Mesopithecus* from the site of Shui Tang Ba near Zhaotong in northeastern Yunnan Province, China that further extend the range of this successful disperser. Shui Tang Ba is a lignite mine which has yielded mammals, birds, amphibians, and fish denoting a freshwater margin environment. Several mammalian species identical or similar to those known from Lufeng suggest that the site is of very late Miocene age. The *Mesopithecus* fossils from Shui Tang Ba comprise a nearly complete mandible, a proximal femur, a calcaneus, and an isolated lower molar. All but the isolated molar may represent a single individual. The mandible is that of a female; the dentition lacks only the incisors, and the teeth are very lightly worn. The calcaneus exhibits the great breadth of the sustentaculum tali characteristic of *Mesopithecus* and features denoting potential for eversion and inversion. The proximal femur is remarkable because the morphology of the articular surface of the head, the thickness and perpendicular orientation of the neck, and the large size and lack of superior projection of the greater trochanter are consistent with arboreal leaping. *Mesopithecus* from Shui Tang Ba was dentally typical for the genus but was an arboreal leaper.

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vania State University and Bryn Mawr College.

Community, landscape, and climate reconstruction of contemporary sites using multiple biotic and abiotic proxies.

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The 28 – 27 Ma Chilga strata, northwestern Ethiopia, provide multiple proxies for paleoecological and paleoclimate reconstructions pertinent to environments of primate evolution, from an otherwise poorly represented time and place. This study samples two stratigraphically equivalent paleobotanical sites located 1.5 km apart, Guang and Bull's Bellow. These sites differ taxonomically, but their equal age permits tests of within-proxy methodologies. From their composition, we hypothesized Bull's Bellow represents an earlier stage of community succession than Guang, and this should be associated with differences in species richness, evenness, lateral heterogeneity, and insect damage specialization. At least four sublocalities were collected along a single stratum at each site. Totals of 844 and 434 leaves were collected from Bull's Bellow and Guang, respectively. Mean annual precipitation and temperature (MAP, MAT) were estimated from leaf morphology, the overlapping distributions of nearest living relatives (ODA), oxygen isotopes from paleosol phyllosilicates (for MAT) and paleosol geochemistry (for MAP). MAP estimates derived from leaf morphology are somewhat greater than modern (1200 mm/year): 1200 – 1400 mm/year. All proxy estimates are statistically indistinguishable from each other and document greater equability of rainfall than modern. MAT estimates from leaf morphology range from 24° to 37° C (modern MAT of 21° C), with estimates for Bull's Bellow consistently lower than those for Guang. Values are consistent among proxies, but have large margins of error. Ecological analyses found greater potential richness, greater insect damage specialization, and less evenness at Guang, all consistent with a species-rich, heterogeneous mature forest, undersampled for its diversity.

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Variation in foraging behavior and color vision status in wild female black-and-white ruffed lemurs (*Varecia variegata*).

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Among mammals, primates exhibit a unique capacity for trichromatic color vision. This feature is not ubiquitous throughout the order, and the genetic basis for trichromacy varies across lineages. Many platyrrhines and lemuriiforms maintain a sex-linked polymorphism, providing heterozygous females the potential for trichromacy. This variation may be maintained through differential advantages conferred during foraging. There is some suggestion that trichromats can better detect conspicuous (red against a green background) food, while dichromats might better detect more cryptic food. Consequently, individuals should exhibit different foraging patterns depending on color vision status. We present foraging data on a wild polymorphic population of black-and-white ruffed lemurs (*Varecia variegata*). Behavioral data were collected on five adult females in Mangevo, Ranomafana National Park, Madagascar. We used a combination of 5-minute instantaneous sampling and continuous recording conducted during full-day focal follows, to record detailed observations of all feeding bouts, including whether the food item would be perceived as conspicuous or cryptic based on *in situ* classification by a human trichromat. We then sequenced exons 3 and 5 of the X-linked opsin gene to determine color vision status for these same individuals. While results indicate that females do not vary significantly from each other in their food foraging patterns, within some females, there are differences between foraging patterns on different food color categories. This variation shows no clear correlation with color vision status in this sample. This represents, to our knowledge, the first study examining possible links between individual foraging behavior and color vision in wild lemurs.

Thumb muscle moment arms in select catarrhines: what can we infer about soft tissue biomechanics from bones and fossils?

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Several studies have focused on muscle insertion sites in the primate hand in an effort to infer manipulative capabilities of fossil hominins. However, a direct association between muscle morphology, biomechanics, and insertion markings remains elusive. The hypothesis that the length of a muscle marking is indicative of a muscle's relative moment arm between species is tested on the intrinsic thumb muscles of primate cadaver specimens (1 *Pan*, 2 *Pongo*, 2 *Papio*, 3 *Homo*). The moment arm values were compared to attachment

marking lengths from larger samples of prepared bones.

The length of the first dorsal interosseous muscle's origin and associated skeletal marking are longer in *Homo* than in other genera (Jacofsky, 2002). The moment arm data indicate that the longer muscle origin in *Homo* creates a larger moment arm for thumb adduction. The proximal, middle, and distal fibers have a mechanical advantage of .8, 2.9, and 7.9 respectively in *Homo*. *Pan* and *Papio* have only proximal fibers with a mechanical advantage of 0. *Pongo* demonstrates an intermediate mechanical advantage (2.2) but the muscle functions as an abductor when the thumb is flexed and only adducts when the thumb is extended. Since the distal progression of the muscle is evident from skeletal samples, it is possible to infer the relative mechanical advantage of this muscle from the length of the marking on bones and fossils. This technique should be expanded to include other intrinsic muscles and will help to refine the interpretation of fossil primate manipulative capabilities. This study was made possible by a NSF IGERT grant on Musculoskeletal and Neural Adaptations in Form and Function (NSF grant # 9987619).

The evolution of food sharing in primates.

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Food sharing refers to the un-resisted transfer of food from one individual to another, thus reflecting high social tolerance. Since sharing is altruistic by definition, hypotheses about its evolution must give ultimate explanations for such high tolerance. While sharing with infants is explained by nutritional or informational benefits to the offspring, sharing among adults is often explained by reciprocal exchange, such as food-for-sex or food-for-support. We tested these hypotheses in a sample of 68 primate species with comparative phylogenetic analyses using both maximum likelihood and Bayesian approaches. We found only weak support for the informational hypothesis for sharing with infants and no support for the nutritional hypothesis. However, sharing with infants emerged as a necessary precondition for the evolution of food sharing among adults. The evolution of sharing among adults, in turn, was strongly correlated with the presence of opportunities for reciprocal exchange. In particular, sharing from males to females was explained by the opportunity for female mate choice ("food-for-sex") and sharing among males and among females by the presence of male-male and female-female coalitions respectively ("food-for-support"). We conclude that opportunities for reciprocal exchange lead to the evolution of high social tolerance,

which can be expressed in food sharing in species that already share with infants. We discuss possible constraints on the evolution of sharing, such as strong dominance hierarchies and attractiveness of the diet, and make predictions about other species not included in the sample. We conclude by drawing inferences to the evolution of sharing in humans.

This study was funded by the Cogito Foundation (grant S-106/06), the A. H. Schultz Foundation and the University of Zurich.

Urinary cortisol differences in grey checked mangabeys (*Lophocebus albigena*) inhabiting disturbed and undisturbed forest areas of Kibale National Park, Uganda.

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The detrimental effects of the destruction and disturbance of tropical forests due to human activities on wildlife, including wild primates, are well documented. However, there is a paucity of quantifiable physiological evidence to suggest that coping with the stress of habitat disturbance is reflected in an animal's physiology. A common response to stress is the elevation of cortisol, a hormone that mobilizes energy stores in response to stressful situations but also has negative effects on growth, reproduction, and overall health, especially if elevations are chronic. Here we test the hypothesis that Kibale National Park's grey checked mangabeys living in a disturbed forest habitat (Mainaro) exhibit higher levels of non-invasively collected urinary cortisol than those living in a relatively undisturbed area (Ngogo). Behavioral data indicate that Mainaro mangabeys spent time in smaller groups, traveled more, and were in polyspecific associations more often than Ngogo mangabeys. Urine samples were collected opportunistically and assayed for cortisol in the Yale Reproductive Ecology Laboratory using an enzyme immunoassay (EIA). We hypothesized that cortisol would be higher in mangabeys in the disturbed forest compared to mangabeys in the undisturbed forest. Our hypothesis was supported (Mann-Whitney U = 802.0, $p < 0.0001$). We conclude that non-invasive assessments of hormone biomarkers of stress are a useful method for gauging wild primate well-being, and documenting the subtle, unobservable effects of habitat perturbation-induced stress.

This study was supported by the Yale Institute for Biospheric Studies (YIBS), the Yale Center for Human and Primate Reproductive Ecology, and the Yale STARS program for undergraduate research.

Trauma - life and death in the medieval city of Toruń, Poland.

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Analysis of traumatic injuries in archaeological populations provides insight into past lifestyles and activity patterns, and presents anatomical, biomechanical and socio-cultural information for constructing inferences about their causes. This study focused on a medieval urban population from Toruń (Poland, XII-XVI century AD). The authors hypothesized that (1) males would exhibit higher frequency of cranial and long-bone trauma, and (2) males would show higher frequency of repeat trauma. Crania and major long bones were examined macroscopically for antemortem and perimortem injuries, with bones suspected of exhibiting an injury radiographed. Trauma frequencies for this population were obtained using Judd's (2002) individual count method.

216 skeletons were analyzed for traumatic injuries. 8.3% (n=18) of population exhibited signs of trauma, including 1% (n=1) of subadults, 8.1% (n=3) of females and 19.3% (n=11) of males. 15.7% (n=9) of males exhibited signs of cranial injury, which was absent among females, suggesting that males participated in and suffered from interpersonal aggression. Surprisingly, long bone trauma was slightly more common among females than males (8.1% vs. 7%), implying that females suffered more from accidents (i.e. falls). Out of 18 individuals exhibiting signs of trauma, all females and three males exhibited multiple episodes of injury, with four individuals showing trauma to the same body segment (i.e. radius and ulna on the same side). It is unknown whether these injuries were sustained independently or simultaneously. The majority of individuals with multiple injuries were above 35 years of age at time of death, suggesting a cumulative effect of trauma over lifetime.

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Ethnic differences in diurnal patterns of blood pressure variation: comparisons among African-American, Asian-American, European-American and Hispanic-American women.

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Aspects of diurnal blood pressure (BP) variation have been associated with cardiovascular disease risk. Specifically, smaller waking-sleep differences and greater daytime variability are associated with increased risk of cardiovascular morbidity and mortality, particularly in women. The purpose of this study was to compare daily BP variation, both across and within daily work, home and sleep microenvironments among African-American (N=82; Age=39.7+8.9), Asian-

American (N=22; Age=35.2+8.6), Hispanic-American (N=25; age=37.5+9.4) and European-American (N=122; Age=37.2+ 9.4) women. The women all worked in clerical, technical or professional positions at two major medical centers in NYC. Each wore an ambulatory BP monitor during the course of one mid-week workday. Ambulatory BP variation at work (11AM-3PM), home (approx. 6PM-10PM) and during sleep (approx. 10PM- 6AM) as well as average BP levels and change across these microenvironments were compared among the ethnic groups using ANOVA techniques. The results show that the variability of diastolic BP at work was significantly lower among Asian- and European-American women than among African- and Hispanic-American women (all at p<.05). In addition, Asian-American women had significantly smaller work-sleep systolic changes than either European- (p<.026) or Hispanic-American (p<.009) women. African-American women also had smaller work-sleep changes than the European- (p<.032) and Hispanic-American (p<.014) women, but the Asian-American women's changes tended to be smallest. These findings suggest that both daytime variability and waking-sleep changes may differ by ethnicity and support earlier studies showing that African-American and Asian populations have an attenuated waking-sleep BP change relative to European-Americans.

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Genomic data confirm *Tarsius* is the sister taxon of Anthroidea.

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The relationship of tarsiers to other primates has been a controversial topic for more than a century. Groupings of tarsiers with either strepsirrhine primates in a prosimian clade or with anthropoids in a haplorrhine clade have been weakly supported despite numerous morphological and molecular studies. Using the publicly available whole genome assembly of the Philippine tarsier, *Tarsius syrichta*, we have been able to infer the phylogenetic relationship of *Tarsius* within Primates. In addition, we present estimates of divergence times within the primates. Phylogenetic reconstructions using a 1.26 million base pair multiple sequence alignment derived from 1078 orthologous genes in 17 mammalian species provide over-

whelming statistical support for the presence of a haplorrhine clade. Using maximum likelihood local molecular clock methods, we estimate a Cretaceous time of origin for Primates (72.6 Ma) and for Haplorrhini (68.6 Ma) as crown groups. Examination of rates of nucleotide substitution in the three major extant primate clades show that anthropoids have a slower substitution rate than either strepsirrhines or tarsiers. Thus, from the perspective of nucleotide substitution, the Anthroidea can be considered the most primitive clade. Our results provide the phylogenetic framework on which morphological, reproductive, and genomic features can be reconstructed in Primates. Particularly the identification of *Tarsius* as the closest relative to Anthroidea will allow for future study of anthropoid specific traits. It is now clear that the evolution of primate genomic and phenotypic features need to be understood in the broader context of mammalian phylogeny.

This study was funded by NSF grants BCS-0751508 and BCS-0827546.

Did *Oreopithecus bambolii* have an African ancestor? New evidence from its nasal bones.

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Oreopithecus bambolii is frequently posited as an enigmatic ape because of the combination of a hominoid-like postcranium with a highly unusual dentition. Harrison and Rook (1997) propose that *Oreopithecus* is the sister-group to *Dryopithecus* based on a robust zygomatic with rugose superior portion, and supposed postcranial similarities that both presumably share with apes. Other authors support a closer relationship between *Oreopithecus* and the African middle Miocene nyanzapithecines (*Mabokopithecus*, *Nyanzapithecus*, *Rangwapithecus* and *Turkanapithecus*) based on uniquely shared beak-like premolars and relatively long and narrow molars with inflated cusps that restrict the size of the occlusal basins. *Oreopithecus* further shares diagnostic synapomorphies with *Mabokopithecus*, such as a hypocone-trigon crest of the maxillary molars and the centroconid of the third mandibular molar. New evidence from its previously unidentified nasal bones yields important information for assessing its systematic relationships. Examination of a high-quality cast of the nearly complete skeleton IGF 11778 indicates that the nasal bones of *Oreopithecus* are short, strongly expanded superiorly and inferiorly and possess a triangular superior margin. Quantitative and qualitative morphological comparisons considering the range of variability within primates reveal that this combination of features is only shared with *Turkanapithecus* and possibly rep-

resents an apomorphy for the Oreopithecidae. For those Eurasian fossil apes for which nasal bone morphology can be determined (Anoiapithecus, Pierolapithecus, Sivapithecus, Ankarapithecus, Hispanopithecus, Ouranopithecus, Lufengpithecus) nasal morphology differs from Oreopithecus in being longer, much narrower superiorly and lacking an abrupt expansion toward the nasal aperture. This study provides corroborative evidence, therefore, for an African origin of *Oreopithecus*.

Sexing human blood and bones with metal stable isotopes.

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Reliable sexing of human ancient remains depends on the presence of the coxal bone or well preserved DNA. Iron stable isotope ratios (⁵⁶Fe/⁵⁴Fe) have been recently measured in human organs, and an unexpected result was the discovery of a ⁵⁶Fe-depletion in blood of males compared to that of females. Bones are good candidates to record the iron isotope signature of blood because they are permanently irrigated by blood. To test this hypothesis, we have measured the iron, but also the copper (⁶⁵Cu/⁶³Cu) and zinc (⁶⁶Zn/⁶⁴Zn) isotope composition from a suitable corpus of well-preserved phalanges (n=43) belonging to individuals buried at the necropolis of Saint-Laurent de Grenoble, Isère, France. The sex was previously estimated from coxal bone morphology. The metals were purified by liquid chromatography on ion exchange resin, and iron, copper and zinc isotope compositions measured by high resolution multiple-collector inductively coupled plasma mass spectrometry. The results show that bones record the iron isotope signature of blood, males being ⁵⁶Fe-depleted relative to females (p<0.02). Moreover, bones of males are ⁶⁵Cu-enriched compared to that of females (p<0.03). No difference is found in the ⁶⁶Zn/⁶⁴Zn composition of bone between males and females. Using metal isotope data measured in human blood, we demonstrate by mass balance calculations how metabolic processes can be responsible for the isotopic pattern observed in males and females. These results are a first step towards the development of a new method to determine the sex of human fossil based on isotopic analysis of metals in bones.

Association between locomotor tendencies, habitat use and skeletal trauma in nonhuman primates.

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Exploring how positional behavior and habitat use covary with bone fracture frequencies among nonhuman primates may contribute to understanding the impact risk avoidance and morphological adaptation to injuries have on human and primate evolution. The purpose of this research is to assess how common locomotor behaviors and broad habitat use tendencies are associated with skeletal fracture frequencies. It is hypothesized that more arboreal primates will have fracture frequencies exceeding those of more terrestrial primates and that primates whose locomotor repertoire includes more specialized behaviors will exhibit higher frequencies than those of more generalized arboreal and terrestrial quadrupeds.

I conducted macroscopic and radiographic examinations of long bones from 1607 nonhuman primates encompassing 20 species housed at The Ohio State University, the Cleveland Museum of Natural History, the American Museum of Natural History, the National Museum of Natural History, and the Caribbean Primate Research Center. Species were placed in categories based on degree of arboreality and dominant locomotor mode. The results of a multiple correspondence analysis suggest that there is a correlation among locomotor groups, long bones, and fracture frequencies ($\chi^2_{144} = 201,046$). Contrary to expectations, terrestrial primates tend to be associated more with increased fracture frequencies than arboreal primates, despite the highest frequencies coming from predominantly arboreal species. Although not statistically significant ($\chi^2_3 = 4.6577$), generalized arboreal quadrupeds exhibit the highest fracture frequencies when comparing locomotor modes, followed by leapers, terrestrial quadrupeds, and brachiators. These data suggest that although associations exist between locomotor tendencies and fracture frequencies, patterns are not straightforward.

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Variation in morphology and torsion patterns of metatarsals in *Pan*.

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The habitat of common chimpanzees ranges from moist and dry forests to

forest galleries, and extends into savanna woodlands. Bonobos, on the other hand, are restricted to tropical forest mosaic landscapes and swamp forests. Comparative studies on locomotor behaviour within *Pan* indicate that bonobos use more arboreal locomotion than common chimpanzees. Differences in habitat utilization and locomotor behavior within *Pan* likely impact functional morphology of the foot, especially metatarsals, creating a good model for exploring anatomical functional adaptations. Shape of tarso-metatarsal articular surfaces and metatarsal torsion have been used to describe degree of arching in the midfoot transverse arch. We evaluate proposed functional linkages by applying geometric morphometric methods to quantify inter- and intra-specific variation in shape and size of distal and proximal articular surfaces of anatomically associated *Pan* metatarsals (*P. troglodytes troglodytes* n=16, *P. t. schweinfurthii* n=12, and *P. paniscus* n=15). We also measure variation in metatarsal torsion angle of the metatarsal rays, calculated between vectors in sagittal planes of proximal and distal articulations.

In a 3D shape analysis, noticeable distinction in the configuration of the transverse arch between species exists. *P. paniscus* has a relatively high transverse arch compared to *P. troglodytes*. Considerable variation in metatarsal torsion also exists within species. For example, *P. paniscus* has a relatively high degree of lateral torsion of metatarsals II – V compared to *P. troglodytes* subspecies. Differences in transverse arch and metatarsal orientation corroborate anatomical adaptations presumably related to different degrees of grasping in the locomotor repertoire of genus *Pan*.

This study was funded by the Claude Leon Foundation and Institute for Human Evolution, University of the Witwatersrand.

Reproductive ecology and female health: crucial role of energy availability, and inevitable problems created by physiological trade-offs and antagonistic pleiotropy.

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Studies in human reproductive ecology point to the crucial role of energy availability in physiology and metabolism of reproductive processes of human females. Availability of metabolic energy during all stages of life of the woman, including her fetal and childhood development, and adulthood, determine levels of reproductive steroids hormones and subsequently chances of conceiving. High energetic costs of pregnancy and lactation explain why women with high

parity often have poor health in older age and, consequently, reduced lifespan. Modern clinical medicine usually ignores findings from the area of human reproductive ecology, but evolutionary medicine suggests that this knowledge is useful in both medical practice and public health preventive programs for women. Most important aspects include treatment of infertility, prevention of reproductive cancers and of diseases, such as diabetes, cardiovascular diseases, and Alzheimer's, the risks of which often increase in women who paid high costs of reproduction.

This talk will also emphasize that programs of effective disease prevention are difficult to design due to the existence of physiological trade-offs and pleiotropic effects of genes, including APOE, PPAR-gamma, IL-10, ERS1, which encode traits important for both fertility and health in women. For example, high lifetime levels of reproductive steroid hormones have both beneficial and detrimental effects: they increase chance of pregnancy but also the risk of breast cancer.

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Allometry of sexual dimorphism in sub-cortical structures of the human brain.

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Sub-cortical structures play vital roles in relaying information to and from higher cortical regions to other regions of the brain. They are also considered to be an evolutionarily more conserved part of the brain. However, recent research suggests that this region may not be as static as previously assumed. Questions concerning scaling of the sub-cortex may help in understanding how sub-cortical regions vary in response to differences in overall brain size, sex, and age in the adult human brain.

This research tests a series of hypotheses concerning relationships between size and shape (static adult scaling relations) in brains of adult modern humans using *in vivo* measurements from magnetic resonance imaging (MRI) scans. Subjects include 192 healthy individuals, consisting of two age categories: ages 18 to 35, and ages 50 to 80. MRIs were segmented in an automated fashion using FSL (FMRIB Software Library). The measurements of interest include total brain volume, nucleus accumbens, amygdala, caudate nucleus, hippocampus, pallidum, putamen, and thalamus. The statistical analysis included reduced major axis regression with each structure regressed against total volume, followed by regression against the geometric mean.

Our results suggest that male and female brains are not uniformly scaled versions of one another, and that each region exhibits its own distinct scaling pattern depending on sex and age. For example, the nucleus accumbens and the pallidum appear to be uncorrelated with total brain volume, while others are correlated, scaling either allometrically or isometrically with brain volume. This implies complex relations among brain regions. This project was funded by the Beckman Institute for Advanced Science and Technology Cognitive Science/Artificial Intelligence Summer Fellowship and the Department of Anthropology and the University of Illinois, Champaign-Urbana.

Predation on early Miocene primates, *Proconsul*, *Dendropithecus*, and *Limnopithecus* from Rusinga Island.

KIRSTEN E. H. JENKINS. University of Minnesota.

The early Miocene deposits from Rusinga and Mfangano Islands, Kenya, present a unique opportunity to study the ecology of past primate communities. This work represents the first formal taphonomic analysis of the Kisingiri primate assemblage in order to identify predator-prey relationships. Preliminary taphonomic reports of the *Proconsul* assemblage suggested that some individuals were accumulated as prey by creodonts. Here, this hypothesis is further tested by comparing surface modifications and skeletal part frequencies to actualistic studies of modern carnivore assemblages as well as modern raptor assemblages. Isolated specimens of *Proconsul*, *Dendropithecus*, *Limnopithecus*, as well as fossil lorisooids from Rusinga and Mfangano Islands were also examined for predation damage. Data on the location, frequency and size of tooth pits, gnawing, raptor damage and insect modification, and, where possible, breakage patterns were collected on specimens. Multiple tooth pits and gnawing on fossils are consistent with damage produced by modern carnivores and were identified on *P. nyanzae*, *P. heseloni*, *Dendropithecus*, and the fossil lorisooids. Variation in tooth pit size suggests different creodont species preyed on different primates. Irregular puncture marks on both species of *Proconsul* fossils were recorded and are consistent with damage left by modern raptors when de-fleshing carcasses. These results confirm that while creodonts were responsible for accumulating a portion of the primate assemblage on Rusinga Island, raptors also consumed even the larger *Proconsul*. This is the first evidence of raptor predation on fossil primates from Rusinga and informs our understanding of the selection pressures faced by our earliest hominoid ancestors.

This study was funded by the University of Minnesota Anthropology Department and NSF, grant number 0852609.

Assessing the local geological variability on strontium isotopes from skeletal remains from 4th - 5th century A.D. Aila, Jordan.

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Certain isotopes in human skeletal tissues can be strong indicators for the presence of immigrants at an archaeological site. This research focuses on identifying immigrants into ancient Aila using the strontium isotope ratio ⁸⁷Sr/⁸⁶Sr from the dental enamel of Byzantine period burials (n=28). Aila, located at the tip of the Gulf of Aqaba in the Red Sea, served as an important maritime and overland trading center for much of its history. Accordingly, the site contains numerous examples of imported artifacts and architectural styles from the Levantine and Red Sea regions during this period. Did individuals seeking economic gain from the prosperous seaport, such as traders, travelers, or residents of the surrounding desert regions, inhabit the city? Or are the varied stylistic influences the result of diffusion via a transitory population?

The ⁸⁷Sr/⁸⁶Sr results present a surprisingly wide array of strontium isotope values from permanent dental enamel, extending much above the range provided by local faunal and adult human bone values. It is statistically improbable that immigrants from different regions would present a perfectly normal distribution of isotope values reflecting their childhood locales. However, children at Aila could have consumed a very different diet than the adults at varied levels, resulting in much higher-than-expected ratio and a wide but normal distribution. Results from additional sampling of 15 geological formations and 3 groundwells in the Aqaba region suggest that childhood diet at Aqaba contained an unknown supplement that originated in the Precambrian formations surrounding the city, and that these are locally-born individuals.

Structural differences of orthologous brain-expressed genes between *Gorilla* and human revealed by high-throughput RNA sequencing.

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Evolutionary changes during human ancestry have resulted in adaptive brain plasticity which persists over extended de-

velopmental periods and, in its extent, differentiates humans from other apes. Elucidation of the molecular basis underlying these changes can help address the fundamental question of what makes humans unique, and requires comparative analysis of genes expressed in hominid brains. Transcriptome projects, which have lagged far behind genome projects, analyze all ribonucleic acid (RNA) molecules transcribed from the genome in a given tissue or organ, and are necessary to fully document the structure and hence the information content of expressed genes. Differences in gene structure, rather than gene sequence, between related species are increasingly recognized as contributing to the genomic basis of interspecies distinctions, thanks to their impact on the length and sequence of orthologous proteins, untranslated regions, and non-coding RNAs.

To test the hypothesis that structural differences of orthologous genes can be detected in a comparison of the well-described human transcriptome to the heretofore-uncharacterized *Gorilla* transcriptome, we sequenced the *Gorilla* platum temporale transcriptome using high-throughput Illumina Solexa technology. Our analysis is the first to document actual structures (genomic positions of promoters, exons, introns, and splice sites) of over 21,000 brain-expressed, coding as well as non-coding, *Gorilla* genes. New gene termini, unseen in human orthologs, were observed for 358 *Gorilla* genes, a subset enriched ($p=0.0239$) in known genes functional in axon guidance. These newly identified interspecies gene structure differences of axon guidance factor genes may impact neuronal network formation and hence developmental synaptic plasticity. This study was funded by the National Science Foundation, grant numbers BCS 0827546, BCS 0827531, and BCS 0550209.

Identification of quantitative trait loci for cranial capacity in a population of baboons (*Papio hamadryas* ssp.).

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Increasing brain size is one of the hallmarks of hominin evolution. Relatively large brains require a constant supply of glucose. Because brains are metabolically expensive to maintain, their energetic costs must have been outweighed by the evolutionary benefits of increased relative brain size. Previous research has examined these costs and benefits

but not the genetic underpinnings of brain size. Explicating the genetic architecture of a trait may indicate why a trait responds to the environment in a certain way, shaping our inferences of both past selective pressures and expected change in response to current ecological constraints.

For a trait to respond to selection, a significant portion of its observed variance must be heritable, or transmissible from parent to offspring. Demonstrating a genetic component to variation is done by comparing trait values in a large sample of individuals of known relationship. A collection of crania ($N=906$) was prepared from the colony of baboons housed at the Southwest National Primate Research Center. As a proxy for brain size, cranial capacity was measured from reconstructions of sequential computed tomography scan slices. Quantitative genetic analysis of these data using a variance components approach with age, age-squared, and sex as covariates indicates that cranial capacity is significantly heritable in this population ($h^2=0.5$, $SE=0.15$). Quantitative trait loci (QTL) were identified via whole genome linkage mapping using 331 microsatellite markers. Identified QTL provide lists of potential candidate genes that can be assessed in future studies for their relevance to brain size evolution using comparative genomic and population genetic approaches.

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Feeding ecology of olive baboons in the Kibale forest: preliminary results on diet and food selection.

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Baboons (*Papio*) are one of the most studied primate genera. Most of what we know about baboons, however, derives from savanna habitats while little is known about baboon ecology in forests. We present preliminary data on the feeding ecology of a newly habituated group of olive baboons (*Papio anubis*) in Kibale National Park, Uganda from 60 days of group follows across the year (July 2009-July 2010). We recorded foods eaten, and when possible collected representative samples for nutritional

analysis ($n=9$). When individuals discarded parts of an otherwise suitable food, we collected those for analysis ($n=12$). We counted 190 feeding events on 32 species and 10 different plant parts, comprising fruits (46%), stems (33%), tubers (7%), leaves (7%), and other items like mushrooms, insects and seeds (7%). Food items analyzed represent 77% of species consumed during feeding events. Foods and discards were similar in protein, energy and non-structural carbohydrates. Fat content was extremely low in all food parts (<3%). Foods eaten were lower in hemicellulose than discarded counterparts while cellulose was similar between discarded and eaten parts. Surprisingly, eaten foods had higher lignin than corresponding discards, but not when all eaten and discarded parts were compared. No foods or discards contained hydrolyzable tannins. While 10 of 12 discarded parts had condensed tannins, only 5 of 9 eaten parts did, suggesting that tannins may play a role in food selection. The study of baboon feeding ecology in forests is important as it elucidates feeding plasticity among baboon populations.

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Contextualizing human skeletal collections in Hrdlička's Gulf States catalog through archival research.

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Aleš Hrdlička published craniometric data for thousands of individuals in a series of well-known catalogs. The *Gulf States* catalog (1940), for example, includes 714 individuals from 42 locations in Florida and provides an important source of data on biological variation for this state. However, provenience information is meagerly reported - a factor which limits the utility of these data in comparative analyses and in some cases misrepresents the archaeological context. Here we present results of archival research in the Smithsonian Institution Archives for seven of the largest Florida skeletal collections published in Hrdlička's *Gulf States* catalog. We accessed unpublished field notes, personal correspondence, and accession information to identify provenience data that better delimit sample contexts. Here we focus on two of these collections: Canaveral and Perico Island. Of 91 individuals from Canaveral, 59 can be allocated to specific mounds within the area. As such, "Canaveral" is a meaningless provenience. Of the 102 individuals from Perico Island, 101 can be allocated to more specific provenience locations in this multi-component site. In both cases, using Hrdlička's provenience label masks important contextual information which

impacts the results of biodistance analyses using these samples. This poster demonstrates the importance of accessing archival records and the continued need for a contextualized consideration of human skeletal samples in biological anthropology. Because the majority of these individuals are still curated at the National Museum of Natural History, presenting these data from archival records increases their utility for future research.

Postures adopted during vertical clinging and grasping in *Propithecus verreauxi* and *Varecia variegata*.

LAURA E. JOHNSON and DANIEL SCHMITT. Department of Evolutionary Anthropology, Duke University.

Most primates regularly use vertical clinging and grasping postures on arboreal supports. Unlike other vertebrates, primates (with the exception of Callitrichines) cling without claws or adhesive pads. Thus the ability to effectively maintain a clinging posture may rely on other anatomical features such as long limbs or digits and the ability to generate sufficient force normal to the substrate. Several primates habitually use vertical clinging postures in association with leaping (VCL). Although static clinging and leaping are separate behaviors, primates with specializations for VCL may cling differently, and possibly more efficiently, than arboreal quadrupeds. To explore this hypothesis, two strepsirrhine species of similar body size but different locomotor specializations (*Propithecus verreauxi*, a specialized leaper and *Varecia variegata*, an arboreal quadruped) were filmed with multiple cameras while clinging to vertical, cylindrical substrates of 2", 4" and 8" in diameter at the Duke Lemur Center. Joint positions were digitized from video using dltvd5 in MATLAB. *P. verreauxi* adopted a narrow range of postures, with flexed hindlimbs (ex. on the 2" substrate, knee angle average=11°, range=5°-16°), keeping the body close to the substrate. In contrast, *V. variegata* shows greater variability in postures but on average uses relatively more extended hindlimbs (ex. 2" substrate, knee angle average=56°, range=17°-102°) moving the hindquarters up and away from the substrate. These results suggest a VCL primate has anatomical specializations that facilitate efficient clinging, as evidenced by their consistent use of flexed hindlimbs, keeping the body close to the substrate.

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Modelling of longitudinal data.

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Fitting a mathematical model to longitudinal data is a powerful analytical tool in any discipline that requires the analysis of repeat measurement data. In the study of human growth, repeat measurements are clustered within individuals, thus violating a principal assumption of independence of observations in conventional regression analysis. Multilevel models (MLM) that introduce random variation between clusters allow researchers to consider the often hierarchical nature data.

MLMs were applied to longitudinal growth data on urban (n=402) and rural (n=422) Indian infants enrolled in two different cohort studies to produce weight-for-age and length-for-age curves. Different previously proposed growth models (Count and Berkey-Reed), and different age transformations for models that are not defined at age zero (age+1 and age+9/9), were tested using the MLM approach. Covariates, including breast feeding status at three months and maternal education, were fitted and entered as random slopes.

A multilevel version of the Berkey-Reed model best described infant growth in these cohorts, although an appropriate age transformation could not be found. Breastfeeding status had no significant effect on growth, but the weight growth of urban infants was significantly different for each maternal education group, with infants of illiterate or primary school education mothers generally weighing 0.25kg less than those born to mothers with secondary/college education.

With a MLM it is possible to identify independent inter-group effects while simultaneously adjusting for individual growth characteristics. This technique can be applied to any data that demonstrates clustering of observations, as is often found in longitudinal study designs with physiological outcomes.

Documenting dental inventories, development, and wear in Osteoware.

ERICA B. JONES. Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, DC.

Due to its relative hardness and resistance to many destructive taphonomic processes, the dentition tends to be the best preserved and most commonly recovered skeletal tissue. If dental data is properly recorded and analyzed, it can often give a fairly accurate picture of the number of individuals present at a site, their age at death, health status, and cultural practices, including diet.

Osteoware is a relational database that simplifies recording of dental observations by the use of visual schema and numerical coding. For each individual

and for each set of dentition (deciduous and permanent), a score is recorded on a diagram of a dental arch to indicate the status of the tooth associated with each socket (e.g., present or lost antemortem). Loose and supernumerary teeth can also be coded in the data screens. Each tooth is then assigned a stage of formation, using the standards of Moorrees, Fanning, and Hunt (1963). Similarly, stages of dental occlusal wear are recorded for each erupted tooth, using the descriptions, visual images, and coding provided by Smith (1984).

The dental data is fully integrated with other modules in Osteoware, allowing an even more complete understanding of the demography of the sites under study. Cross-referencing skeletal age indicators with dental age indicators can be particularly useful in determining the minimum number of individuals by age categories and for potential sorting of commingled remains. The presentation will discuss protocols and provide case studies of data entry for dental inventories, development, and occlusal wear using Osteoware.

Osteoware is supported by grants from the National Center for Preservation and Technology and Training (NCPTT), National Park Service, and the Smithsonian Web 2.0 Fund.

Using geolocation at the US Mexico border isotopic fingerprinting in modern Mexican populations: using strontium, carbon, 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, and oxygen isotopes in human tooth enamel. In addition to database progress new information on five unknown forensic cases compared to the database will be presented.

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 154 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, FISIONS 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. Training set blind sample comparison of unknown samples against the database shows reclassification in 88% of cases and correct classification (within 2sigma) in over 70% of cases. Five forensic cases are also compared against the database and results of their classification matrix are discussed.

"Who are your People?" Ascribed identities and the social uses of genomics.

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Four of the most enduring ways in which social identities are ascribed to people are through attributions of their Future potential (saved v. damned, free v. slave, etc), Ancestral lineage (name, family, clan), Community membership (religion, class, origin place, etc.), and Ethnic affiliation (race, people, culture etc.). In our society, these four identifiers, the "FACE" facts, are usually embraced when they confer social advantage and repudiated when they do not. They have always been powerful factors in the establishment of social hierarchies and the preservation of social power. They are also the four features of human identity that genomic profiling promises to allow us to clarify, by revealing our molecular predispositions, family connections, genealogical migrations, and population mixtures. The FACE facts that genomics generates may create some ascriptive classifications that disrupt established social hierarchies in constructive ways. But experience is already suggesting that where genomic profiling reinforces existing social identity markers, it is also likely to reinforce their existing social uses. This is a risk that finer grained molecular studies can only exacerbate, unless their results are carefully contextualized within the larger debate over the justice of the social classifications they might serve.

Y-chromosome variation of a Ch'orti' Maya population in Eastern Guatemala.

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The Ch'orti' language descends from the Cholan branch of Classic Maya which split into Ch'olti' and Ch'orti' in Eastern Guatemala, where descendants of Ch'orti' speakers have resided for ~2,000 years. The Ch'orti' Maya in eastern Guatemala represent the only likely descendants of the Central Maya region remaining in Guatemala. The Ch'orti' region is of particular interest to biological anthropologists for several reasons. While it is clear that the Maya were the ruling class in the Central area, there is also evidence that the Lenca, Xinca, or other non-Maya groups may have made up the peasant class. Ch'orti' history has likely allowed for a higher degree of non-native admixture than found among other Maya. While there are linguistic, ethnographic, and archaeological data there is a lack of biological data on the Ch'orti'. This study aims to test the hypothesis that the unique history of this region has given it a higher level of paternal genetic variation than found in surrounding areas. DNA was extracted from 21 males residing around Jocotán, Chiquimula, Guatemala. Y SNPs were characterized using HyBeacons[®] PCR probes or sequencing, and STRs were characterized using AFLP. Haplogroup Q represents 76% (62% haplotype Q1a3a, and 14% Q1) of the sample. These results were compiled with data from surrounding Native American populations from the literature for analysis. While there is evidence of non-native admixture within the Ch'orti', the paternal lineages in this region are still predominantly native, and there are different patterns of non-native gene flow compared to surrounding populations.

This research was funded by a General Research Fund grant from the University of Kansas and the Tinker Foundation Summer Field Research Grant.

Stratigraphy, taphonomy, and age of a *Homo erectus* calvaria from Sambungmacan.

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Java, Indonesia, is a unique place to yield a large number of *Homo erectus* fossils, hence has a key role in human evolutionary studies in Asia. However, some uncertainty about the chronology of these fossil specimens has hampered

detailed documentation of morphological evolution and variation in Javanese *Homo erectus*. The fossil specimens from Sambungmacan, Central Java, are no exception to this situation: Some researchers view these fossils as contemporaneous with those of the late Pleistocene Ngandong High Terrace, whereas others expect that Sambungmacan *Homo erectus* were chronologically intermediate between the Sangiran/Trinil and Ngandong groups of *Homo erectus*.

In this study, we attempt to reconstruct the basic sedimentary history of the Pleistocene terrestrial sequence in the Sambungmacan Cemeng area, from where two calvariae of *Homo erectus* (Sambungmacan 3 [Sm 3] and 4 [Sm 4]) were scooped up from the riverbed of the Solo River. We also tracked the original stratigraphic level for Sm 4 by examining the mineralogical characteristics of its attached sandy matrix. Our field observation, analyses of heavy mineral composition of the sediments, and fission track dating of tuff samples suggest that Sm 4 was derived from a fluvial channel deposit dated to ~0.27 Ma. The presence of framboidal pyrite in the attached matrix of Sm 4 indicates that the calvaria was deposited in its source layer soon after the individual's death.

'Matters of care and concern': lessons for anthropological genetics from osteology's repatriation and NAGPRA experience.

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Before and since the passage of NAGPRA (the Native American Graves Protection and Repatriation Act), osteologists, skeletal biologists and bioarchaeologists have struggled with repatriation's cultural and practical implications for their research. In this paper, I first present my own and others' data suggesting that human skeletal research has declined in North America in the twenty years since repatriation became legal reality. I interpret and analyze these data as functions of both actual repatriation requests, as well as disciplinary reluctance to engage with the processes set forth by the law.

NAGPRA governs the repatriation of Native American ancestral human remains, associated funerary objects, and other items with ongoing cultural meaning for living Native people. The law also mandates consultation between museums, academic institutions and federally-recognized Native tribes and nations. It is not, however, an ethical guide for the treatment of human remains, or for the fostering of respectful relationships between individual scientists, federal agencies, and Native descendants.

Although other guidelines (e.g., 45 CFR 46, the Belmont Report) secure the pro-

tection of living human subjects in anthropological genetic research, the assumed gap between living and dead may be useful in evaluating how skeletal repatriation may inform ethics in anthropological genetics—and vice versa. Westerners perceive sharp material and cultural distinctions between “living” blood and “dead” bone. For many indigenous people, however, these distinctions are not as forcefully evident. I also examine how these cultural dynamics have emerged in skeletal repatriation processes, and how they may provoke novel ethics dialogues in anthropological genetics.

Across-species variability in primate coat color supports Gloger's rule.

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Gloger (1833) observed that bird populations living in warm and wet habitats were darker compared to those found in dry, cool areas. However, this hypothesis has seldom been tested, particularly for mammals. Here, we test Gloger's rule using a dataset consisting of more than 100 primate species representing all major primate clades. We used museum skins, digital photography, and color correction software to quantify the brightness of the dorsal and ventral surface of each species. We utilized the mean actual evapotranspiration (AET) within the geographic range of each species as a proxy for habitat conditions. AET values are high in warm, wet environments. We included additional variables that may influence pelage coloration: body mass, positional behavior, and time since the specimen was collected. To examine the possible relationship between pelage brightness and AET, we used a method developed by Freckleton and Jetz (2009) that simultaneously accounts for the potential confounding effects of phylogenetic and spatial autocorrelation in the data. We found that decreasing levels of AET were significantly related to decreasing pelage darkness on the dorsal surface, while controlling for other effects. Thus, we found general support for Gloger's rule in primates. The mechanism driving Gloger's rule is not easy to discern, but may include a thermoregulatory benefit by increased water evaporation from dark hair, increased resistance to keratin degrading microorganisms in hair with large amounts of eumelanin, and/or increased background matching for light colored species living in cool, dry habitats.

This study was funded by the Leakey Foundation, the Field Museum, Washington University (St. Louis), and Yale University.

Suicide – pattern and distribution of specific traumata on the skull.

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Differentiating between skull lesions as a result of interpersonal or intrapersonal conflict (self-harm) are of crucial importance in forensic anthropology and paleopathology. Identification of a suicide specific pattern and/or distribution of lesions on the skull was subject of this study.

The historic specimen collection at the Department for Forensic Medicine in Vienna, built up over the last two centuries, hosts cranial skeletal remains from 261 individuals, 44 of them committed suicide.

From these 44 individuals, 37 (84,1%) experienced gunshot trauma, 6 (13,6%) sharp force and 1 individual blunt force trauma. 23 (62,2%) of the gunshot entrance lesions were on the right side of the skull, predominantly in the region of the temple, 4 (10,8%) were in the same area but on the left side. Another 3 (8,1%) were found on the forehead, 5 (13,5%) on the palate and 2 (5,4%) on the occiput. One blunt force trauma, a massive terrace fracture, was caused by a jump from the 5th floor. Half of the sharp force induced traumata were caused by pointed objects (nails and awls) and the other half by axes. These 3 rare cases of self hacking left in all cases multiple (>20) testing lesions around the final death blow.

No specific suicide pattern for gunshots was evident, but there were no shots to the face or to the apex of the head. Sharp force trauma, predominantly associated with psychological problems, were always multiple, therefore might be easily misinterpreted as the results of interpersonal conflict involving mutilation.

eSkeletons: a digital library of primate anatomy.

JOHN KAPPELMAN and PETER KEANE. The University of Texas, Austin.

Anatomy is taught at many educational levels but a scarcity of specimens means that large numbers of students do not have access to the materials required for the traditional approach to the subject. The web offers a unique solution to this dilemma, and we present here our latest approach to this problem.

The core of www.eSkeletons.com includes all of the separate elements of the skeleton digitized in 2-D and 3-D. Humans are a central focus of the site, and a new application is directed to an on-line course in human osteology. Many nonhuman primate species are also included, and because several of these taxa are rare or endangered, the

site also helps to inform users as to the plight of these animals. The user can navigate through the various regions of the skeleton, select a region, and then view the elements. All six orientations are provided, along with a 3-D animation, and the user has the option to activate labels for muscle origins and insertions along with joint surfaces. Because comparative anatomy is so important, the user can select an element from different taxa for visual comparisons of size and shape. We have also constructed a digital calipers for on-screen measurements, and one of our special comparative tools permits the user to superimpose one element over the other. The database is organized for ease of editing and updating and designed so that other taxa can be easily added to the digital library.

Thanks to several generations of UT undergraduate and graduate students who have worked on this project, and support from NSF and UT Austin.

The biological implications of the origins of agriculture in Eastern Europe.

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The Trypillian culture complex of western Ukraine is hypothesized to be one of the earliest agricultural communities in Eastern Europe dating to as early as the 6th millennium B.C. (Kadrow et al. 2003). The hypothesis has been supported by archaeological evidence including stone tools believed to be sickles, as well as the presence of Venus figurines representing the existence of a fertility cult. Notably, no grinding stones or artifacts associated with the processing of agricultural products have been discovered in large areas of the Trypillian homeland, leading some archaeologists (Tkachuk, 2010) to question the extent to which the Trypillian people relied upon farming. Excavations carried out at Verteba Cave, located in the Ternopil Region of Ukraine, during the summers of 2009 and 2010 have unearthed some of the only burials to be definitively associated with Trypillian artifacts. Analysis of 14 individuals, ranging in age from 6 months to 50 years of age, was undertaken to determine if the interred individuals exhibited skeletal markers typical of the transition to an agrarian lifestyle. The population exhibited numerous dental caries and a dental abscess. Additionally, the existence of enamel hypoplasias suggest nutritional stress during development, which is a hallmark of early agricultural societies. Therefore, bioarchaeological analyses of the finds at Verteba Cave support the hypothesis that the Trypillian population was practicing subsistence agriculture.

Geometric morphometric analysis of maxillary central incisor crown form.

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Studies of tooth morphology have been essential in human biology and phylogeny. Dental traits related to genetic diversity have been studied over a long period and grossly evaluated based on the standard Arizona State University (ASU) reference plaque. However, grading by subjectively-based observation has possibility of inter- and intra-observer measurement errors. We aimed to analyze crown models three-dimensionally to assess shoveling shape. Micro-CT scanned data of 38 maxillary central incisors housed in Aichi-Gakuin University and Brown and Herbranson Imaging were used to create crown models of outer enamel surface (OES) and dentino-enamel junction (DEJ) form. All data were evaluated according to the shoveling grade on the ASU Dental Anthropology System into weakly (grade 0-2) shovel-shaped and strongly (grade 3-7) shovel-shaped group. Homologous models consisting of the same number of data points of the same topology were created and the distance matrices between tooth models of OES and DEJ were analyzed by using multi-dimensional scaling analysis (MDS). Student's t-test was used to compare the MDS scores between weakly and strongly shovel-shaped groups. The result of t-test in OES model confirmed significant differences between two groups ($p < 0.001$), and a negative correlation coefficient of 0.53 was obtained between shoveling grade and MDS score. On the other hand, the result in DEJ model was not statistically significant ($p = 0.07$) between two groups. Our results indicate that geometric morphometric analysis of micro-CT scanned tooth crowns represents a powerful solution for objective shape assessment of human teeth.

This study was funded by The Hori Information Science Promotion Foundation.

Creating sustainable primate-based tourism: a view from the Central Suriname Nature Reserve.

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Sustainable tourism is meant as a means of economically supporting an area while protecting the environment. Two aspects contribute to truly sustainable primate-based tourism. First, the primate population cannot be negatively affected. Second, tourists must have a

good experience so that they recommend the location to others. Prior research demonstrates that tourists want a memorable experience: for wild-life-based tours this includes close contact with the animals (including eye contact) and observation of natural behaviors. I studied primate response to tourist presence in the Central Suriname Nature Reserve (CSNR) through a theoretical lens of predator/prey interactions.

Primate response to tourists differed by species. Brown capuchins, squirrel monkeys and howler monkeys did not flee or alarm call in the presence of tourists while bearded sakis, wedge-cap capuchins, tamarins and spider monkeys did. Further, primates who did not respond to tourists were seen feeding. In addition, there were no statistically significant effects of tour group size, speed or noisiness on primate anti-predator responses.

Results indicate that under certain circumstances tourism may have negligible impact on some primate species. To remain sustainable, tourism in the CSNR should focus on species who do not demonstrate anti-predator behaviors in the presence of tourists—also contributing to the economic sustainability of tourism. Tourists are likely to have a better experience when they have more time to observe primates performing behaviors such as feeding. More research is needed in order to better predict primate response to tourists and to understand what tourists in the CSNR want to see.

Collagen fiber orientation heterogeneity (CFO-Het): does this new characteristic reflect habitual load history in the chimpanzee femur and does it corroborate CFO based on image gray levels?

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Gray levels (GLs) in circularly polarized light (CPL) images reflect predominant CFO: darker GLs represent longitudinal orientation, brighter GLs represent oblique-to-transverse orientation. CFO-Het (variability of CFO) is a new characteristic that might correlate more strongly with habitual load history than CFO or secondary osteon morphotype score (osteonMTS) (Skedros et al., 2009 BONE). CFO-Het = the full-width at half-maximum (FWHM) of an image GL profile (larger FWHM = greater CFO-Het). Eight skeletally mature chimpanzee femora (50% shaft; proximal shaft = 70% and 80%) were embedded in methacrylate, ultramilled, and imaged in CPL. FWHM was measured from GL profiles of the CPL images where we measured CFO and osteonMTS in our previous studies. CFO-Het data were analyzed for section location and quad-

rant (anterior, posterior, medial, lateral) differences. We hypothesized CFO-Het to be greatest in regions with predominant shear (torsion and/or neutral axis regions). Results showed that CFO-Het correlated with CFO ($r \sim 0.88$) and osteonMTS ($r \sim 0.63$). Unexpectedly, CFO-Het is highest in the medial 'compression' cortex ($p < 0.05$) of the proximal shaft (habitual bending) but, as expected, was not significantly different quadrant-wise in the 50% shaft (comparatively more diffuse torsion/shear). However, the 50% shaft had unexpectedly lower CFO-Het than the proximal shaft ($p < 0.05$). CFO-Het generally corroborates CFO-based load history data, but does so unexpectedly and less consistently than the CFO and osteonMTS data that we previously reported for these bones. But CFO-Het could reveal toughening mechanisms not shown by CFO data in bones where osteonMTS data cannot be obtained (e.g. none/few secondary osteons).

Odontometric analysis of the reanalyzed and expanded *Cercopithecoides* sample from the Haasgat fossil assemblage, Cradle of Humankind, South Africa.

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Previous paleontological work (1987-1993) on fossiliferous *ex situ* sediment blocks from the Haasgat cave site, 19km northeast of the Blaauwbank Valley sites, has yielded a diverse faunal assemblage including no fewer than two extinct species of cercopithecoid assigned to *Papio angusticeps* and *Cercopithecoides*. Previous research on the *Cercopithecoides* sample had identified 25 craniodental specimens, including a nearly complete adult female cranium (HGD 1167) and the most complete juvenile cranium (HGD 1166) recovered for *Cercopithecoides* in South Africa. After resuming research at Haasgat in 2010, we have reassessed all previously recovered fossil materials. Here, we present the updated Haasgat *Cercopithecoides* assemblage, with basic descriptions and a comparative odontometric analysis with craniodental material assigned to *Cercopithecoides williamsi* from several South African fossil assemblages. Our results indicate that 20 of the 25 specimens originally assigned to *Cercopithecoides* can be supported, while four (HGD 1176, HGD 1185, HGD 1187 and HGD 1221) are *P. angusticeps* (expanding the previously documented sample of *P. angusticeps* to 87 specimens), and one (HGD 1187) is Bovidae. After reviewing all primate

and non-primate material, including a number of uncataloged elements, we have identified an additional eight specimens (one partial maxilla, one isolated upper molar and six partial mandibles) attributable to *Cercopithecoides*, bringing the total sample from the 1988 *ex situ* sample to 28. Unfortunately, the more complete crania (HGD 1166 and HGD 1167) could not be located by the repository institution for the collection (Council of Geological Sciences). Thus, data included for both specimens derive from polyurethane casts.

Strontium stable isotope analyses of human bone reveal no Wari state emissaries in the Las Trancas Valley of the Nasca region of Peru (750-1000 A.D.).

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During the Middle Horizon of prehistoric Peru, the Wari state and the local society of Nasca on the south coast (750-1000 A.D.) had a close relationship as evidenced by the Wari imperial site of Pataraya in the Tierras Blancas valley, similarities in ceramic styles, and the ease of travel from the Wari heartland.

Since strontium isotope ratios are distinct between the Nasca region and the Wari heartland, these analyses should be able to clarify the nature of the association between the Wari and the Nasca. We sampled twelve individuals buried in three cemeteries located in the southernmost Las Trancas Valley of the Nasca region that straddle the time periods before and during the Middle Horizon. Included within this larger sample are individuals who are buried with Middle Horizon imperial and local style ceramics.

Strontium stable isotope analyses of human bone do not reveal any individuals with a highland origin. Based on these data, no evidence exists of emissaries from the Wari heartland in the Las Trancas Valley of the Nasca region. These data suggest that direct Wari influence may have been contained in the northernmost Tierras Blancas Valley. The Nasca living in the Las Trancas Valley may have successfully resisted direct Wari imperial control. Previous dietary studies showed that the Nasca region was not converted to maize monocropping for imperial purposes (Kellner and Schoeninger 2008). This study highlights the diversity of local and imperial strategies used during state expansion.

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Skeletal indicators of body mass in human juveniles.

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The ability to determine body mass from juvenile skeletal remains has important implications in the fields of biological archaeology, paleoanthropology, and forensics. Femoral head diameter is frequently used to estimate body mass in adult skeletal remains. However, longstanding assumptions regarding the accuracy of the femoral head for estimating body mass lack contemporary and large-scale verification in subadults. Ruff (2007), and now more recently Robbins et al. (2010), have attempted to address this issue but with small sample sizes (n=20) from the Denver Growth Study and from Franklin County, Ohio respectively. Predictive equations for body mass were generated from cross-sectional clinical data of modern juvenile femora. A questionnaire will provide information about the individual's age, body weight, and activity level. Radiographic measurements of the femoral head and distal metaphysis were taken to determine the most accurate equations for each age group. Preliminary results seem to support Ruff's (2007) findings. The distal metaphysis appears to better estimate body mass for individuals into their early teens, but in the mid to late teens the femoral head loses its accuracy and the femoral head becomes more appropriate. These equations will provide the means in which to extrapolate body mass estimates for unidentified subadults remains in modern forensic cases. This will also help to shed light on changes in body mass associated with prehistoric diet and activity transitions.

One of the key characteristics of ancient DNA, low copy number, may be a product of its extraction.

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From the outset, it was observed that the genetic material extracted from ancient remains is typically in a chemically degraded state and in low copy number. During the past 20 years of ancient DNA (aDNA) research, these observations have rarely been challenged.

With the goal of maximizing success in working with aDNA samples, a number of studies have compared DNA yields using

various extraction techniques. Such studies often found one extraction method superior to others tested, under particular conditions (e.g. age and state of preservation of the remains, associated impurities in the samples). However, these previous studies began with no knowledge of DNA quantity in the samples prior to extraction. While researchers may have identified the best extraction method within a candidate pool of methodologies, they had no means to determine how poorly these methods performed relative to complete recovery of DNA material.

In this study, we created an aDNA standard (a concoction of DNA thought to resemble aDNA with regard to strand length) that we can control precisely in copy number. Our experiments show that the typical extraction steps widely used in aDNA studies all perform very poorly in retaining short segments of DNA. In fact, we can literally create acceptable "aDNA" copy numbers during the extraction of standards that far exceed most copy number expectations for an ancient sample. Therefore, it is possible that ancient specimens have far more preserved genetic material than previously thought, and low copy number is the result of extraction techniques.

Applying Geographical Information Systems (GIS) to analyze functional surfaces: a study using the distal humerus.

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Sex estimation is an important component in bio-archaeology. The distal humerus is a durable bone and Rogers (1999, 2006, 2009) has suggested that the olecranon fossa shape shows differences in males and females. GIS has previously been used in non-traditional ways to examine teeth (Bartling and Schleyer 2003), though its utility in bone has been restricted to distribution patterns at archaeological sites. This study used a GIS to examine the functional surfaces of bone.

Coordinate data for 140 (70 male, 70 female) left distal humeri were collected with a Microscribe digitizer from the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History. Coordinate data were imported into ArcMap 9.3 (ESRI 2008), which was used to define the olecranon fossa and calculate maximum and average slope, maximum curvature, and volume. The outline of the olecranon fossa, as determined through GIS, was then used for Elliptical Fourier Analysis through Shape 1.3 (Iwata and Ukai 2002). Fordisc 3 (Jantz and Ousley 2005) was used to perform discriminant function analysis on the new (or GIS-derived) variables. Using stepwise selection, the correct classification of males and females was 82.5% cross-validated.

The results show the utility of the method for instances when linear measures may not be practical, such as with highly degraded material. This method

for analyzing functional surfaces provides another means for quantitative research, as well as a means to quantify qualitative data, especially regarding shape.

Development of a GIS-based habitat suitability model for two lemur species in Betampona Nature Reserve, Madagascar.

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The use of Geographic Information Systems (GIS) technology has been a valuable tool in the prediction of species occurrences for both ecological and conservation purposes. Researchers have been able to combine information from satellite images, GPS data and field studies to determine the probability of species occurrences based on a number of ecological and environmental variables. The purpose of this study was to create a GIS model of habitat suitability for 2 sympatric lemur species in a 2228 ha forest located in north-eastern Madagascar. Behavioral and ecological data was collected on 7 radio-collared groups of lemurs for 9 months in 2007-2008. This data was then combined with remotely sensed Landsat TM and SRTM images to create 4 measurable environmental variables (forest cover, elevation, slope and aspect) in an effort to better understand the distribution of these 2 lemur species in this forest. This habitat suitability model was used to create maps of the forest in which each lemur species is most likely to occur. Conclusions are that the microhabitat and vegetative structure of the forest need to be taken into consideration to refine this model further. The model described in this paper provides valuable information as to the importance of each of the ecological variables measured in the prediction of the occurrence of each of the lemur species studied. This study was funded by a Fulbright grant.

Righting the wrongs of the past: estimating the original provenience of confiscated mummies with isotope analyses.

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In 2007, the Federal Bureau of Investigations (FBI) confiscated nine mummies from White City's Million Dollar Museum near Carlsbad, New Mexico which was unlawfully displaying Native American remains. The sample consists of seven adults, including one female and three possible males, one male infant, and one male

fetus. The FBI curated the mummies with the Maxwell Museum of Anthropology for study and, if possible, eventual NAGPRA compliance. The Million Dollar Museum's records did not specify original provenience of the remains, so isotopic analyses and radiocarbon dating were conducted to determine the origins of the mummies.

We measured the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values from tissue and bone collagen, $\delta^{15}\text{N}$, $\delta^{13}\text{C}$ and $\delta^2\text{H}$ values of hair, and $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values of the carbonate in enamel apatite. Due to inadequate quantities and degradation a subset of analyses were run for each individual. Results produced averages of: 13.59 for $\delta^{15}\text{N}$, -9.96‰ for $\delta^{13}\text{C}$ of tissue (n=7); 8.77‰ for $\delta^{15}\text{N}$, -8.11‰ for $\delta^{13}\text{C}$, and -81.4 for $\delta^2\text{H}$ of hair (n=4); 10.85‰ for $\delta^{15}\text{N}$ and -8.30‰ $\delta^{13}\text{C}$ of bone not treated for humic acid (n=7); 10.38‰ for $\delta^{15}\text{N}$ and -7.90‰ for $\delta^{13}\text{C}$ of bone treated for humic acid (n=7); and 0.30‰ $\delta^{13}\text{C}$ of and -6.38‰ for $\delta^{18}\text{O}$ of apatite (n=4). Results are suggestive of individuals from the Four Corners Region dating between 250 and 2080 \pm 35 years BP, with one outlier potentially from the Plains dating to 1860 \pm 30 years BP.

Dietary differences between immigrants and locals in Imperial Rome.

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Although the general diet of people in Imperial Rome consisted primarily of grain, olives, and wine, historical sources indicate that dietary practices varied based on age, sex, and social class. Recent paleodietary work in the Roman countryside and at Italian ports has shown that different food webs were utilized in spite of the proximity of these sites to one another and to the sea. To date, no other study has examined the extent to which the diet of immigrants (both free and slave) affects dietary reconstructions of the population of Rome.

In order to investigate the alimentary resources used in Rome during the Imperial period, we subjected the teeth and bones of 35 individuals from the Casal Bertone and Castellaccio Europarco cemeteries to carbon and nitrogen isotope analysis, as well as strontium and oxygen isotope analysis. Although there were no statistically significant differences between the perimortem diets of locals and immigrants, 15% of the immigrants to Rome had significantly different childhood diets. These individuals' much higher carbon isotope ratios suggest consumption of a diet with comparatively more C_4 plants. Further, those individuals whose childhood diets were statistically different from the local diet apparently consumed a local diet after immigrating to Rome,

as their perimortem carbon isotope values fall within the local dietary range. We conclude that there is a wide variation in the diets consumed by people in Imperial Rome and that part of this variation is likely related to the presence of immigrants in the population. This research was supported by grants from the NSF (BCS-0622452) and the Wenner-Gren Foundation.

A preliminary report on the health status of the skeletal remains from the Kentucky Horse Park Site.

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Thirty-three graves, containing 34 individuals were excavated from the Kentucky Horse Park Cemetery (15FA315), which dates from the 1800's to 1850's. The sample consists of eight juveniles, and 26 adults (13 Females; 10 Males; 3 Unknown). Macroscopic examinations of the cranium were used to assess ancestry. This poster presents data on stature, estimated weight, and pathological lesions, and compares the Kentucky Horse Park data to that collected from individuals buried in similar local cemeteries (Terrill and Old Frankfort), and a comparable sample from the early period of the Freedman Cemetery in Dallas, Texas. While there are no apparent statistical differences in quantity or type of pathological lesions between African and European populations at the Horse Park, there are differences in average stature and weights for these populations, which may represent differences in occupational stresses and nutrition. Like the Frankfort Cemetery, Kentucky Horse Park Cemetery has more variability in stature and weight in the African population relative to the European population, and differences based on sex. The Kentucky Horse Park appears to be better off than their urban counter parts, with less stress during the childhood periods (fewer infectious pathological lesions and fewer hypoplasias). This poster serves to inform us about the heterogeneity of lifestyles and experiences of people in this early period in the development of this country.

Variability in Middle Woodland mortuary practices at the Pete Klunk (11C4) and Gibson (11C5) sites.

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The Pete Klunk (11C4) and Gibson (11C5) sites comprise a core body of data for understanding Middle Woodland (50 BC - AD 400) period peoples. Bioarchaeological analyses of the two sites have informed on multiple aspects of prehistoric life, including health and disease, biological and genetic relationships, diet, mortuary practices and ritual life, among others. Despite their

importance, the temporal place of the cemeteries within the Middle Woodland period has remained under-explored, with chronology anchored on low resolution, culturally sensitive indicators of time. Absence of temporal control precludes a nuanced understanding of cultural and biological change and hinders new research based on these data. Recent analyses have implicated relatedness and mortuary practices in the creation of ancestorhood and ancestor ideology in the Lower Illinois Valley Woodland period; however, analyses of mortuary practices and biological distance revealed differing patterns at Pete Klunk and Gibson. In this paper, I present eight new radiocarbon dates from the Pete Klunk site. These data are analyzed with recent assays from the Gibson site in order to identify intra- and inter-site sequences of moundbuilding, change in funerary practices, and biological relatedness between cemeteries and mortuary tracks. Results indicate that while ritual and associated genetic signatures between mortuary tracks were neither static over time nor identical at either site, the underlying symbolic meaning embodied similar ideological messages conveying ideas of community membership and social order. These results are then placed in the context of regional expressions of Middle Woodland mortuary behavior, relatedness and ideology.

Death and the (narrow) maiden: pelvic dimensions, mortality, and obstetrics versus thermoregulation.

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New World indigenous populations collectively exhibit wider body breadths than populations from similar climates in Europe and Africa, despite having as much variation in other dimensions associated with thermoregulation (e.g., intralimb proportions). Wide pelvic breadths may have initially resulted from “cold filtered” adaptations in ancestral populations. Retention of wide pelvic dimensions, however, remains unexplained, though obstetric constraint is one likely factor. Previous studies have demonstrated a correlation between pelvic non-obstetric and obstetric dimensions with climate. Many other studies have also demonstrated a correlation between obstetric dimensions and mortality. This study examines the relationship between obstetrics and mortality in a geographically and climatically diverse sample of

indigenous pre-contact North American groups. Linear obstetric and non-obstetric pelvic dimensions, in addition to sciatic notch shape semi-landmark data, were obtained from over 250 males and females representing ten archaeological groups from the Arctic, Plains, Southwest and Southeast. Individuals were aged and categorized as either “young” (under 25) or “not young” (over 25) at time of death. Analyses indicate that, in all samples and accounting for body size, older females have wider pelvic anteroposterior outlet and multiple pelvic mediolateral dimensions than younger females. This pattern persists among high latitude samples, even though all females are significantly wider and larger in these colder climates. No age-related patterns are observed among males. Female sciatic notch shape correlates with anteroposterior dimensions, but no obstetric dimensions that significantly differ between age categories. These results argue for some obstetric constraint on changes in pelvic shape after colonization of the Americas. This study was funded by a National Science Foundation Collaborative Research Grant, BCS division, #0962752.

A taphonomic study of two chimpanzee infanticide victims from Gombe National Park, Tanzania.

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Infanticide in chimpanzees is a complex phenomenon; behavior varies considerably among cases. It is similar in some respects to monkey hunting and in others to conspecific aggression directed at non-infant chimpanzees. Whether infanticide more closely resembles one or the other may provide further insight into chimpanzee aggression, and the adaptive function of infanticide in particular. Behavioral evidence reveals both similarities and differences between hunting and infanticide in chimpanzees. We turn to skeletal evidence to provide additional information that may be useful for further exploration of the nature of infanticide in chimpanzees. Comparing patterns of skeletal damage may be relevant when considering how closely infanticide resembles hunting versus other forms of conspecific aggression. This taphonomic analysis compares skeletal damage to 2 chimpanzee infanticide victims from Gombe National Park, Tanzania, with damage to mon-

key prey skeletons reported elsewhere (Pobiner *et al.*, 2007). For each infanticide victim, we calculated the number of identified specimens (NISP), minimum number of elements (MNE), bone survivorship, and bone fragmentation. Similarities between monkey prey and chimpanzee infanticide victims include crenulated and step fractures to long bones, incipient fractures on ribs, and compression fractures to the cranial vault. Differences include a much higher frequency of vertebrae and phalanges in the chimpanzee infant sample compared with monkey prey. Because it is uncertain whether infanticide completely resembles either predation or other forms of conspecific aggression, it may be useful to think of infanticide in chimpanzees as a phenomenon distinct from either. This study was funded by the University of Minnesota Thesis Research Grant and the University of Minnesota Department of Anthropology.

Cochlear labyrinth size and hearing abilities in mammals.

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Morphometric studies of the bony labyrinth for the cochlea in mammals and the basilar papilla in archosaurs have revealed functional associations between the morphology of the auditory epithelium and hearing abilities. In primates, the volume of the cochlear labyrinth is correlated with the high frequency limit of hearing, but it has remained unclear whether this relationship is characteristic of mammals generally. Here we report the results of an analysis of cochlear labyrinth volume and hearing abilities in a broad comparative sample of mammals. Petrosals of 27 species from 8 therian orders were CT scanned with a resolution of 20-40 microns. The cochlear labyrinth was segmented using a variant of the half-maximum-height method, and the resulting measurements of cochlear volume were compared with published audiograms. These data reveal a significant negative correlation between cochlear labyrinth volume and both the high frequency limit of hearing (Spearman $R = -0.72$; $p < 0.001$) and low frequency limit of hearing (Spearman $R = -0.62$; $p < 0.001$). Similar results are obtained when the effects of body mass are held constant using partial correlations. Our findings indicate that as mammalian absolute cochlear size increases, both the high and low frequency limits of hearing tend to decrease. Furthermore, species with large cochleas for their body mass tend to have audiograms shifted toward

a lower range of frequencies than comparably-sized species with smaller cochleas. These results provide further evidence that cochlear labyrinth morphology may be used to estimate the hearing abilities of extinct species.

Selection vs. drift in Neandertals.

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Scholars working under the neutral model of evolution have used both genetic data and fossil evidence to argue that genetic drift is the primary force responsible for variation between human populations, especially in regards to skeletal differences between Neandertals and modern humans. These analyses, though, often require implicit assumptions about population sizes and variance within groups, ones that have not been tested against the paleoanthropological record. It is thus necessary to have a better understanding of how they affect the models under study. Furthermore, the equations utilized to demonstrate the strength of drift may have a high likelihood of Type II errors. We test the hypothesis that cranial differences between these ancient human populations are the product of drift by developing univariate equations to understand the morphological differences between the two groups. Then, we simulate the amount of differentiation that ought to occur if drift is the primary evolutionary force causing change and, using resampling, compare this to the observed diversity seen in fossil populations. By this method we avoid problems inherent in multivariate tests that require knowing the variance within each subpopulation, a difficult statistic to assess for small population sizes. We show that (1) many of the equation utilized in earlier studies have a high likelihood of Type II errors and (2) that drift may not be as strong a force as has been previously argued. We conclude that natural selection should not be rejected as a significant factor in producing skeletal difference between Neandertals and modern humans.

Possible late introgression from archaic hominins into the mitochondrial gene pool of modern human lice.

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Human head and body lice (*Pediculus humanus*) are host-specific parasites that have coevolved with their human hosts for millions of years. As such, human lice may be used as faithful markers for events in the history of

their human hosts. However, unlike their hosts, human lice have an extremely old mitochondrial DNA (mtDNA) coalescence time (ca. 2 million years). Such an old coalescence time may be explainable by either large ancestral louse population sizes or by migration between spatially structured populations of lice. To investigate these scenarios, we examined the deep coalescing mtDNA lineages to determine whether they were the result of large louse effective population size or relics of ancient population structure in their human hosts using an approximate Bayesian computation (ABC) simulation technique.

Our coalescent simulations suggest the most probable explanation of such old coalescent dates is that peripheral populations of lice were isolated for hundreds of thousands of years before undergoing secondary contact with lice on modern humans. We propose that these peripheral lice populations may have arose on late-surviving archaic hominin lineages before host-switching onto modern humans sometime during the late Pleistocene. Though there is no direct evidence that archaic hominins co-occurred with modern humans outside of Europe, these findings suggest the possible co-occurrence of and contact between modern and archaic hominins in Asia.

Intra- and interspecific call recognition: responses of both female baboons and sympatric ungulates to playback of chacma baboon alarm and contest calls.

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Many nonhuman primate vocal repertoires contain calls that sound similar but are produced in very different contexts. Playback experiments can determine if subtle differences among vocalizations affect listener behavior – both within and between species. Using trials that simulated chacma baboons encountering predators and trials mimicking male-male baboon competition, we tested whether four sympatric ungulate species could distinguish these contexts. Despite both sequences being equally startling and varying only in call type, subject ($n = 20$) responses were stronger following alarm sequences ($p = 0.001$). Furthermore, impala, the most frequent associates of baboons, were best able to differentiate sequences, lending support to social learning hypotheses. Ours is the first heterospecific call recognition study

comparing responses among multiple community members varying in experience with the calling species. However, which vocalizations ungulates are attending to remains unclear. For example, both sequences contained equal numbers of male wahoos, loud double-barks produced in both contexts. Although they should elicit very different responses in listeners, contest wahoos and alarm wahoos grade together acoustically. Despite the strong similarities between call sequences, female baboon subjects ($n = 12$) in our second playback experiment had stronger responses to alarm than contest wahoos (look latency: $p < 0.02$; look duration: $p < 0.01$; movement: $p < 0.05$). Although human observers can use sophisticated computer software to quantify acoustic differences in graded vocalizations, only experimental trials such as these can tell us whether conspecific and heterospecific listeners attend to these differences. We will illustrate both experiments using video clips. This research was funded by The Ohio State University and the University of Pennsylvania.

Population-based effects on limb proportion and implications for stature estimation.

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Length of long bones is positively correlated with stature in humans. This study assesses accuracy of Trotter and Gleser's regression formulae to estimate human stature. Trotter and Gleser found that different ancestral populations require different formulae. This study uses a sample of 126 individuals from the Hamman-Todd Collection to test five different formulae, which vary by bone, for each of the following groups: black females, white females, black males, and white males. Lengths of the femur, tibia, fibula, humerus, ulna and radius and maximum heights of thoracic and lumbar vertebrae were measured to represent limb and torso lengths. The t-test was used to compare the limb-stature and torso-stature proportions between males and females and whites and blacks. The t-test was also used to compare Trotter and Gleser's estimated statures to known stature. Results show that men have significantly longer arms and forearms relative to stature than females. Whites have significantly longer torsos relative to stature than blacks, whereas blacks have significantly longer forearms (ulna) and lower limbs (femur and fibula) relative to stature than whites. Significant differences between estimated and known statures were only found among blacks. These results highlight Allen's rule and are consistent with previous studies which find that blacks and whites have different limb-stature proportions, and thus result in different regression equations for stature estimation.

Evolution of the hominin hand: old and new evidence from the Plio-Pleistocene.

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Over the course of hominin evolution, the hand was freed from the constraints of locomotion and used primarily for manipulation. However, the details of this complex transition are not well understood. Though there are numerous Pliocene hominin hand fossils, it is rare that they have a clear taxonomic affiliation and rarer still that the bones come from a single hand or individual. Thus, the evolutionary pathways of morphological change within the hominin hand remain unclear and our understanding of intrinsic manual proportions and overall function is limited. Until recently, it was not until *H. neanderthalensis* that we had a fossil sample complete enough to address such fundamental questions about hominin hand evolution.

Here we discuss the implications of recent fossil hominin discoveries in South Africa (ca. 2 mya) of relatively complete and articulating wrist and hand remains from single individuals with clear taxonomic affiliations. These fossils allow us to address questions about Plio-Pleistocene hominin hand evolution and function on which we previously could only speculate. These fossils shed light on the function of specific joint complexes as well as function of the hand as whole. They show that the transition from early hominin symplesiomorphic morphology to the derived condition found in later *Homo* occurred in a mosaic fashion, with different combinations of features typically considered to be primitive or derived found in different hominins.

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Aerobic capacity of Peruvian high altitude natives: a test of the developmental adaptation hypothesis.

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High altitude natives are reported to have outstanding work capacity in spite of the challenge of oxygen transport and delivery in hypoxia. Studies suggest

that high altitude natives have higher VO_2 max at high altitude than sea-level natives, but lower than elite athletes tested at sea-level. One of the explanations proposed to explain these differences is developmental exposure to altitude, and its effects on the cardiorespiratory system.

In order to evaluate the developmental effect of lifelong exposure to hypoxia on aerobic capacity, we conducted VO_2 max tests on two groups, before and after a 2-month training period at sea-level. We used a variation of the migration study approach: Group 1 consisted of sea-level born and raised volunteers (N=34, 18-35 years) and Group 2 consisted of high altitude born and raised volunteers (N=32, 18-35 years), but who migrated to sea-level as adults. Both groups identified themselves as having Quechua ancestry. Group 2 did not have a significantly higher VO_2 max at high altitude ($2.43\text{l}/\text{min} \pm 0.52$) compared to Group 1 ($2.29\text{l}/\text{min} \pm 0.51$, $p=0.412$), and they did not differ in arterial saturation (SaO_2) at VO_2 max (Group 1 = 81.84 ± 0.72 , Group 2 = 82.87 ± 0.799 , $p=0.35$), after controlling for the effects of sex, age, body weight, fat free mass and the initial differences (pre-training) in cardiorespiratory fitness between groups.

In sum, our results indicate that birth-place (i.e., developmental exposure to altitude) did not constitute an important factor to determine VO_2 max at hypoxia.

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Responding to chronic stress: longitudinal perspectives on metabolism.

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It has recently been suggested that a "stress response" may increase survivorship of individuals, particularly when individuals are undergoing dramatic shifts in resources. A stress response may increase survival by activating two separate physiological pathways that continuously replenish energy stores: activation of the sympathetic-adrenal system (SAS) when mobilization of energy is required for physical responses, and activation of the hypothalamic-pituitary-adrenal (HPA) axis to decrease energy requirements in times of psychosocial stress when energy balance is positive and physical demand decreased. While some studies attribute laboratory-induced, acute mental stressors that activate SAS with increased metabolic cost, no studies have evaluated the influence of chronic, HPA-inducing stressors (when energy balance is positive) on energy expenditure. The present study tests our hypothesis that resting metabolic rate (RMR) decreases with prolonged exposure to psychological stress. RMR, blood pressure, saliva samples, a 10-item Perceived Stress Scale questionnaire, and a

questionnaire of adherence to protocol and weekly academic work were collected on 17 female students for the duration of a 10-week academic term. Saliva samples were assayed for salivary cortisol (indicative of HPA activity). A significant increase in RMR was observed with increased salivary cortisol concentration ($p=0.028$), indicating that HPA activation may lead to an increase in metabolic cost instead of the hypothesized decrease. We suspect that the observed increase in cost could be resulting from increased maintenance requirements caused by physiological responses to chronic stress, including higher blood pressure, heart rate and wear on organ systems.

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Population-specific natural selection at genetic regions associated with HIV-1 viral load set-point control.

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HIV susceptibility and pathogenicity exhibit both inter-individual and inter-group variability. The etiology of inter-group variability is still poorly understood, and could be partly linked to genetic differences between groups. These genetic differences may be traceable to different regimes of natural selection in the 60,000 years since human radiation out of Africa. Here, we examine population differentiation and haplotype patterns at several loci identified through genome-wide association studies on HIV-1 -control, as determined by viral-load setpoint in Caucasian and African-American populations. We use the genome-wide SNP dataset on the Human Genetic Diversity Panel of 53 world-wide populations to compare measures of F_{ST} and extended haplotype homozygosity (EHH) at these candidate regions to the rest of the genome. We find that the Europe-Middle East pair-wise F_{ST} in the associated regions is elevated compared to the rest of the genome, while the sub-Saharan Africa-Middle East pair-wise F_{ST} is very low, suggesting that genetic differentiation (diversifying/positive selection) occurred outside of sub-Saharan Africa, while balancing or purifying selection occurred in sub-Saharan Africa. We also find greater EHH, indicative of recent positive selection at these associated regions, among all population subgroups except for sub-Saharan Africans and Native Americans. These findings

corroborate findings from other studies suggesting recent evolutionary change at immunity-related regions among Europeans, and shed light on the potential genetic and evolutionary origin of population differences in HIV-1 control. This study was funded by NIH Grant Number T32HL007457 from the National Heart, Lung, and Blood Institute

A new angle on the anterior dentition of platyrrhines: a preliminary report.

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Living saki-uakaris (pitheciins), *Pithecia*, *Chiropotes* and *Cacajao*, have an unusual incisor-canine complex adapted to harvesting hard-husked fruits. To better document their morphology as a basis for systematic and functional analyses, we quantified the orientation of the incisors (procumbence) and canines (lateral splay) in a variety of platyrrhines. While upper incisor procumbence clearly distinguishes pitheciins, the orientation of the lowers is comparable to the pattern exhibited by other platyrrhines. All demonstrate a uniform inclination in spite of the diverse challenges associated with ingestive behaviors and food choices that are reflected in crown morphology. This implies that the arrangement of the incisor battery exhibits a mechanically optimal plan within the masticatory system. The steep inclination of pitheciin upper incisors is an effect of the exaggerated crown height of the occluding lowers. The lateral splay of the lower canines, associated with a large diastema and a squared symphyseal region, separates the saki-uakaris from the other taxa examined, but the uppers do not. Early middle Miocene Patagonian fossils suggest an ancestral pitheciin pattern involving elevated lower incisor crown heights, probably in association with stout, modestly tall and non-everted lower canines set in a narrow, gap-free symphysis. The fully modern condition is evident in younger forms, such as *Cebupithecia* from La Venta, Colombia. Reconstructing the diets of the earlier pitheciins continues to be difficult, as some exhibit a unique mosaic, with highly distinctive postcanine teeth. The best modern dietary analogues for the early pitheciins may be *Callicebus* and *Aotus*.

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Morphometric analyses of hominoid facial synapomorphies with implications for the taxonomic status of *Afropithecus*.

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Traditionally, Early Miocene non-cercopithecoïd catarrhines were identified as hominoids based largely on plesiomorphic craniodental evidence. More recent studies have defined apes almost exclusively from postcranial features, and on this basis a number of researchers now regard the Early Miocene "dental apes" as basal catarrhines. Nevertheless, four features in the hominoid cranium are thought by some researchers to represent hominoid synapomorphies: inferior position of the upper extent of the premaxillary suture; a non-projecting interorbital bridge; a vertically expanded naso-alveolar clivus; and a wide anterior palate. Here, we present a quantitative assessment of all four features based on a sample of 500 extant anthropoids in order to determine their reliability for distinguishing hominoids within this group. Clivus height and palate width were assessed using standard linear distances. We quantified the superior-most position of the premaxillary suture as its relative position when projected onto a line connecting nasion-rhinion. The shape of the nasal bridge was captured using semi-landmarks, from right to left dacryon, superimposed by a generalized Procrustes analysis. Both univariate and multivariate analyses demonstrate significant variation in these four features within each superfamily, but palate width and naso-alveolar height are the more reliable indicators of hominoid status. Based on results from the extant taxa, we determined the affinities of the enigmatic catarrhine primate *Afropithecus*. Despite its primitive postcranium, the cranial morphology of *Afropithecus* falls comfortably within the hominoid range for each feature, supporting its taxonomic status as an ape.

Cross-sectional geometry of prehistoric Late/Final Jomon period foragers in comparative context.

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Cross-sectional properties of femoral and humeral diaphyses among Late/Final Jomon people from the Yoshigo site (4000-3400 BP) are reported. Comparative samples include prehistoric foragers from Alaska (open-ocean rowing), California (river rowing), and Georgia (river rowing). All measurements were

size-standardized and compared using MANOVA with Tukey's HSD test ($P \leq .05$). Jomon males have significantly smaller femoral MA values than Alaskan foragers, larger humeral CA, TA, Iy, and J compared to all other foragers, and greater MA and Ix values than foragers from Georgia and California. Humeral diaphyseal shape differs between Jomon and Alaskan males, with Jomon males having more circular diaphyses. Jomon females have significantly larger femoral CA and MA compared to Alaskan foragers, and significantly greater humeral CA, TA, Ix, Iy, and J than other foragers used for comparison. Diaphyseal shape (Ix/Iy) is also significantly greater in Jomon females compared to females from California and Georgia. The results show that Jomon males do not differ greatly from Alaskan males in femur rigidity or shape, but Jomon females have greater femoral torsional rigidity and medullary area compared females from Alaska. However, Jomon humeral diaphyses are more circular and have greater compressive/tensile strength and bending rigidity compared to open-ocean and river rowing groups. These trends reflect variation in directionality, frequency, and intensity of mechanical loading, likely stemming from differences in resource procurement activities.

The assessment of genetic drift across species through the analysis of ancestral and derived frequency spectra.

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Genetic drift is a random process whereby allele frequencies change from one generation to the next. This process is associated with the loss or fixation of variant alleles in populations. Our study focuses on the dynamics of genetic drift by analyzing DNA sequence data across 50 non-coding loci (~500 bp each) from apes and modern humans. Our ape sample includes five individuals from three species: *Gorilla gorilla*, *Pan troglodytes*, and *Pan paniscus*. From these ape species, we determine both ancestral and derived allele frequency spectra in 82 modern human individuals from over 40 populations across Africa, Europe, Asia, and South America. Deviations from the ancestral allele frequency spectrum were caused by founder effects during the peopling of the world. The derived allele frequency spectrum is also affected by founder effects and drift, but necessarily involves new mutations and thus rare alleles. In comparing the ancestral and derived frequency spectra we can make inferences about the timing of human founder effects and the distribution of unique population variants such as ancestry informative markers

(AIMS). Our principal conclusions are as follows: first, common alleles are typically older than the migration out of Africa. Second, a few modestly frequent AIMS characterize African populations. These are ancestral alleles that were lost in the out of Africa migration. Third, we find very few AIMS highly diagnostic of non-African populations. Calculations from coalescent modeling indicate that few are likely to exist, even throughout the entire genome.

Morphological integration in Primate limb morphology.

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Morphological integration tests for associations between structures that are developmentally or functionally related. It is expected that traits that are integrated will be more highly correlated with each other than traits that are unrelated. Most studies of morphological integration have concentrated on the integration of cranial structures. This study examines the genetic and phenotypic integration of the postcranial skeleton in two Primate taxa. The study tests patterns of integration between adjacent elements within each limb, as well as integration between homologous components between the forelimb and hindlimb.

Thirty-four dimensions, representing the scapula, upper limb elements, pelvis and lower limb elements, were measured on 365 cotton-top tamarins (*Saguinus oedipus*) and 275 rhesus macaques (*Macaca mulatta*), all of known genealogies. Maximum-likelihood methods were used to estimate trait heritabilities, as well as phenotypic and genetic correlations. The hypotheses that there is significant morphological integration between adjacent elements within a limb, as well as serial components between fore- and hindlimb were tested using Mantel tests.

The phenotypic and genetic morphological integration patterns were generally similar. There is significant integration between adjacent elements within the macaque upper limb and the lower limb in cotton-top tamarins. Significant serial homology was present in both cotton-top tamarins and macaques. Patterns of phenotypic and genetic variation reflect the influence of the major genes which influence limb development. Differences in locomotion between these two taxa do not modify the effects of genetic influences on limb development.

Skeletal collections from the Caribbean Primate Research Center and University of Tennessee are gratefully acknowledged.

A child hemi-mandible associated with an Epi-Paleolithic Natufian pit dwelling from Dederiyeh cave, Syria.

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Although paleo-biology of Natufian hunter-gatherers is an intriguing issue in the course of modern human evolution, human skeletal remains have been uncovered mostly from the south Levant. A new juvenile mandible, which was found on the floor of a Natufian pit dwelling inside Dederiyeh cave in Syria, should be worth describing even in its immature status. It is a hemi-mandible with the right ramus to the body portions preserved well. Only two teeth surviving in the alveoli are moderately worn first and second deciduous molars, while mixed (permanent/deciduous) dentition are lost. Using sequential CT images, we visualized the morphology of the hidden permanent dental crowns of lateral incisors (r/l), right canine, first and second premolars, and second molar. The developmental status indicates the age at death to be in juvenile (6 to 9 years old) compared to the modern standards.

In addition to observation of the permanent dental crowns, we compared the symphyseal cortical bone distribution with those of growth series of modern Japanese and of Prehistoric Jomon, hunter-gatherer-fishers in Japan. The cortical bone thickness of the Natufian juvenile exceeds that of the comparative ages and almost reaches the adult value of the modern Japanese, while the Natufian value is comparative to the juvenile data of the Jomon. This is congruous with a hypothetical shift from the "robust" to "gracile" mandibular morphology within the modern human evolution, which is manifested early in ontogeny.

Variation in modern human frontal sinus morphology.

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Statistically significant differences in frontal sinuses are recorded among modern human populations. Correlation between frontal sinus morphology and climate is rarely formally tested. The present study investigates the relationship between frontal sinus morphology and climatic variables.

The sample consists of 84 crania from four modern (Iraq, Egypt, Papua New Guinea, and the Philippines), and two archaeological samples (pre-contact Peru and Sumerian Kish). Skulls were radiographed in the A-P plane, and frontal sinuses were digitized. Traditional craniometrics were recorded as part of a larger study. Climate data (precipitation, maximum and minimum temperature) were drawn from the NOAAs, NCDC Global Daily Summary Database.

Multivariate statistical testing clustered the samples in two groups based on Mean Sinus Area (Iraq and Egypt with relatively large, and Papua New Guinea and the Philippines with relatively small sinuses). While variation in frontal sinuses cannot be associated with allometric scaling or cranial size, a high correlation was found with climate data, particularly relative degree of seasonal variation ($r=0.96$). Correlation with average temperature and precipitation tested low.

The results of the this study indicate that recorded variability in frontal sinuses morphology could be associated with environmental variables, particularly relative degree of seasonal variation. Regions experiencing greater seasonal shift in temperature are associated with samples found to possess statistically significant greater mean frontal sinus size.

Into the fire: examining the manifestation of pot polish.

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The presence of pot polish in an assemblage of fragmented human remains is considered key to establishing the identification of cannibalism, yet often such assemblages exhibit a rather low percentage of fragments with pot polish. This poster will present the results of a novel study exploring why pot polish is present at such low percentages by replicating prehistoric processing methods as authentically as possible using a replica ceramic vessel, stone blades and tools, and a wood fueled fire. While several studies of pot polish manifestation have previously been conducted this study will be unique in that it will attempt to replicate the taphonomic conditions that are likely to have created the pot polish seen in archaeological assemblages, specifically the use of wood fueled fire and a replica ceramic vessel to boil the bone fragments. Data on the presence of pot polish on bone fragments from four separate timed trials of boiling defleshed and fragmented sheep forelimbs will be compared and correlated with the length of boil time to assess the conditions required to produce pot polish.

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sity of Utah Undergraduate Research Opportunity Program.

Static and ontogenetic allometry in gibbons: a geometric morphometric analysis.

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Questions about within-species variability, allometry, and levels of sexual-dimorphism in fossil hominoids are commonly addressed using the extant great apes as a comparative framework. However, this framework is incomplete without the gibbons, especially for understanding evolutionary relationships among Miocene apes. Traditionally referred to as the lesser apes, the Hylobatidae are the smallest, most speciose, and most numerous of the living non-human apes. They are also the most morphologically homogeneous and least sexually dimorphic group of hominoids.

Here we present a geometric morphometric analysis of ontogenetic and static allometry in gibbons. We measured three-dimensional coordinates of 145 anatomical landmarks and 313 semilandmarks on surface and CT scans of subadult and adult crania of *Hylobates* and *Symphalangus*. After Procrustes superimposition we then computed principal component analyses in shape space and form space. Within-group static and ontogenetic allometric trajectories were assessed by regressing the shape coordinates on centroid size.

Our results indicate that the shape changes during ontogeny in gibbons are similar to the shape changes previously reported for great apes. Genus-specific differences are already observable early in ontogeny, and the subsequent ontogenetic trajectories are almost parallel. We (1) visualize patterns of sexual dimorphism in *Hylobates* by comparing female and male average shapes, (2) document the cranial shape changes during ontogeny, and (3) compare the vectors of within-group static and ontogenetic allometric trajectories. Finally (4) we test to what extent the shape differences between *Hylobates* and *Symphalangus* can be explained by allometric scaling along a common growth trajectory.

This study is funded by the University of Toronto, NSERC, and the Max Planck Institute for Evolutionary Anthropology.

Teen motherhood and fast life histories.

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Teen motherhood is the prevalent child-bearing pattern in most traditional societies. Yet, young motherhood is associated with negative biological and social outcomes in the developed world. This discrepancy and the debate over the

causes of poor pregnancy outcomes reveals several questions that remain unanswered. 1) How young is biologically too young to initiate reproduction? 2) What are the life-time fitness consequences of early motherhood? 3) Are risks biologically or sociologically determined? From an evolutionary perspective, if pregnancy at a young age poses significant risks, older first-time mothers are expected to have lower risks of infant mortality. However, delaying reproduction also shortens a mother's reproductive career. To evaluate the cost of young motherhood and the tradeoff between age-related risks and lifetime fertility outcomes, I use cross sectional and longitudinal reproductive history data from a group of South American hunter-gatherers. Results show that Pumé mothers under the age of 14 have four times the risk of infant mortality and lower life-time fertility. But, mothers also gain no surviving fertility advantage by delaying reproduction past their mid teens. While the youngest of mothers clearly are at increased risk, results suggest that the negative consequences of teen motherhood are not associated with biologically costs, but the availability of non-maternal support to raise young. Comparisons to studies of teen motherhood in developed societies suggest that childrearing practices rather than pregnancy risks explain much of the cross-cultural discrepancy in the prevalence, success and attitudes toward teen motherhood.

Metatarsal cross-sectional properties vary with first metatarsal abduction angle.

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In the terminal stance phase of walking (toe-off), the metatarsal heads push against the ground, providing the impetus to move both forward and upward and producing both axial compression and bending in the metatarsals. In feet which have adducted first metatarsals, the center of the ground reaction force is believed to be more medial (between the first and second metatarsal heads) than in feet with abducted first metatarsals, where it is located under the second and third metatarsal heads. If this is the case, then first metatarsals should experience lower loading and third metatarsals higher in feet with abducted first metatarsals than in those with adducted ones. Because bones respond to the forces applied to them, metatarsal section properties should follow this pattern.

Left and right anteroposterior digital radiographs of the feet of 50 people (25 women) with no inherent or acute foot pathology were examined. Angles between the metatarsals, metatarsal lengths and midshaft cortical thick-

nesses were measured using Osirix. Cross sectional area, area moment of inertia, section modulus and allowable beam-column loads were calculated assuming a circular cross section and using standard formulae.

In this group, increasing first metatarsal abduction was correlated with decreased section modulus ($p = 0.015$) and cortical thicknesses were higher in individuals with more abducted first metatarsals ($p = 0.015$ and 0.009 , respectively). Metatarsal section properties appear to provide evidence for the off-loading of ground reaction forces from the first to second and third metatarsals in feet with abducted first metatarsals.

The bony labyrinth of Cioclovina, an early modern European from Romania.

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The bony labyrinth is thought to preserve a strong phylogenetic signal and to be minimally affected by epigenetic processes. In particular, it has been shown to differentiate Neanderthals from modern humans, and is commonly listed among the derived features of Neanderthals. Early modern humans have also been proposed to show an inner ear structure different from that of recent people, and similarities have been found between Upper Paleolithic Europeans and their African contemporaries.

Here we examine the inner ear structures of the Cioclovina calvaria, one of the earliest reliably dated modern human specimens from Europe. This specimen has been proposed to show Neanderthal affinities, although that interpretation has been challenged. Cioclovina was scanned using a Siemens sensation 64 medical CT scanner. Both labyrinths were virtually reconstructed after manual segmentation of the 3D CT scan data using Amira 5.2 and Aviso 6.2 software. Two comparative samples of 20 recent Europeans and 20 Africans were included in the analysis, as well as 18 Neanderthals, 2 pre-Neanderthals and 8 early modern humans. Eleven measurements were taken and analyzed with univariate statistics. Seven measurements were further used as variables in principal components and discriminant analyses using SAS.

Results show that Cioclovina falls within the range of normal modern human variation. In the PCA, it falls in the wide zone of overlap between all modern humans and

Neanderthals and is closest to other Upper Paleolithic Europeans. It is classified as a modern human with a posterior probability of 0.84.

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Nutritional deficiencies and growth in a prehistoric subadult sample of the Jemez Pueblo, New Mexico.

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Although the demography, mortality, and pathology of many Puebloan populations have been examined using skeletal data, little is known of the pre-contact individuals from Jemez Pueblo collected in the early 20th century. Examination of the pre-contact subadult skeletal sample from the pueblo provides an impression of their health and nutritional status. To this end, age, cribra orbitalia (CO), porotic hyperostosis (PH), and humeral and femoral diaphyseal lengths were evaluated in 106 juvenile skeletons.

41% (n=43) of the juveniles exhibited one or more of the pathologies. 24.5% had PH, 7.5% had CO, and 8.4% had signs of both. These frequencies are considerably lower than published data for other Southwest Pueblos, including Chaco Canyon (61% PH; 87% CO), Tijeras (78% PH; 46% CO), and Grasshopper Pueblo (50.4% PH; 42% CO).

An estimate of the growth rates of Jemez versus modern children can be obtained by plotting humeral and femoral length versus age. Growth rates of the Jemez subadults are depressed relative to modern populations. The overall femoral diaphyseal length at 15-18 years of age at Jemez was nearly 30 mm shorter than in modern populations, indicating a markedly reduced stature. The low frequencies of PH and CO may be indicators of better health in the Jemez subadults, or a particularly striking example of the osteological paradox. However, the diminished stature may indicate that the correct interpretation is that the Jemez people suffered pronounced nutritional or health stresses.

What makes us human: insights from sequencing extinct hominin genomes.

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A genetic comparison between modern humans and their extinct relatives

could both address the relationship between us and them and offer the possibility to identify genetic changes that happened specifically on the human lineage. Furthermore it may allow identifying and understanding the evolutionary history of genes and positions in the modern human genome that experienced recent positive selection after divergence of modern humans and their extinct relatives. Using a combination of high-throughput DNA sequencing technologies and multiple improvements in ancient DNA retrieval, library construction and targeted library enrichments, the Leipzig laboratory has recently, in collaboration with several groups, completed a first version of the Neandertal genome as well as a genome sequence of an extinct hominin discovered in the Altai mountains in southern Siberia named Denisovan. The analysis of both the Neandertal and Denisovan genome revealed evidence of gene flow between certain modern human populations and both extinct hominins. From the analysis of the data we were furthermore able to draw conclusion about diversity within and among the extinct hominins and by scanning the human genome for regions of positive selection using the Neandertal and Denisovan genome, we identified several strong candidate genes involved in diet, cognitive traits, and skeletal morphology that were potentially selected on the modern human lineage.

Morbidity and mortality in a preindustrial New World city: the paleodemography and paleopathology of Postclassic Cholula.

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Demographic studies have suggested that preindustrial Old World cities had high rates of morbidity and mortality due to the unhealthy urban environment. Prehispanic New World cities differed significantly from those of the Old World, not just in terms of their epidemiological environments, but also in terms of their social, political, and economic organization. A paleodemographic and paleopathological investigation of 309 Postclassic skeletons from the New World urban center of Cholula was carried out in order to assess morbidity and mortality and to determine how population dynamics in this Mesoamerican city compared to those observed in preindustrial Old World cities. Several new methodological approaches, including transition analysis, a parametric model of mortality, and a multistate model of health were incorporated into the analyses. The age-at-death distribution, constructed using transition analysis, indicates that young adult mortality was low and that most of the individuals who lived into adulthood survived past the age of 50. The presence of a

number of pathological lesions, including porotic hyperostosis and cribra orbitalia, enamel hypoplasias of the incisor and first and second molars, and proliferative lesions of the femur and tibia, increased the risk of death; however, enamel hypoplasias on the canines and proliferative lesions on the fibula had no effect on mortality in this population. Results indicate that the cultural and epidemiological environments of Cholula contributed to the formation of urban demographic patterns in this New World city that differed somewhat from those found in the Old World. This project was funded by grants from the Foundation for the Advancement of Mesoamerican Studies, Inc., the Wenner-Gren Foundation, and the Research and Graduate Studies Office of the Pennsylvania State University, and by a Hill Fellowship and a Sanders Award from the Department of Anthropology of the Pennsylvania State University.

Not all Neandertals used their front teeth as tools: evidence from dental microwear texture analysis.

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The extreme gross wear of Neandertal anterior teeth has been a topic of debate for decades. Several ideas have been proposed, including the excessive mastication of grit-laden foods and using the front teeth as a tool or third hand. However, other important factors have been challenging to incorporate into interpretive models. The present study seeks to better understand Neandertal anterior tooth wear by integrating climate, site location, and the three factors known to affect anterior dental microwear signatures: diet, abrasive load, and non-dietary anterior tooth use.

High-resolution casts of more than 65 Neandertals from over 30 sites were examined and scanned for anterior dental microwear textures using a white-light confocal profiler. Using a 100x objective lens, four adjacent scans were generated, measuring a total area of 204 x 276 μm . These scans were uploaded and analyzed using Toothfrax and SFrax SSFA software packages. The resulting Neandertal data were then compared to several modern human comparative samples.

Results indicate that Neandertals have high textural fill volume, low anisotropy, and extremely high scale of maximum complexity values. The closest analogs among modern human groups were arctic peoples, specifically the Aleut and Tigara samples. This suggests that Neandertals were engaging in high magnitude or repetitive loading of the anterior teeth, probably associated with non-dietary anterior tooth use behaviors. That said, there is significant variation among sites in microwear texture attributes, suggesting differences in Neandertal anterior tooth use across space.

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Coordinated patrolling behavior by unrelated breeding males in the golden snub-nosed monkey (*Rhinopithecus roxellana*).

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The existence and maintenance of modular societies in primates, in which multiple one-male units associate to form much larger bands, is of theoretical interest from an evolutionary perspective. The null hypothesis for the relationship between non-kin OMU leaders is hostility under typical sexual selection assumptions. However, modular societies are common in Asian colobines, including the golden snub-nosed monkey (*Rhinopithecus roxellana*). This study presents a preliminary report of previously unreported patrolling behavior involving spontaneous coordination of activity by more than one breeding male. The Dalongtan group of golden snub-nosed monkeys at Shennongjia National Nature Reserve in Hubei province, China was observed during July 2010. This group consists of four associated one-male units and an all-male unit. During this period, the patrolling behavior was observed 8 times for an average frequency of .67 bouts/day. The behavior was stereotypical and always involved at least two individuals. Males would leave their families behind, follow each other either on the ground or in the trees, and not vocalize during the entire bout. The group of males would ascend into the same or neighboring trees and watch an area silently. This is in sharp contrast to fights between males, which always involve loud screams either from the combatants themselves or other nearby individuals. The target of these patrols may be the group's all-male unit. Male reproductive advantages gained through cooperatively defending breeding females may be a mechanism which promotes the cohesion of modular societies in *Rhinopithecus roxellana*.

This study was funded by the NSF EAPSI program, Conservation International's Primate Action Fund, the L.T. Jordan foundation, and the Texas A&M Department of Anthropology.

Basics in paleodemography: age-at-death distribution of the early Medieval skeletal sample of Lauchheim by the complex method and tooth cementum annulation.

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In paleodemography, age-at-death distributions of past populations help to

reconstruct population-specific mortality, fertility and migration patterns. Our study investigates the age-at-death distribution of 1337 individuals of the Early Medieval (450/80 and 680 AD) skeletal sample of Lauchheim. The presentation pursues previous investigations by evaluation of the individual age-at-death estimates. Lauchheim is a unique site as it is well documented, almost completely excavated and can be merged to the closely situated settlement.

To receive a realistic age-at-death distribution, we apply two aging methods, Tooth Cementum Annulation (TCA) and the Complex Method (CM) for adults. First, interobserver error of TCA did not reveal significant counting differences between the well trained observers. Second, the age spans of both methods are compared. The significantly higher age spans for CM are narrowed down by TCA for over 80% of individuals. Third, age-at-death distributions for CM and TCA are compared. Due to grading effects CM shows no sex-specific differences. Besides an early adult female mortality, TCA counts reveal a mortality peak that is 10 years earlier (41-45 years) compared to males (51-55 years). In both TCA counts, females grow older than males. In CM both sexes grow equally old. Finally, TCA and CM age results are combined to receive a realistic age-at-death distribution of the entire skeletal population. Despite higher costs and higher time investment, we suggest applying the TCA method for selected paleodemographic approaches to receive new insights into the life history of past populations by more precise population specific mortality patterns.

A cut above the rest: trepanation among the post-imperial Chanka of ancient Peru.

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Ancient cranial surgery, called trepanation, was often practiced by groups in the pre-Columbian Andes to alleviate inter-cranial pressure caused by traumatic injury. This paper reports on the bioarchaeological evidence for pre-, peri-, and post-mortem trepanations among different skeletal sub-populations affiliated with the Chanka society (AD 1000-1400) of highland Andahuaylas, Peru. Human crania (n = 213) excavated from commingled burial caves at four pre- and post-imperial sites in the region were examined to see how different trepanning techniques may have impacted survivability among distinct sub-population groups over time. A systematic characterization of this ancient surgical practice tests associations between: 1) the timing and location of the trepanation, 2) the manner of incision, and 3) associated patterns of healed and unhealed cranial fractures.

This study also examines the distribution of trepanation along age, gender, and ethnic lines.

13.6% (n = 29) of examined skulls sampled show evidence of at least one trepanation. Significant differences in trepanation use, technique, and survivability are apparent on the skulls of men and women, those with and without cranial modification, and individuals from both the pre- and post-imperial eras. Additionally, evidence of post-mortem trepanations on at least five crania indicate likely attempts by practitioners to improve the procedure. The data show that trepanation techniques transformed, both through time, and among different Chanka sub-population groups. Results suggest distinct (though not intractable), culturally-informed, understandings of how to heal an unwell body in the ancient past.

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Allometry of head and body size in Holocene forgers of the South African Cape.

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Opportunities to assess morphological allometry in small-bodied human populations are rare. The foragers of the Later Stone Age of the South African Cape are characteristically small-bodied. During the period of ca. 3500-2000 years BP (uncalibrated ¹⁴C dates), many skeletons show reduced stature, body mass and cranial size, which has been tied to possible resource stresses. This study examines the relationship between cranial size (centroid size) and body size (femoral length, femoral head diameter, bi-iliac breadth) in this population during the Holocene, including the time of most variability (total N = 65). RMA regression of body size on cranial size indicates negative allometry between head and body size. Residuals (from OLS regression of body size variables on centroid size) are regressed on radiocarbon date to examine changes in the relationship between body size and cranial size. The results indicate that femoral length, and to a lesser degree femoral head diameter, decline more abruptly than cranial size. More ancient skeletons are shorter and lower in body mass for a given cranial size compared to more recent skeletons. Cranial size is more conserved when growth falters. The magnitude of the femoral head diameter residuals is greater among more ancient specimens. They are most variable in the third and fourth millennia BP, suggesting a greater disassociation

between body mass and cranial size in this period. These results are significant for modeling body size and cranial size changes through hominin evolutionary history and through unique processes such as island dwarfing.

Critical periods, intergenerational signaling and human health.

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The importance of fetal or infancy developmental plasticity as an influence on adult biology and health is now widely recognized. It has been hypothesized that the fetus or infant may use maternal hormonal, metabolic or behavioral cues of local ecology to establish appropriate biological settings. A sensitivity to maternal phenotype, which developed in response to both current and past environments, could convey an integrated signal of matrilineal historical experience and thus serve as a reliable index of typical local conditions. This concept of phenotypic inertia implies a co-evolution of maternal cues and fetal/infant responses in service of phenotypic information transfer, which should leave signatures in the architecture of developmental biology. Specifically, it is hypothesized that the timing of critical periods in the development of a subset of biological systems is not random or simply due to unavoidable constraints, but have been shaped by natural selection to overlap with periods of direct transfer of relevant maternal cues. This model could help explain the gradual, intergenerational pace of change for many environmentally-responsive phenotypes, and the poor efficacy of short-term interventions aimed at changing phenotypes with intergenerational components. Policy and public health implications will be discussed.

Reconstructing health at Apollonia, Albania: impacts of Corinthian colonization.

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We test the hypothesis that health at the Greek colony of Apollonia, Albania (established 588 BCE) declined with colonization and the consequent urbanization of the settlement. Stress indicators (cribra orbitalia, porotic hyperostosis, and dental pathologies) were analyzed for three localities: Apollonia (n=226), the mother-city Corinth (n=85), and Lofkënd (n=143), an inland site near Apollonia predating colonization. Schepartz determined that pre-colonial Apollonia shows greater prevalence of pathology than neighboring Lofkënd, revealing a potentially more stressful

coastal environment at Apollonia. Statistical treatment (chi-square) reveals trends of increased prevalence of ante-mortem tooth loss (6% to 14%; n=83, 1127 sockets assessed; p<0.001). Although not significant, there are also increased prevalence of cribra orbitalia (from 28% to 39%; n=73; p=0.33), porotic hyperostosis (15% to 20%; n=133; p=0.48), and linear enamel hypoplasia (85% to 89%; n=91, 273 teeth assessed; p=0.36).

Whereas stress indicators increased at Apollonia, health at Corinth improved following the establishment of its colonies. After colonization, prevalence decreased for cribra orbitalia (from 43% to 26%; n=46; p=0.35), porotic hyperostosis (30% to 8%; n=34; p=0.1), and dental caries (23% to 12%; n=54, 626 teeth assessed; p<0.001) at Corinth. Human response to urbanization differed at Apollonia and Corinth. While health declined at Apollonia following colonization, it improved at Corinth after the establishment of colonial relationships. This research was supported by a Fulbright U.S. Student Grant, a Sigma Xi Grant-in-Aid of Research, and the International Centre for Albanian Archaeology.

Crown and cusp base areas in early *Australopithecus*.

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Crown and cusp base areas of high resolution replicas of the mandibular molars of *Au. anamensis* and *Au. afarensis* were analyzed. The *Au. anamensis* sample comprised specimens from Allia Bay and Kanapoi sites and the *Au. afarensis* sample was drawn from Hadar, Laetoli, and Maka. Cusps and cusp boundaries were identified following previously established methods and measurements were taken from photographs of each specimen at 6x magnification; direct observation of the replicas was used to discern problematic cusp boundaries. Results indicate that the overall crown base areas of *Au. anamensis* M₁ and M₃ are smaller than those of *Au. afarensis* but statistical differences were only observed in M₁. Our measurements were compared to those previously reported for other *Australopithecus* taxa (i.e., *Au. africanus*) and early *Homo*. Although measurement schemes differ slightly between studies, differences between our data and previous reports for *Au. afarensis* represents less than 5%. Compared to *Au. africanus*, molar crown base area of *Au. anamensis* are smaller for all tooth types, whereas only M₁ crowns

are smaller in *Au. anamensis* than in early *Homo*. Analysis of individual cusp areas using Mann-Whitney *U* test between *Au. anamensis* and *Au. afarensis* shows that M₁ hypoconid cusp area is significantly smaller in *Au. anamensis*, whereas *Au. anamensis* M₃s have significantly smaller protoconid and metaconid cusp areas. No differences were observed in M₂s. These results on crown and cusp base areas are compared to univariate analysis of mesiodistal and buccolingual measurements of molars from these taxa obtained from published data.

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Variation in the mandibular curve of Spee in fossil *Homo* and extant populations.

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Function of the mandibular curve of Spee (COS), a concave arc measured across the tooth occlusal surfaces from M3 to the canine, has been studied in extant humans primarily in clinical orthodontics. Although COS function is poorly understood, it may be tied to the maximization of bite force associated with mandibular molar tilt (Smith, 1986; Baragar and Osborn, 1987; Osborn, 1987). Since function of the COS is of clinical importance in extant humans, quantification of COS variation along a greater range of mandibular size, shape, and dental wear in fossil hominins may inform both contemporary orthodontic practice and dentognathic changes across Pleistocene *Homo*.

In a preliminary study, we documented that COS concavity is significantly correlated with alveolar prognathism when comparing African-American and European-American samples. Here, we test the hypothesis that this relationship remains significant when extending the range of mandibular size and shape variation to include Pleistocene *Homo* mandibles. A maximum of 56 3-D coordinate landmarks were recorded along the occlusal surface of the dentition, facial skeleton, and mandible in 289 African-American and European-American individuals from the Cleveland Museum of Natural History and casts of n=7-22 fossil *Homo* specimens from several repositories. The data was analyzed using principal components analysis of Procrustes scaled shape variables and thin plate spline analysis. Results show that fossil hominins generally confirm, and extend, the correlation between a less concave

COS and pronounced alveolar prognathism found in our extant humans. Moreover, these results are not inconsistent with previous research regarding dietary adaptation and function.

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How have taphonomic studies contributed to our understanding of early hominin foraging behavior?

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Since the 1980's, extensive taphonomic research has been undertaken with the goal of explaining the significance of the faunal assemblages from prominent early hominin sites in East Africa such as Olduvai Gorge. This research has included experimental, actualistic, and ethnoarchaeological studies that focused on skeletal element representation and bone surface modification. A review of the cumulative result of these studies finds them inconclusive, with different research groups arriving at contradictory conclusions despite having examined similar lines of evidence. One problem may be that researchers have often taken observations made under very specific or controlled circumstances and used them with the intent of identifying general patterns of behavior among early hominins. Another problem has been the reluctance to recognize that, rather than general patterns, it may be atypical conditions, such as drought, that are most likely represented in the fossil record. Survival in such extreme conditions would have required behavioral flexibility among hominins, and this flexibility would have benefited early *Homo* in adapting to the changing Pleistocene climate. Data summarized here show that modern African carnivores display a range of behavioral variability that is typically underestimated by paleo-anthropologists. By examining such variability in successful carnivore lineages, we may begin to speculate on the different ways that early hominins may have adapted to fluctuating environmental conditions while defining a new ecological niche for themselves.

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The role of rainfall and anthropogenic factors in shaping the life history schedule of Verreaux's sifaka (*Propithecus verreauxi*).

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Verreaux's sifaka manifest a variety of life history traits indicating a relatively "slow" life history schedule. Specifically, these creatures are marked by a long generation time, take a long time to reach sexual maturity, and live long lives. In this study, I

conduct a coalescent-based simulation, using microsatellite loci, to assess historical changes in population size. Demographic and genetic parameters were estimated from the variation in microsatellite loci using an exponentially decreasing population model within a Bayesian framework. Results show that the Verreaux's sifaka population at Beza Mahafaly Special Reserve experienced a historical population decline that began around 2300 BP (credible interval: 3611-1736 years). This date corresponds with the first evidence for human arrival to Madagascar. Beginning around 4000BP Madagascar climate shifted to increasing aridity and rainfall patterns in this region of Madagascar are stochastic. It is likely that human activity, coupled with a stochastic rainfall climate, has contributed to the negative population growth rate of Verreaux's sifaka. I argue that Verreaux's sifaka are characterized by a "declining population paradigm." I connect these results to analytical and simulation studies that show how the strength of selection acting on life history traits changes as a function of population growth rate. In particular, when the population growth rate is negative, selection favors a late age at first reproduction, a long reproductive lifespan, a long lifespan, and weak selection on early survival. Implications for the pace of life history evolution in this population will be discussed.

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Left, right, neither: trabecular bone and the question of laterality in *Pan*.

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Previous research has demonstrated significant asymmetry in human metacarpal cortical and trabecular bone consistent with a population-level functional bias favouring the right hand. Among non-human primates, particularly apes, ethological data (captive and/or free-living) suggest either a modest population-level asymmetry or conversely, the presence of an individual – but not population – hand preference. Research on chimpanzee skeletal samples has suggested a significant asymmetry in whole bone dimensions of, e.g., the humerus, implying a population-level preference in limb use. In this study we examine structural asymmetry in trabecular bone from the head and base of paired first, second and fifth metacarpals in a sample (n = 13) of free-living chimpanzees from West and Central Africa (Tai Forest and Cameroon). Ethological data for hand preference is known for four of the West African animals. Measures of

bone volume fraction, connectivity, 'plate-ness', trabecular thickness, number and anisotropy, derived from micro-CT imaging of 4.5 mm volumes of interest centrally positioned within each head / base were collected. We found no significant differences for any measure (McNemar's test for paired samples; combined sexes). As well, no pattern is apparent for directional asymmetry and hand preference in those animals of known hand use. Accepting the efficacy of trabecular bone to record functional signals, our results challenge the arguments of population and/or individual-level hand preference in chimpanzees. They also pose the question: if asymmetry exists in long bones of the upper limb (e.g., humerus) why does this not translate into the hand?

This study was funded by the Natural Science and Engineering Research Council of Canada (Grant183660-03), the Max Planck Society, and the EVAN Marie Curie Research Training Network (MRTN-CT-019564).

The Bronze Age diet in Auvergne (France): a stable isotope approach.

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This study aims to contribute to dietary reconstructions of Bronze Age populations in the Centre of France and to discuss socio-economical practices, as well as management of food resources. During the Bronze Age, economy is characterized by metal exploitation and transformation, leading to new social relationships and hierarchy. Food resources are mainly coming from herding and agriculture. However, based on contextual information (difference visible in funeral practices), it has been argued that food consumption might vary according to social and/or biological aspects. Further, cultivation of C4-plants (like Millet) is attested in France during the Bronze Age, but no precise information is available regarding its purpose.

In order to obtain individual and specific dietary data, we performed stable isotope analyses (C and N) on extracted collagen of 60 human and 22 animal remains from three contemporary French sites close each other and dated to the Early Bronze Age (ca. 2300-1600 BC cal.): Chantemerle (Puy de Dôme), Orcet/Le Tourteix (Puy de Dôme), and Dallet/Machal (Puy de Dôme). Stable isotope data are integrated with biological (e.g. sex, age, pathology) and archaeological information (e.g. burial practices).

Unlike $\delta^{13}\text{C}$ data, human $\delta^{15}\text{N}$ results indicate a wide range of values. Animal

values show more or less the same pattern, with some species, like *Bos* sp., distinct from the other ones. Both human and animal values do not support the hypothesis of any C4-plant as a significant protein intake. Moreover, first statistical data indicate that human $\delta^{15}\text{N}$ variation appears to be independent of biological factors. This work is funded by The Nestlé France Foundation and INRAP.

Gelada bachelors take the easy way out.

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Primate males without access to females employ a variety of strategies to gain access to females, ranging from simply monitoring opportunities for mating to acquiring third-party information about male-female relationships in order to find easy targets for takeover attempts. We investigated the types of information bachelor geladas (*Theropithecus gelada*) use. Geladas are Cercopithecines with a complex, modular society composed of large bands of one-male units and un-mated bachelor males. Bachelors gain mating opportunities primarily by taking over a unit (thereby acquiring exclusive reproductive access to the unit's females). We asked, do bachelors know which males and females belong together in a unit (which will allow them to capitalize on weak relationships)? We conducted 41 playback experiments with 17 bachelor subjects, simulating copulations of familiar males and females. In 18 cases the males and females came from the same unit, while in 23 cases they came from different units (an extremely rare natural occurrence). Subjects did not respond differently based on unit membership. Instead, observational data indicate that bachelors attend primarily to fights between other bachelors and leader males. Although typically only one male successfully takes over a unit, most takeover attempts involve multiple bachelors fighting the unit male. Fighting a tired male may improve a bachelor's chance at a successful takeover, and monitoring fights may therefore present a simple way for bachelors to gain mating opportunities. We discuss these results in comparison with other primate males that do monitor the relationships between mated males and females.

Utilizing multiple sexual diagnosis methods to obtain better answers to gender-based questions at Barbuise-La Saulotte, France.

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Answering gender-based questions is an integral part of studying funerary popu-

lations. However, each collection being different, sexing methods must be the most well-suited to the remains. This concept is illustrated at Barbuise-La Saulotte, France. This site dates to the middle-to-late Bronze Age transition, a poorly understood era defined by diversifying funerary practices.

Because of poor conservation and the removal of skulls and coxae during the Bronze Age, accurately sexing individuals is difficult. In 2003, S. Rottier sexed 35 of 102 individuals during excavation or research using morphological methods or skeletons' robustness. Utilizing new and revised methods chosen specifically considering this collection, we augmented this number.

The primary diagnosis identified the sex of 13 individuals using a morphological method (Bruzek 2002) and the Probabilistic Sex Diagnosis (Murail *et al.* 2005). Individuals sexed previously were compared to the current study to evaluate identifications made on coxae visible at excavation which have since decomposed. With 100% agreement between studies, we retained sexes of 15 additional individuals. The sex of 17 additional individuals was determined by secondary diagnosis as outlined by Murail *et al.* 1999.

Forty-five of 102 individuals were sexed during this study, 10 more than previously. Given the collection's preservation, achieving this level of determination indicates that choosing sexual diagnostic methods based on the collection is integral to obtaining optimal results. At Barbuise-La Saulotte, this led to establishing an estimated sex-ratio suggesting female predominance, a mean measure of divergence between sexes indicating biological homogeneity, and that varying funerary practices seem unrelated to sex.

This study was funded by the UMR PACEA, Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux I, Bordeaux, France

Dental topographic analysis of pitheciine (*Pithecia*, *Chiropotes*, *Cacajao*) second mandibular molars.

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Pitheciines are specialized seed predators. Although seeds masticated by *Pithecia* are more resistant than those masticated by *Chiropotes*, the more folivorous *Pithecia* is typically recognized to exhibit the least reduction in occlusal relief. Comparative analyses suggest *Cacajao* represents the most specialized sclerocarpic harvester and, by inference, should masticate the

softest seeds. We predicted that, relative to *Aotus* and *Callicebus*, pitheciines will exhibit low shearing ratios (SR), relief indices (RFI) and Dirichlet energy (DE), while orientation patch count (OPC) should be highest among pitheciines, consistent with enamel crenulations. Within pitheciines, *Pithecia* should exhibit the highest values, followed by *Chiropotes* and *Cacajao*.

SR, RFI, DE and OPC were quantified from 3D digital models of second mandibular molars. As predicted, *Aotus* and *Callicebus* exhibit the highest SR, RFI and DE. However, *Aotus* does not differ significantly from *Chiropotes* for DE. Contrary to our predictions, *Pithecia* exhibits significantly lower SR than *Chiropotes* and *Cacajao*, and there is no difference between the latter taxa. Furthermore, RFI and DE are similar across pitheciines, with no significant differences. *Aotus* has significantly lower OPC than all pitheciines, but *Callicebus* differs only from *Pithecia* and *Chiropotes*. *Cacajao* has significantly lower OPC than *Pithecia* and *Chiropotes*, while the latter taxa do not differ. Our results suggest that pitheciine molars, particularly those of *Pithecia*, are adapted to postcanine crushing of seeds. *Chiropotes* and *Cacajao* molars appear adapted to seeds with similar mechanical properties. However, low OPC in *Cacajao* relative to other pitheciines may indicate less efficient mastication of seeds and/or leaves.

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Mitochondrial DNA analysis of ancient Siberian canids.

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Thirteen canid fossil samples and one contemporary wolf sample were obtained from various archaeological and paleontological sites located in the Siberian Arctic. The oldest of these samples include the extinct wolf, *Canis variabilis*, suggested to be at least 70,000 years old based on biostratigraphical data. The radiocarbon dates for the remaining twelve canid fossil samples range from as recent as 1,700 years before present (YBP) to around 47,000 YBP. In order to elucidate the origin of modern wolves and shed insight into dog domestication, we extracted DNA from the canid skeletal remains, which included teeth and bone, and analyzed ~300 basepairs of the mitochondrial DNA (mtDNA) control

region. We successfully produced sequences for all fourteen canid samples and identified nine haplotypes, which were compared with ~1,000 published sequences for dogs and wolves from the literature. Among the nine haplotypes, seven are novel, while one is shared with domestic dogs and another with domestic dogs and wolves. Three of our canid samples that date to around 8,100 YBP have the same haplotype shared with both domestic dogs and wolves. Results from the phylogenetic network illustrate that most of our canid samples are derived haplotypes located at the tips of the branches. A recent study suggested a single origin of domestication for dogs from numerous wolves and our study provides important clues to the domestication process and phylogeny of modern dogs as well as wolves.

Patterns of sexual dimorphism in *Gigantopithecus blacki* dentition.

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Sexual dimorphism is an important component of morphological variation, and has been associated with other variables related to socio-ecology, adaptation, phylogeny, and behavior. For example, highly dimorphic species such as gorilla tend to show intensive male-male competition and polygynous mating system. Among all extant and extinct primate species, *Gigantopithecus blacki* is arguably of the most dimorphic, if not the most dimorphic, in size. However, the high level of size sexual dimorphism in *G. blacki* has not been tested with statistical rigor, because the measurement used, the ratio of male and female means, does not have sampling distributions. In addition, it is quite difficult to assess sex for isolated teeth, which make a substantial portion of *G. blacki* sample. This paper uses an estimate of size sexual dimorphism without relying on sex diagnosis, and tests the statistical significance by applying a data resampling approach. *G. blacki* dental sample (n=47) is analyzed to test the hypothesis of no difference in size sexual dimorphism between *G. blacki* and comparative samples of gorilla (n=224) and chimpanzee (n=65). The results showing that dental size dimorphism in *G. blacki* sample is greater than comparative samples are tested with statistical significance.

Mandibular morphological evidence for dietary differences between two temporally distinct Nubian populations.

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The association between primate craniodental morphology and dietary behavior has been well investigated in the scientific literature. In humans, the unique functional dynamics of the temporomandibular joint (TMJ) place specific constraints on bite force generation during mastication. Because of this, any pathology affecting the function of the TMJ can potentially jeopardize an individual's ability to adequately process food. Diets containing mechanically challenging foods may increase the risk of TMJ degradation and ultimately the overall health of the individual.

We have compared the burial remains of two temporally distinct populations from Nubia: a Mesolithic population (~11 kya) from Wadi Halfa and a Coptic Christian population (~750 AD) from Kulibnarti. We hypothesize that the stark differences in dentocranial morphology between these distinct populations are indicative of drastically different dietary habits and that the higher prevalence of TMJ disease in the Mesolithic population suggests utilization of more mechanically challenging dietary resources.

In order to test this hypothesis, we have estimated the bite-force capabilities of each specimen by analyzing key components of mandibular morphology including the dimensions of the ramus, the robusticity of the mandibular symphysis, gonial eversion, and the rugosity of the attachment sites for the major muscles of mastication. We conclude that the Mesolithic population was capable of generating higher bite forces, which, in combination with the preponderance of TMJ disease evidenced in the Mesolithic sample, implies a more mechanically challenging diet. Our results support the conclusions of Carlson and Van Gerven (1977) who also found evidence of dietary differences between the same populations.

Digital UV/IR photography for tattoo evaluation in mummified remains.

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The presence and location of tattoos can be an important component in the identification of remains in the extended postmortem period if remnants of skin persist. However, when there is significant mummification, elucidation of tattoos can be technically difficult due to skin discoloration and dehydration. Many methods have been proposed to increase the visibility of tattoos in the extended postmortem interval including rehydration and exposing subdermal tissue, both have some (but limited) applicability. While some early attempts to use ultraviolet and infrared illumination for the visualization of tattoos have

been published, they were of limited use because of the technical issues involving film-based photography. Recently, digital cameras sensitive to the ultraviolet and infrared spectra have been produced for the forensic market. These have the advantage of quick visualization of results and minimal marginal cost to allow optimization of image acquisition. The authors present a case in which ultraviolet and infrared photography allowed visualization of a small tattoo in mummified remains, which was imperceptible in the visual spectrum. At autopsy, the body was largely skeletonized, with mummification of the back and upper extremities. Anthropological and dental evaluation was consistent with the missing person. The decedent was known to have a small tattoo of a heart on the back of her left hand, thought the exact location was uncertain. Under both UV and IR photography, a small heart-shaped tattoo was noted between the metacarpals of the thumb and index finger.

Residential mobility in the rural Greek past: a strontium isotope investigation.

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Archaeological excavations conducted at the ancient city of Stymphalos and the nearby Cistercian monastery of Zaraka in the Valley of Stymphalos, located in the Greek Peloponnese, yielded a number of human graves. Neither group of burials were contemporaneous with the structures in which they were interred and they are believed to represent small farming populations occupying the valley during the Late Roman/Early Byzantine and Late Medieval periods. A dietary reconstruction using stable carbon and nitrogen isotope analysis conducted by Carlie Pennycook found that while most individuals had similar $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, a few had values suggesting a significantly different diet. It was hypothesized that the dietary differences observed were the result of residential mobility. The goal of this study is to determine whether some members of the Stymphalos and Zaraka burial groups were in fact migrants into the valley.

This study employs Sr isotope analysis to investigate individual residential mobility. The Sr values reported here provide preliminary evidence for such mobility. A number of samples from both Stymphalos and Zaraka, including those with the most unusual $\delta^{13}\text{C}$ values, show Sr values departing from those expected for the valley. These preliminary results suggest that dietary differences observed within these populations relate to residential mobility due to

marriage practices, labour-related seasonal movement, or mass population movement during times of turmoil. The radiogenic isotope facility at the University of Alberta is supported, in part, by an NSERC Major Resources Support Grant.

Measuring sexual dimorphism in the hominoid proximal ulna using a discriminant function analysis.

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Sexual dimorphism studies focusing on primates have largely been performed on the skull and dental skeleton; less is known about the primate postcranial skeleton in terms of skeletal differences between the sexes. While research suggests that the pattern of dimorphism in the distal humerus is indicative of the pattern of dimorphism in the entire elbow joint, no studies comparing dimorphism between the distal humerus and proximal ulna have been performed in hominoids. In this study, a new, validated method of measuring sexual dimorphism in the proximal ulna of humans will be performed to compare the sexual size dimorphism of the proximal ulna in the hominoid species *Pan troglodytes* and *Gorilla gorilla* using a discriminant function analysis. Specimens used in the study were collected from the Cleveland Museum of Natural History. Overall, 36 chimpanzee and 50 gorilla left proximal ulnas were measured. Using the discriminant function analysis, female chimpanzees (N=23) were correctly classified 73.9% of the time, whereas males (N=13) were correctly classified 76.9% of the time, giving an overall classification success of 75.0%. Both female (N=24) and male (N=26) gorillas were correctly classified 100% of the time. A low percentage of classification in chimpanzees may be related to small sample sizes and lower sexual size dimorphism overall. Future research hopes to address these issues. The high success of classification in gorillas suggests that the utilization of discriminant function analyses could be highly efficient in categorizing other skeletal elements into sex.

Using automated high density quasi-landmarks to test for associations between normal facial feature variation, genetic ancestry and candidate gene variation in Cape Verdeans.

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A new method of summarizing facial feature variation from 3d photos was compared to traditional, low-density manually placed landmark methods in a sample of 248 individuals, ages 18-40, from the Cape Verde islands, which have a history of extensive European and African admixture. For all individuals, DNA was collected and proportional European and African genetic ancestry was estimated using AIMs. 3d photographs of faces were acquired using the 3dMDface imaging system. Traditional landmark coordinate data from 22 standard anthropometric landmarks was collected as well as Principal Component scores from an analysis of 10,000 high-density quasi-landmarks, which are collected over the full facial surface and provide a better representation of normal morphological variation in the entire face.

ANOVA was used to test for associations between measures of facial variation and genetic ancestry estimates, conditioning sex, age, height, weight and body mass index. These results for Cape Verde were compared to two other West African/European admixed population samples, namely African Americans and Brazilians. The Cape Verde individuals share some of the facial trait/genetic ancestry correlations with the other two populations but also exhibit some distinct differences in facial morphology, particularly near the nose. In addition, we examined 30 craniofacial selection-nominated candidate genes that are known to be involved in Mendelian craniofacial dysmorphologies and to show high allele frequency differences between West African and European populations for admixture linkage to variation in facial traits. ANOVA results reveal distinct patterns of facial variation associated with different candidate genes.

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Resettlement contributes to conservation and development in Korup National Park, Cameroon.

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Critics of the "people-free parks" approach to biodiversity conservation argue that schemes to resettle park residents have caused widespread human

suffering and are altogether unsuccessful. They contend that human presence inside protected areas is compatible with conservation goals. A resettlement scheme in Cameroon's Korup National Park (KNP) has been criticized for being unnecessary and a detriment to local livelihoods. We surveyed forests, households, hunters, and bushmeat markets and conducted interviews to re-evaluate the effectiveness, from a biological and economic perspective, of the 2003 resettlement of Ekundukundu village. We found that hunting by people living inside and on the periphery of KNP is threatening large-bodied vertebrate species, especially primates. Comparing pre- and post-resettlement economic activities, we found that the number of animals harvested by Ekundukundu hunters, the time villagers invested in hunting, and the amount of income derived from hunting has declined. These changes are associated with an increase in the diversity of alternative income generating activities, which have compensated most resettled households for the loss of income from hunting. Although some Ekundukundu villagers and hunters from other villages still hunt in the former village area, hunting intensity remains relatively low and primate diversity is high there. Resettlement has reduced hunting by Ekundukundu villagers, encouraged threatened species to use the former village area, and improved the economic development for many resettled households. Resettlement in KNP appears to have supported both conservation and development agendas. We discuss how to improve the implementation and monitoring of future resettlement programs in KNP.

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Environment explains subsistence tool use in *Pan troglodytes*.

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Cultural, genetic, and environmental factors influence tool use. However, we lack a precise understanding of the mechanisms underlying said factors

resulting in tool use behavior. We hypothesize that tool use is an evolved response to the intensity of resource competition. To test our hypothesis, we analyze variation in classes of subsistence tools among *Pan troglodytes* populations. Because our interest is the ultimate causal mechanisms underlying tool use, we define broad tool categories based on the resource extracted instead of specific technique or tool material. Rainfall and temperature seasonality are proxies for competition intensity. Geographic distance among sites is a proxy for cultural and genetic components, since the transmission of tool traits via diffusion and migration are negatively related to distance. Multivariate strategies of tool use are compared across sites, and their relationships to said variables are assessed using mantel tests and ordination vector-fitting. Our results indicate that environmental variables best explain variation in tool use ($r^2=0.5562$, $p=0.0396$). Genetic and cultural explanations were rejected when no significant relationship for geographic distance between sites was detected ($r=0.3283$, $p=0.354$) but tool use and longitude approached significance ($r^2=0.5659$, $p=0.0702$). Vector fitting analyses reveal that rainfall seasonality is strongly correlated with tool use. The results suggest a trade-off between investing in costly behavior, and extracting difficult-to-obtain yet nutritious resources. Seasonality, which is associated with bottlenecks in resource availability, may be a selecting force for the evolution of tool use in chimpanzees. This process may explain the emergence of tool use in many species, including humans.

Human-specific brain energy utilization features are reflected in gene expression during childhood: an RNA-world perspective.

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Brain size in humans deviates from allometric trends in other mammals, and is enlarged threefold compared to other apes. In addition, human brain tissue has an exceptionally high metabolic rate. While most investigations of human brain evolution and metabolism have focused on adult brain, the metabolic demands are far greater in childhood, when relative brain size is also

greater. Maximum glucose uptake in the human brain occurs later than in rhesus macaque, with a well-defined peak at 35% of mature age. The molecular basis of this human-specific brain energetics expansion, however, remains incompletely understood.

Recently, a large new class of mammalian genes, encoding non-messenger, long non-protein-coding ribonucleic acid (lncRNA) molecules of unknown function, has been discovered. Numerous lncRNAs have primate-specific sequences and/or evidence of rapid, lineage-specific evolution. To test the hypothesis that lncRNA expression, and by implication function, is correlated with human-specific brain energetics, we have quantitated the levels of nearly 6,000 lncRNAs in surgically resected human brain samples ($n=36$, ages 0-18) originating mostly from the temporal lobe. To our knowledge, this is the first ever *in vivo* study of lncRNA gene expression during the childhood human brain development timecourse. Our age-dependent differential expression analysis pinpointed nine lncRNAs with expression levels mirroring the human glucose uptake curve, including lncRNAs encoded by novel genes with anthropoid-specific exons and with primate-specific repeat sequences contributing splice sites. Future functional analysis of these RNAs' relevance to brain energy metabolism in the context of human brain size and energy demands is warranted.

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Murder in the Agora: violent death and illicit burial in ancient Athens.

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Since 1931, American excavations in the ancient Agora of Athens, Greece have excavated eighteen wells containing human remains. The dates range from the Neolithic to Byzantine periods, indicating that the practice of burial in abandoned wells persisted for millennia. Many skeletons are perinatal infants; two adults were deposited as formal burials, complete with associated pottery, and others are clearly associated with the Herulian sack of Athens in AD 267. At least five individuals, however, exhibit potentially fatal perimortem trauma, and appear to have been deposited in the wells without any formal grave goods or evidence of war-related conflict or other crisis. The nature of the trauma inflicted on the skeletons and their informal burial suggest that these individuals were violently killed and deposited in the wells, perhaps to hide the bodies. All five exhibit clear perimortem trauma to the skull. Four sustained multiple cranial fractures, and the fifth was beheaded with multiple blade cuts. Two also exhibit perimortem fractures on the post cranial skeleton. Three of the victims, desig-

nated AA 10 (Classical), and AA 78 - AA 79 (Byzantine), were deposited during historic periods when it would have been illegal to bury a corpse within the city. The other two subjects of this paper, AA 1 (Neolithic) and AA 296 (Mycenaean) died before formal laws regarding burial are known to have existed in Athens. However, their deposition in abandoned wells indicates a casual, if not furtive, deposition and suggests that they too were victims of murderous intent.

Prevalence and patterns of disease in the late-Roman cemetery population of Frilford, Oxfordshire.

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The occupation of the Roman army (AD 43 - 410) had a crucial impact on the British landscape and its inhabitants. Skeletal evidence from cemeteries associated with Roman settlements provides valuable information on the demographic and social impact of the occupation. The Roman town of Frilford, Oxfordshire has been subject to excavations since the 19th century, though previous conclusions about the Frilford population have been based on limited skeletal evidence, assessment of grave goods, and outdated migration theories. Crania ($N=136$) from the associated cemetery were used to conduct a macroscopic osteological analysis of the demography and health of the population to further explore the impact of 'Romanization' on the Frilford individuals. Thirteen females, 50 possibly females, six males, 41 possibly males and 26 individuals of unknown sex were recorded in the sample, though issues with preservation may reflect biases in sex estimation. Pathologies observed in the sample included a high prevalence of dental disease, cribra orbitalia, remodelled periosteal new bone growth, and healed trauma. The results suggest a combined military and civilian population exposed to periodic concentrations of people, seasonal malnutrition and occupational accidents. However, more work is required to ascertain confirmed evidence of some proposed diagnoses and the distribution of sex and age in relation to these pathologies with confidence. This study was funded by The Rosemary Cramp Fund, awarded 2010.

Traces of a homicide in the Coptic monastery of Deir el-Bachit in Thebes-West, Egypt.

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In the necropolis of Thebes-West a Coptic monastery, dating between the 5th and 8th century AD, is currently excavated by the German Archaeological

Institute. Deir el-Bachit was inhabited by monks, who were buried at the adjacent cemetery. During the excavation, a skeleton was found in an arch, which was originally used as a storage room. According to the fabric found attached to the skeleton the individual could be dated to the 16th to 18th century. The anthropological investigation revealed that the skeleton was a female, who died at the age of 19 to 23. Additionally, several bones of an unborn fetus, approximately 6th lunar month, were recovered close to the female skeleton. The skull of the young woman showed a severe trauma at the right parietal bone close to the sagittal suture. The injury was most probably caused by a blunt force and showed no evidence of healing. The dating of the fabric pattern and the sex of the skeleton clearly shows that the individual didn't belong to the monasterial community. Moreover, the lethal skull trauma and the unusual burial place strongly suggests that the pregnant woman was the victim of a homicide.

Documentation of pathological conditions in Osteoware.

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Osteoware makes detailed documentation of pathological conditions possible. A flexible structure includes a drop-down menu to select individual bones, bone types, or skeletal regions, and a screen to choose side, bone aspect (e.g., anterior), and section (e.g., proximal 1/3 of diaphysis) using radio buttons and check boxes. When a condition such as arthritis crosses a joint, a drop-down menu is used to choose all affected bones. Once the location of the condition is established, one or more data entry pages within the Pathology Module can be selected to document the type of condition. These pages include: Abnormal Bone Loss, Bone Formation, Trauma, Porosis and Vascular Impressions, Arthritis, Bone-Specific Abnormality (including size and shape), and two pages specific to conditions affecting the vertebral column. More than one page may be used to document a condition. Within the pages, specific information about the conditions is selected, including descriptions of the bone surface, severity, and extent of surface affected. If the condition does not correspond to any of the available data entry pages, the "Other pathology not in system" box is checked.

An unlimited text field is available for descriptions of the condition, which should refer to any information selected within the data entry page(s), and specific information as needed to further document the condition, such as measurements. While diagnosis is not the

object of this description, patterns of lesions should be mentioned.

The database can be queried and linked to other data tables within Osteoware for meta-analysis within and across populations.

Osteoware is supported by grants from the National Center for Preservation Technology and Training (NCPTT) National Park Service, and the Smithsonian Web 2.0 grant.

A new technique for linear enamel hypoplasia quantification.

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Linear enamel hypoplasias (LEH) are an important component to the study of childhood stress in ancient skeletal populations. These enamel defects can reflect any form of extreme stress from high disease load to inadequate nutrition during development. Though the exact causes that lead to acute stress which form individual LEH are difficult to determine, the impact and duration of these stresses can be examined. This project outlines and tests a minimally invasive means of studying the surface structure of dental enamel in order to attempt to quantify fill volume of LEH. A sample of teeth ($n = 35$) from the ancient Egyptian site of Akhetaten (modern day Tel el-Amarna) that exhibit visible linear enamel hypoplasia was utilized in this study. The teeth were first cleaned of any surface debris and etched using Pulpdent Etch-Rite dental etching gel (38% phosphoric acid solution), and were then molded using President's Jet Regular Body Dental Impression Material (Coltene-Whaledent). These high-resolution molds were then cast, and the casts scanned using a Roland Dr. Picza Touch Probe Scanner. The resulting point clouds were then analyzed with ArcView GIS software. Results show this method to be a simple, effective way to quantify severity of total events resulting in LEH, as opposed to more invasive methods like thin sectioning.

Human bioarchaeology at Shahr-i Sokhta (3rd millennium BC), Iran: Palaeopathology, dental histology and isotopic analyses of ancient human hair.

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The extent (20-25 ha of cemeteries, up to 40,000 graves), the exceptional preservation (human hair, nails and soft tissue), and the artefactual evidence for the several contextually distinct groups at Shahr-i Sokhta ('craftsmen' and 'herders') provides a unique record with which to study the development and health status of urban civilization during the Bronze Age. Given the intensive

craft work evidenced at Shahr-i Sokhta, and its urban extent, the following problems can be posited: Was dentition used as a tool or a 'third hand'? What is the rate of AMTL? Are growth disruptions/stress episodes visible in the dentition? What can we say of diet? The hypotheses are that human dentition was used as a tool, AMTL rates are relatively high, multiple stress episodes present on dentitions, and human hair and bone are well enough preserved to allow C and N analysis.

The following methods and materials were used (including pilot studies): C and N stable isotope analysis of human hair (N=6 individuals), C and N stable isotope analysis of human bone (N=20 individuals), dental histology (N=3 individuals), statistical analysis of AMTL (N=974 tooth positions) and dental wear (N=37 dentitions).

Understanding socio-economic transformations through time is one of the major foci of current (bio)archaeological research, both at regional and global scales. The differential dietary regimes indicated by the stable isotope studies of hair, and the differential use of dentition as a tool indicate clear potential for exploring social differentiation at Shahr-i Sokhta, through integration of contextual, anthropological and isotopic data.

This study received funding from ICAR.

Dietary variability of ring tailed lemurs (*Lemur catta*) and Verreaux's sifaka (*Propithecus verreauxi*) based on $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values from feces.

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We present stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopic data from sympatric ring tailed lemurs (*Lemur catta*) and Verreaux's sifaka (*Propithecus verreauxi*) inhabiting the Beza Mahafaly Special Reserve (BMSR). We collected fecal matter and behavioral data on 14 collared ring-tailed lemurs and 14 collared sifaka throughout an eight-month period that included a distinct wet and dry season. For each primate, we collected data on one group that lived in a protected parcel of riverine forest and one group that inhabited forests that were anthropogenically-disturbed. In total, we analyzed 224 fecal samples (122 lemur and 122 sifaka). Lemur feces had higher $\delta^{13}\text{C}$ ($P < 0.001$) and $\delta^{15}\text{N}$ ($P < 0.0001$) values than sifaka. Intraspecific lemur comparisons revealed significant monthly differences in $\delta^{13}\text{C}$ values ($P < 0.01$). Lemurs also had enriched $\delta^{13}\text{C}$ values during the wet season ($P < 0.05$) and the lemur group living in

the protected parcel had depleted $\delta^{13}\text{C}$ values ($P < 0.01$). Sifaka comparisons revealed monthly differences in $\delta^{13}\text{C}$ ($P < 0.0001$) and $\delta^{15}\text{N}$ ($P < 0.001$) values. For sifaka, $\delta^{13}\text{C}$ values were also enriched in the wet season ($P < 0.0001$) while $\delta^{15}\text{N}$ values were depleted ($P < 0.01$). The sifaka group living in the protected parcel was enriched in $\delta^{15}\text{N}$ ($P < 0.0001$). Our feeding observations (130.3 lemur hours and 137.1 sifaka hours) revealed that each primate relied on different foods throughout the year, based primarily on availability. This research supports the implementation of stable isotope analysis of carbon and nitrogen at an effective method to track changes in diet temporally and spatially at BMSR.

This study was supported by the National Science Foundation (Grant #0525109), the University of Colorado-Boulder's Innovative Seed Grant Program, and the University of Colorado-Boulder's Undergraduate Research Opportunities Program.

Quantifying urinary C-peptides in wild geladas (*Theropithecus gelada*).

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Accurate measurements of energetic condition are a critical variable for understanding the ecological factors that limit primate growth and reproduction. However, reliable energetic estimates have been notoriously difficult to obtain, requiring laborious measurements of feeding rates and energy expenditure. C-peptides offer a promising alternative. As a polypeptide segment released by proinsulin, C-peptides are secreted on an equimolar basis with insulin, thus accurately reflecting energetic condition. Furthermore, C-peptides are measurable in urine, providing a non-invasive method to assess energetic condition in wild populations. Here, we validate the measurement of C-peptides using captive and wild urinary samples from geladas (*Theropithecus gelada*). Our objectives for this study were to show both analytical and biological validation. We collected samples from captive individuals ($n=24$ samples from 12 individuals) at the Bronx Zoo (New York) and from wild individuals ($n=60$ samples from 20 individuals) in the Simien Mountains National Park (Ethiopia). For the analytical validation, we demonstrated parallelism and accuracy ($r^2 > 0.99$) using a commercially available radioimmunoassay. For the biological validation, we found (1) that C-peptides were higher in the captive vs. wild population, and (2) within the wild population, C-peptides were higher during the wet season vs. dry season. Therefore, our results indicate that urinary C-peptides can be reli-

ably measured in geladas, offering a useful tool for assessing how energetic condition mediates the relationships between ecology, social status, growth, and reproduction.

This study was funded by the University of Michigan.

Testing the efficacy of sex determination in the human pelvis using geometric morphometrics and semilandmarks.

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While it is widely recognised that the pelvis is the most reliable skeletal element for sex determination, many of the most diagnostic features (e.g. ventral arc, subpubic concavity, medial aspect of ischiopubic ramus) are located on the anterior portion of the pelvis, which does not always preserve in forensic and archaeological cases.

Geometric morphometrics (GM) offers powerful statistical tools for shape analysis, enabling a flexible approach that accommodates the analysis of specific localised regions. Here, we use GM techniques to determine if semilandmarks taken on curves of the pelvis (iliac crest + iliac spine, interior curve of pelvis inlet, and obturator foramen) discriminate individuals of known sex (20 Males, 20 Females) as accurately as 20 landmarks covering the entire innominate. Results were compared with an analysis of femoral head shape as a baseline. To assess efficacy of sex determination, Principal Component (PC) scores were subjected to Discriminant Function Analysis (DFA), where PC scores explained 90% of total variance.

Results show that most accurate determination of sex was for the whole innominate (Males = 100%, Females = 94.1%), suggesting that caution should be exercised where the whole pelvis is not preserved. However, it is notable that individual curves gave results of 76-82% accuracy in the case of the iliac crest and interior curve, even with the relatively small sample sizes employed here. These results compared with only 41-47% accuracy for femoral head morphology. Hence, GM methods may provide a viable approach to sex determination in the case of partially preserved innominates.

Taking advantage of spatial data: the utilization of density estimates to manage mass disaster scenes with commingled human remains.

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Total stations and high-resolution GPS allow rapid recordation of precise spa-

tial coordinates even in scenarios with thousands of scattered fragmented human remains. This spatial information is key to documenting provenience and establishing chain of custody. Currently, the full range of analytical possibilities offered by this type of spatial data have not been fully explored.

The present study illustrates the application of sampling designs and density estimates derived from field ecology and epidemiology to the management of mass disaster scenes and the solution of commingling issues.

Plot and plotless sampling methods were used to estimate evidence densities in two sets of experimental scenarios: Preset surfaces with known areas, quasi-isotropic evidence distributions and known item sizes; and mock scenes with detonated vehicles to generate realistic anisotropic distributions with unknown evidence sizes and densities.

The controlled experiments compared density estimates obtained from different plot (capture-recapture) and plotless (*distance*) methods, with the known densities. The mock bomb scenes were used to assess efficiencies in a quasi-real scenario and the potential effect of anisotropic distributions on the two sampling methods. The real densities were approximated in this case by conducting line searches until evidentiary elements were no longer found.

Results suggest that reliable evidence density estimates can be obtained in these scenes with minimum resources. This would allow scene management to focus recovery efforts on areas with higher or lower densities, scene control and release. The spatial data also introduces proximity of remains as a variable in commingling analysis.

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Morphological integration between the human os coxa and femur.

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The femur and os coxa form a functionally integrated unit which develop and act in tandem in order to distribute the forces necessary for locomotion. The covariation of these two bones is deduced from their functional dependence, but little has been done to investigate the subtle patterns of morphological integration between the two. Three-dimensional coordinate locations of 67 landmarks (39 on the femur, 28 on the os coxa) were collected for 48 individuals from 14 countries, spanning a latitudinal range from Australia to Greenland. A PLS analysis with a 10,000 round permutation was run for the Procrustes coordinates in order to statistically investigate the pattern of covariance between the two bones. Results of this analysis show that overall morphol-

ogy of the femur and os coxa do not covary significantly (RV coefficient=0.2932, $p=0.1403$). Previous studies have identified a strong relationship between the proximal femur and body shape (approximated by biiliac breadth). When we explored variation in specific regions of the femur and os coxa to determine the areas of greatest covariance, the regions most closely approximating pelvic breadth and mediolateral femoral breadth throughout the head, neck, trochanteric, and subtrochanteric regions were found to covary significantly ($p=0.0427$, RV coefficient=0.2197). The results of this study indicate that morphological integration within the hip is strongest in measures of breadth, particularly at the proximal end of the shaft, but does not extend down the length of the femoral diaphysis.

Friends or casual acquaintances: identifying meaningful relationships among wild chimpanzees.

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Given that primates are one of the few mammal orders where the majority of species live in permanent groups, many studies have focused on understanding the complexities of group living such as the formation of social relationships. Identifying important social relationships in a primate group involves calculating measures of affiliative behavior such as association time, grooming, and coalitional behavior which can be balanced with agonistic measures such as aggression. In this paper, we first review and evaluate different measures used for identifying strong social bonds among chimpanzees including the Pepper Index (Pepper et al. 1999) and preferred social partnerships (Gilby & Wrangham 2008). We then examine whether the value of these measures vary based on the age/sex class of the individuals involved. We test several different methods of identifying relationships among free-living adult male and female chimpanzees living in the Kanyawara community in Kibale National Park Uganda. Results show that for males, rates of grooming or indices of spatial association are essential for differentiating intra- and intersexual relationships. In contrast, for females, party-level association indices are sufficient for identifying strong social bonds. We conclude that measures used to identify social relationships among wild chimpanzees must take into account the age/sex composition of the dyads involved in order to ensure that true relationships exist.

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Parallel lumbar and pelvic morphology in atelines and early hominids: clues to the earliest hominid adaptations to upright walking?

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Human bipedality is unique among primates, and lumbar lordosis is its most critical functional requirement, because it obviates the need for the bent-hip-bent-knee (BHBK) gait as practiced by African apes. The latter have eliminated lumbar mobility by trapping the one/two most caudal lumbar between dorsally extended ilia (Lovejoy & McCollum, 2010, *Phil. Trans. Roy. Soc. B*. In press). The earliest known hominids show an opposite state—emancipation of the most caudal lumbar by reduction in iliac height and expansion of sacral alar breadth. Moreover, the Last Common Ancestor of African apes and hominids retained a long lower spine (most likely 6 lumbar) (McCollum et al., 2009, *J. Exp. Zoo. (Mol. Dev. Evol.)* 312B: 1-13). Such mobility would have permitted more effective bipedality than is seen in extant apes. However, the most caudal lumbar in Old World Monkeys is also partially trapped by dorsally extended ilia. Could iliac height reduction and sacral broadening have been the earliest adaptations to upright walking in hominids?

Atelines (*Ateles*, *Brachyteles*, *Lagothrix*, *Alouatta*) have flexible prehensile tails, which, when used simultaneously with their forelimbs for support, induce extreme lordosis. We anatomically examined (dissection, MRI, X-ray) their pelvis and lumbar columns and also observed lower limb postures “in the wild.” We find striking parallels with hominids in both, suggesting that lowering iliac height is a possible first step in directly evolving bipedality without any reliance on a BHBK gait.

Dimensions of the birth canal and age at death in prehistoric New Mexican women: a test of evolutionary optimality.

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The human female pelvis is an evolutionary compromise between bipedalism

and encephalization. Of the four main pelvic forms -- gynecoid, anthropoid, android, and platypelloid -- gynecoid is considered the best suited for the human birth mechanism due to its large, elliptical inlet. The remaining three types are ranked most to least suitable as anthropoid, android, and platypelloid. Modern medicine reduces the effects of having a less optimal pelvic shape. However, in prehistory it is likely that there would be evidence of evolutionary pressure on pelvic form through a correlation between pelvic dimensions and the age of death in women of childbearing age.

To test this hypothesis, prehistoric New Mexican females ($n=45$) aged 16-50+ years (estimated by Lovejoy or Suchey-Brooks protocols) were examined. Pelvic shape was determined by 6 measurements of the pelvic inlet and outlet. These measurements were regressed on estimated age at death. Contrary to expectations, none of the regression attained statistical significance at $p < 0.05$. Multivariate approaches also yielded no significant association with age. Maximum acetabular diameter, a proxy for size, correlated best with age ($r = 0.35$, $p = 0.02$). Thus, we conclude that variation in pelvic dimensions in this sample did not present a significant evolutionary pressure but larger women tended to survive to older age.

Documenting age and sex related morphology in Osteoware.

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The age and sex unit of Osteoware has been designed to increase the efficiency of standardized data collection by employing an easy to use mix of fill in the blank and point and click options. For each tracking number created, the user is directed through a series of steps to record data for age and sex estimation. The data collected follows in the tradition of “Standards for Data Collection,” by Buikstra and Ubelaker (1994), including postcranial epiphyseal fusion, cranial suture closure, auricular surface changes, and change to the pubic symphyses. Change in rib morphology is an addition to the methods for data collection not previously used in “Standards.” Information used in the assessment of age for juveniles and adults has been combined into one area of data collection ensuring that the same data is collected for all individuals. Based on documentation of these morphological changes related to age, a number of categories are available including age ranges and descriptive options to summarize the data on age for each individual.

Pelvic and cranial morphology used to assess sex in the skeleton follows closely the methods described in “Standards.” An important addition has been made

in the summary options, the AMBIGUOUS category, for cases when there are indicators for each sex, to distinguish between ambiguous and unidentifiable sex in the skeleton. This presentation outlines the unit in Osteoware for documentation of age and sex in skeletonized remains and presents two case studies of catalogued remains from the Smithsonian Institution collections. Osteoware is supported by grants from the National Center for Preservation and Technology and Training (NCPTT), National Park Service, and the Smithsonian Web 2.0 Fund.

Variation in morphofunctional units of the human nose and climatic adaptation.

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For more than a century, anthropologists have recognized an association between nasal shape and climate as evidence of natural selection on human craniofacial form. Clinical research investigating nasal airflow dynamics and temperature/moisture modification has supplemented anthropological research by providing a better understanding of nasal function. However, the anthropological literature, while generally incorporating large and globally diverse samples, has focused almost exclusively on measurements of the *external* nose. Conversely, clinical research has focused on the functionally important *internal* nose, but has paid little attention to within or between group variation. In this study, we assess variation across morphofunctional units of the *complete* nasorespiratory tract (external vestibule, nasal valve area, internal nasal fossa, and nasopharynx) by combining a morphometric analysis of extant human crania (n=830) from major geographical (Arctic Circle, Europe, Africa, Asia, and Australia) and climatic zones (polar, temperate, warm-arid, and equatorial) with a correlational analysis of skeletal nasal measurements and physiologically informative nasal passage cross-sectional dimensions. Consistent with theoretical expectations, our analyses demonstrate that the internal nasal fossa (INF) displays the greatest range of shape variation within the overall nasofacial complex. Specifically, crania from extremely cold-dry environments show A-P elongated, S-I tall, and especially M-L narrow INFs, while crania from extremely hot-humid environments are characterized by attenuated, short, and wide INFs. Moreover, INF morphology shows clinal distributions within geographic samples in our study (e.g. Nordic, Central, and Mediterranean Europeans),

with the same directionality, if not magnitude, of INF shape contrasts found between broader geographical comparisons.

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Case of multiple fractures due to probable beating with extended survival during the 16th and 17th centuries in France.

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Non-lethal polytrauma has been rarely described in paleopathology because they are most often incompatible with an extended survival. We are introducing here the case of an extended survival with several disabling residual ankylosis and whose origin was probably multiple assaults committed with some blunt objects.

The studied case was male with an age estimated at more than 50 years old, interred in the Notre-Dame-du-Bourg necropolis, in Digne (Alpes de Haute Provence - France, 16th-17th centuries). The skull, the mandible and the bones of the two lower limbs were free from traumatic lesions. There were major sequelae of quasi-symmetric fractures of the two elbows and of the wrists, of a phalanx, of the pelvis, of ribs and of vertebrae. The lesions only affected the trunk and the two upper limbs, notably excluding the skull, the most affected part in general during fights. There probably was a will to hurt, but not to fiercely kill this man who was not able to avoid being hit. So, we have to consider that the victim was immobilized, even bound in a position where his arms, his hands and his chest were exposed to repeated blows from the attacker(s) who gave him a thrashing. So, a beating could be the cause of this polytrauma. Despite the seriousness of the lesions, his extended survival, further to major sequelae, shows the good quality of the cares given and of the human support for this great disable man in a little rural city during the 16th and 17th centuries in Southeast France.

The endosteal lamellar pocket as an indicator of childhood and adolescent modeling drift direction and magnitude during long bone growth.

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Long bone modeling drift occurs at the peri- and endosteal membranes and

affects changes in bone size, shape, and position. Previous reports proposed the Endosteal Lamellar Pocket (ELP), a hemi-circumferential deposit of dense primary lamellar bone as a meta-feature indicating modeling drift in much the same way the secondary osteon indicates remodeling. Though it was hypothesized that the adult ELP originated from previous phases of rapid growth during adolescence, the exact nature and timing of primary endosteal bone drift in sub-adults was unknown. In order to gain a more complete view of long bone modeling drift, 64 juveniles from the archaeological site of Xcambó were analyzed using polarized light microscopy. The ELP was present in each of 3 age groups tested: 5-9, 10-14, 15-19. In comparison to its adult counterpart, the juvenile ELP was much larger as a percentage of total cortical tissue. It was not uncommon for ELP lamellae to account for nearly the entire cortex of one side of a transection. This occurrence is contrary to the general notion that diametric growth and long bone shape is achieved simply by periosteal expansion and endosteal resorption. In addition, it was found that near this site of dramatic bone modeling drift, even the nutrient foramen was forced to drift as well, rather than solely being buried by periosteal apposition. These preliminary results suggest the ELP can be used successfully as an indicator of drift and that shape change during long bone growth may be much more complex than previously imagined.

Analyzing microscopic variation along the femoral and humeral diaphysis: A histological examination of the ELP as an indicator of long bone modeling drift.

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Bone modeling drift accounts for the adult long bone's diameter, morphology, and position, providing useful information for skeletal biological and bioarchaeological understanding of bone morphology. Previous studies have suggested the Endosteal Lamellar Pocket (ELP) as a meta-feature for modeling drift investigations. Until now the ELP has only been reported in long bone midshafts from archaeological population samples. However, since the meta-feature results from normal patterns of bone growth and adaptation, it should be common in any skeletal collection. To test this hypothesis and establish a baseline of data collected from known age and sex individuals 16 individuals from the Xoclán historic cemetery collection were examined microscopically, assessing ELP morphology and prevalence at 3 sites along the humeral and

femoral diaphyses. The ELP was present in nearly every sample analyzed, and was present in the majority of the total cross-sections viewed. Its prevalence and size were greatest in the distal femoral diaphysis. This pattern was not as clear in the humerus where often proximal and distal transections demonstrated larger ELPs than their mid-diaphyseal counterparts and overall variation in ELP position and size was greater. Results corroborate previous descriptions of ELP morphology and suggest that the distal aspect of the femur accounts for more of this element's growth via drift than the proximal. More quantitative analysis is necessary to provide a complete assessment of ELP histological and biomechanical variation among individuals, skeletal elements, and populations. This study was funded by Deutsche Forschungsgemeinschaft (DFG).

Enamel development and thickness in Fulbe pastoralists and Nso agriculturalists, Cameroon.

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The degree to which environment impacts upon forming teeth is important to document for studies of incremental enamel development that increasingly identify taxonomic differences amongst hominoids. Here, we examined enamel development, and thickness, in two human ethnic groups (Fulbe; Nso) with different diets. Traditional Fulbe pastoralist subsistence is aimed at the production of milk leading to a diet rich in nutrients necessary for dental development. Nso subsistence is more varied (predominantly agricultural). The duration and rate of enamel development, and thickness, were calculated from microstructure using standard histological methods in permanent molars and incisors (n=31) extracted for clinical purposes. Informed consent was granted. Diet reconstruction during the period of dental development included carbon and nitrogen stable isotope analysis of root dentin (n=10). The average Fulbe carbon and nitrogen isotope values (-11.2±1.1 and 10.5±0.4) were enriched compared to Nso (14.1±1.5 and 9.1±0.6), which is consistent with an emphasis on the consumption of terrestrial animal protein such as milk among the pastoralists. While Fulbe cusp formation times were generally slightly less compared to Nso, differences between the groups in teeth that formed after weaning were not consistent. Enamel took more than 4.0

years to form in one anomalous molar, and was distributed over a greater dentin core compared to all others. Average enamel thickness lay within the modern human range. Mean daily enamel secretion rates differed slightly between incisors and molars. Dietary differences between Fulbe and Nso are not greatly or consistently reflected by differences in enamel development.

Grooming claws: what are they and who has them?

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Living strepsirrhines possess a specialized structure on the second pedal digit referred to as a grooming claw, which is often considered to be a diagnostic feature of this group. However, grooming claws are also present on the second and third pedal digits of tarsiers and on the second pedal digits of the platyrrhine *Aotus*. The origin of these features is unclear. Are they true claws (falculae) or are they secondarily derived from primate nails (ungulae)? Are all grooming claws homologues or did they arise separately in different primate lineages? Are they present in other primate groups?

This study examines the affiliation and distribution of these structures via morphometric analysis and a survey of primate skeletal material. Morphology of the distal phalanx, which supports the grooming claw, was examined and compared to conspecific third pedal distal phalanges which bear ungulae, as well as heterospecific second and third pedal distal phalanges which bear ungulae, tegulae, or falculae. Data analysis consisted of principal coordinates analyses using Euclidean distances of size-adjusted shape variables. Results show that grooming claws are morphometrically distinct, and possess distinguishing characteristics of ungulae while lacking those of falculae. This suggests that grooming claws are not true claws. Additionally, the survey of primate skeletal material demonstrates unappreciated variation in the second pedal digit of platyrrhine species. Most notably, members of genus *Callicebus* possess a grooming claw. The presence of this feature in non-strepsirrhine lineages suggests that interpretations of its phylogenetic significance in the fossil record should be approached with caution.

Semicircular canal orthogonality, not radius, best predicts mean speed of locomotor head rotation: a new hypothesis with implications for reconstructing behaviors in extinct species.

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Semicircular canal radius (SCR) is often used to infer locomotion in extinct primates. Two problems confront these inferences: 1) locomotor 'agility' is a rank-score from visual impressions, and 2) ~80% of SCR variance is explained by body mass alone whereas <0.2% of SCR variance is actually explained by agility rank. Consequently, SCR-based agility inferences are reasonably accurate only when body mass is known precisely and only for species with very low or high agility ranks.

To improve upon the accuracy of canal-based locomotor inferences, we measured angular head velocities in 11 strepsirrhine species exhibiting diverse locomotor behaviors. Cranial CT scans of the same taxa were used to predict vestibular sensitivity to rotations in all directions. Mapping *in vivo* head rotation onto predicted sensitivity, we found unexpectedly that axes of rapid rotation do not align with axes of high sensitivity. Instead, axes of rapid rotation aligned with axes of mean sensitivity. Evidently, the brain most accurately interprets rotations presented about axes of mean sensitivity, and accurate perception of movement is most important during fast head rotation. We call this the "fast-accurate hypothesis."

The fast-accurate hypothesis implies that fast animals should benefit from minimizing anisotropy in vestibular sensitivity, which can be achieved by orienting ipsilateral canals at near-orthogonal angles. In PGLS regressions, rotational head speed is more highly correlated with canal orthogonality (R²=0.7565, p<0.001) than with SCR (R²=0.1569, p=0.2). Our equations predict mean rotational head speed from *canal measurements alone* and outperform existing body-mass-dependent models.

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Evidence of metric asymmetry and oral pathologies in hominin mandibles from the Pleistocene of Kenya.

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This research reports the presence of metric asymmetry on three mandibular remains from the Pleistocene of Kenya. The presence of pathological lesions on the jaws is provided here as an explanation for the asymmetry. The mandibles observed include the KNM-ER 992, KNM-WT 15000 and KNM-BK 67. The first two jaws come from the Turkana Basin, northern Kenya, while the later is from the Baringo Basin, in the Rift Valley of Kenya.

This study included both morphometric analysis and descriptions of pathological conditions on the mandibular remains. Dental abrasions on the specimens were also investigated during the study. The

corpus height and thickness measures were taken from both the left and right sides of each mandible. Compared antimeres of the respective corpi indicate the presence of localized asymmetry on the mandibles. These jaws also show evidence of dentoalveolar abscess on their horizontal rami that coincide with reduced corpus metric dimensions and decreased dental abrasion. Therefore, corpus robusticity that occur on the healthy sides of the jaws, are proposed to be due to differential mechanical loading during chewing prompted by pain avoidance from the infected sides, thus leading to alveolar bone built-up, but with the opposite effect of bone resorption on the affected areas. The Pleistocene occurrence of dentoalveolar abscess indicates that this oral pathology was not unique to post-agricultural skeletal populations as anthropologists maintain. These findings show that periodontal disease occurs early in our evolution and that answers as to how our ancestors coevolved with oral flora should be sort.

A constructivist evolutionary approach to primate behaviour and ecology: a case study in West Java, Indonesia.

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Application of the socioecological model guides researchers to seek the social and behavioural manifestations of sensitivity to ecological variables. It is increasingly understood that in addition to the distribution of risks and resources in the environment, as well as the competitive regimes of conspecifics, primate social systems are subject to the influences of past and present anthropogenic alterations. The frequent overlapping of human and nonhuman primate ecologies creates a complex dynamic that can be characterized as a form of co-participatory niche construction. I examine broad patterns of primate sympatry and anthropogenic influences on primate populations in West Java, Indonesia. Both qualitative and quantitative assessments of multiple study sites are provided to contextualize specific examples of primate behaviour within human-influenced ecosystems. For example, the density and ranging of Javan gibbons (*Hylobates moloch*) at one site is examined in relation to indices of habitat quality. In this case, ecological differences such as tree species richness ($\chi^2=1.85$, NS), availability of food trees ($G=73$, NS), diameter at breast height ($F_{(1,2)}=6.386$, NS), and canopy volume ($F_{(1,2)}=.001$, NS) fail to predict patterns of spatial distribution and ranging behaviour. As such, processes that produce modifications to the social and ecological niche by nonhuman primates (e.g., range occupancy and territorial defense), as well as human-nonhuman primate interactions, need to be considered in an expansion of the socioecological model.

This research approach contributes to both a theoretical and applied understanding of complex ecological systems.

Human intraspecific brain: body size correlations: towards a causal model for human brain mass variation.

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To date no study has sufficiently documented the range of modern human brain mass variation in a single population and how this covaries with parameters such as age, body mass and height. In this study we analyse one of the largest known databases of brain and associated body size measures from autopsy records obtained over a 20-year period from the Hamburg University Hospital, Federal Republic of Germany. The database consists of a total of 18,335 autopsy records drawn from a European population (12, 131 males; 6,204 females) of individuals aged between birth and 100 years. Using a cohort approach we examined the strength of correlative relationships in brain and body size with both traditional regression analysis and structural equations modelling. Results indicate that early on life (0-3 years of age) brain mass and body parameters are highly correlated with r values ranging from 0.91 to 0.94 and associated with steep regression slopes. The strength of these correlative relationships rapidly change with age beyond 5 years to eventually reach the commonly reported regression statistics of $r = 0.17$ to 0.40 observed in adults. Structural equations modelling was used to decipher the manner in which height, body mass and age contribute to early brain mass variation. Four 'causal models' were successfully fit ($P>0.05$) on the 0-3 year-old cohort having been rejected by the other cohorts. These results indicate that brain: body size scaling relationships vary with age and highlight the range of variation in brain mass for a single population. This work was supported by the South African National Research Foundation (2068364).

Lead levels in teeth as a measure of life-time lead exposure in children.

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Lead exposure is a major health problem in children including a deficit in IQ, deleterious growth development and behavioural effects even at very low levels of exposure. The usual test for lead exposure is to assess blood lead level (BLL), but this indicates only recent lead exposure. This study aims to develop a method to assess long term cumulative lead exposure using tooth lead levels. We will ascertain whether milk teeth are suitable biomarkers of exposure. Two deciduous molars each were collected from 15 children aged 6-8 years living in Northeast England. Using histological sections, the distribution of lead in the different growth layers was quantified by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). BLLs were measured using ICP-MS. Incremental growth lines in enamel and dentine are used to investigate the age of exposure at each sampling point. Blood lead levels ranged from 0.5-6.8(g/dl), and none of the children had a BLL above the WHO threshold of 10(g/dl). Calcium normalised lead ratios (²⁰⁸Pb:⁴⁴Ca) were measured as lead body burden and these intensities vary across individual teeth. Comparatively low intensities of ²⁰⁸Pb:⁴⁴Ca were observed in enamel, higher ratios were found around the dentine close to the pulp cavity. Preliminary results indicate that these ratios in postnatal dentine are consistent at the same age, and slightly increase with age after birth. The combination of histological dating of growth areas of milk teeth in combination with LA-ICP-MS analysis is likely to be useful in establishing the history of lead exposure in children.

Primatology meets palaeoanthropology: the Oldowan.

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In "An ape's view of the Oldowan" Wynn and McGrew (1989) argued for an ape adaptive grade of technological competency in australopithecines. They scrutinized evidence from Oldowan sites and compared it with behavioral observations of extant apes, but especially the chimpanzee. Recently, Haslam *et al.* (2009) proposed a new interdisciplinary field, primate archaeology, to consider the past and present material record of the Order Primates.

Here we revisit the Oldowan from the perspective of primate archaeology. We review recent evidence from the archaeological record and from the study of living primates, especially *Pan* spp. These include: 1) experimentally-induced fracturing of stone by bonobos and transmission of techniques to offspring; 2) cultural transmission and social conformity of tool-using skills in captive and wild chimpanzees; 3) *chaîne opératoire* theory applied to chimpanzee nut cracking work-sites illuminates operational sequences in tool transport and use; 4) selectivity of organic raw materials by chimpanzees extends to lithics; 5) chimpanzees use large-scale mental mapping of wide-spread fruit resources; 6) chimpanzee foraging is technologically nuanced, e.g. tool use in obtaining prey; 7) chimpanzee nest-sites in more open habitats indicate re-use, selectivity and seasonal differences in ranging. Field studies of capuchins and long-tailed macaques reveal percussive technologies used in processing nuts, roots, mollusks and crustaceans. The dialogue between primatology and archaeology yields new methods and insights to aid our understanding of hominin technological and cultural evolution.

Can fibular robusticity be used to infer mobility patterns in past populations?

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Because of their role in weight bearing, the bones normally used to infer mobility patterns in past populations are the femur and the tibia. Nevertheless, studies of living hominoids and modern human athletes have demonstrated that the structural properties of the fibula are significantly correlated with mobility patterns. This study assess variation in fibular cross-sectional properties (CA, I_{max} , I_{min} , and J) within a sample of 155 individuals from the Late Upper Paleolithic (LUP), Neolithic and Iron Age of Italy, Medieval Germany, and contemporary athletes (long distance runners, field hockey players) and controls. The aim of this research is to investigate the correspondence between fibular diaphyseal properties and inferred mobility patterns in past populations. Cross-sectional measurements were taken at the midshaft, and both fibular rigidity and the ratio of tibial to fibular rigidity were analyzed (see Marchi, 2007). LUP, Neolithic and Iron Age samples display the highest relative fibular rigidity, comparable to that of modern hockey players. The pronounced fibular rigidity associated with hockey players is explained as the skeletal adaptation

to habitual multi-directional lower limb loading associated with their sport. The LUP, Neolithic and Iron Age individuals are thought to have been very active and resided in a region of uneven terrain; therefore the requirement for repetitive directional changes throughout the gait cycle where likely frequent. It is suggested that the inclusion of the fibula in analyses of skeletal and fossil remains will allow for a more nuanced appreciation of the influence of mobility patterns on bioarchaeological populations.

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Coastal South Africa and the evolution of the modern human lineage and the coastal adaptation.

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Homo sapiens arose in Africa between 200 and 100 ka ago directing our attention to MIS6, when from 195-123 ka the world was in a fluctuating but predominantly glacial stage when much of Africa was cooler and drier, and when dated archaeological sites are rare. Pinnacle Point (south coast of South Africa) is one of the few localities in Africa dated to this crucial time. The research team here has shown that by ~162 ka humans had expanded their diet to marine resources, begun using and modifying pigments, produced bladelet stone tool technology, and very early heat treatment of lithics. The Pinnacle Point sites also include a later sequence of MIS5 occupations that document an adaptation that increasingly focuses on coastal resources. Recently published from Pinnacle Point are a high resolution coastline model and a speleothem sequence of climate and environmental change that shows that as the coastline distance shifted in response to global changes in sea level, the current Cape flora shifted as well. A model is developed that argues that when populations were small people focused their residential sites at the intersection of the coast and the geophyte-rich Cape flora, and this model is tested with archaeological data from Pinnacle Point. Exploiting coastal resources requires mapping to tidal rhythms to intercept productive collecting tidal cycles. This requires cognition capable of making novel associations between lunar phases and tidal rhythms, and was not possible until after a fully modern cognition evolved, explaining the late appearance of the coastal adaptation.

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Dentoalveolar remodeling in hominoids.

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In-vivo dentoalveolar remodeling and the maintenance of dentognathic homeostasis are of critical importance for the functional and phyletic interpretation of dentognathic features in hominoids and hominins. Here we ask whether patterns and mechanisms of dentoalveolar adaptation differ between extant humans and great apes, reflecting conspicuous differences in dentognathic architecture and biomechanics between these groups. We used CT data of a sample of $N=80$ adult skulls of humans (Australian aborigines) and great apes (chimpanzees, gorillas, orangutans) to score 4 indicators of dentoalveolar remodeling (continuous eruption, lingual tipping of the anterior dentition, edge-to-edge bite of the anterior dentition, mesial drift of the posterior dentition). Results show that patterns of in-vivo dentoalveolar remodeling are largely similar in all examined taxa. Also, patterns of dentognathic aging are similar among taxa. This indicates that hominoids share a common set of basic compensatory mechanisms maintaining dentognathic homeostasis, irrespective of the architecture of the masticatory system, and irrespective of diet. These findings are important for discriminating patterns of evolutionary change from patterns of inter-/intraspecific variation due to aging.

Ancestry and identity.

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We rarely conceptualize evolutionary anthropology in the context of kinship, the oldest research question in social anthropology. In this paper, I discuss recent work in the history of genetics and anthropology, and its bearing on the issue of understanding the meaning of genetics in modern society. Identity (what you are) is universally constructed from a negotiation between ideas of Ancestry (where you came from) and Emergence (what you became). Genetics provides an authoritative scientific voice on ancestry, and to focus upon genetics has commonly involved reducing identity to merely ancestry. Thus, "we are descended from apes" can be transformed into simply "we are apes" by privileging the genetic similarities that tend to reveal that

descent over the ecological divergence that tends to obscure it. The choice to privilege genetic similarities over ecological differences, however, is an arbitrary one. In human affairs, no less than in ape affairs, "you are simply your ancestry" is a highly politicized statement. Earlier generations took August Weismann's doctrine of the "continuity of the germ-plasm" very politically, as well as its opposite, "the inheritance of acquired characteristics". At the core was the question of whether one could transcend ancestry, or whether race was really the crucial determinant of one's potential life course. By concealing the politics of ancestry, and not grappling with claims on behalf of human genetics in historical context, we risk not benefiting from the ethical debates of earlier generations.

Mitochondrial haplogroup C4 confirmed in ancient North America.

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While mitochondrial haplogroup C has long been recognized as a founding Native American lineage, only in recent years has the phylogeny of this haplogroup been revealed with fine-grained resolution (Tamm et al. 2007, Volodko et al. 2008, Malhi et al. 2010, Perego et al. 2010). A motif of coding region single nucleotide polymorphisms (SNPs) has been identified for each of the four haplogroup C clades (Volodko et al. 2008), thereby enabling greater specificity in haplogroup determination, which is essential to the study of the peopling of the Americas. In this report, we review the literature on haplogroup C4 and identify its geographic range in order to better understand the dispersal of this founding Native American matriline. We also identify potential instances of haplogroup C4 in datasets from previously published ancient DNA papers. Finally, we present mitochondrial genetic data on two ancient Native Americans belonging to haplogroup C4, confirming the presence of this subhaplogroup in prehistoric North America. These two individuals of distinct matriline were interred at the Angel Site, a Middle Mississippian (ca. A.D. 1050-1400) mound center located on the Ohio River east of Evansville, Indiana. Overall, this study contributes to the understanding of mitochondrial subhaplogroup patterning in the Americas, the timing and origin of founding Native American matriline, and the role that genetic drift played in shaping the modern mitochondrial gene pool.

An examination of potential mass burials within St. Michael's Cemetery, Pensacola, FL.

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St. Michael's Cemetery is the oldest extant cemetery in Pensacola Florida, dating to 1812. Since 2000, anthropologists from the University of West Florida (UWF) have been engaged in ongoing research at the cemetery aimed at documenting its use history. A total of 3,198 extant grave markers have been recorded, but historical records suggest that earlier, unmarked graves may also be present. A GPR survey conducted in 2008 identified 3,915 sub-surface anomalies that may represent burials predating the official inception of the cemetery. Several of these anomalies are significantly larger than would be expected for single interments, and possibly represent mass burials from colonial epidemic events. To test this hypothesis, the UWF Forensic Anthropology Field School conducted excavations at two of the large anomalies in the summers of 2009 and 2010. The goals of these excavations were: (1) to determine whether the sub-surface anomalies do indeed mark mass graves; and (2) to determine the chronology and ethnicity of any burials encountered using attributes such as body position, burial orientation, body treatment, and associated artifacts. While neither of the first two anomalies excavated actually proved to be a mass grave, several individual unmarked burials were exposed and documented. This presentation describes the results of the first two seasons of excavations at St. Michael's and discusses future avenues of research on the other large GPR anomalies, and on the human remains discovered to date. This study was funded in part by a UWF SCAC Faculty Grant.

Relationships among crown formation time, fluctuating asymmetry, and linear enamel hypoplasia in gibbons and gorillas.

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Fluctuating asymmetry (FA) is a pattern of asymmetry in a group of organisms in which size differences between left and right body structures are normally distributed around a mean of zero. In individuals, FA appears as small differences between right and left body structures that are random with respect to which side is larger. Using gorillas and gibbons, this project tests the hypothesis that the amount of time canine crowns take to form affects the opportunity for FA to develop. Additionally, a sub-sample is used to test the hypothesis that the presence or absence of linear enamel hypoplasia (LEH) is associated with the magnitude of FA.

Mesio-distal and bucco-lingual dimensions of maxillary and mandibular canines were measured to calculate FA in a total of 101 gorillas and 87 gibbons. The results support the hypothesis that gorilla males, whose canines take longer to form than those of females, exhibit greater FA than gorilla females. Male and female gibbons, whose canines take a similar length of time to form, exhibit similar FA levels. Furthermore, gorilla males generally exhibit greater FA than gibbon males in the maxillary dentition, consistent with the crown formation difference between these two taxa. Finally, individuals with LEH have greater FA than those in which LEH is absent. Although the results lend support to the hypotheses, not all results are statistically significant, owing to small sample sizes for some tests. These results suggest that teeth which form over longer periods of time experience greater growth perturbation.

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Preliminary isotopic analysis of Post-Meroitic to Christian period Nubians from the Ginefab School site, Sudan.

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The Post-Meroitic period (c. A.D. 350-550) in Upper Nubia was an era of political decentralization between the Meroitic empire (c. 350 B.C.-A.D. 350) and the consolidation of Christian kingdoms. In the Fourth Cataract region, this transition coincides with fort construction, the presence of arrowheads in graves, and violent skeletal trauma, which may suggest that non-local individuals migrated into the area. At the Ginefab School site, a large cemetery (n=103) spanning the late Meroitic to Christian periods, variable grave styles may reflect migration of people into this area. Additionally, an increase in dental pathology during the Christian period may represent a dietary shift. To test these hypotheses, we examined paleomobility and paleodiet at the Ginefab School site using radiogenic strontium and stable carbon and oxygen isotope analyses of 11 archaeological humans and 8 modern faunal samples.

At the Ginefab School site, modern faunal samples exhibited mean ⁸⁷Sr/⁸⁶Sr=0.70688±0.00036 (1σ, n=8). For archaeological human remains,

mean $^{87}\text{Sr}/^{86}\text{Sr}=0.70708\pm 0.00025$ (1σ , $n=20$), mean $(^{18}\text{O}_{\text{carbonate}})_{\text{V-PDB}} = -1.5 \pm 1.6$ (1σ , $n=20$), and mean $(^{13}\text{C}_{\text{carbonate}})_{\text{V-PDB}} = -4.6 \pm 1.9$ (1σ , $n=20$). These data suggest that all individuals consumed strontium, oxygen, and carbon from the same or similar sources, implying that there is little variability in paleomobility or paleodiet at the Ginefab School site. Although these data suggest that there were no large-scale migrations during this time, existing isotopic data concerning diet, population interactions, and mobility in ancient Nubia are limited. This study extends isotopic research into a new region, farther upstream, eliciting considerations for future investigation.

This research is based upon fieldwork directed by Baker under licenses granted to Arizona State University by the US Department of Treasury, Office of Foreign Assets Control (Nos. SU-1897 & SU-2122). Field and laboratory support was provided to Baker 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) and by an Undergraduate Research Assistantship awarded to Masoner from the School of Human Evolution and Social Change, Arizona State University. Laboratory support to Knudson was from the Institute for Social Science Research and the School of Human Evolution and Social Change at Arizona State University.

Evolutionary change in hominin orbital morphology since the Upper Paleolithic in Western Europe.

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This study examines morphological change in size, shape, and orientation of the hominin eye orbit through the application of univariate and multivariate statistical procedures. Craniofacial measurements were taken on skulls of individuals representing different regions and time periods in Western Europe, to test a hypothesis of no change in orbital morphology since the Upper Paleolithic. Linear regression, ANOVA, and principle components analysis are used to test the hypothesis, examine patterns of orbital change among temporal groups, and to investigate how the orbit varies in association with other characteristics of the face and cranium.

Results of this analysis indicate that the orbit has undergone a number of anatomical changes during recent human evolution, and particularly in shape of the orbital margins, which have become taller and narrower through time. This trend is associated with increased cranial globularity and decreased facial prognathism, as indicated by a strong negative correlation

between the orbital and cranial indices, and a positive correlation between the orbital and facial projection indices. Reduced orbital breadth is also associated with a relative change in biorbital and interorbital breadth, where despite a marked decrease in the former, the latter remains unchanged. Decreasing orbital depth and anterior projection of both the upper and lower margins show that the orbits have become anteroposteriorly shorter since the Upper Paleolithic. These results indicate that future research should examine the relationship among the orbit, eye, brain, neurocranium, and midfacial anatomy, in the context of functional constraints of the eye and ocular tissue within the orbit.

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Examination of the manual skeletal morphology of knuckle-walking and non-knuckle-walking primates using micro computed tomography (μCT).

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Computed tomography analyses of primate long bones have revealed differences in trabecular architecture and subchondral bone density distributions among species using different modes of locomotion. Thus far studies have focused on the hind limbs of monkeys and the distal radii of monkeys and apes. To better understand the biomechanical effects of knuckle-walking on the manual elements, μCT scans of digit III were taken for knuckle-walking (chimpanzee and gorilla) and non-knuckle-walking quadrupedal primates (rhesus macaques). Previous studies have revealed differences in the external shapes of the proximal and middle phalanges of knuckle walkers with the proximal phalanges having higher degrees of curvature than the middle phalanges. This results from the combined use of suspension (effecting increased proximal phalangeal curvature) and knuckle walking (effecting a "flattening" of the middle phalanges). To determine whether a locomotor "signal" exists within phalanges, the internal structure of the proximal and middle phalanges and the subchondral bone distribution within the metacarpal heads were examined using Avizo 5 3D Visualization software. The palmar surfaces of the proximal phalanges of the knuckle walkers and macaques showed thickening, as did the dorsal surfaces of the middle phalanges of knuckle walkers. Increased subchondral bone density occurs on the dorsal aspects of the metacarpal heads in all taxa. These results show a correlation between hand posture during locomotion and bone density, directly reflecting weight support patterns. Hyperextension at the metacarpo-

phalangeal joints during terrestrial locomotion occurs in all three taxa, increasing bone density on the dorsal aspects of metacarpal heads.

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Leprogenic odontodysplasia: new evidence of a rare and poorly understood malformation from the St. Jørgen's medieval leprosarium cemetery (Odense, Denmark).

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Leprogenic odontodysplasia (LO), also known as *dens leprous*, consists in an anomalous root development of the permanent upper incisors. This malformation was firstly reported by Danielsen in 1970 in Danish non-adult skeletons from medieval leprosaria cemeteries. Hitherto, no clinical cases are known and its etiological and epidemiological significance are poorly understood. The aim of this study is to discuss a case of LO found at the St. Jørgen's leprosarium cemetery (13th-16th/17th centuries), housed at the ADBOU (Anthropological Database of the Odense University), Southern Denmark University. The macroscopic inspection of 191 individuals, with facial bones preserved, revealed a juvenile, aged 13-19 years old, with an upper right central incisor, detached from the corresponding alveolus, presenting a short root with an annular constriction located about 1.5 mm above the neck. The radicular diameter decreased considerably until the apex. Atrophy of the anterior alveolar maxilla process, extending from the central incisors to the canines occurred. This individual also exhibited other rhinomaxillary (eg. absorption of the piriform margins including the anterior nasal spine) and foot changes (such as phalangeal achroosteolysis) compatible with a diagnosis of lepromatous leprosy. This case reinforces the debate about the significance of this rare condition only observed in Danish skeletal series from medieval leprosaria cemeteries. Possible hypothesis to interpret this condition are discussed, including its pathognomonic value and/or whether it indicates an early onset of leprosy in childhood. The understanding of leprogenic odontodysplasia epidemiology and its relationship with leprosy will benefit from clinical and skeletal studies. This study was funded by Fundação para a Ciência e Tecnologia, grant reference: SFRH/BD/16155/2004.

Using phylogenies and social networks to detect the modality of disease transmission in wild primate social groups.

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A number of studies have used phylogenies of disease-causing organisms to investigate the spread of an infectious disease through a population, but few (if any) studies have used phylogenies to infer the transmission mechanism of an infectious disease. Although the transmission modes of many human diseases are known, the mechanisms for transmission in wild primate populations are frequently uncertain. This is particularly true for primate populations experiencing deforestation and the introduction of invasive species. Both of these processes may introduce new infectious diseases that spread in novel ways through primate social groups and populations, often with profound effects on the conservation of threatened species.

We simulated disease phylogenies under to investigate whether network regression techniques provide an effective means to distinguish among several hypothesized transmission mechanisms for a spreading pathogen. We focused on a single social group in which disease can spread through sexual, social, and environmental contact. We demonstrate that network regression can distinguish sexually transmitted diseases (STDs) from non-STDs. Moreover, the approach can distinguish among several alternative networks for non-STDs (e.g. co-drinking at water holes compared to grooming networks). One advantage of network regression is that it requires only basic behavioral data and a disease phylogeny, both of which are obtainable from wild primates. In contrast to many other epidemiological approaches, network regression does not require detailed records of when individuals became infected. The technique is also useful in the context of human behavioral pathologies, which often spread through cultural processes with similarly unknown transmission mechanisms.

This research was supported by Harvard University.

Biomechanical stress: a comparative analysis of sexual dimorphism in prehistoric Tennessee populations.

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Bioarchaeological studies can provide a general idea of sex differences/similarities in subsistence patterns by analyzing sexual dimorphism and labor intensification of a population (Stock and Pfeiffer 2004). Current research suggests that sexual dimorphism has decreased over time due to a shift in subsistence patterns (hunter-gathering to agriculture) that requires both sexes to participate in similar activities. The purpose of this research is to explore sexual dimorphism of the upper limbs in the 14th Century AD Averbuch skeletal collection (female n=62, male n=75),

Mouse Creek (3MN3, 4MN3) and Toqua (4OMR6) a Late Mississippian (900-1450AD) group from West Tennessee (females n=24, males n=12), and Eva (6BN12), Kays Landing (15HY13), and Big Sandy (25HY18), a Archaic (5000-500 BC) sample from East Tennessee (females n=32, males =17). Standard measurements were taken of the humerus, ulna, and radius, as described in Moore-Jansen et al (1994). Size, defined as the geometric mean, and shape variables, the proportions of the geometric mean or size, were computed according to Mosimann and co-workers (Mosimann and James, 1979; Darroch and Misimann 1985). A one-way analysis of variance (ANOVA) was performed on the size and newly transformed shape variables. Results indicate a significant difference in size between samples ($p < .0001$). An index of sexual dimorphism (ISD) was also calculated and supports the hypothesis that sexual dimorphism decreased with a shift to agriculture. This study provides a better understanding of how the shift from hunter-gathering to agriculture production has changed the sexual division of labor in past societies.

Early postnatal infant feeding and weight gain: implications for future metabolic risk.

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Infant feeding behavior may increase future metabolic risk by accelerating growth or increasing adiposity during the early postnatal period. However, comparisons of weight gain for breast-fed and formula-fed infants have yielded conflicting results. The purpose of the study was to test nutritional and demographic factors as predictors of weight gain and body mass index (BMI) in early infancy. Anthropometric, demographic, and feeding data were collected for a cohort of 319 term infants enrolled in the Jackson County Women, Infants, and Children program in Medford, Oregon. Infants were measured at a single enrollment visit that occurred between birth and 3 months of age. Based on feeding records completed by the mother and staff nutritionists, infants were classified as: breast-fed only, mixed-fed (breast-fed and formula-fed), or formula-fed only at the time of the visit. In separate regression models, feeding category, sex, ethnicity, and birth weight were tested as predictors of weight gain since birth and as predictors of BMI at the time of the visit. Higher weight gain was predicted for breast-fed only, male, and lower birth weight infants. Higher BMI was predicted for breast-fed only, male, His-

panic, and higher birth weight infants. Breast-fed infants and Hispanic infants also had higher weight-for-age and weight-for-length z-scores. Although formula feeding has been linked to risk of subsequent obesity, the effect on early post-natal growth may be a less important mechanism than effects on later growth or effects on neuroendocrine function and feeding behavior. This study was supported by a grant from the Northwest Health Foundation.

Hips don't lie: age and mortuary practice based on burned subadult and adult ilia from Bab edh-Dhra', Jordan.

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The color of 244 adult, subadult, and infant ilia from Charnel House A22 at Early Bronze Age (2950-2200 BC) Bab edh-Dhra', Jordan was documented in order to assess degree of burning among the three age groups. Due to the inclusion of all ages in the tomb, it was hypothesized that there would be no difference in burning patterns among the three groups. This project also tested the hypothesis that the bones were defleshed when burned by examining color differences on various portions of the ilia. Two anatomical landmarks (medial and lateral) were identified on infant, subadult and adult ilia. Each landmark was assigned a color category based on the Munsell color chart. L*a*b values were also generated using a spectrophotometer for comparison. Chi-square tests were employed to assess statistical differences. There was no difference in color among age categories on either iliac landmark [medial portion: $p=0.97$ (adult n=87, subadult n=42); lateral portion: $p=0.64$ (adult n=71, subadult n=56)]. There was no difference between medial and lateral portions on either the adults ($p=0.055$) or subadults ($p=0.097$). Finally, a comparison of placement within the charnel house by age revealed no difference ($p=0.070$). It was concluded that children and adults were treated the same with regard to mortuary practices. It was also determined that neither group was cremated, but that the skeletons burned as a result of a fire in the charnel house that most likely occurred after the tomb was no longer in use.

This project was funded by the National Science Foundation's Research Experiences for Undergraduates (SES 1005158).

Paleopathological analysis of the Early Middle Age in Northern Italy: a first preliminary survey.

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The present research project aims at illustrating the joint goal of the University of Milano and Padova's anthropological working groups, i.e. to develop a preliminary paleopathological perspective of the early Middle Age in northern Italy, which is particularly interesting since it is a transition period where new foreign populations arrive.

As regards Lombardy, eight necropolises (Campione d'Italia, Erba S. Eufemia, Garlate, Villa d'Adda, Bolgare, Cremona Piazza Marconi, Montichiari, Brescia Piazza Labus, Sirmione S. Pietro in Mavinas) ranging from the VI to the IX century, encompassing circa 680 individuals with three belonging to the Langobard group, were studied.

Traditional demographic methods were applied for aging and sexing. Palaeopathological analyses were performed by morphological methods and in some cases with radiological, histological, biomolecular and 3D imaging techniques. These populations show in decreasing order the presence of osteoarthritis typical of rural economy, stress markers, trauma (mainly healed fractures), infectious diseases (mainly tuberculosis), anaemia and arthritic diseases of both a degenerative and possibly rheumatic origin, DISH, gout, scurvy, 1 case of trepanation, of spina bifida and of Eagle's syndrome, – a picture which is quite different from the Roman one in the same regions and which may indicate the degradation of living and working conditions.

These results may contribute to a better understanding of a period in northern Italy for which very little is known from historical sources.

Infant mortality and seasonality in wild Sanje mangabeys, *Cercocebus sanjei*.

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Infant mortality is a fundamental factor influencing population growth, thereby directly impacting the population viability of primate species. These critically important infant mortality data are examined for one of the world's most threatened primates, the Endangered Sanje mangabey, *Cercocebus sanjei*, endemic to the Udzungwa Mountains, Tanzania. Demographic and phenologi-

cal data collected over 23 continuous months (September 2008 – July 2010) are presented and specifically analyzed to assess infant mortality in relation to the ecological variables of monthly fruit availability, rainfall and temperature, factors which have been proposed to influence infant survival. Censuses conducted during group follows (X=18.1 days/month) recorded 24 live births during the study period. Infant mortality within the first year of life was 47.6%, one of the highest rates recorded for a cercopithecine. Infant deaths occurred throughout the year, but were not evenly distributed, with the highest peak in June. This clustering correlated with onset of the dry season, the period of lowest fruit production and decreased average daily temperature. Tick-borne disease, prevalent in the Udzungwa region, is also examined as a potential contributing factor, as both infants and adults exhibited a visible increase in tick infestation during this time. These results are of significant concern given the conservation status of this rare and understudied species, as it may signal the potential for a population decline.

This study was funded by the National Science Foundation Doctoral Dissertation Improvement Grant (D.F. & G.M.M.; award numbers 0925901 and 0925690), The Leakey Foundation (D.F. & G.M.M.), Primate Conservation, Inc. (G.M.M.; C.L.E.), Margot Marsh Biodiversity Foundation (D.F.; C.L.E.), Conservation International Primate Action Fund (G.M.M.), Idea Wild (D.F. & G.M.M.), the University of Texas at San Antonio International Education Fund and Department of Anthropology Doctoral Research Grant (G.M.M.) and Stony Brook University Dean's Fellowship for Professional Development (D.F.); Wildlife Conservation Society (C.L.E.); and the Critical Ecosystem Partnership Fund (C.L.E.).

A comparison of histomorphometric data collection methods.

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Skeletal histomorphometry is an important tool for physical anthropologists and can be used to estimate age and to examine pathological conditions, activity levels and overall health and nutrition. In physical anthropology, measurements most often analyze cortical bone because of its durable nature. Although the variables skeletal biologists examine have been standardized, the actual techniques used to accrue these data from a thin section may vary. The purpose of this research was to examine the accuracy of newer technological tools used to measure variables in comparison to the standard eyepiece counting reticule to determine whether there

was a significant variance in results from each method. Total area (Tt.Ar.) and cortical area (Ct.Ar.) were measured and used to obtain a measurement of relative cortical area (Tt.Ar/Ct.Ar.). Three researchers with varying levels of experience with histomorphometry compared four methods of obtaining these variables; one of them being the use of a Merz[®] counting reticule and three others using the commonly used software, ImageJ[®], to measure cortical and total area but obtaining the thin section images in three different manners: 1) using a flatbed scanner, 2) overlaying multiple images of a thin section using Photoshop[®] and 3) using a digital SLR camera with macro settings. Statistical analyses using ANOVA indicate no significant differences amongst observers and the four methods examined. The benefits and drawbacks of each method are discussed as well as precautions one should take while conducting histomorphometric data collection.

Modeling the ecological niche of the Angolan Black and White Colobus monkey, *Colobus angolensis palliatus*.

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Ecological niche models can aid in understanding the relationship between environmental factors and an animal's geographic distribution. In this study, ArcGIS 9 and Maxent were used to predict the distribution of *Colobus angolensis palliatus*, a subspecies of Angolan Black and White Colobus monkey that resides in fragmented forests throughout East Africa. In particular, this study was undertaken (1) to discover the predicted distribution of *C. a. palliatus* in Kenya and Tanzania under two different taxonomic scenarios, (2) to ascertain the probability of their occurrence in these areas, (3) to see how these results compare to the IUCN habitat map, and (4) to recognize which environmental variables best explain their geographical distribution. Results of this study suggest that while the predicted distribution differs under the two taxonomic scenarios, precipitation and temperature variability measures seemed to be important in determining *C. a. palliatus* distribution. These results were similar to the IUCN habitat map; however, compared to the IUCN habitat map, these results both over-predicted and under-predicted their distribution. This study highlights current environmental differences in *C. a. palliatus* habitat in Kenya versus Tanzania. It also uncovers probable areas in which to find these monkeys, which is invaluable when undertaking additional behavioral or genetic research. Finally, these results serve as a starting point from which to uncover past *C. a. palliatus*

distributions or make future climate change predictions.

Skeletal pathology in mountain gorillas (*Gorilla beringei beringei*) from Parc National des Volcans, Rwanda.

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Analyses of pathology from the skeletal remains of wild primates can provide unique and valuable insight into morbidity and mortality, and complement health information gleaned from veterinary monitoring of populations. Here we report results from an investigation of skeletal pathology in a well-documented sample of mountain gorillas recently recovered from Rwanda [N=23 adults (19 crania, 22 post-crania), 20 infants/juveniles (20 crania, 19 post-crania)]. Gross observations of pre-mortem skeletal lesions were classified into four possible categories following Carter et al. (2008) and Lovell (1990): arthropathies, traumatic injuries (including healed fractures, amputations), abnormal bone formation and/or resorption, and developmental abnormalities.

Among adults examined here, most individuals showed some evidence of mild pitting or proliferative change at joint surfaces or margins, particularly in the axial skeleton. Moderate to severe arthropathies, apparently unrelated to trauma, were observed in 57% of adults. Probable pre-mortem trauma affected 52% of adults; six of these individuals exhibited amputations of distal limb elements. Rare developmental abnormalities and other pathologies observed among adults include accessory costal facets, thoracic scoliosis, and complete ankylosis of vertebral spinous processes. Thirty percent of infant/juveniles examined showed evidence of skeletal pathology; healed fractures were the most common, affecting 4 individuals, while one individual also showed multiple inflammatory lesions. Given availability of associated long-term veterinary and behavioral records, these results have potential to generate important insight into the impact of health on mountain gorilla life history, and form a basis for comparisons with data reported

previously from this population and other long-term great ape study sites.

This project has received funding support from the National Geographic's Committee for Research and Exploration, Leakey Foundation, and National Science Foundation (BCS 0852866, BCS 0964944).

Exploratory studies of doubly-labeled water (DLW) and accelerometry in American Samoan children.

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Sedentary life likely contributes to decreased energy expenditure (EE), positive energy balance and adiposity in Samoan children. Measuring physical activity (PA) levels among youth is crucial for supporting this hypothesis and designing effective interventions. In 2009 we conducted a pilot study using doubly-labeled water (DLW) and accelerometry to measure PA and total EE over a 6-day period among 37 American Samoan children, (17 boys and 20 girls, ages 8-12). We collected a baseline urine sample prior to DLW ingestion, followed by three urine samples on that day and two samples on the 6th day, and children were instructed to wear Actical[®] activity monitors (AC), except when in water and, if necessary, asleep. Participants wore the AC >8 hours an average of 3.8 days; 26 (70.3%) met the 3-day quality control (QC) requirement. Girls wore the AC longer than boys (4.5 vs. 3.0 days; $p=0.02$), as did older children, >10 years (4.2 days vs. 3.4 days; $p=0.18$). Twenty-five (69.4%) of the urine samples passed QC; more boys than girls had acceptable DLW data (82.4% vs. 55.0%; $p=0.08$). Fieldworkers reported trouble producing urine specimens and some adding of water. Seventeen children had acceptable AC and DLW data, providing reasonable associations; r ranged from 0.48 to 0.79 for several EE metrics. However, their estimates are not interchangeable, and future studies require both accelerometry and DLW to provide more nuanced and accurate representations of PA and EE. Qualitative studies indicated more training of children and parents will be necessary for future planned work. Financial support from the NIH Brown University Framework in Global Health award, TW R25-TW008102 (STM) and Loyola University seed grant funds (AL).

Analyses of sex-ratios among residents of the Khumbu region of Nepal support the Trivers-Willard hypothesis.

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The Trivers-Willard hypothesis predicts a sex ratio bias contingent on maternal condition in species characterized by variation in male reproductive success. A male-biased sex ratio among mothers in good condition, and a female-biased sex ratio among mothers in poor condition is expected. Studies in humans have thus far provided mixed answers to the question of whether or not sex ratio is affected by maternal condition. The present study assessed whether or not the introduction of a western cash economy influenced the observed secondary sex ratio in Nepal's Khumbu region. Because acculturated villages provided better access to the cash economy and to health facilities, residence in an acculturated village was used as a proxy for "good" maternal condition. We analyzed demographic data gathered by survey in 1971 and 1982. The sample included 734 children from the 1971 survey and 1598 children from the 1982 survey. Using Poisson regression we analyzed the extent to which the sex ratios in age-stratified groups differed between the acculturated and unacculturated villages. We reasoned that older women were subjected to minimal acculturation effects during their child-bearing years. In both the 1971 and 1982 datasets the younger women in the acculturated villages displayed significantly higher ($p=.014$, $p=.016$) proportions of male offspring. We found a lack of significant deviation between acculturated and unacculturated post-menopausal women which underscores the impact that the transition to a market economy had on women in Nepal's Khumbu region.

Intra- and interspecific variation in Middle Eocene mytoniins with a further assessment of the validity of the genus *Mytonius*.

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Our ability to understand the paleobiology and biogeography of Uintan primates has been constrained in the past by taxonomic problems and an inability to understand both intra- and interspecific variation in a context similar to studies of recent primates. The goal of this study is to better understand these factors in a problematic group of Middle Eocene primates. The status of the genus *Mytonius* and its relationship to or

synonymy with the genus *Ourayia* is a case in question. Over 130 published and unpublished dental specimens from northeast Utah, southern California and the trans Pecos and Laredo regions of Texas were analyzed qualitatively and quantitatively to examine this question. The results strongly support the validity of *Mytonius* as a distinct genus. While certainly similar to *Ourayia* in many respects, it consistently differs from the latter in numerous traits. Many of these relate to a different P₄ morphology (a major basis for its original diagnosis) and a consistent de-emphasis of cusp development and their incorporation into shearing crests in the upper and lower molars. The differences almost certainly indicate distinct feeding adaptations. A "large" and a very small species are now known. *Ourayia*, however, retains a more primitive P₄ morphology and greater cusp development in the molars. Metric and morphological evidence support the interpretation that, in addition to the type species *O. uintensis*, at least two additional species, one larger and one smaller are present in southern California. There is no evidence that *Mytonius* is present in southern California.

This study was funded by the Undergraduate Research and Creative Activities Program at the College of Charleston.

Seasonality in the diet of sooty mangabeys (*Cercocebus atys*) from Tai Forest, Ivory Coast.

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Seasonal fluctuations in resources influence primate ranging, group size, activity budgets, and dietary breadth. Reliance on spatio-temporally heterogeneous foods such as ripe fruit or young leaves may involve dramatic proximate responses; however, even primates utilizing more ubiquitous resources can exhibit significant seasonal variation in feeding. Terrestrial mangabeys consume large quantities of hard seeds and nuts collected from the forest floor. Owing to their ability to resist decomposition, some of these foods are available for periods beyond seasonally-restricted fruiting. We hypothesize that consumers of these items will exhibit more limited seasonality in feeding patterns. To test this, we studied adult female sooty mangabeys (*Cercocebus atys*) in the Ivory Coast's Tai forest from July 2008 to August 2009 and generated monthly diet profiles based on five minute focal samples. Diets were compared to phenological data on food trees collected bi-monthly from 2005–2010.

Results indicate that of the foods comprising the sooty mangabey diet, only three by themselves comprised more than 3% of annual feeding actions. Nearly 80% of the annual diet was comprised of five foods and of these, three – invertebrates, fungi, and *Sacoglottis gabonensis* nuts – were consumed every month. Monthly consumption of *Sacoglottis* ranged between 19% (December) and 79% (May) and was uncorrelated with production of ripe fruits. Thus, the most frequently consumed sooty mangabey foods are available year-round, yet their monthly consumption varies significantly. We conclude that consumption of top ranked foods by Tai mangabeys is not driven primarily by seasonal availability.

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Variation in age at introduction of weaning foods in small-scale farming and herding populations is inversely associated with indicators of pathogen risk.

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Infant's age at introduction of weaning foods varies substantially among human populations. Since weaning affects maternal and infant energetics as well as interbirth interval, this variation has implications for life history, demography, and public health. However, the underlying causes of the variation are not well understood. One hypothesis is that mothers increase their fitness by increasing infant age at introduction of weaning foods in response to pathogen risk until a point of diminishing returns is reached, after which they decrease.

We tested the pathogen risk hypothesis with ethnohistoric data from 57 natural fertility, small-scale farming and herding populations. Age at introduction of weaning foods was regressed on an index of pathogen risk. We also carried out a partial Mantel matrix test in which we correlated age at introduction of weaning foods with pathogen risk while controlling for genetic distance, to account for the potentially confounding effects of phylogenetic autocorrelation. Contrary to expectation, the relationship between age at weaning food introduction and pathogen risk was linear and negative rather than quadratic. One explanation for why our analyses did not support the hypothesis is that a maternal response to increasing disease risk is to redirect energy from breastfeeding to the conception of additional offspring. Others are that increasing

disease risk may drive mothers to invest in their own immunological responses at the expense of their infants, or that earlier cessation of exclusive breastfeeding results in higher rates of pathogen transmission. Suggestions for future analyses that can distinguish among these possibilities are made.

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A call for the creation of a generalized anthropogenic disturbance scale for primate field research.

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Field primatologists often work in environments that have sustained moderate to severe anthropogenic alteration. It is important for researchers to disclose the levels of environmental modification in order to allow for appropriate cross-site comparisons of behavioral or ecological data. Recognizing that human-commensal primates differ from more remote populations does not negate their utility as study populations. Rather, the study of commensal-living primates has much to offer in terms of identifying minimal requirements for a species' survival and for understanding behavioral and ecological plasticity.

To encourage greater transparency in field data collection, I propose the development of a simple, generalized anthropogenic disturbance scale. This preliminary scale was adapted from the ordinal classification presented by Bishop and colleagues (1981), with the addition of a category for diet and an expansion of options under each heading. Following this standard, disturbance levels of each primate troop may be identified in the literature by a four-character code. Each character represents, in turn, habitat modification, dietary modification, human-primate interactions, and predation risk. The options provided under each category allow for thousands of possible combinations, yielding a simple but detailed description of a study population's environment. It is my hope that this scale will allow for identification of inter- and intra-specific variation, better criteria for identifying pathological behaviors associated with disturbance, and a clearer understanding of the consequences of environmental degradation on wildlife. In addition, the scale may prove useful as a measure of anthropogenic change over a single troop's history.

The research that generated this idea was funded by Earthwatch Institute and Conservation International.

The size and shape of life history in the hominin fossil record.

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Deciphering the relationships among of growth, development, and life history is difficult in extant taxa, and nearly impossible for fossil species. While dental histology has provided a crucial temporal framework in which juvenile fossils can be placed, the nature size-shape relationships within these life histories is still not well understood. Here I provide a simple approach to analyzing size and shape in the cranial ontogeny of extant hominines and the fossil hominin *Australopithecus africanus*. Using exemplar specimens to represent the terminal growth form in each species, specimens were related to their exemplar by the Procrustes distance between their 3D landmark configurations. This provided a measure of how much shape change might still be expected in the growth of each juvenile. Size was measured as centroid size of each configuration, and compared to the exemplar in a similar fashion. Bivariate plots of the resulting metrics offer a simple illustration of how size and shape are related during ontogeny.

Results of this research suggest that *A. africanus* has a size-shape relationship very similar to that of modern humans. Interestingly, gorillas also share this relationship between size and shape during post-M1 ontogeny, whereas the two species of *Pan* share a different pattern. These results run counter to what might be expected from the timing of dental development. Moreover, they suggest that the ontogenetic allometry in the human lineage might be primitive among hominines, with *Pan* exhibiting a derived condition.

Dental microstructural confirmation of dietary differentiation in extinct lemurs.

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Traditional semi-destructive methods of evaluating Relative Enamel Thickness have contributed significantly to knowledge of extinct primate diets. Technological advances now allow researchers to compile robust 3D datasets utilizing nondestructive microCT scanning. To date, however, few strepsirrhines have been included in such analyses. Here we present results of our microCT study of the internal structure of molars of one extant (*Propithecus verreauxi*) and two extinct (*Archaeolemur* sp. cf. *A. edwardsi* and *Megaladapis edwardsi*) lemurs. The degree to which the latter two overlapped in diet has been the subject of recent debate. Data collected included enamel volume, dentine vol-

ume, surface area of the EDJ, average enamel thickness and relative enamel thickness. Using a combination of Discriminant Function Analysis (to discriminate extant hard-object processors from other species) and Principal Components Analysis, we compared our data to published data from 17 anthropoid species (175 individuals). The DFA yielded a highly significant function with post-hoc classification success of 93.8%. The scores of *Archaeolemur* and *Megaladapis* were very different; *Propithecus* had intermediate values. Of these, only *Archaeolemur* was classified as a hard-object processor. For the PCA, two factors captured 96.1% of the variance; the first (68.9%) correlated strongly with tooth size and the second (27.1%) with hard object processing. Factor 2 scores again separated *Archaeolemur* from *Megaladapis* at opposite extremes; *Archaeolemur* clustered with *Cebus*, *Cercocebus*, *Paranthropus*, and *Homo*, while *Megaladapis* clustered with *Gorilla* and *Gigantopithecus*. We conclude that the dietary overlap between *Archaeolemur* and *Megaladapis* was likely minimal, and that *Archaeolemur* was a capable hard-object processor.

This study was funded by the UMass Natural History Collections David J. Klingener Endowment fund.

Footprint evidence of the Chinese Yeren.

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The '70s saw a keen interest by the Chinese government in the "snowman question." A state-sponsored expedition was mounted to central China (Hubei Province) to investigate the possible presence of a correspondingly large bipedal hominid, referred to as the Yeren, or wild man. A team lead by Professor Zhou Gouxing gathered eyewitness accounts, hair samples, and ambiguous footprints, but no specimen of Yeren was retrieved. In 2008 the author met with Professor Zhou at the Beijing Museum of Natural and proceeded to Hubei's Shennongjia National Nature Reserve to interview a park ranger, Mr. Yuan, who claimed to have observed a Yeren in the reserve, at a distance of approximately 250 m. The site was at an elevation of approximately 2100 m in a mosaic of forest and sedge meadows. The Yeren, covered in reddish brown hair, was sunning itself. When Yuan called out, it rose and walked away bipedally. Yuan cast a clear pair of its footprints, which measured approximately 38 cm in length, 16.5 cm across the forefoot, and 10 cm across the heel. The footprints indicated a plantigrade, pentadactyl foot lacking evidence of claws. The hallux was larger than the lateral toes and non-divergent. A mid-tarsal pressure ridge indicated a significant degree of flexibility in the midfoot.

In all distinguishing characteristics the casts resembled the ichnotaxon *Anthropoidipes ameriborealis* MELDRUM 2007. This evidence suggests independent corroboration of the existence of an unrecognized bipedal primate species with a circum-Pacific distribution.

Social influence on sex-typical behavioral development in wild *Lemur catta*.

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In primates, species-typical, sexually differentiated behavioral development emerges from a complex system of interactions among intrinsic and extrinsic factors over the course of a protracted developmental period. One important component of this system is the interaction between an individual and its social environment. While it is known that outcomes of this interaction will be influenced by other system components, the relationship between socialization and behavioral sex differentiation has rarely been investigated in natural settings. Here, I present analyses of behavioral data collected from wild *Lemur catta* infants (aged 0-11 months, n=29), juveniles (12-23 months, n=8), and adults (≥ 48 months, n=13) during focal animal follows over twelve months at Beza Mahafaly Special Reserve, Madagascar. A suite of behavioral sex differences developed well before sexual maturation—a pattern not previously documented. As in adults, juvenile females both directed toward others and received significantly higher rates of aggression, and spent more time grooming new infants than their male peers. During this time, juvenile males spent significantly more time in close proximity to adult males while juvenile females spent significantly more time in close proximity to their mothers and non-maternal adult females, suggesting that behavioral sex differentiation may be facilitated by sex-specific social association in this species. This research identifies potential social foundations of sex-typed behavioral development in *Lemur catta* that can be further investigated in future work, and contributes to a nascent, comparative database of sexually differentiated behavioral development needed for understanding the evolution of primate and, ultimately, human sex-typed behavior.

This study was funded by The L.S.B Leakey Foundation, a Sigma-Xi Grant-in-Aid-of Research and the Graduate and Professional Student Association and SHESC at Arizona State University.

Testing the accuracy of new and underappreciated adult age estimation methods.

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Estimating adult skeletal age-at-death is an important step in reconstructing

life history and demographic profiles. New and revised age estimation methods are often published in the literature, but their use in forensic or bioarchaeological contexts is rarely reported. This preliminary study applied nine age estimation methods to 20 male skeletons (mean age 54.5 yrs, range 29-85) from the JCB Grant Collection at the University of Toronto. The commonly used Suchey-Brooks and Todd pubic symphysis methods, the Lovejoy et al. and Buckberry and Chamberlain auricular surface methods, and the Işcan et al. fourth rib method were compared with the newer or less established Rouge-Maillart et al. acetabulum method, the Passalacqua sacrum method, and the Kunos and DiGangi et al. first rib methods.

The most accurate age estimation method was Buckberry and Chamberlains', followed by Rouge-Maillart et al., Passalacqua, and Kunos' methods. Suchey-Brooks, Todd, and Lovejoy et al.'s methods performed admirably, while Işcan et al.'s had the worst accuracy rating. Most age estimations fell within their 95% confidence interval range. Based on this small sample of older males, most of the newer methods had a higher accuracy rating than the more commonly used methods. Newer methods tend to be developed using a higher proportion of older individuals, allowing them to better categorize persons over 50 years rather than lump them into a "50+/60+" category. Their higher categorical mean ages reflect this change. Despite the improvements, newer methods tend to follow the pattern of over-aging younger individuals and under-aging older individuals.

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Regourdou 1: a new neandertalian pelvis, preliminary study and perspectives of functional interpretation.

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Recently, two reconstitutions of a neandertalian pelvis and associated functional implication have been published with contrary results. Studies with new data are necessary to further investigate the question. Two years ago, new fragments of pelvis were discovered in the collections, from the Regourdou site (Montignac, France), of the Musée National de Préhistoire (Les Eyzies-de-Tayac, France).

The newly discovered fragments are associated with the young adult Regourdou 1 whose remains also include an

almost complete sacrum (still unpublished). Our study proposes an exhaustive morphological description of these bones associated with measurements and a comparison of visual and linear traits. Our comparison material is composed of neandertalian pelvis (Tabun C1, Kebara 2, Feldhofer 1, Krapina 207 and 209, La Ferrassie 1) and a large sample of French modern pelvis.

According to preliminary results, the ilium and ischium fragments, well preserved, match the sacrum of Regourdou 1 and form a relatively complete pelvis, allowing us to study morpho-functional implications. Our analysis shows that the morphology of the Regourdou 1 pelvis is typical of late Neandertals while our metric data point out that it is in neandertalian variability. Regourdou 1 presents characteristics which have already been described in Kebara 2 or Feldhofer 1 (e.g. the obliquity of the antero-inferior iliac spine and the thinness of the cotylo-sciatic breadth). The discovery of a new almost complete pelvis from Regourdou 1 opens up new prospects for the study of the morphology of Neandertals' birth canal and its obstetrical implications.

A quantitative analysis of residual rickets prevalence in early modern London.

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Rickets is the result of prolonged vitamin D deficiency in sub-adults caused either by a lack of sun exposure or poor nutrition. It was first recorded as a significant problem in London during the mid-17th century, where contemporary medical practitioners described it as epidemic. Analysis of the cultural and environmental changes during this period supports the recorded decrease in vitamin D synthesis. However, this epidemic is not substantiated by skeletal material from London during this era especially in adult material where residual markers were lower than expected. The study of residual rickets has historically relied upon visual methods of diagnosis as exemplified by Brickley, Mays and Ives (2010). Diagnosis is primarily made by the presence of bending deformities in the long bones, however this attribute is only found in the more extreme cases. A new method for quantitative diagnosis of residual rickets based on the presence of flaring in the distal epiphyses of the radii and femorae is proposed. Material was taken from four early modern archaeological sites from the Museum of London, and flaring as an indicator of residual rickets was assessed based on a number of measurements. This study shows that there is potential for this new method to identify more cases of rickets when diaphyseal bending is not severe enough

to warrant diagnosis alone. The addition of new tools for measuring prevalence of vitamin D deficiencies can benefit historical analysis, as this disease is a direct reflection on the cultural and environmental context of the period. This study was funded by the School of Classics, Humanities, and Archaeology at the University of Edinburgh.

Whole-stride substrate reaction forces in brachiating siamangs.

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Although brachiation in Hylobatids (gibbons and siamangs) has been studied multiple times, until now, whole stride kinetics from brachiation are lacking in the literature. Reaction forces of one handhold have been determined and modeled during steady brachiation, assuming all hand contacts were similar. However, during brachiation in a natural environment, locomotion is often unsteady; hence each hand contact may induce different kinetics. The aim of this study is to understand how hylobatids cope with the complexity of their environment by using an, at first glance, simple pendular mechanism.

We collected more than 200 substrate reaction force measurements of one to three consecutive handholds, on three different setups, from three siamangs. The combined use of three 3D force transducers and four cameras allows for a total body kinematic and kinetic analysis. Vertical peak forces showed more variation than expected and varied between one to four times bodyweight. Data were gathered for both continuous contact and ricochet brachiation, but interestingly, a lot of strides had a duty factor very close to 0.5.

During a pendular movement it is expected that the body first accelerates and then decelerates after mid-support. Remarkably the fore-after forces often showed an opposite pattern in two consecutive handholds. This means that, although energy recoveries remain substantial (over 50%), siamangs do not always fully use the gravitational induced acceleration and deceleration cycle during brachiation.

This study was funded by the National Fund for Scientific Research (Belgium) and by the Flemish Government (through the CRC).

Ontogenetic changes in prehensile tail use by lowland woolly monkeys (*Lagothrix poeppigii*) in Yasuní National Park, Ecuador.

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Although the locomotor and positional behaviors of adult lowland woolly monkeys are well documented, little attention has been paid to the use of locomotor behaviors by immature members of this species. We investigated locomotor profiles of juvenile and subadult *Lagothrix poeppigii* in Yasuní National Park, Ecuador to explore how individuals of these age categories navigate their environment and differ in their locomotor behaviors. Of particular interest for woolly monkeys are developmental changes in use of the prehensile tail, a conspicuous apomorphic feature of atelines. To document the postural and locomotor repertoire of juveniles and subadults, we collected focal video samples during June and July 2008 using a Sony Handycam HD digital camcorder. Locomotor behavior (general activity, locomotor/positional mode, tail usage, substrate size, tree zone) was scored, post-hoc, from the videos using point samples in 5-s intervals, with over 5,000 point samples scored.

Use of the prehensile tail for support begins early, as clinging infants wrap their tails around their mother's tail/limbs, and increases throughout ontogeny as individuals begin to travel independently. In particular, adults use the prehensile tail to support body weight during foraging more than subadults and juveniles, suggesting an increasing reliance on the weight-distributing benefits of the tail with increasing body size or increasing efficiency of its use. Tail use during locomotor travel was much lower among all age classes and did not follow an ontogenetic trajectory. Additional research is needed to elucidate the locomotor behavioral strategies of juvenile versus adult *Lagothrix* individuals.

You can't tell a book by its cover: the effects of age, sex and physical activity on enthesal changes in an Italian contemporary skeletal collection.

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Entheses and their pathological modifications (enthesopathies) are widely used to infer biomechanical stress differences and to reconstruct specific activities in past human populations. However, the multifactorial etiology of these features makes it necessary to critically review their reliability as skeletal markers of activity.

In this study, we investigate the role of age, sex and life-style on enthesal development and modifications.

For this purpose, 484 skeletons representing individuals with known age at death, sex, and profession were analyzed with regard to enthesal modifications. All the skeletons come from the Frassetto collection of Sassari, (Italy, early 20th century). 23 postcranial entheses were studied regarding the development of enthesal robusticity (surface rugosity) and proliferative as well as erosive enthesopathies. The scoring method proposed by Mariotti et al. (2004, 2007) was used for the data collection.

Results indicate age as the main factor influencing enthesal modifications. Sex-related patterns are also evident. However, physical activity only plays a minor role in the expression of the observed features, and it appears that robusticity lateralization and modifications of specific attachment sites are more informative about life-style. Overall, our results indicate that caution is warranted when using skeletal markers as indicators of biomechanical effects in bio-cultural reconstructions.

The impact of habitat quality on reproduction in female red colobus monkeys (*Procolobus rufomitratus*) in Kibale National Park, Uganda.

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Female mammalian reproduction requires sufficient nutrition to support the high metabolic and physiological costs associated with conception, pregnancy, and lactation. Using the endangered red colobus monkey (*Procolobus rufomitratus*) as a model, we investigate the relationship between habitat quality and female reproduction. By comparing groups living in previously logged areas of the forest with groups living in unlogged areas of Kibale National Park, Uganda, our three main objectives were to determine: 1) the relationship between previous logging activity and current habitat quality, 2) the impact of habitat quality on female reproductive hormone concentrations, and 3) the impact of habitat quality on female reproductive success.

Focal follows of 40 females in 6 groups of red colobus (3 in the logged areas and 3 in the unlogged areas) resulted in approximately 7000 hours of observation time. Global Positioning System, Geographic Information System, and Remote Sensing technologies were used to create maps of the ground cover in each group's home range. Urine and fecal samples were collected and analyzed using radioimmunoassays to

determine reproductive hormone concentrations. Hormone analyses indicated that reproductive function of females living in disturbed areas is significantly diminished compared to those living in unlogged areas. Additionally, while females in both the logged and unlogged areas produced offspring, infants in the logged areas experienced higher mortality. This study demonstrates the physiological connections between habitat quality and female reproduction. Determining how ecological factors impact hormones is crucial for understanding how environmental changes may have impacted females, with implications for human evolution. This study was funded by NSF-DDIG, LSB Leakey Foundation, Primate Conservation Inc, The Explorers Club, The Sophie Danforth Conservation Fund, Primate Action Fund, Idea Wild, and the University of Illinois Graduate College.

Dietary and anthropometric assessment of nutritional status among agriculturalists of Ngilo-Ilo, East Java.

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Since the description of the Flores hominid remains in 2004, there has been increased interest in the nutritional ecology and origins of small body size among indigenous populations of Indonesia. Previous research on dietary consumption and energy expenditure among rural Javanese populations has found high activity levels and marginal energy intakes (eg., Edmundson 1977, 1979). To further explore aspects of energy balance and nutritional health in this region, we collected anthropometric, dietary, and activity data on 84 men and 113 women (18-80 years) from the agricultural village of Ngilo-Ilo in East Java.

Agriculturists of Ngilo-Ilo are short and light. Mean (\pm SE) stature and body weights are 159.9 \pm 0.9 cm and 51.8 \pm 1.0 kg, respectively, for men, and 147.7 \pm 0.6 cm and 45.8 \pm 1.1 kg for women. Body mass indexes (BMI) average 20.3 \pm 0.3 kg/m² for men and 20.5 \pm 0.3 kg/m² for women, with 27% of the sample being underweight (BMI < 18.5 kg/m²). Dietary energy intakes are significantly lower than daily expenditure levels (1157 \pm 51 vs. 2303 \pm 49 kcal/day in men; 887 \pm 36 vs. 1914 \pm 35 kcal/day in women; P < 0.001), in part reflecting the fact that measurements were taken during the "fasting month following a religious practice". Protein intakes are also significantly lower than WHO recommendations (31.9 \pm 1.8 vs. 41.4 \pm 0.8 g/

day in men and 24.0 ± 1.0 vs. 36.6 ± 0.9 g/day in women; $P < 0.001$).

These findings indicate that seasonal nutritional stress remains a persistent problem for agricultural populations of Indonesia. Future work will explore the health consequences of and possible adaptations to such nutritional constraints.

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Primate tail function: balancing the variables.

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The function of primate tails in locomotion is poorly understood. While the role of prehensile tails is increasingly well studied, there are few empirical studies of tail use in balance, and little mention of the tail's potential importance in changing whole body center of mass (COM) in the vertical and fore-aft planes. We hypothesize that tail movements will fluctuate with the body's COM in walking, but at higher speeds and on arboreal substrates tail movement will increase to play a greater role in balance. The angle and height of the proximal and distal tail are measured relative to the tail base during quadrupedal locomotion for a range of arboreal and terrestrial primates ($n=9$ species) on flat ground or a raised horizontal pole. Irrespective of phylogeny, anatomy, and preferred locomotor substrate, we find that primate tails are placed in position at the initiation of a locomotor bout and remain relatively fixed in the vertical and fore-aft planes. Variability increases in some primates at higher speeds and when pole size is very small. Movements in the tail base (and hence body) have little effect on overall tail position, implying that active mechanisms may isolate tail movements from those of the body. We find that it may be possible to separate the components of tail movement related to body movements and complex social behaviors from those involved in active control of locomotion, and provide new insight into tail function and anatomy in non-prehensile species.

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Increased expression of carbonic anhydrase 2 in frontal cortex in human evolution.

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Human cognitive specializations are a central focus of physical anthropology, and elucidating changes in gene and protein expression among extant primates is crucial to understanding how the human brain has evolved. Comparative genomic studies suggest that humans evolved patterns of gene expression to support high levels of synaptic activity and plasticity. However, these studies focus mainly on gray matter (GM), and recent neuroimaging studies suggest that functional changes in GM are accompanied by reorganization of myelin sheaths in the underlying white matter (WM). In this study, we report that carbonic anhydrase 2 (CA2), an enzyme involved in the generation and compaction of myelin, is strongly upregulated at RNA and protein levels, presumably in response to increased metabolic demands during hominin evolution.

Microarrays indicate increased CA2 mRNA expression in adult human GM compared to chimpanzees and macaques, and is confirmed by polymerase chain reaction (PCR) analysis. Western blotting of human frontal cortex indicates that increased message is accompanied by increased levels of CA protein, and also indicates that CA2 is more abundant in human WM compared to GM. Immunohistochemistry confirms these results and also indicates that CA2 is strongly expressed in oligodendrocytes, both in GM and WM. The strong expression of CA2 in adult human WM agrees with previous studies demonstrating that myelination is a process that continues well into adulthood, and the higher levels of expression in humans compared to chimpanzees and macaques is consistent with an increase in human neuronal and synaptic activity.

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The reproductive ecology of breastmilk immunity in Ariaal women of northern Kenya.

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Women invest significant energy in lactation in order to provide their infants with nutritional and immunological support during the first few months of life. Several lines of evidence suggest that the generation of immune components in breastmilk is energetically

costly, making passive immune transfer a maternal resource subject to life history trade-offs. Life history theory generates hypotheses and predictions governing trade-offs between reproduction and the production of passive immunity, with women seeking to maximize fitness by adjusting energetic investment between offspring and somatic maintenance. This study examines three predictions derived from life history theory: 1) breastmilk immunity will decline over the lactation period, demonstrating reinvestment in somatic maintenance; 2) breastmilk immune production will decline with increasing parity; and 3) breastmilk immunity will be associated with maternal energy stores. These predictions were tested in lactating Ariaal women, a natural fertility population from northern Kenya. Two hundred and forty five lactating Ariaal women participated in anthropometric measurement and breastmilk collection. Breastmilk was assayed for immunoglobulin A (IgA), the most abundant immune component in breastmilk. There was a polynomial relationship between breastmilk IgA with and months postpartum, with IgA levels initially declining then rebounding during later lactation. Extremely parous women had a significant drop in breastmilk IgA, indicating a cumulative cost of IgA production over the reproductive span. However, there was no evidence of an association between IgA and maternal body composition. The talk will conclude by discussing challenges and future directions in the study of female reproductive ecology and immunity.

This study was supported by NSF Grant Number BCS-0750779 and a Leakey Foundation General Research Grant.

Putting pieces together again: statistical formula for os coxa and sacrum.

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Ancient and modern mass graves with commingled human remains are in need of investigation all over the world. Important collections include those of the Holocaust, Iraqi Kurds, the Battle of Wisby and the *Titanic* (if she is raised), just to name a few. One major hindrance to this investigation is the sometimes difficult task of putting individuals back together again due to postmortem processes that can take place in and around mass graves such as fluvial movement, grave site disturbances or the settling of dirt separating different elements. Many bones can be matched by color or general fit as belonging to a given individual. But when these methods do not work due to investigator bias or inexperience, more than one element as a possible fit or, there are no matching colors, a statistical formula may be helpful.

This study explores the possibility of deriving a formula to statistically match

both left and right os coxae with its respective sacrum. Approximately two hundred males and two hundred females from the Hamann-Todd collection housed at the Cleveland Museum of Natural History (CMNH) were examined. Two different measurements each were taken from the left and right os coxa auricular surface and left and right sacro-iliac joint articulation surface for a total of eight measurements from each individual. The values were statistically assessed using regression formulae. Male regression analysis results show 76% with a p-value of >0.001 . Upon completion, female results are expected to show similar results.

Patterns of morphological integration and modularity in the expression of craniofacial robusticity characteristics in extant *Homo sapiens*.

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Within genus *Homo*, characteristics such as thick cranial vaults and expanded supraorbital, infraorbital, temporal, and nuchal regions are collectively viewed as aspects of craniofacial robusticity. The work of some researchers suggests that these features may be tied to a broader "robusticity complex", in which the expression of all of the individual robusticity characteristics, or superstructures, of the cranium are intrinsically linked. If true, previous studies employing characteristics of craniofacial robusticity as independent features could be called into question.

This study investigates patterns of expression between features of craniofacial robusticity in a geographically diverse sample of extant *Homo sapiens* (n=140) using a morphological integration framework in which statistically significant levels of correlation between features of craniofacial robusticity are demonstrative of integration, while non-significant levels of correlation provide evidence for modularity as independent expressions of these traits. Craniofacial robusticity is examined among four specific regions in our sample: the frontal, zygomaxillary, temporal, and occipital regions. The expression of robusticity among these regions is quantified using 72 three-dimensional coordinate landmarks and evaluated via partial least squares regression analysis.

Results show that while levels of interaction between the highlighted areas of craniofacial robusticity are characterized by relatively low correlation values, many of these obtain statistical significance providing at least partial evidence for integration between subunits and thus the presence of a craniofacial

"robusticity complex" in extant *Homo sapiens*.

Longitudinal changes in the composition of milk from *Gorilla gorilla*.

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The lack of longitudinal milk composition data in nonhuman primates primarily is due to the fact that milk collection generally requires the mother to be separated from her offspring and anesthetized, both of which are minimized in the wild and captivity. Animal care staff at the Smithsonian National Zoological Park trained an adult female *Gorilla gorilla* to permit unsedated physical examination, including manual expression of the mammary glands. Milk samples were collected weekly from the offspring's birth in January 2009 through June 2010. Samples were analyzed for protein (n = 24), fat (n = 19), and sugar (n = 19), including at least one sample from each month of lactation, with the goal of documenting the pattern of compositional changes over the course of lactation in *G. gorilla*. Protein content was higher and more variable in the first 45 days of lactation ($1.94 \pm 0.15\%$ versus $1.0 \pm 0.01\%$, $P < .001$). In samples after 45 days protein (minimum = 0.9%, maximum = 1.1%) and sugar (minimum = 6.7%, maximum = 7.8%) were relatively constant; fat was the most variable (minimum = 0.8%, maximum = 3.3%) and tended to increase with infant age ($r = .448$, $p = .071$). These compositional changes are similar to those seen in human milk. Higher protein concentration early in lactation may reflect increased immunoglobulin content and increases in milk fat later in lactation may reflect inclusion of solid foods in the offspring's diet, and thus longer internursing intervals. Gorilla milk appears remarkably similar to human milk on these parameters.

Measuring the genetic affect of the Mississippian transition in the Lower Illinois River Valley: an ancient DNA analysis.

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The transition to Mississippian (MISS) Culture (~1050 AD) brought about many changes to the everyday lives of ancient Native Americans, including an

increase in maize production, mound building, larger towns, and the production of shell-tempered pottery. Changes in religion and mortuary practices were also a component of the spread of MISS culture, but were these changes due to cultural diffusion through population movement? Our research uses ancient DNA analysis to determine if a population replacement as well as a change in the postmarital residence pattern accompanied the transition from the Late Woodland (LW) to the MISS period in the Lower Illinois River Valley. We focus on mitochondrial DNA (mtDNA) results from the Schild Cemetery and Yokem Mounds, which contains burials from the LW and MISS periods. Genetic discontinuity was observed in a comparison of mtDNA between the MISS Schild and the Middle Woodland Klunk Mounds populations, but the time difference between these two populations is too wide to accurately determine the influence of the MISS transition. In order to fully evaluate the hypothesis that migration occurred with the diffusion of the MISS culture we have included LW Schild and Yokem individuals in our standard population genetics analysis, as well as their MISS counterparts. We also evaluated the influence of genetic drift using computer simulation methods. A comparison of male and female mtDNA diversity from the LW and MISS populations will be used to test the hypothesis that a shift from patrilocal to matrilineal postmarital residence occurred due to the MISS transition. This study was funded by NSF0962759.

Empirical estimates of migration rate: case study of Yemen.

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In order to better understand human demographic changes, it is necessary to unravel the relationship between physical human movement and its genetic signal and, furthermore, to identify appropriate values that describe the amount of human movement and movement of genotypes. Currently there is no empirical value that estimates migration in human populations, particularly migration as it might have occurred 10,000s years ago. In Spring 2007, we collected over five hundred (n=552) saliva samples with geographic information of the individuals, their parents and grandparents in Yemen and sequenced HVRI of the mitochondrial DNA. We calculated the number of individuals whose birthplace was different from their mother's birthplace (n=110) and father's birthplace (n=104), obtaining similar values for both. We calculated the distance between places

of birth for each individual relative to their parents. The average distance between individuals' birthplace and their mothers' was 66Km and from their fathers' was 77Km. These values allow us to gain insight into how far people in developing countries are moving in one generation. We also calculated the number of haplotypes for the individuals (n=86) and the number of haplotypes for all samples (n=287). We determined the proportion of individuals who moved (0.22) and the proportion of haplotypes that had moved (0.33) based on those whose birthplace was different from their mother's. These values allow us to recognize the difference between human physical movement and movement estimated from genetic signals. These data provide a starting point to understanding migration using empirical demographic and genetic data. This study was funded by NSF, Grant BCS-0518530.

Linear enamel hypoplasia (LEH) and age at death (AAD) at medieval St Gregory's Priory and cemetery, Canterbury, UK.

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Studies of linear enamel hypoplasia (LEH) are widely employed in assessments of health status of prehistoric populations. The majority of research has focused on LEH as a permanent mark of childhood pathophysiological "stress", though specific causation of the pathology has not been established, creating a multifaceted means of stress examination. Here, we examined LEH in human burials from St Gregory's Priory and adjacent cemetery, dating to the medieval period in Canterbury, UK. The cemetery and Priory burials represented lower (n=30) and higher status (n=19) social groups, respectively.

Linear enamel hypoplastic defects were counted on mandibular and maxillary anterior permanent teeth. The age and sex of each skeleton was estimated using standard methods. Differences in LEH, and AAD, were sought between the social groups. Results indicate a significantly greater prevalence of LEH in the cemetery (mean=17.6) compared to the Priory (mean=7.9; $t=-3.03$, $df=46$, $p=0.002$). Adult age at death was also significantly lower in the cemetery (mean=39.8years) compared to the Priory burials (mean=44.1years; $t=2.275$, $df=47$, $p=0.013$).

Results indicate that childhood stress may reflect adult mortality in this sample, and that the wellbeing of individuals from diverse social backgrounds can be successfully assessed via LEH studies. Results are discussed in terms of the multifactorial etiology of LEH, as

well as heterogeneity of pathogen immunity and mortality.

Multi-proxy approach to deep-time paleoclimate reconstruction.

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Study of paleoecologic parameters within a paleoclimate framework permits evaluation of the interplay and feedbacks between surface and ecosystem processes. Robust deep-time paleoclimate reconstructions require a multi-proxy approach involving comparable and complimentary proxies. Mean annual continental paleotemperatures have been assessed using organic and mineral proxies including fossil leaf patterns and physiognomy, lake sediment pollen distributions, and the oxygen (and hydrogen) isotope compositions of biogenic hydroxyapatites and soil-formed carbonates, phyllosilicates and Fe-oxides. Promising new directions include the use of 'clumped-isotope thermometry' of paleosol carbonates and biomarkers of lacustrine Archaea and fossil soil microbes.

Lacustrine records have long provided high-resolution continuous time-series of regional hydroclimates. Fossil soil morphologies coupled with major element chemistry yield quantitative estimates of mean annual precipitation and seasonality that are consistent with independent paleobotanical estimates. The oxygen isotopic values of soil-formed minerals are also reliable tracers of soil- and meteoric water, and in turn, regional hydrologic processes. The hydrogen and carbon isotope compositions of leaf wax biomarkers show promise as proxies of paleo-aridity and aridity-induced plant metabolic changes. Where available, the textural and geochemical compositions of stalagmites are proving to be powerful recorders of changes in regional air temperature and effective moisture that can be precisely dated. Lastly, paleoatmospheric pCO_2 can be estimated using independent and complimentary CO_2 proxies: the stomatal-index method for fossil leaves and the stable isotope compositions of soil carbonate and goethite. Additionally, the fossil leaf stomata approach shows promise as an effective paleoaltimetry proxy.

Exploring catastrophic mortality during the Amarna Period in Ancient Egypt (BC 1351-1334).

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The Amarna Period in Egypt (BC 1351-1334) is characterized by the relocation of the political and religious capitals to a virgin location and an abrupt change in religion and art. One hypothesis for

this change, supported by historical texts, suggests that the large-scale cultural change was an adaptation to epidemic disease. This study examines sex differentials and the overall mortality profile structure of the Amarna commoner cemetery (n = 208) to assess the likelihood of epidemic disease being present. Age-specific mortality distributions are compared to known attritional and catastrophic mortality samples associated with intense cultural change. These comparisons demonstrate that the overall structure of the Amarna demographic profile is consistent with a catastrophic mortality sample. For instance, infants (0-5) constitute 21% of the sample, juveniles (5-15) represent 18.7%, and young adults (15-25) comprise 20.6% of the sample. Younger individuals should be the least represented in attritional mortality samples and generally constitute the healthiest individuals in the population. Sex differentials determine if mortality was greater in one sex and the resulting affect on the overall distribution. Females outnumber males 1.14:1 and peak later than males within the 25-35 year age group. While initial observations suggest females show elevated risks of dying, ANOVA shows it to be not significant. Mortality rates, indiscriminate of sex, at Amarna appear to reflect an acute mortality crisis resulting in a catastrophic mortality pattern; supporting the idea that epidemic disease could have affected the traditional Egyptian way of life during the Amarna period.

Parallelism in primate brain expansion has a conserved genetic basis.

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The expansion of the brain is a major hallmark of primate evolution. However, whether brain expansion is limited to a few lineages or is a ubiquitous trend across the primate phylogeny is not clear. Using phylogenetic methods and published datasets of brain size we have reconstructed the evolutionary trajectories of brain size in primates. Our results show that, from a small-brained ancestor, brain size has increased multiple times independently across primate lineages. However, despite a general trend to expand, brain size does decrease in some lineages.

We subsequently explored whether the parallel evolution of increased brain size is due to parallelism at the molecular level by sequencing six genes with known roles in neurogenesis across 21 species, representing all major clades of anthropoids. Using molecular tests for

selection, we show that these loci have been under pervasive positive selection across anthropoids. Furthermore we found that the molecular evolution of several of these genes, including two microcephaly genes (*ASPM* and *CDK5RAP2*), is positively associated with brain size. This association is stronger with neonatal brain size than adult brain size, suggesting a role in prenatal development that is consistent with a direct effect on neuronal proliferation. Interestingly, *ASPM* shows a negative association with brain size in the Callitrichidae, a family in which brain and body size has secondarily decreased. This study demonstrates that brain expansion has occurred in parallel across primates and that the genetic basis of brain size evolution may be conserved.

Premolar root variation in *Pan* and its implications for hominin systematics.

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Variation in premolar tooth root number and morphology plays a central role in hominin systematics. The goal of this study is to document variation in maxillary and mandibular premolar root morphology in a large sample of *Pan* to establish expected levels and types of variation in fossil hominin taxa. This study employs high resolution computed tomography to assess external root form and the distribution of root canals within each premolar. For each premolar, the number of roots and canals was scored on a categorical scale and both jaw and tooth size measurements were recorded to test for a correlation between size and root form.

CT scans of premolars representing 51 *Pan troglodytes verus* (46 maxillae/21 mandibles from 24 males/20 females/7 unknown) were segmented to produce virtual models. Root number and canal number were recorded for each specimen and measurements included root volume, surface area, and length(s) including standard linear dimensions of the maxilla and mandible. Kruskal-Wallis and Mann-Whitney statistics were used to test whether jaw and/or tooth size differed between premolars with different root and canal configurations. The results indicate a considerable difference in the degree of variation in root form and canal number depending on premolar position which has implications for interpreting the significance of variation within the hominin fossil record. No relationship was found between jaw size and root/canal number. The correlation between root/canal number is not always clear from external examination, highlighting the importance of examining canal number when characterizing root morphology in extant and fossil taxa.

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Bone tapping in several Upper Midwest archaeological populations: an osteological and experimental analysis.

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Bone tapping is a postmortem modification of human remains seen in several precontact peoples of the Upper Midwest. Previous analyses of bone tapping in these groups have primarily looked at the archaeological aspects of the phenomenon. Preliminary osteological analysis of sites from western Minnesota and Wisconsin suggest that almost all individuals exhibiting tapping are adults, with a majority being males. Bone tapping is most commonly seen in femora, followed by humeri and tibiae. The average dimensions for the perforations include a length of 17.5cm and width of 8.5cm. In some of the sites, similar numbers of perforations occur on the distal and proximal ends of the bones, while other sites show a preference toward tapping of the distal bone ends. Tapping is generally seen in only a small subset of a given population.

In addition to the osteological analysis, this study includes an experimental aspect. Femora from *Bos taurus* were used as a proxy for human bones and tapped at intervals spanning from the day of death to two months postmortem using a stone tool similar to that used archaeologically. The experimental work suggests that tapping occurred in the perimortem period based on the appearance of hinge fractures and embedded bone fragments. However, this study also suggests that temperature fluctuations, season of death, and location/ placement of the remains may greatly impact the timeframe during which the bone displays a "green bone" response, thereby complicating any estimations of the exact timing of the phenomenon archaeologically.

New middle Miocene hominoid partial innominate from the Siwalik sequence of Pakistan.

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A partial left innominate identified as *Sivapithecus indicus* has been recovered from the Chinji Formation, Potwar Plateau, dated at 12.3 Ma. Cranial and caudal portions are missing, but original dimensions can be estimated, along with the degree of iliac flare and the orienta-

tion of the ilium relative to the acetabulum. Among living and fossil primates it is least unlike *Proconsul nyanzae*, although exhibiting some probable derived features. This is the seventh *S. indicus* postcranial element recovered from the Chinji Formation, and the first innominate for the genus. Size suggests that it is female, likely between 20–25 kg. The fossil has a very robust linea arcuata and a smaller ischial tuberosity than cercopithecoids and hylobatids. The iliac fossa is relatively broader than *P. nyanzae* but is unlike extant great apes.

The innominate is compatible with the inference that *S. indicus* was primarily arboreal and had a varied locomotor repertoire consisting of both pronograde quadrupedalism and occasional antipronograde activities such as vertical climbing. The extent to which the specimen helps resolve the degree of postcranial homoplasy between *Pongo* and the African apes remains unclear.

Ontogeny of sexual dimorphism in long bones of gorilla.

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Among great apes, gorillas show the most pronounced sexual dimorphism. Several morphometric analyses document how craniofacial dimorphism is brought about during ontogeny. However, comparatively little is known about the ontogeny of sexual dimorphism in the postcranium, because long bone morphology and associated trajectories of ontogenetic shape change are difficult to quantify. In this study, three-dimensional data of *Gorilla g. gorilla* femora are acquired using medical CT and micro CT technology. Cross-sectional features (*i.e.*, external radius, surface curvature, and cortical bone thickness) are measured and visualized along the entire length of the diaphysis, and from infant stages to adulthood, utilizing Elliptical Fourier Analysis and methods of morphometric mapping. Morphometric maps are further processed with a combination of 2-dimensional Fourier analysis and multivariate analysis of shape. Our results show that males and females share ontogenetic patterns, but that males follow an extended ontogenetic trajectory. Diaphyseal shape variation that is independent of ontogeny and sex was also examined. These analyses indicate considerable intraspecific variation in muscular topography.

Luminance contrasts and the adaptive advantage of monochromatic vision in a nocturnal exudativorous primate.

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It has been suggested that the energetic cost of maintaining functional short (S-) opsin pigments might exceed the adaptive advantages of dichromatic vision under scotopic conditions. Such a view is supported by the convergent evolution and prevalence of monochromatic vision among nocturnal primates. For advocates of this hypothesis, the existence of functional S-opsin pigments in species such as tarsiers is taken as evidence of a recent adaptive shift from diurnality to nocturnality. Yet recently, a signature of purifying selection at the S- and M-opsin gene loci was reported for the aye-aye, a nocturnal primate. For such species, the advantages of detecting chromatic signals or cues are unknown; further, the tasks in which luminance cues alone might explain S-opsin inactivation are also unknown. Recently, the ecological advantages of detecting luminance contrasts has been shown for diurnal, frugivorous primates, but scarcely anything is known for nocturnal species. To address these issues, we measured the spectral reflectance of foods consumed by *Galago senegalensis braccatus*, *Tarsius bancanus*, and *T. syrichta*. Next, we used irradiance spectra under twilight, full moon, and new moon conditions to calculate the radiance spectrum of each food object and to estimate the relative quantum catches for each species. The results of our models suggest that *Galago*, a monochromat, can subsist on luminance contrasts alone. Accordingly, when the luminance contrasts of critical stimuli are high, natural selection might favor the loss of S-opsin pigments.

This study was funded by Sigma Xi and the David and Lucile Packard Foundation.

Dental attrition patterns in two cercopithecoid species from Tai forest, Ivory Coast.

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Sooty mangabeys (*Cercocebus atys*) of the Tai forest obtain most of their food – including several species of hard seeds – from the ground. Among the craniodental adaptations to hard-object feeding are enlarged P₄s and thick molar enamel. The most frequently consumed foods, *Sacoglottis gabonensis* seeds, are processed using incision and powerful isometric biting on the postcanine teeth. Sympatric red colobus (*Procolobus badius*) contrast sharply with *Cercocebus* by being main canopy foragers. While hard objects are not unknown in the *Procolobus* diet, their prevalence is far below that observed among the Tai mangabeys. Thick enamel, and in the

case of *Cercocebus* enlargement of the P₄, are hypothesized to represent adaptations to a high-attrition diet. We contrasted macroscopic wear in these species to evaluate the null hypothesis that patterns of attrition between them would be similar, despite dietary differences.

We measured attrition as the proportion of exposed dentine area to dental crown area for P₄-M₃ in adult *Cercocebus* (n=16) and *Procolobus* (n=18) of both sexes. Dentine exposure on P₄ relative to attrition on M₁ scales similarly in the two taxa; however, at a given proportion of dentine loss on the molars, *Cercocebus* displays relatively more attrition on the P₄. Variation in P₄ attrition is higher in *Cercocebus*. The finding of absolutely greater wear on M₃ versus M₁ is never observed in *Cercocebus*, but it is occasionally observed in *Procolobus*. These data compel rejection of the null hypothesis and provide evidence of different utilization of individual teeth in the two taxa.

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Behavioral and ecological consequences of sex based differences in taste bud densities in *Cebus apella*.

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Fungiform papillae (FP) are the only gustatory structures on the anterior tongue. Taste buds (TBs), which are located in FP, house taste receptors. In humans, FP and TB densities correlate with taste sensitivity and food preferences. *Homo*, *Pan*, and *Cebus* females have higher FP densities than males. *Homo*, *Pan*, and *Cebus* have larger brains, slow development, and higher offspring investment compared to most primates. An increase in maternal investment places an intense pressure on females to (1) obtain high-quality foods, and (2) detect potential toxins at low levels. Higher FP densities in females may be a foraging adaptation for pre/post natal development. This study examines sex differences in TB densities in *Cebus*. TBs can be used to evaluate differences in taste sensitivity. We asked the following questions: (1) do males have fewer FP, but more TBs than females, (2) do males have fewer FP and TBs than females, and (3) do males have fewer FP, but match females in the TB count? TBs were counted on four female and six male *C. apella* tongues. Tongues were embedded, serially sectioned, and stained with hematoxylin-and-eosin. Females have 1.5TB/FP, averaging around 4TB/FP. Male values range between 0.2TB/FP, and average 1 TB/FP. Furthermore, there are notable size differences in FP. Females have larger FP and higher FP and TB densities. The anatomical evi-

dence indicates that females have greater taste sensitivity than males. Future research on food preference/selection in *Cebus* is expected to show sex specific behaviors similar to those observed in *Homo* and *Pan*.

This study was funded by MU-Advance.

The roles of immunity in human life-history trade-offs and evolution.

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Immunological research has traditionally focused on clinical and molecular studies to characterize the structure and function of various immune responses used for allostatics. More recently, the study of ecological immunology has focused on explicating the physiological and ecological determinants of variation in immune functions and ultimately the fitness consequences of this variation. One broad perspective is that because immunocompetence is an integral part of organismal life histories, it is involved in physiological trade-offs with other functions. Several studies in humans now conclude that development, maintenance and activation of immune responses generate a substantial energetic burden. Furthermore, increased metabolic demands during infection are met largely through the actions of various hormones and immune factors. In fact, many molecules exhibit pleiotropic actions on metabolic, immune and reproductive functions, including thyroid hormones, cytokines, glucocorticoids, and androgens. The present paper reviews the evidence for metabolic costs of immunity in humans, trade-offs between immune activation and growth/reproduction in humans, and those studies which attempt to identify the proximate endocrinological moderators of immune functions. Understanding the precise energetic costs of acute immune activation in adults will facilitate better treatment plans for metabolic dysregulation during illness, and a more complete understanding of the immunomodulatory actions of hormones will benefit clinicians who utilize hormone supplementation to treat a variety of conditions. Furthermore, results suggest that “feeding a cold, and starving a fever” may be appropriate advice given that different immune functions elicited by different pathogens have different energetic and nutritional needs. Funded by Indiana University-Bloomington and University of Wisconsin-Milwaukee.

Dental pathology and dental morphology in Osteoware.

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Recording dental pathology and dental morphology using written forms is cumbersome and inefficient. Osteoware pro-

vides a simple interface that allows fast and accurate recording of dental data. Dental pathology including carious lesions, abscesses, hypoplastic lesions, as well as cultural modifications can be recorded. The method for scoring hypoplastic lesions and modification is consistent with Standards for Data Collection from Human Skeletal Remains (Buikstra and Ubelaker, 1994). The choices for scoring carious lesions and abscesses have been expanded in Osteoware compared to Standards, providing greater flexibility in scoring location and severity. Osteoware further facilitates accurate scoring of dental pathology by modifying the available pathology categories based on the dental inventory for each tooth.

Dental morphological data collection is based on the Arizona State University Dental Anthropology System. Ideally, the ASU dental casts should be used in conjunction with Osteoware. All of the descriptions for dental morphological traits are provided in Osteoware and are taken directly from the ASU System (Turner, Nichol, and Scott, 1991). For each morphological trait, text boxes appear next to the appropriate teeth in a diagram of the dental arcade so scores can be entered quickly and easily. This presentation demonstrates the procedure for recording dental pathology and morphology using Osteoware through several case studies.

Osteoware is supported by grants from the National Center for Preservation and Technology and Training (NCPTT), National Park Service, and the Smithsonian Web 2.0 Fund.

Facial mask markings used to reveal taxonomic differences in the Bornean slow loris (*Nycticebus menagensis*).

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A better understanding of subtle morphological disparities, such as pelage pattern and color variation, vocal cues, and genetics have aided in elucidating the true number of nocturnal primates over the past decade. Such an example can be noted within slow lorises (genus *Nycticebus*), which were once comprised of only two species, but taxonomic studies revealed an array of speciation, resulting in the recognition of three additional species. Diversity is still being noted in the newly described species, such as the Bornean loris (*N. menagensis*). With extreme differences in adult facial masks and the geographic barriers isolating the populations, a taxonomic study was justified. Bornean loris museum specimens and photographs were used to study facial morphological differences to assess the

possibility of subspecies or species. Nine facial mask differences were significant in demarcating species. These nine features influenced the amount of white visible on the face, supporting the idea that contrasting color patterns aid in species recognition. Similar facemask patterns significantly clustered together by geographic regions ($E = 0.07$, $F(14, 88) = 17.5$, $p < .05$). Based on facemask differences and geographic boundaries, our results support the classification of three subspecies of Bornean lorises: *N. m. menagensis* found in the north of Borneo, *N. m. borneanus* in central Borneo and *N. m. bancanus* of the South of Borneo.

This study was funded by the Primate Society of Great Britain, Primate Action Fund, Primate Conservation Inc., and The Margot Marsh Biodiversity grant.

A comparative study of the occurrence of transverse radiopaque lines in archaic, early modern, and Holocene human populations.

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Transverse radiopaque lines (TRL's) are a hard-tissue pathology which develop in subadult long bones after episodes of nonspecific stress such as nutritional or metabolic insult. This pathology is well documented in archaeological contexts and is used as a tool for making paleodemographical inferences about the general health of populations. Stable isotope studies have suggested that early modern humans were exploiting a wide range of dietary resources by the mid-Upper Paleolithic, while Neanderthals appear to have utilized a narrower spectrum of resources, expending more energy on large game. This may be a significant factor in differential survival success; Neanderthals might have been more susceptible to seasonal resource fluctuations and may have suffered increased nutritional and metabolic stress as a result.

This study will evaluate differences in the frequency and timing of TRL's among three Pleistocene and Holocene subadult populations. Radiographs of the tibial distal shafts of 200 archaic, early modern, and Holocene humans were scored as displaying or not displaying TRL's. TRL's were counted, and age-at-formation was calculated. Kruskal-Wallis nonparametric tests were used to compare the frequency of occurrence of TRL's and age-at-formation among the three groups. Results indicate that archaic humans developed more TRL's than early and Holocene humans, and they formed those TRL's earlier in life. This is consistent with other research indicating that Neanderthal populations experienced high levels of non-specific stress

early in ontogeny, which may be related to seasonal food shortages among Late Pleistocene populations.

Temporal patterning within the Tipu cemetery based on fluoride-ion electrode analysis: demographic and health implications.

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This project ascertains the sequence of burials using fluorine analysis at the Colonial Maya site of Tipu in order to explore demographic and other cultural effects associated with European contact. The cemetery at Tipu in west central Belize, dating from within the first century of Spanish contact, has provided one of the largest and best preserved ancient Maya skeletal series, with over 500 burials recovered. These interments have undergone general bioarchaeological analysis, but thus far, there has been no means to evaluate how demographic, health, and activity patterns might have changed over time. This is of interest given the rapid culture change associated with this time period, especially since the site underwent large fluctuations in population size due to immigration from the Northern Yucatan. By measuring fluoride ion levels within the sample using an electrode, a relative chronology was determined using both horizontal and vertical location to test for patterning. The overall range of fluorine levels was not marked, reflecting the relatively short use of the cemetery from 1541-1704. Variation in fluorine levels allowed for the determination of the cemetery's spatial partitioning and documented changes in demographic distribution and mortuary practices, including burial orientation and stacking of interments. In particular, these findings have helped further the understanding of the roles of gender and status within the cemetery at Tipu, especially over time.

3D modelling to analyze heat dissipation on fossil endocasts.

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Brain evolution in the human genus is associated with a definite increase in metabolic expenditure. Currently, there is no agreement on the existence of specific cooling mechanisms in *Homo sapiens* to balance the heat production related to such high metabolic rates. At the same time there is little information on the thermoregulatory biology of the brain mass in our own species. Cortical and meningeal vessels have been hypothesized to have a functional role in this sense, as suggested by anatomical differences among fossil hominids. Here, we

present a model to analyze heat dispersion on fossil endocasts, as function of brain geometry and basic physical properties associated with heat conduction. Combining digital imaging and numerical integration techniques, we used the heat equation to quantify heat dynamics on the surface of fossil endocasts, dividing the space in a three dimensional cubic lattice. After CT-based endocasts reconstruction and voxel-based 3D model rendering, we find numerically the stationary heat distribution on the regular lattice defined by the voxels. Although this study rely only on raw geometry without considering further anatomical or histological elements, some differences between modern humans, Neandertals, and Australopithecines merits attention. Advantages and limits of the method are discussed accordingly.

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Replication of standard caliper measurements using photo imaging software: a case study using temporomandibular fossa metrics.

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ImageJ photo imaging software is used to test the hypothesis that standard sliding caliper measurements can be consistently replicated using measurements taken from digital photographs. Left and right anterior, posterior, and lateral measurements were taken on the temporomandibular fossae of one-hundred and nine individuals from the Hamann-Todd Osteological Collection. Pencil marks were used to identify landmarks for caliper measurements and were then erased and one basicranial photograph of each individual was taken to scale using a digital camera. The landmarks were then reestablished using only the images, and the same measurements were taken on the same individuals. A paired samples t-test is conducted to investigate the replicability of the two measurement methodologies. Results demonstrate that the left and right photographic anterior measurements (articular tubercle to temporal spine) differ significantly from the caliper measurements. Left and right lateral measurements (articular tubercle to postglenoid process) from the digital images do not differ significantly from the caliper measurements. Left posterior measurements (posterior tubercle to temporal spine) based on the images do not differ significantly from the caliper measurements, although the right posterior measurements differ significantly.

Methodological factors of landmark variability, scale and measurement error, and parallax explain the discrepancies between the two measurement methodologies.

Self-selected walking speeds: do females and males carrying children choose differently?

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Determining the metabolic cost and movement consequences of child-carrying is critical to our understanding of human evolution. Current hypotheses of behavioral interactions within early human populations suggest that female and/or male relatives might have helped mothers of small children carry their offspring for periods of time, effectively transferring to these mothers more energy for breast-feeding or future reproduction. To determine how child-carrying affects the free walking speed choices of adults as a function of sex and task, we calculated the walking speed of 6 females and 6 males as they walked around the perimeter of a gym while performing 12 tasks in a randomized order. Tasks consisted of all combinations of 3 loading conditions – carrying a 10kg toddler-proportioned manikin on the shoulders or hip, or a comparable mass around the waist – and 4 walking speed directives (“slowest”, “walk-all-day”, “brisk”, and “fastest” walks). We found that speed category ($p < .0001$), sex ($p = 0.08$), and the interaction of sex and speed ($p < .0001$) affected free-walking speed, but not loading condition (General Linear Model). For all loading conditions, females walked significantly faster than males (or marginally so) at all but the fastest speed category, with the sex difference decreasing with speed (14, 11, and 7 % difference from slowest to brisk walk). At the two fastest speed categories, free-walking speed was slower for hip than for shoulder carrying. Although the carrying task was a larger burden for the females due to their smaller body mass, females consistently chose faster walking speeds than males. This study was funded by 3M Faculty/Student Collaborative Grant #212607 (Center of Excellence for Women, Science, and Technology), the Office of Collaborative Undergraduate Research, and the Endowed Professor in the Sciences at St. Catherine University, St. Paul, Minnesota.

Growth velocity and percent of achieved adult growth of juveniles at the Campbell site.

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sity of Missouri, ³Department of Anthropology, University of North Carolina Wilmington.

This study documents and interprets patterns of long bone growth in a Late Missippian sample from the Campbell site (23PM5) (ca. AD 1350 to 1540), Pemiscott County, Missouri. Occupants of the site were sedentary, maize agriculturalists. Sedentary, agricultural lifestyles are associated with increases in chronic infection and dietary deficiency. Stressors of this nature often negatively impact longitudinal growth. Several interrelated hypotheses are tested to better understand how such environmental processes impacted longitudinal growth at the Campbell site. First, it is predicted that the rate of growth at Campbell will be reduced when compared to groups with lesser rates of infection and wider dietary breadth. Percentages of achieved growth and age will significantly differ between the Campbell site and comparative samples. Maximum diaphyseal lengths of the humerus, radius, ulna, femur, and tibia were collected from all available individuals from the Campbell site ($n=132$). Comparative data were derived from four samples, which span a diverse selection of time periods and subsistence strategies: Japan (Jomon, forager), Alaska (Point Hope, forager), Kulubnarti (Nubia, agriculturalists) and Mistihalj (Bosnia-Herzegovina, pastoralists). Age was estimated on the basis of dental eruption and formation. The results of this analysis indicate that individuals at the Campbell site differed in their patterns of growth, particularly from the hunter-gatherer samples. In general, Campbell juveniles were smaller and delayed in relative growth of long bones.

This study was funded by the University of Missouri-Columbia Undergraduate Research Mentorship Fellowship.

Prediction of the timing of catch-up for children with delayed skeletal maturation.

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Normal variation in skeletal maturity can yield a skeletal age (SA) that differs from chronological age (CA) by a few years without being considered pathological. Some children with delayed maturation (SA < CA) remain delayed for a number of years, while others

catch up to their peers (SA = CA) relatively quickly. We hypothesize that the probability of such "catch-up maturation" varies with CA and SA. SA was assessed using the FELS Method for 19,240 hand-wrist radiographs from the Fels Longitudinal Study of 626 boys and 590 girls born 1921-2001, aged 1m-18y. We predicted future SA using multivariate regression and an empirical method of trajectory matching to illustrate the range of future patterns of skeletal maturity among children with similar SA histories.

Our data suggest that, for those who are delayed in skeletal maturation, the probability of catching up to one's CA-matched peers increases prior to the average age of onset of the pubertal growth spurt in stature (10.7y for boys, 8.7y for girls). This probability decreases prior to the average age at peak height velocity (13.8y for boys, 11.5y for girls), and then increases again (since all individuals eventually reach the mature state). Our findings are relevant on several levels: 1) they provide insight into the relationship between maturation and growth, 2) knowledge of the probability of "catch-up maturation" assists pediatricians in determination of treatment timing, and 3) progress and tempo of maturation provide insights into key developmental processes and life history relevant to comparisons within and across taxa.

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Dietary adaptations of prehistoric Japanese in light of nitrogen isotopic compositions of bone collagen amino acids: with special focus on aquatic resources.

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The stable nitrogen isotopic compositions of bone collagen amino acids from a variety of archaeological human and faunal populations from Japan were investigated. The samples are assigned to wide range of prehistoric periods mainly including Initial Jomon (c. 10,000-6,000 BP), Early Jomon (c. 6,000-5,000BP) and the Okhotsk Culture Period (c. AD 550-1200).

At the two Jomon sites, we observed characteristic and consistent isotopic values for two amino acids: glutamic acid and phenylalanine. While glutamic acid showed quite a large inter-trophic ¹⁵N-enrichment along the food chain,

phenylalanine showed little ¹⁵N-enrichment. However, at the coastal site of the Okhotsk Culture, unexpected $\delta^{15}\text{N}$ variability of phenylalanine was observed for marine faunal species. Because most of the marine species are migratory, we think that the variability reflects the isotopic differences of nitrogen sources between oceanic regions. In addition, several factors such as ocean currents and differences in tools and strategies for procuring marine animals might relate to the observed isotopic differences between these periods.

We have developed a range of new methods for quantitatively evaluating the consumption of marine protein using the $\delta^{15}\text{N}$ values of glutamic acid and phenylalanine. By applying these methods to above samples, we estimated that the coastal Jomon and the Okhotsk Culture populations obtained approximately 70-80% and 60-100% of their dietary protein from marine resources, respectively. In contrast, it seems that the inland Jomon population consumed little marine protein.

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Bioarchaeology of a French medieval monastic cemetery: interpreting ritual changes and the impact of historical events.

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The site of Saint-Laurent de Grenoble (Isère, France) is one of the oldest Christian sites in France (A.D. 380-1800). Following typical historical sequence, Christian burials gradually replaced older Gallo-roman cemeteries. The first Christian monument officially consecrating the cemetery was a *memoria* dedicated to the first bishop of Grenoble (A.D. 380-420). With the growing Episcopal influence, Saint-Laurent quickly evolved into a formal church (A.D. 500-600).

Two main transitions influenced the composition of the burial grounds during Saint-Laurent history: (1) The settlement of the Benedictine monks in 1022 helped renew the declining church by developing a monastery. (2) During the 14th century the joint influence of repetitive plagues (1342, 1346..) and the Hundred-year war majorly strained local populations.

The contextual analysis of over 600 skeletons has been developed in order to evaluate the impact of these events, specifically: (1) the ritual changes brought by the monks and (2) the economic crisis associated with natural disasters and war. Biological variables (stature, demography, paleopathologies..) were assessed in combination with archaeological data (burial

type, artifacts deposits..) in order to properly interpret the results.

Most variables clearly indicate a key transition in the cemetery composition with the settlement of the monk, toward high status individuals. In addition, the political and economical consequences of the 14th century's turmoil resulted in a major degradation of health and increased mortality for local populations.

A finite element analysis of the catarrhine sixth cervical vertebra: a preliminary investigation of stability hypotheses.

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Morphological variation in the anthropoid lower cervical spine has been linked to differences in positional behavior, but hypotheses examining how this variation reflects differences in mechanical environment have yet to be tested. Previous work suggests that suspensory primates have skeletal mechanisms that restrict and stabilize movement in the coronal plane, while non-suspensory primates, including humans, will demonstrate features promoting stabilization in the sagittal plane. Finite element analysis provides a method to investigate structure-function hypotheses regarding bony response to different force moments. Finite element models of four catarrhine species—*Homo sapiens*, *Pan troglodytes*, *Papio anubis*, and *Australopithecus afarensis* (A.L. 333-106)—were constructed from microCT scans, scaled, and compared. Pure moments of force were applied to the transverse and spinous processes to induce anteroposterior and mediolateral bending, as well as torsion about the vertical axis of the spine. The resultant stress differences were calculated and compared among taxa. The *Pan* vertebra demonstrates reduced stresses during lateral bending when compared to other specimens, suggesting generalized stabilization in the coronal plane, whereas the *Homo* and *Papio* vertebrae appear to be more optimized to resist bending in the sagittal plane. These results support stabilization hypotheses that cervical vertebrae shape is linked to differences in positional behavior. The pattern of response exhibited by the *A. afarensis* vertebra is most similar to that of the *Pan* vertebra; however, the stress magnitudes experienced by the fossil vertebra generally place it intermediate between extant humans and chimpanzees. Implications for *A. afarensis* positional behavior are discussed.

Alloparental behavior in captive *Galago senegalensis*.

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Observations of alloparenting in galagos, a relatively nonregregarious primate

taxon, are scarce due to the difficulties of observing wild infant behavior in nocturnal species that frequently raise young in nests and to the rarity of colonies with co-housed adult females. We previously reported three case studies of grandmothers allonursing infants (2 males, 1 female). Here we extend our analysis of these cases to other affiliative behaviors between infants, mothers, and grandmothers. We determined the relationships between subjects, the rate of behaviors, and the ages at which they occurred. Focal adult and infant observations of *Galago senegalensis braccatus* were made in the Arizona State University colony between 1976 and 1990. The colony contained two matriline caged separately because unrelated adult females are extremely aggressive to each other. The groups ranged from two to seven individuals. When the ages of these three infants were divided into four time periods prior to weaning (0-2, 3-5, 6-8, 9-11 weeks), the relative frequencies of the mother and grandmother approaching, grooming, or carrying the infant were very similar across time to the patterns found previously with nursing, though the pattern of alloparenting by infant's age was unique for each infant. Only mothers and grandmothers ever carried an infant. Alloparental behavior was more prominent in grandmothers than other females. Our findings suggest that grandmothering may be a occurs in nongregarious primates, deserves attention in field studies, and may be a form of kin selection in this species that is expressed across a suite of behaviors.

Analysis of hypoplastic defects in a Roman Period (1st – 4th c. AD) skeletal sample from Vagnari (Italy).

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This study examines the prevalence and timing of linear enamel hypoplasias (LEH's) in the deciduous and permanent dentitions of 48 individuals recovered from a rural Roman cemetery at Vagnari, south Italy. These results are used to investigate infant and childhood health in relation to historical and archaeological evidence concerning the health of children in Roman Italy. All teeth (n = 525) were examined for enamel defects and revealed an overall prevalence of 64.6% in the permanent dentition. No LEH's were observed in the deciduous dentition (n = 131). The prevalence of LEH's in contemporaneous Roman samples are higher than in the Vagnari sample, suggesting that political-economic variables may have contributed to the comparatively healthy conditions for subadults at Vagnari. There is no statistically significant difference in LEH prevalence between the

sexes within the Vagnari sample, suggesting similar levels of stress in males and females during childhood. These results are inconsistent with historical sources, which imply that male children were preferentially favored in Roman society. The subadults (0-15 years) experienced a higher average number of defects per tooth, whereas the average number of defects progressively decreases in the older age categories. This evidence suggests that Roman children who suffered fewer stress events during dental development may have also experienced greater longevity (45+ years). Measurement of each LEH indicates a peak occurrence at 2.75 years, which is interpreted as indicating the end of the weaning process and is consistent with historical evidence for Roman weaning practices. Hypoplasias occurred until around 6.5 years, suggesting that stress was experienced throughout childhood, and not just during weaning.

Associations between 2D:4D, testosterone and androgen receptor gene sensitivity in haplorrhines.

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The second to fourth digit ratio (2D:4D) is a marker for prenatal androgen effects (PAE) and has been linked to the programming of sexually selected traits in primates. In humans high 2D:4D (lower PAE) is associated with insensitivity of the androgen receptor gene (ARG), but relationships with testosterone (T) have been contradictory. Here we investigate relationships between 2D:4D, T and ARG sensitivity across haplorrhines. Data on 2D:4D was taken from our own studies and other variables were taken from the literature. The ARG contains a CAG repeat sequence which correlates with the gene's transcription capacity: mean CAG sequences (CAGn) that are short are more sensitive to T and induce larger physiological effects from the same levels of androgens. Analyses employed species-level CAGn and male serum T and were phylogenetically controlled. Results show significant associations across super families: species with higher T had lower 2D:4D and lower body size and 2D:4D was positively correlated with CAGn. Ceboidea had higher T than Old World species, but 2D:4D overlapped. Cercopithecoidea had lower 2D:4D and higher T than hominoids, but CAGn did not significantly differ. In apes Hylobatids had the shortest CAGn, lowest T, but highest 2D:4D. This pattern differed in great apes: higher 2D:4D was associated with longer CAGn and higher T, with humans exhibiting the most extreme values. Through hominid evolution increasing 2D:4D may be indicative of increasing

androgen insensitivity despite the apparent increase in T levels. We discuss the possible implications of down-regulation of the ARG on hominid social evolution.

Virtual reconstruction of *A. africanus* endocasts and new cranial capacity estimates.

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The fossil record of *Australopithecus africanus* includes several fairly well preserved specimens that allow the size and morphology of this species' brain to be investigated. However, most specimens are not complete, distorted to some degree, and/or contain stone matrix in the endocranial cavity. The use of CT data has facilitated investigations of the endocranium, especially of skulls filled with matrix. Today, surface semilandmarks and geometric morphometric methods make it possible to reconstruct missing parts and correct for distortion in a reproducible and reliable way. Here, we reconstruct virtual endocasts of Sts 5, Sts 60, Sts 71, StW 505, Taung, and MLD 37/38 using a probabilistic approach and provide new endocranial volume (EV) estimates.

After segmentation of preserved portions of the endocranial cavity and reconstruction of bilateral portions by mirror-imaging, we used computer algorithms to reconstruct missing parts. We measured endocranial landmarks and several hundred semilandmarks on curves and surfaces to capture the available morphology in detail. The same landmark set was measured on samples of chimpanzees and humans. For each *A. africanus* specimen, we created multiple estimations of the missing and distorted parts via thin-plate-spline warping, using Sts 5 and the modern individuals as reference specimens. We validated our method by simulating missing portions in Sts 5 and comparing our reference-based estimates to the true EV. The variation of EV among the multiple reconstructions reflects the estimation uncertainty caused by the variability among reference specimens. We discuss the results with respect to the choice of reference specimens and previous literature.

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Hominoid cranial base variation supports a valid taxonomic distinction between *Paranthropus boisei* and *Paranthropus robustus*.

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We use the nature and the degree of intraspecific variation in cranial base variables among extant higher primates (*Homo sapiens*, *Pan paniscus*, *Pan troglodytes*, *Gorilla gorilla* and *Pongo pygmaeus*) as comparative analogues to test taxonomic hypotheses within the *Paranthropus* clade. A multivariate randomized Levine test is performed on principal component factor loadings of logged cranial base measurements and geometric mean ratio (or GMR) shape data. When logged data are considered, the variation in the combined sample of *Paranthropus boisei* and *Paranthropus robustus* exceeds the variation within each extant hominoid species, but the variation within either *P. boisei* or *P. robustus* does not exceed the intraspecific variation within any of the extant hominoid species. When GMR shape data are considered variation within *P. boisei* but not *P. robustus* exceeds the variation within each of the extant hominoid species. The degree of the variation in *P. robustus* does not differ significantly from between sex samples of any extant hominoid species, within sex (i.e., single sex) subsamples of the extant hominoid species, geographically defined groups of modern humans, or of any fossil taxon. The variation in *P. boisei* does differ from pooled sex samples of extant hominoid species in terms of shape or in single sex samples of hominoids in terms of size, or of *H. ergaster s.l.* in terms of shape and *H. habilis s.l.* in terms of size. These comparative logged cranial base data are consistent with a taxonomic distinction between *P. boisei* and *P. robustus*.

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The origin and dispersion of the Tupiguarani Indians: a comparative cranial multivariate analysis.

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The discussion about the origin and expansion of the Tupiguarani Indians is prominent among South American archaeologists and anthropologists. In-

formation from archaeology, ethnology and historical linguistics suggests that the Tupiguaranis originated in Central or Southwestern Amazonia and spread in two distinct directions: one towards the south, performed by the Guarani populations, and another along the Atlantic coast of Brazil, performed by the Tupi populations. In this context, some researchers have proposed an ancestral-descendent relationship between the Amazonian Marajoara pottery tradition and the Tupiguarani pottery tradition. The aim of this work is to test this scenario by means of multivariate comparison of cranial morphology among 16 skeletal series, including Guarani, Tupi, and Marajoara human skeletal remains. The comparisons were undertaken through Principal Components and Mahalanobis's Distances analyses. Our results strongly suggest a close association between the Tupiguarani and the Marajoara skeletal remains. In other words, the results obtained support the long held idea that the Tupiguarani culture originated in the Amazon and subsequently spread to other parts of Brazil, Bolivia, Paraguay, Uruguay and Argentina mainly by means of demic diffusion.

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Grooming reciprocity in wild male chimpanzees.

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Understanding cooperation remains a central issue in evolutionary anthropology, although the importance of direct reciprocity as an evolutionary mechanism is questioned. Biological-markets theory provides a useful model for understanding the evolution of cooperative behavior in social groups. Applied to the grooming interactions of non-human primates, as the grooming-trade model, it makes a specific prediction regarding the occurrence of reciprocity: that this should occur when otherwise-preferred rank-contingent benefits are not available. We investigate this model as an explanation for grooming reciprocity among wild male chimpanzees, testing specific predictions derived from the model, using data from the Sonso (Budongo) community.

Our results provide mixed support for the grooming-trade model. While some grooming – and grooming within particular dyads – was directed by lower to higher ranked individuals and higher ranked individuals were on average more reciprocal in their grooming, the prediction that more reciprocity should occur between individuals close in social rank was not supported. Reciprocity varied considerably between dyads and was not related to absolute grooming

effort. The majority of dyads showed a tendency towards reciprocity in their grooming (expressed by duration) but only a small proportion showed strongly reciprocal grooming, although each male had at least one reciprocal grooming relationship. For most dyads, reciprocity of effort occurred through unbalanced participation in grooming bouts. In bouts where both individuals groomed, effort was matched through mutual grooming, not through alternating roles. We suggest that our results are best understood by incorporating risks of currency inflation and cheating into the grooming-trade biological markets model.

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Environmental influence on sexual size dimorphism in humans.

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In humans, as well as in other members of the animal kingdom, females and males exhibit certain levels of sexual size dimorphism (SSD). Mild compared to other species, SSD in humans is well documented. Although variations in SSD between populations have been observed, factors that lead to it are still unclear. Myriad studies analyzed correlation between inter-population variability in SSD and social stratification, polygyny, sexual division of labor, temperature, latitude, and size (Rensch's rule), reporting various levels of correlation. The present study investigates correlation between SSD (measured as a ratio of mean male height to mean female height) among 68 modern human populations and several environmental variables: climate (minimal, maximal and average temperature, seasonality, and precipitation), and latitude. Also, Gross Domestic Product (GDP) per capita and infant mortality were included in the analysis as a proxy measure of socioeconomic status, to test the hypothesis that male stature is more sensitive to environmental factors. Reduced major axis regressions revealed no statistically significant correlation between SSD and climate. Absence of correlation with infant mortality and GDP, did not confirm that male stature is more plastic than female. Allometric regression on population data showed a strong positive linear correlation between female and male height. However, the obtained slope value is inconsistent with Rensch's rule, suggesting that SSD cannot be seen as a function of stature.

Morphological variation of the paranasal sinuses in strepsirrhines.

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Variations in the paranasal sinus anatomy of extant and fossil anthropoid primates have been extensively examined using computed tomography (CT), and have potential utility for phylogenetic analyses. We used this approach to evaluate the anatomy in 18 genera of extant strepsirrhines. The maxillary sinus is formed in all the genera. The loriforms have an additional pseudostium opening to the nasal cavity. In *Propithecus*, the inferior meatus expands laterally in the region anterior to this sinus, as seen in *Gorilla* and *Pithecia*, and the maxillary sinus is segmented into three distinct chambers which have openings to the middle meatus, respectively. In *Eulemur*, an additional sinus-like cavity is formed in the region posterior to this sinus. Sphenoidal pneumatization with an opening to the ethmoidal region is found in all the genera, despite of differences in volume. Distinct patterns of pneumatization of the frontal region are found in *Eulemur*, *Daubentonia*, *Indri*, *Propithecus*, and *Avahi*. The frontal sinus in *Avahi* communicates with the maxillary sinus. In many of the other genera, a small cavity expanding from the ethmoidal region is formed in the circumfrontal-ethmoidal region, and this feature is probably homologous to the frontal sinus. The paranasal sinuses are more variable in form in the Indridae than in the other families. The present study confirms the view that the lack of paranasal sinuses in the Old World monkeys is quite unique among the order Primates.

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The mosaic morphology of LB1: a new 3D geometric morphometric study.

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The taxonomic position of the LB1Flores hominin is strongly debated. Analysis of different skeletal elements has given diverse results: proposed attributions range from early *Homo* to Australopithecine to microcephalic modern human. So far lacking in the analysis of LB1's cranial morphology is the careful evaluation of a large sample of microcephalic modern humans. Here we use geometric morphometric methodology, six microcephalic modern humans, 299 *H. sapiens*, 12 *Pan troglodytes*

and a sample of fossil specimens (1 *H. habilis*, 3 *H. erectus*, 5 *H. neanderthalensis*, 2 *H. heidelbergensis*) to re-examine the morphological affinities of LB1. Three landmark datasets (neurocranial, face, temporal bone) were collected and analyzed separately and combined in order to assess the influence of neurocranial shape and size on results. The data were analyzed with Principal Components Analysis, regression analysis, Canonical Variates Analysis and discriminant analysis.

We show that different datasets give different results. Our neurocranial dataset classified LB1 as *H. erectus* but was highly influenced by neurocranial (brain) size. It showed a high degree of misclassification between *H. erectus* and microcephalic specimens. Our facial and temporal bone datasets were less influenced by size, but were ambiguous in their classification of LB1, pointing respectively to late *Homo* and to microcephalic modern human affinities. Our study confirms a mosaic morphology in LB1 and highlights the importance of sample composition and measurement selection in the interpretation of this controversial specimen's cranial morphology.

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3D, 2D or score: a comparison of methods for assessing MSM development.

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Musculoskeletal stress markers (MSMs) have been used to reconstruct the behaviors of past human groups but have been criticized on several levels regarding their interpretive reliability for habitual muscle use. One critical factor is that qualitative methods for assessing MSM development have high intraobserver error rates. New methods that quantify MSM surface area may create representations of MSM development that are more objective and ultimately allow more robust statistical analyses. This study utilized a NextEngine 3D laser scanner to measure the surface area and basic dimensions of seven upper limb muscle insertions on the humeri, radii, and ulnae of a sample of adult males ($n=12$) from the Pottery Mound site (LA416) in central New Mexico. Qualitative data was collected from direct bone observation using the Hawkey-Merbs method. The hypothesis tested is that 3D, 2D and qualitative methods will not agree in their results, and that quantitative methods, particularly MSM surface areas, will produce more detailed results. Descriptive statistics and results of Mann-Whitney U tests for asymmetry in MSM development for these quantitative data sets (surface areas and length-width dimensions) were visu-

ally compared among the three data sets. Quantitative and qualitative data were also statistically compared using correlated samples parametric one-way ANOVA. Mann-Whitney U tests for asymmetry in MSM scores and paired t-tests for asymmetry in surface areas produce very different results. 3D data suggests general symmetry in upper limb musculature for these agriculturalists. Categorical scores suggest asymmetrical musculature. These two methods agreed that only two MSMs were symmetrically developed.

Complex patterns of selection at pigmentation loci.

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Variation in human skin pigmentation reflects adaptation to the intensity of ultra-violet radiation (UVR). Under the traditional model, as humans expanded into regions of low UVR novel genetic variants associated with lighter pigmentation arose and were favored by natural selection. This classic model of a hard selective sweep makes certain predictions about patterns of variation in and around pigmentation loci. To test this model, resequencing data for 10 pigmentation loci were generated for 152 chromosomes from six geographically distinct populations. Comparisons with a set of 61 neutrally evolving loci using metrics such as F_{ST} and summaries of the site frequency spectrum reveal that, as a class, pigmentation loci are indistinct from neutral regions in Africans ($TD_{pigmentation} = -0.80$, $TD_{neutral} = -0.82$; $p = 0.92$), non-Africans ($TD_{pigmentation} = -0.38$, $TD_{neutral} = -0.04$, $p = 0.16$), and single populations. However, some loci do differ in specific populations, e.g. the gene *MATP* exhibits an excess of high-frequency derived alleles only in the French Basque ($FWH = -4.11$; $p < 0.01$). The lack of a clear signal of directional selection for pigmentation loci as a class at either the regional or population level suggests that the processes of adaptation and selection have been heterogeneous across human populations. Further, while some individual loci clearly fit the classic model of a hard sweep, this may not be appropriate for all loci in all populations. Alternative scenarios, such as selection on standing variation or polygenic adaptation, may be better models for the evolution of pigmentation variation.

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The Global Mammal Parasite Database: integrating data to examine primate ecology, conservation and infectious disease.

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Wild primates are hosts to a wide diversity of infectious diseases, including many that also infect humans. Understanding the drivers of this diversity is fundamental for many basic questions in evolutionary anthropology, ranging from the role of pathogens in primate socioecology to how parasitism has shaped human evolution. At a practical level, many human infectious diseases have origins in non-human primate populations, and parasites are increasingly important to primate conservation.

In this talk, we describe an online resource – *The Global Mammal Parasite Database* – that we launched in December 2004 and have continued to develop. The database involves collaboration among more than 20 researchers, students and assistants and is freely available for others to use at “<http://www.mammalparasites.org>”. Starting with 2462 records of host-parasite associations, the primate database has more than doubled in size (currently 5650 records) during the past five years, with substantially broader coverage of both host and parasite species. In addition to data on host-parasite combinations and references, records include data on prevalence, sample size, parasite taxonomy, parasite transmission mode, host specificity, and geographic sampling.

In organizing this long-term collaborative effort, we gained new insights to building and integrating large databases, sharing data online, and authorship issues. We describe some of our solutions, including: organizing data into a relational database structure with controls on data entry and checking; achieving taxonomic concordance for hosts and parasites among the 450+ references; engaging with independent research groups that are using the data; and sharing the credit with contributors to the database.

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HPA activity in pregnant and lactating Tsimane' women: implications for maternal health and infant brain development.

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Despite the tremendous interest in understanding the consequences of prenatal stress for fetal health and adult disease risk, the adaptive functions of HPA activity in healthy pregnancies have been less widely considered. Given the

unique human reproductive strategy of giving birth to highly altricial infants, glucocorticoids may play a pivotal role in facilitating parturition and accelerating fetal tissue maturation. The goals of this study are 1) to document the HPA reactivity scope in basal and reactivity measures of cortisol in pregnant and lactating Tsimane' women, and 2) to discuss implications for maternal health and infant brain development. Results indicate that pregnant Tsimane' women have elevated basal cortisol but dampened reactivity measures compared to nonpregnant women, a finding suggestive of maternal buffering during pregnancy. Lactating women have similar cortisol profiles compared to nonlactating women, raising the possibility that breastfeeding serves an important role in attenuating HPA activity following birth, thus reducing the risk for related pathophysiologies such as postpartum depression. Furthermore, Tsimane' infants and children display less rapid negative feedback following a naturalistic reactivity event, an inhibitory process that is coordinated in the hippocampus. These findings are consistent with the proposed hyporesponsive period of HPA activity that extends through infancy and early childhood in part, to protect the developing hippocampus and hypothalamus from the neurotoxic effects of cortisol. Maternal provisioning may overlap with this sensitive period for postnatal brain growth and serve to buffer adversity until the negative feedback mechanisms of the HPA axis are entrained.

This study was funded by a National Science Foundation DDIG BCS-0622576, an American Association of University Women Dissertation Fellowship, a Northwestern University Graduate Research Grant, and a Northwestern University Fellowship and a Northwestern University FAN grant.

Documenting taphonomy and cranial modification in Osteoware.

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Taphonomy is the study of the postmortem changes to bone. Comprehensive documentation of these changes are essential as part of any osteological analyses. As taphonomic descriptions are often qualitative, they present a challenge to the researcher how to document the variables accurately and precisely, as well as analyze the data in comparative contexts. Osteoware addresses these issues by standardizing the data collected with a comprehensive form and providing ample space for description. Observations that are documented include bone color and staining; weathering and surface damage; cultural and curatorial modifications; and the presence of any adherent materials.

Cranial modification resulting from cultural practices as well as inadvertent

deformation such as plagiocephaly should also be thoroughly documented. Documentation should include both skull shape and indicators as to the deforming device(s). Osteoware provides the Osteologist with three forms that standardize the data collection and also a field for long description. This presentation will demonstrate how to use the Osteoware database to document observations regarding taphonomic changes and cranial modification and will include case studies from the Natural Museum of Natural History collections. Osteoware is supported by grants from the National Center for Preservation Technology and Training (NCPIT) National Park Service, and the Smithsonian Web.

Daily energy expenditure in highly active humans in a natural temperate environment.

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How much energy do humans expend undergoing rigorous physical activity in a natural temperate environment? Numerous studies have explored the cost of human basal metabolism, thermoregulation, and activity; however few have taken this research outside of the laboratory and into a natural environment. In this study, we measured the daily energy expenditure of healthy, highly active adults participating in a National Outdoor Leadership School course. Daily energy expenditure (kCal/day) was measured over a six day period using the doubly labeled water and flex-heart rate methods. Daily activity, including hiking and rock climbing, and daily caloric intake were also measured during this period. Resting metabolism measurements and flex-heart rate calibrations were performed using oxygen consumption and carbon dioxide production both before and after subjects participated on their course. The high activity levels of and limited cultural buffering available to this sample allows this study to serve as a model for predicting daily energy expenditure for early human pastoral cultures as well as modern hunter gatherer societies. Furthermore, this study provides the basis for future comparison of human daily energy expenditure in extreme hot and cold environments.

Systematic examination of infant growth metrics and their association with development of obesity in early adulthood: The Fels Longitudinal Study.

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Rapid infant growth predicts obesity, but the best metric for use in clinical settings is unclear. We compared growth status measures: weight for age CDC z-scores (CDCWAZ), length for age CDC z-scores (CDCLAZ), and weight for length z-scores (CDCWLZ) measured every 3–6 months from birth to 3 years, and rapid infant growth (defined as $> +0.67$ SD change in score) from birth to each subsequent age, in relation to the risk of obesity (BMI > 30 kg/m²) in early adulthood (20–30 years of age) in 512 infants in the Fels Longitudinal Study. Odds ratios (OR) and c statistics were calculated using logistic regression models adjusted for sex, gestational age at birth, age at adulthood obesity assessment, maternal and paternal BMI and birth CDCWAZ. For the status measures, CDCWAZ at 1 month had the strongest association and greatest c statistic for risk of obesity (OR=6.0, 95% CI 2.0–17.6, $c=0.834$, comparing those \geq 75th percentile to those $<$ 75th percentile). CDCWLZ and CDCLAZ were more weakly and inconsistently associated. Looking at rapid infant growth, CDCWLZ change from birth to 36 months provided the strongest association and greatest c statistic (OR=7.6, 95% CI 1.6–36.7, $c=0.858$, comparing those $> +0.67$ SD to those -0.67 to $+0.67$ SD). These c-statistics are high, indicating comparable predictive ability to widely-used chronic disease risk assessment tools such as the Framingham Risk Score. Simple infant growth metrics, in combination with parental BMI, may provide a useful tool for targeting obesity prevention efforts very early in life.

Anthropological study on medieval Korean people.

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Anthropological study on ancient remains excavated from archaeological

site is very important to understand physical characteristics, health and disease of medieval Korean. We will present herewith our research achievements on medieval Korean people until now.

Medieval Korean human remains have been mainly collected from lime soil mixture barrier (LSMB) tomb of Joseon dynasty of Korea (1392–1910). But, the unique structure of the LSMB tomb resulted in the unexpected preservation of the corpse from putridity and decomposition. Recently, we have been engaged in the excavation of the tombs for several years and collected human remains, which composed our Joseon Dynasty Human Remains Collection. The numbers of the collected cases of ancient Korean remains are as many as 200, and these samples has been used in our anthropological researches.

In the past years, we found dental caries, osteoarthritis (OA), rheumatoid arthritis (RA), diffuse idiopathic skeletal hyperostosis (DISH), spina bifida, kyphosis, spondylolysis, osteomyelitis and traumas from them. The parasite infection by *Ascaris lumbricoides*, *Trichuris trichiura*, *Pragonimus westermani* or *Chlonorchis sinensis*; and viral infection were also found in medieval human remains. The studies of enamel hypoplasia, harris lines, and arteriosclerosis in the mummy, aDNA studies on autosomal and Y-STR analysis have been done as well.

Through our researches, we were able to confirm the various diseases affected medieval Korean society. These researches would be helpful for us to understand characteristics and changes of ancient diseases and physical states of ancient Korea people.

This work was supported by the Seoul National University *Brain Fusion Program* Research Grant.

Bear phalanx traumatically introduced into a living human: prehistoric evidence.

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Traumatically induced skeletal injuries are relatively common in the archaeological record. Most such injuries can be ascribed to a 'normal' range of events that occur during an individual's lifetime. Alternatively, a more restricted group of trauma induced skeletal injuries in prehistoric populations provides deeper insights into cultural history. Such cases might include those referable

to medico-surgical and religious/ritualistic practices. We describe prehistoric evidence of the traumatic insertion of an *Ursus* distal paw phalanx into the elbow region of a living human that then healed and remained *in situ* until death and its cultural implications.

The individual derives from the Central California archaeological site of CCo-295. Assessment of the artifactual component suggests a Middle Horizon date (≈ 1500 –500 B.C.). The skeleton is that of a female aged between 30–40 years. Comparisons were made with the other 159 recovered individuals to define the normal range of arm bone morphology and compile data on the range of pathological conditions present. Three *Ursus* subspecies ($n=15$) were examined in order to identify the taxon represented by the phalanx.

The distribution of fractured bones indicates crushing by a heavy object. This woman was wearing bear paw elements at the time of her injury, either as an arm band or attached to her clothing. A bear phalanx was driven into her elbow region, the basal phalangeal tubercle being impressed into the supra-articular region of the humerus. The presence of *Ursus* body parts indicates an elevated societal role for this female, mostly likely that of a shaman or healer.

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MorphoBank: collecting and storing phenomic data for phylogenetic research in the "cloud".

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The web-application and database, MorphoBank, has been in place for a decade for use by biologists assembling phenomic data to test phylogenetic hypotheses of fossil and living species. This web workspace and archive supports distributed, collaborative research by autonomous groups of scientists. MorphoBank implements many tools similar to those in widely-used desktop programs (e.g., MacClade) but in a web environment. Several advantages result from this development: 1) Teams can collaborate on data collection in real time, particularly as teams, rather than individuals, increasingly conduct phylogenetic research. All team members simultaneously work on one copy of the data; 2) New media manipulation tools permit documentation of characters and states with a range of media, such as 2D and 3D images, video, and sound. Use of media frequently enhances communication of homology concepts; 3) New zooming and labeling tools implemented in MorphoBank leverage the dynamic power of the web to make media affiliated with cells maximally useful; 4) The database permits storage

of metadata (species names, media, collection information, etc...) that map to Darwin Core 2 and Dublin Core community standards. Collecting data in MorphoBank marks a shift from keeping data on local hard drives to keeping it within the "cloud" where software can be centrally maintained and upgraded. One of the largest projects in MorphoBank currently is the NSF-sponsored Assembling the Tree of Life for Mammals project with a team of over 20 researchers collaborating on over 4,000 phenomic characters for phylophenomics.

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Survey of actual and potential insect prey for two chimpanzee communities of Gombe Stream National Park, Tanzania.

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Insects are consumed by chimpanzees across Africa, though often little is known regarding the availability and abundance of insect prey (or potential prey). Here we present results from a transect survey of ants, termites, and honeybees in Gombe Stream National Park, Tanzania.

We walked twenty-two paired 500m transects (one following an existing trail and the other in a random cardinal direction from the same origin) and two additional 500m transects in late 2009 – early 2010. The habitat type along each transect was scored at 10m intervals. We hand-collected samples from all social insect nests and trails detected within 3m of the transect. The eleven transects on existing trails were re-walked to assess driver ant (*Dorylus* spp.) abundance.

Insect genera known to be consumed by chimpanzees were abundant across the area surveyed. Among ants, *Crematogaster* spp. were detected on every transect. Both *Pachycondyla* spp. and *Camponotus* spp. were common. *Dorylus* spp. were rare, and *Oecophylla longinoda* were not detected. Among termites, *Pseudocanthotermes* spp. and various soil-eating termites were detected more often than *Macrotermes subhyalinus* (counting both mounds and foragers). We detected one honeybee (*Apis mellifera*) hive, and foraging honeybees were uncommon.

Gombe chimpanzees ignore some potential insect prey that are abundant, accessible, and palatable. In the Kasakela community, insect prey choice does not correlate with abundance as measured by our survey. We conclude that the potential rate of intake for different

insects, the corresponding caloric and nutritional returns, and community feeding traditions have stronger influences on prey choice than relative abundance.

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The ontogeny of feeding ecology in ring-tailed lemurs.

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Social processes help shape feeding behaviors and guide developing animals through key life history and dietary transitions. Learning what and where to eat from other group members may be essential for some primate species to master complex feeding ecologies, whereas in others directed social learning may not be present. Few comparative data, particularly from strepsirrhines, are available to test hypotheses on social processes associated with the ontogeny of feeding behavior. Here I present mixed longitudinal data collected on infant, juvenile, and adult ring-tailed lemurs at the Beza Mahafaly Special Reserve to document the transitions through food types and test for directed social processes (e.g., co-feeding) that contribute to young animals learning group-specific diets. Infant lemurs show food exploration behaviors as early as two weeks and ingest young leaves at four weeks, mature leaves and flowers at five weeks, tougher to process fruits at seven weeks, and show no suckling behavior by the end of seven months. Infant diets largely overlap with maternal diets. Juveniles have more diverse diets than either adults or infants and show higher dietary overlap with members of their own age category than with other members of the social group. Infants typically use co-feeding behaviors as they begin to feed on their own. However, rather than as a targeted learning process, it seems that the act of their nearest neighbor feeding (typically their mother) stimulates an infant to feed on the nearest items, whether or not it is typical of group diet. This study was supported by the National Science Foundation (DDIG # 0851761), J. William Fulbright Foundation, Primate Conservation, Inc, and the ASU School of Human Evolution & Social Change.

A 3D musculoskeletal model of the chimpanzee for movement analysis.

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Chimpanzee locomotion has long provided a critical comparative context for studies of human locomotor performance and the evolution of hominin bipedalism. However, in contrast to humans, much about the mechanics, energetics and control of chimpanzee locomotion is still unknown. Musculoskeletal modeling and simulation provides a robust method for integrating complex morphological and experimental data, and permits estimation of quantities that are difficult or impossible to measure *in vivo*. In this study, we develop a model of the chimpanzee in order to begin filling the gaps that exist between our understanding of human and chimpanzee neuromusculoskeletal function.

We constructed a 3D musculoskeletal model of the chimpanzee (*Pan troglodytes*) in SIMM[®]. The model includes geometric representations of skeletal elements, kinematic descriptions of the joints, and Hill-type models of 35 muscle-tendon units of the hind limb. The model allows calculation of muscle-tendon lengths and moment arms, as well as force and moment generation capabilities of the hip, knee, ankle and foot musculature. Here, as an important step in model validation, we compare the predicted muscle moment arms from our model to previously published measurements from chimpanzee cadaveric specimens.

We found good correspondence between the predicted flexion-extension moment arms in our model and the published data. In general, our model reproduced both the direction and magnitude of the measured moment arm functions. These results indicate that our musculoskeletal model is suitable for inverse and forward dynamics analyses of chimpanzee hind limb function during walking, running and jumping.

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An assessment of biological affinities among the prehistoric inhabitants of the Iranian Plateau and adjacent regions based on allocation of permanent tooth size.

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While archaeologists have long claimed the inhabitants of the Iranian Bronze Age site of Tepe Hissar participated in a trade network that stretched across Central Asia, a recent dental study (Hemphill 2010) found no evidence that gene flow accompanied these contacts. However, an earlier craniometric study

(Hemphill 1999) yielded a pattern of phenetic affinity between southern Turkmenistan and Iranian Plateau samples indicative of gene flow. This study seeks to resolve the contradictions in the results of these prior studies through an assessment of the patterning of permanent tooth size allocation. Patterning of permanent tooth size allocation among the inhabitants of Tepe Hissar (n = 139) was compared to those obtained from 12 archaeological samples from Central Asia and the Indus Valley (n = 465). Raw tooth size was scaled against the geometric mean by sample to correct for sex dimorphism and evolutionary tooth size reduction. Pairwise differences in tooth size allocation were assessed with simple Euclidean distances. The diagonal matrix of Euclidean distances was submitted to hierarchical cluster analysis, neighbor-joining cluster analyses, multidimensional scaling, and principal coordinates analysis. Results are consistent and clarify affinities between the inhabitants of Tepe Hissar and south Central Asians. Tepe Hissar inhabitants appear to have experienced gene flow with Middle Bronze Age populations of southern Turkmenistan, but not with Late Bronze Age populations of southern Uzbekistan further east. Tepe Hissar possesses equally close affinities to the later inhabitants of Hasanlu IV. Such findings suggest trade connections shifted from Central Asia to the west by the Late Bronze Age.

Testosterone correlates of paternal care and mating effort in savannah baboons.

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Testosterone (T) is widely used as a biomarker of reproductive tradeoffs primarily because of its positive effects on sexual behavior and physiology on the one hand and negative effects on paternal care on the other. However, previous studies on the role of T in mediating reproductive tradeoffs have mostly focused on monogamous species or on seasonal breeders. Consequently, there are major gaps in our knowledge of whether T mediates the tradeoffs between mating effort and paternal care among non-monogamous males in species that breed throughout the year. In the present study of adult males in a wild population of savannah baboons, we determined whether opportunities for mating and paternal care predicted concentrations of T. Mating opportunities were estimated using the number

of fertile females whereas opportunities for paternal care were estimated using the number of immature offspring a male had in the group. We determined concentrations of T non-invasively from fecal samples. Controlling for age, dominance rank, season, and temperature, which are known to influence T levels, we found that only the number of a male's immature offspring predicted concentrations of fecal T ($t = -2.287548$, $p = 0.0231$); males with more immature offspring had lower concentrations of T than did males with fewer immature offspring. Our findings are consistent with the predicted inhibitory effect of T on paternal care but are surprising for a species that reproduces throughout the year. Results of the present study suggest that paternal care is an important component of reproductive effort in male baboons. This study was funded by the National Science Foundation, grant numbers IBN-0322613 and BSE-0323553 to J.A. and S.C.A.); the National Institute of Aging, grant number P30AG024361 to J.A. and S.C.A.); and the National Science Foundation's Doctoral Dissertation Improvement Grant to P.O.O.

Mechanoreceptivity of prehensile tail skin varies between atelines and *Cebus*.

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The prehensile tail of New World Monkeys may have evolved twice (in parallel): once among the Atelines (*Alouatta*, *Ateles*, *Brachyteles*, *Lagothrix*), and once in *Cebus*. This line of reasoning derives primarily from musculoskeletal evidence suggesting similar mechanical structure of the prehensile tail in these two groups. Both atelines and *Cebus* have caudal vertebrae capable of withstanding significantly higher bending stresses than nonprehensile-tailed platyrrhine caudal vertebrae. Atelines and *Cebus* also share similar pinnation angles, fiber lengths, and physiologic cross-sectional areas of the prime lateral flexors of the tail (*mm. intertransversarii caudae*), indicating that these muscles are capable of producing higher contractile forces than those of nonprehensile-tailed platyrrhines without any trade-off in contraction velocity. Given that bone and muscle morphology of the prehensile primate tail is drastically different from the nonprehensile tail, the parallels are remarkable. Externally, the most drastic anatomical difference among prehensile tails of ate-

lines and *Cebus* is the presence of a volar pad on the distal third of the ventral tail in the former, and the lack of a volar pad (i.e., fully-furred tail) in the latter. This study investigates the presence of mechanoreceptors (e.g., Meissner's Corpuscles) in the ventral tail skin of atelines and *Cebus*, anatomy associated with high tactile precision and prehension. Our data indicate that the volar pad of *Lagothrix* contains Meissner's Corpuscles, whereas the tail skin of *Cebus* does not. These data suggest an as-yet unidentified means by which *Cebus* samples its environment from a sensory (touch) perspective.

New wrist bones from *Homo floresiensis*.

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The carpals from the *Homo floresiensis* type specimen (LB1) lack features that compose the shared, derived radial-wrist complex of Neandertals and modern humans. This paper comprises a description and three-dimensional morphometric analysis of new *H. floresiensis* carpals: a right capitate and two hamates from another individual at Liang Bua (most likely LB6). The comparative sample includes extant great apes, a world-wide sample of *H. sapiens*, and fossil hominins. The new capitate is smaller than that of LB1, but is nearly identical in morphology. As with capitates from LB1, the apes, and species of *Australopithecus*, the new specimen displays a deeply-excavated nonarticular area along its radial aspect, a scaphoid facet that extends into a J-hook articulation on the neck, and lacks an enlarged palmarly-positioned trapezoid facet. Because there is no accommodation for the derived, palmarly blocky trapezoid that characterizes *H. sapiens* and *H. neanderthalensis*, this individual would have had a plesiomorphically wedge-shaped trapezoid (like LB1). Hominin hamate morphology is more conserved across taxa, and the new specimens fall at the extreme edge of variation for *H. sapiens* in a number of metrics. However, they are exceptionally small, and are plesiomorphic in having a robust hamulus lacking the derived oval-shaped cross section characteristic of human and Neandertal hamuli (and variable in those of *Australopithecus*). Docu-

mentation of a second individual with primitive carpal morphology from Liang Bua further supports the hypothesis that the Flores lineage originated prior to the human-Neandertal cladogenetic event and refutes claims that the LB1 wrist is pathological.

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Human remains from the late Upper Paleolithic of Irlich, Germany – a preliminary report.

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Human remains from the late Upper Paleolithic (Azilien, Ahrensburg Culture, Federmesser Groups) in Central Europe are scarce. In 1953 some human bones, covered with red ochre, and associated artifacts were discovered in material taken from a sand pit near the city of Irlich, Germany. The finds were stored in a local museum archive. In 2000 the finds were re-discovered and analyzed with macroscopic, radiologic, and histological techniques. AMS dating of the bones revealed a calibrated age of 12,500 to 11,200 BP.

The bones could be assigned to at least three individuals, represented by a few complete bones or bone fragments each. Age at death of individual 1 was estimated at 20-30 years. An intact femur and a distal ulna from this individual exhibit layers of porotic bone formation, indicative of a pathological process stimulating periosteal bone apposition. Age at death of individual 2 was estimated at 6 to 10 years, and that of individual 3 at about 1 year.

The artifacts consist of a projectile point (antler), two flint artifacts (backed knife, burin spall), a left mandibular first incisor of a red deer with 10 grooves and a perforation on the root.

The scanty fossil report of individuals from this time period makes even poorly documented and fragmented material an important source for this specific period. The finds from Irlich probably represent a multiple burial which seems to have been common during this time. Re-investigations at the site are not possible due to heavy mining activities during the last decades.

Exploring the limits of using the mandibular ramus angle as a sexual indicator in extant and fossil hominids.

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The study of the human mandible in sexual determination has often been overlooked based on Hrdlička's (1940) overwhelming studies showing its lack of significance and evolutionary track. Yet many studies have taken a second look at the mandible since in many forensic cases or archaeological excavations the mandible is frequently recovered. The aim of this study is to determine the significance of the mandibular ramus angle (MRA) in accurately distinguishing between known sex of fossil hominids with extant African great apes and modern humans.

Using Loth and Henneberg's (1996) technique of sex determination, photographs of known adult male and female African great apes (*Gorilla g. beringei*, *Pan paniscus*, and *P. troglodytes*) (n=112), modern humans (n=55) and *H. neanderthalensis* (n=9) were analyzed in ImageJ to determine the MRA of each individual. Metric measurements of the MRA were completed in lateral view and analyzed in Stat-Graphics.

Results indicate that neither species of *Pan* shows a statistically significant difference (p=0.0583, p=0.04783). However, Neanderthals (p= 0.0216) and modern humans (p=0.0000) do. *Gorilla* is significantly different (p=0.0004), but its pattern is opposite to that of *Homo*. This indicates that the MRA of late *Homo* is more similar to modern humans than African great apes in which future work could reveal if earlier hominids show a comparable pattern. Consequently, our conclusions have the potential to improve the understanding on the acquisition of hominid features throughout our evolution and introduce an alternative reliable method of sexing adult fossil hominids.

Differential diagnosis of patellar pathology: use-wear patterns and pathology from Tell Abraq (2200-2000 BC).

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The examination of co-mingled ossuary collections creates unique analytical challenges as bones can only be examined on an individual basis. The estimation of demographic information and the analysis of disease patterning are much more difficult. The focus of this project is to identify and interpret signs of osteoarthritis and defects consistent with osteochondritis dessicans and osteochondral fracturing, as well as score for the presence and degree of musculoskeletal markers, on a the

patellae from a large Bronze Age (2200-2000 BC) ossuary from Tell Abraq, United Arab Emirates. A preliminary estimate of at least 224 adults and 14 subadults was determined; these are used to examine pathology and trauma. Results indicate a high prevalence of osteoarthritis (approximately 51%) and osteochondral defects (approximately 52%) that was not correlated to estimated sex. This lack of correlation may be due to several factors, including challenges in sex estimation, a skewed sex distribution, or an actual lack of correlation. Regardless of the difficulties of estimating sex, individuals at Tell Abraq were exposed to conditions that fostered the development of osteoarthritis and trauma to the knee. Other studies have suggested that this maritime/agricultural settlement, located on the shores of the Persian Gulf, may have been a very important trade destination as well as a meeting ground for groups moving around the gulf region. The unique pattern of wear and tear and trauma to the kneecaps does support the contention that there are a number different types of laborers interred in tomb.

Evaluating competing models of *Pan troglodytes* foraging tool use across space.

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While primatologists have enhanced our knowledge of tool use behaviors in non-human primates, mechanisms driving foraging-related tool use remain poorly understood. Based on results from a previous hypothesis test on wild chimpanzees (*Pan troglodytes*) by Lindshield et al. (previous paper), we present a set of candidate, mechanistic models of foraging-tool use as a response to competition intensity and cultural transmission. We review the literature and compile a dataset of broad classes of tool use behavior across chimpanzee populations. We use the degree of seasonality of rainfall and temperature as proxies for the intensity of competition, and use geographic distance among sites as a cultural transmission covariate. We evaluate eleven (11) competing, mechanistic models using Akaike's Information Criterion (AIC) and the available tool use data to arbitrate between them. Our best model uses rainfall seasonality as its environmental parameter. This simple model predicts the available data with higher probability than models that include additional environmental variables and cultural transmission. Using our winning model, we predict the probability of tool use behavior

across space and provide a probability map for the African continent. The latter will be useful as a theoretical departure for future researchers to test models using newly acquired data on chimpanzees. Moreover, our models may be useful for understanding variation in tool use behavior in humans and other species.

Recording cranial and postcranial measurements in Osteoware.

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When documenting skeletal remains, metric data can be useful for a variety of purposes, including estimating sex, ancestry, stature, and age. Ideally, the measurements would be standardized to allow the greatest number of comparisons to previously published measurements.

The 34 cranial measurements in *Standards* (Buikstra and Ubelaker 1994) follow those of the Forensic Data Bank (FDB; Moore-Jansen *et al.* 1994), which are predominantly based on Martin's classic definitions. In Osteoware, the cranial measurements follow the Howells (1973) definitions, 60 measurements which include all of the FDB cranial measurements as well as additional measurements, including subtenses, fractions, and radii. These measurements are stored in fields named for Howells' three-letter designations for craniometrics. Mandibular measurements are those included in the *Standards*. Additionally, saving a record requires a designation for whether or not the cranium has been reshaped through cultural means.

Postcranial measurements in Osteoware, as in *Standards*, come from the 44 FDB definitions plus additional vertebral heights and metacarpal and metatarsal lengths. Left and right bones can be entered by choosing side from a drop-down list. Postcranial data are entered separately for adult bones with fused epiphyses and for subadult bones with unfused epiphyses.

The entered measurements are checked as the numbers are entered to help avoid data entry errors. To aid further analysis, Measurements from isolated bones can also be entered through the commingled bones entry program.

Osteoware is supported by grants from the National Center for Preservation Technology and Training (NCPTT) National Park Service, and the Smithsonian Web 2.0 Fund.

Exploring long-term range use among white-handed gibbons (*Hylabates lar*) in Khao Yai National Park, Thailand.

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Standard socioecological models suggest that for many primates home range size fluctuates in response to group size; however, little is known about factors influencing range size in species (e.g. gibbons) for which group size varies little. One possibility is that home range size increases with the presence of additional adult or sub-adult group members. To test this hypothesis, we compared ranging data from one well-habituated gibbon group during three periods spaced across ten years.

In 1994 ranging data were analyzed using a cartographic software program that spatially referenced data onto a measured trail system. In subsequent years data were collected using a permanent botanical grid. We used ArcInfo to overlay maps and performed an affine transformation using 22 common points. Home range areas were determined using the minimum convex polygon method. In 1994, group "A" consisted of two adults and three immatures and home range area was 21.1 ha. In 2002 and 2004 range area increased to 25.1 ha. Average daily path lengths (DPL) corroborate this trend [with significantly longer DPLs in 2002 ($t(16) = 3.831, p \leq 0.002$) and 2004 ($t(12) = 3.095, p \leq 0.013$)]. Thus, despite the potential for increased territorial defense in 2004 range size did not increase. Furthermore, range size and DPLs were smallest when immatures were present.

We speculate that range size corresponds to group composition (rather than size), with the presence of immatures restricting group movement either through an increase in maternal energy requirements or physical limitations of newly independent individuals.

Research in Thailand was supported by grants from IIE Fulbright, National Science Foundation, Boise Fund, Sigma Xi, American Society of Primatologists and the University of Texas at San Antonio.

Investigating Athapaskan history through the analysis of genetic variation in the Tlingit and Haida populations of Southeast Alaska.

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The origins of Athapaskan Indian populations and the timing of their dispersal across the circumpolar region are key

issues for reconstructing the peopling of the Americas, and defining putative links to ancestral Siberian populations. To investigate these issues, we analyzed genetic variation in Tlingit and Haida populations from southern Alaska. In this analysis, we directly sequenced the control region of mitochondrial DNA (mtDNA) in 83 individuals, screened them for eight SNP markers that define the basal portions of the mtDNA phylogeny (L, M, N, and R) through Custom TaqMan assays, and surveyed them for haplogroup defining SNPs through PCR-RFLP analysis. For a select set of samples, we also sequenced the entire mtDNA genome to obtain greater phylogenetic resolution of these maternal lineages. For the Y chromosome analyses, we screened 27 male samples with 23 SNPs and 17 STRs using ABI custom TaqMan assays, AmpF ϕ STR Yfiler, and Y Multiplex II kits. Our results show that the majority of individuals (86.7%) have mtDNAs belonging to haplogroups A, C, and D, with remainder having non-native haplogroups. In addition, some 40% of the male individuals belonged to haplogroups C and Q, with the remainder having non-native haplogroups. These data provide important insights into the genetic and linguistic history of Athapaskan populations in this region, as well as more recent historical influences on genetic variation there. Furthermore, in combination with genealogical, ethnographic and historical information, we are able to explore the migration histories associated with their clans in different parts of Southeast Alaska.

This study was funded by the National Geographic Society, IBM, the Waitt Family Foundation, and the Department of Anthropology at the University of Pennsylvania.

Do we need additions to the geometric morphometrics tool-box?

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D'Arcy Thompson represented direct differences between animal structures by elastic deformations. Fifty years later Oxnard showed they could aid in interpretation of multivariate statistical axes. Nowadays such elastic deformations, as Cartesian transformation grids drawn using thin plate splines, are most useful in understanding geometric morphometric results. They are now very widely used.

New ways of gathering data about forms and patterns use not only standard anatomical landmarks, but also semi-landmarks and sliding landmarks, both of which help to increase the information content of form, especially of relatively large, unfeatureless regions, like

the skull vault. Transformation grids treat these landmarks as points on rubber sheets (in two dimensions) or in rubber volumes (in three dimensions). Elastic distortions of the rubber sheets and volumes computed using thin plate splines can help visualize differences or changes in biological form.

What happens, however, when differences between structures in different species, or changes in structures within a single species, are not well represented by elastic deformations? What happens, in other words, when the differences or the changes involve non-elastic deformations? The developmental, functional and evolutionary biology of landmarks on hominid skulls suggests that non-elastic deformations are common. Sometimes two-dimensional rubber sheets develop holes or cusps, and three dimensional rubber volumes explosions and implosions. Transformation grids are ill suited to such phenomena. In other words the biology indicates that new approaches are needed to handle such complexities. How to do it is the question.

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The effects of logging, hunting, and vegetation on the densities of simakobu monkeys (*Simias concolor*) on the Pagai, Mentawai Islands.

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One of the primary goals of conservation biologists is to determine how various factors affect animal populations and in particular, endangered species. In this study, the effects of three variables - logging, hunting, and vegetation, and the interaction between hunting and vegetation - on the endangered and endemic simakobu monkey (*Simias concolor*) were investigated. The study was conducted in nine forests varying in logging history on the Pagai, Mentawai Islands. Hunting-related, vegetation, and simakobu density data were collected along three 4km long transects spaced 300m apart in each forest. Hunting data included correlates of hunting intensity such as the number of logging roads, local trails, and the number of people observed intersecting the transects. Also, every 200 m, information on all trees ≥ 3 cm dbh within a 25m by 5m quadrat was recorded. ANOVAs and ANCOVAs were employed, but none were significant (e.g., ANCOVA, $df = 8$; $F = 0.3812$, $p = 0.814$). Reasons for this could be the low power of the tests to detect effects of the independent variables (i.e., the main effects), the small

sample sizes ($n = 9$ sites), etc. However, one can envision a scenario in which the upper ranges of simakobu populations are set by resource availability. In turn, resource availability depends on the vegetation in a habitat. Logging either enhances vegetation and resource availability for specific primate species, or diminishes it. Hunting is then layered on top, lowering the densities already established by habitat vegetation and the effects of logging upon it. This study was funded by the Wildlife Conservation Society and Primate Conservation, Inc.

Challenging population-based variation in bone-turnover rates: implications for interpreting the impact of diet and disease, growth and development, and the aging process on rib microanatomy.

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The use of histological assessments for determining bone-turnover rates and its implications for estimating the age of individuals has been critically evaluated in both archaeological and forensic contexts. To date, explanations for why estimated age-at-death values from histological data diverge significantly from expected figures using osteological assessments or autopsy data have generally been explained as a result of influences from biomechanical action and/or metabolic stress.

Our findings related to rib microanatomy and age-at-death of a sample of autopsied individuals known to have died from forms of malnutrition showed extremely slow bone-turnover rates represented by low Osteon Population Density (OPD). A consistent criticism of this work has been that a comparative sample of 'normal' individuals was needed to draw our conclusions. We argue here that the focus should shift to addressing the much broader issue of questioning the existence of inter- and intra-population variation of bone-turnover rates. To this end, an extensive review of the osteological and genetic literature shows no compelling evidence for any type of inherent population variation in the tempo and mode of bone-turnover among humans.

Furthermore, we report here that a comparison of histological age-at-death estimation formulas based on various baseline populations do not show significant differences between them. The implications of these conclusions speak to the need to increase our understanding of bone-turnover rates in the broader context of diet and disease, growth and development, and the aging process. The application of this work to the archaeological and evolu-

tionary record of our species is also highly significant.

Hardness as a proxy for stiffness: the utility of portable durometers for estimating elastic modulus of primate foods in the field.

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Among the material properties of primate foods, elastic modulus (E) or stiffness is recognized as an essential variable for determining fracture characteristics. Assessment of stiffness in the laboratory is straightforward; however, obtaining reliable stiffness measures under field conditions presents significant logistical hurdles. Portable durometers are relatively inexpensive, durable and can provide consistent hardness measurements of primate foods. Hardness can be shown to correlate positively with elastic modulus for some materials. In this study, we evaluate whether Shore A and D hardness values can be effectively used to estimate elastic modulus of plant and other organic materials.

We collected Shore A and D hardness values using hand-held durometers (Hoto Instruments, Northbrook, IL) from a variety of commercially available foods, woods, and primate foods from the Taï Forest, Ivory Coast. Stiffness was determined on the same samples using an MTS 858 tester (Eden Prairie, MN). We calculated regressions for converting A and D hardness to E . The Shore D scale (for harder materials) provides good indication of relative stiffness and reasonable estimates of absolute stiffness of hard primate foods. The Shore A scale (for softer materials) was found to be less effective for predicting relative or absolute E of those foods which return values at the high end of the Shore A range. Finally, due to the heterogeneity of natural materials, the selection of surfaces from which durometer data are collected is critical, and the relationship of hardness to E appears to be distinct for particularly brittle materials.

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The Roman giant: overgrowth syndrome in skeletal remains from Imperial Age.

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The aim of this work is to present a case of gigantism in an Imperial Age skeleton from Fidenae, an ancient town of Latium, situated about 8 km north of Rome (Italy) on the Via Salaria. The skeletal remains of a large adolescent male, 17-20 years old, were excavated in the Torre Serpentana necropolis (Ith-IIIth century AD); this individual exhibits very tall but normally proportioned stature, estimated around 204 cm. The long bones do not show complete epiphyseal union; therefore the stature would probably have been taller, if he had lived longer. In this work the metric data is compared with those from the Roman Imperial Age population and those reported for other cases of gigantism, and differential diagnosis is discussed. The skeletal evidence is characteristic of a form of gigantism, a rare growth disease that may be linked to different syndromes. The most common etiology is associated with a dysfunction of the pituitary gland that causes overproduction of the growth hormone during childhood. This endocrine disorder stimulates cartilaginous growth at the growth plate, delaying epiphyseal fusion and ultimately resulting in increased bone length.

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Metric assessment of the foramen magnum for sex determination in adults and subadults.

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The basal region of the human skull is robust and well protected by soft tissues and tends to withstand inhumations (Graw, 2001; Gapert et al., 2009) and physical insults (Holland, 1989). Osteometric studies have tried to evaluate the skull base and especially the foramen magnum (FM) as indicator of sex in adults (e.g. Gapert et al., 2009; Günay et al., 2000; Uysal et al., 2005) and subadults (Veroni et al., 2009). However in most studies (Gruber et al., 2009) the full potential of the method was prohibited due to the small sample size. Aim of the present study is to assess the use of FM for sex determination in adults and subadults and to develop discriminant functions. The sagittal and the transverse diameter of the

FM were assessed on 597 skulls from an ossuary (17th-19th c. AD, Grisons, Switzerland) and additional data were collected from Central European archaeological populations and skeletal collections (10.000 BC – 1900 AD) for comparative purposes. The FM size showed significant differences between sexes on all larger skeletal samples (>30 individuals). The correlation between FM diameters was significant for both sexes, but low (rho c. 0.25–0.55). The classification accuracy of DFA ranged between 58 % and 75 %. The FM showed no size change after 7 years of age, signifying the use of FM on sex determination of children and juveniles. The present study demonstrates the utility of the FM as sex indicator, particularly useful for subadults and poorly preserved or cremated skeletons.

Nocturnal ranging in a diurnal prosimian primate: is this cathemeral-like behavior an effect of the mating season, habitat, or something else?

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Occasionally, anecdotal reports emerge of nocturnal activity occurring in diurnal primates. The ring-tailed lemur, *Lemur catta*, is a diurnal prosimian for which such anecdotal reports of night 'wakefulness' exist. To further investigate the possibility of nocturnal activity in this prosimian, 5 individuals (3 males, 2 females) from 3 social groups on St. Catherine's Island, USA were fitted with GPS (Global Positioning System) collars across one week of the breeding season in November 2009. Collars were programmed to record location data once every half-hour, around the clock.

GPS data revealed nocturnal activity in the form of ranging behavior (traveling). A peak in nocturnal ranging (apart from the hours surrounding dawn and dusk) took place between the hours of 2300 and 0300. Mean distance travelled during these hours was 213m (n=5). The maximum distance travelled by an individual (a male) was 2.2km in a single night. All but one individual demonstrated nocturnal ranging across the majority of nights the collars were deployed. Data also captured a nocturnal inter-group encounter at 0200 once during the study. These results suggest that under particular habitat conditions (or perhaps only during the mating season), ring-tailed lemurs can exhibit significant amounts of both diurnal and nocturnal activity in a seemingly 'cathemeral-like' fashion. Cathemerality, an activity pattern comprised of distinct periods of diurnal and nocturnal activity, is a trait most commonly associated with other Malagasy prosimians (e.g. *Eulemur* and *Hapalemur* spp.). Night

ranging behavior of this sort by *L. catta* has not been previously described. This research was funded by the Social Sciences and Humanities Research Council of Canada (grant # 820-2008-1047) and the Connaught Fund of the University of Toronto.

Sex and age-specific trends in the loss of life from tuberculosis in Sanday and Westray, Northern Orkney (Scotland), 1861-1961.

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Tuberculosis is an ancient disease that has plagued humans since prehistory. It continues to be a significant factor in human mortality and epidemiology today, and current estimates indicate that around a third of the world's population is infected. In order to investigate the historical epidemiology of tuberculosis in North Orkney, Scotland, historical vital records and census data were used to create multi-decrement age- and sex-specific life tables over a hundred year period. From our life tables we were able to quantify the loss of years of life attributed to the presence of tuberculosis. Whereas females were more likely to die of tuberculosis, males lost a higher average number of years because of infection. Spatial clustering of TB deaths only occurred in villages with piers with little or no clustering in the rural areas that make up most of northern Orkney. While tuberculosis was a major cause of death for much of the Western world in the eighteenth and nineteenth centuries it contributed only a small portion of the total mortality in North Orkney. Most likely, the low population density of Orkney relative to much of the rest of Western Europe kept TB from being a major cause of death. Further analyses will investigate both the influence of socio-economic status and potential underreporting and differential diagnoses in relation to changing physicians over time. Our findings have implications for both understanding the historical epidemiology of preindustrial regions and for understanding tuberculosis mortality dynamics in modern, industrializing regions.

Data collection for this study was funded through the NSF and NICHD.

The distribution of long chain fatty acids across the Cape marine and terrestrial landscape and implications for encephalisation of MSA hominins.

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Recent research has highlighted the potential role of aquatic resources in the development of anatomically and behaviourally modern people in Africa. It is argued that marine and lacustrine foods including molluscs and fish are rich in the long chain, polyunsaturated fatty acids required for human brain development and maintenance. Broadhurst et al. (1998: 3), for instance, hypothesize that the exploitation of aquatic resources is heavily implicated in the expansion of the cerebral among East African hominids which evolved between 1 and 2 million years ago. The first appearance of anatomically modern *Homo sapiens* between 200 000 and 100 000 years ago is furthermore accompanied by evidence of sophisticated lithic technologies and the harvesting of lacustrine molluscs and fish. The proposed link between aquatic resources and brain development is equally salient in the archaeology of the South African coast. In the western and southern Cape, some of the earliest remains of anatomically modern humans occur together with the earliest evidence for the systematic exploitation of marine resources (Berger and Parkington 1995; Parkington 2001; Parkington 2003; van Andel 1989; Volman 1978). It is widely believed that these resources played an important role in the development of anatomically and behaviourally modern people on the subcontinent. However, the actual fatty acid composition of local marine and terrestrial fauna has yet to be determined and reported. We have collected a wide range of samples from indigenous species known to have been eaten by prehistoric foragers who occupied the region during the Upper Pleistocene and Holocene. These will be processed and analyzed to determine their chemical composition. The nutritional value of these resources, including their protein content and that of other essential macronutrients such as iodine and iron, as well as sugar and starch content, will be assessed by means of chemical assays. The fatty acid composition of local marine and terrestrial fauna will be determined through gas chromatography. In this way, the nutritional status of Middle and Later Stone Age hunter-gatherers will be described and the contribution of marine resources to their diets evaluated.

An analysis of non-masticatory wear in the prehistoric Chamorro from Tumon Bay, Guam in the Marianas Islands.

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The prehistoric period in Guam includes the Pre-Latte and Latte periods. A

study from Naton Beach excavated from Tumon Bay in Guam has yielded a large number of Pre-Latte burials which have interesting examples of atypical dental modification, which is not seen on the later Latte burials. While modification of the teeth for non-masticatory reasons has been discussed in various populations around the world, it is rare and found in solitary instances across the Mariana Islands. In both time periods, dental modifications have been noted on the labial surface of the teeth and include horizontal abrasions, tooth filing/incising and possible drilling for inlays. This study focuses on the tooth abrasions.

Macro- and microscopic analyses and digital photographs were conducted using an Omano stereo zoom microscope and Moticom 1000 to elucidate the size and shape of the abrasions and the orientation of the wear. The Pre-Latte sample includes 30 individuals of which 50% (n=15) have tooth abrasion on the labial surface and is not sex specific. The wear appears as horizontal (transverse) striations on the maxillary dentition of the central and lateral incisors, and can extend as far distally as the premolars. Behavioral and task-related activities are considered for reconstructing the dental patterns observed. The need for extensive ethno-anthropological research into use of teeth as tools, subsistence, and crafts is necessary to understand the biocultural phenomena and interaction of the prehistoric Chamorro and the environment in which they lived.

Differential diagnosis of an infection affecting the temporal bone of an individual from Medieval Asturias, Spain.

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This presentation will focus on the differential diagnosis of lesions affecting a single individual recovered from the medieval cemetery of San Juan (Antiguo Colegio San Isidoro) located in Oviedo, Asturias, Spain. The cemetery, which was excavated in 2000, yielded an MNI of 47 individuals dating from approximately 1650-1875 AD.

While multiple individuals recovered from the cemetery present osseous anomalies and disease states, one particular individual (recovered from Tomb 26) exhibits unique bony features associated with some kind of inner ear infection. Unfortunately, this region of Asturias has acidic soils which typically result in poor preservation of osseous materials, thus the only remains available for examination were a fragmentary cranium. The individual is a young adult female aged ~17-25 years. Initially an atypical pattern of asymmetrical dental wear suggested heavier usage of the right dentition. Upon further

inspection, the right external auditory meatus (EAM) was noticed to be enlarged and there was bony destruction and remodeling of the right temporal bone in the region of the sigmoid sulcus with small communications between the intracranium and the inner EAM as well as some changes of the inferio-medial right petrous portion. Because of the bony remodeling present, it is unclear if this infection was the direct cause of death, but the mortality rate of similar intracranial infections is ~20% (Quisling and Johnson 2005). Differential diagnosis specifically from the lesion location and the presence of bony destruction and remodeling, suggests osteomyelitis likely from chronic otitis media, petrositis or mastoiditis (Sherman and Buchanan 2004).

Electromyography of forearm muscles in digitigrade baboons: implications for interpreting the functional morphology of knuckle-walking features in African apes.

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Despite some controversy, researchers hold firm to the idea that the limited range of dorsiflexion at the radiocarpal and midcarpal joints documented in knuckle-walkers is aided by several osseo-ligamentous close-packed positioning mechanisms. Although limited and highly anecdotal, available electromyography (EMG) data from wrist and digit flexor muscles of African apes support these claims. When gorillas and chimpanzees knuckle-walk, there appears to be negligible activity in the flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis, and flexor digitorum profundus muscles. Minimal muscle activity lends support for the hypothesis that only passive mechanisms are needed to prevent these distal joints from collapsing into extreme dorsiflexion as body weight passes over the supporting hand during forward progression.

To investigate this hypothesis further we studied by means of telemetered EMG the activity of forearm muscles in two baboons (*Papio anubis*). Despite their use of an extended digitigrade hand posture, baboons lack the well-developed close-packing morphologies in the radiocarpal and midcarpal joints that are found in knuckle-walkers. We observed that flexor muscles, especially of the wrist, are more active during stance phase in baboons than in knuckle-walkers during both ground and branch locomotion. We infer that these muscles are recruited to minimize dorsiflexion at these distal joints and to maintain a digitigrade posture, which serves to increase effective forelimb length. This new experimental data from non-hominoids supports the interpretation that derived osseo-ligamen-

tous structures that permit close-packed positions in the radiocarpal and midcarpals joints of African apes are knuckle-walking adaptations.

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Comparison of boom calls in *Cercopithecus mona* from Benin and Grenada.

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Cercopithecus mona is one of several guenons known to make low-frequency boom calls. We investigated the level of intraspecific variation in adult male boom calls in a West African and a Caribbean *mona* population living in different habitats. Recordings were made with a Sennheiser shotgun microphone and a DAT recorder, and were analyzed within Raven. *Mona* habitat in Benin is flat, heterogeneous seasonally dry forest (1,100 mm/yr rain) at low altitudes, with relatively low tree diversity and basal area. *Mona* habitat in Grenada is steep, evergreen tropical rainforest (4,060 mm/yr rain) with high tree diversity and basal area. Previous studies have demonstrated that there may be a selective advantage to producing low-frequency calls in densely forested environments, as such calls travel farther and with less attenuation than high-frequency calls. We found the two populations' boom calls to be nearly identical in dominant frequency, lowest frequency, and duration, suggesting that vocal plasticity may be limited. High frequency and bandwidth are significantly different, however, with the Benin population utilizing higher frequencies than the Grenada *monas* ($t=5.33$, $p<0.000$, $n=32$). This may reflect a wider range of acoustic environments available to the Benin population and/or adaptation by the Grenada population in order to take better advantage of a low-frequency acoustic environment. Alternately, the calls in each population may be differentially altered by the surrounding environment or different recording devices. Further studies including additional sites could demonstrate how these acoustic changes, if real, may affect the transmission of these calls in different habitats.

Intercondylar shelf angle: field determination of ancestry from the distal femur.

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In forensic contexts the absence of crania frequently hinders the identification of ancestry. Alternatively, ancestry can be accurately interpreted through the metric assessment of femora. In particular, the radiographic measurement of the intercondylar shelf angle has proven to be an extremely accurate method of differentiating between African and European ancestry groups.

The intercondylar notch height and the posterior cortex of the femur used to assess the intercondylar shelf angle via radiography can also be observed without radiography; yet, a non-radiographic technique has not been developed. Our research fills this void by testing the accuracy of a non-radiographic technique through the analysis of 30 femora from positively identified skeletal remains. Our methods involved laying a straight edged ruler along the most antero-inferior border of the intercondylar notch to the most superior aspect of the intercondylar line. We located Blumensaat's line by orienting the femur in a lateral position such that the medial epicondyle was eclipsed by the lateral epicondyle when viewed from above. Then, using a protractor we measured then angle between the two landmarks. We analyzed the same 30 femora using the Craig and Brogdon techniques and we found no significant differences in the results; thereby, confirming the utility of the non-radiographic method.

Potential of human talus shape for sex discrimination.

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The human talus is subjected to biomechanical forces that affect its size and shape. The potential of the talus for biometric sexing is recognized by anthropologists as it has significant dimorphism relating to its importance in weight-bearing. Variation in talus shape was studied using the Windover collection, a sample where many individuals can be sexed from cranial and pelvic characteristics. Windover is therefore an ideal collection for preliminary studies of sexual dimorphism using non-traditional methods.

A sample ($n=20$) of 10 male and 10 female tali were selected. All tali chosen were from the left side to avoid potential issues of asymmetry. Eleven landmarks, selected to capture the shape of the entire talus including the articular surfaces, were used in relative warps analysis to inspect for key shape differences, regression using shape variables on dummy variables distinguishing males and females, and regression using centroid size and sex as independent variables to account for size factors. There are significant differences (ranging from $p=0.002$ to 0.02) in talus shape between males and females. Further, these analyses identify the pri-

mary areas that produce this variation. The shape of the head was very similar in males and females. The primary differences are lengthening of the body and an increase of the length and width of the trochlear articular surface in males. Based on these results, future study of shape variation in the talus should focus on the trochlea.

Using tests for signatures of selection to validate and prioritize admixture mapping results.

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Admixture mapping is a valuable method for identifying novel gene regions affecting trait values and disease risks that vary among populations. However, since admixture linkage disequilibrium blocks are very large (approximately 6 to 9 cM for African Americans), these regions often contain many genes. Using the idea that tests to detect signatures of selection can help prioritize genotyping for replication and validation, we use admixture mapping and selection screening to identify gene regions and select loci that may identify loci conferring increased risk in a study of preterm premature rupture of membranes (PPROM).

African-American women are at a significantly greater risk of preterm birth than other US resident populations. Women of self-reported African-American ancestry were recruited at Hutzel Hospital (Detroit), the Hospital of the University of Pennsylvania (Philadelphia) and MCV Hospitals (Richmond) ($n = 632$). Genotyping of 371 women with confirmed PPRM and 261 women with normal pregnancy outcomes was completed using a genome-wide panel of 1,509 ancestry informative markers (AIMs) designed for admixture mapping analysis in African-American populations. Using prior allele frequencies from three parental populations (West African, European and East Asian), Bayesian admixture mapping was conducted using the computer program ADMIXMAP. Regions on five chromosomes (2, 8, 11, 19 and 21) were identified as significantly contributing to risk of PPRM. Using Tajima's D, cross-population extended haplotype homozygosity (XP-EHH), and locus specific branch length (LSBL), 14 of 27 SNPs tested show evidence for selection. The SNPs identified using this approach have been prioritized for genotyping in a replication sample.

Activity, ontogeny, and cross-sectional geometry of the femur and tibia.

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This paper explores patterns variation on the cross-sectional geometry (especially shape, as measured by I_{\max}/I_{\min} or midshaft antero-posterior [AP] and medio-lateral [ML] diameters) in the midshaft femur and tibia using three data sets. One data set consists of a world-wide sample of external dimensions of the limb bones, the second of cross-sectional properties derived from CT scans of Zulu, African American, and Khoesan samples, and the third of cross-sectional geometry of the midshaft femur and tibia of 4 women, all of whom have done a substantial amount of running, but started training at different times in their lives. Both the external dimensions and cross-sectional geometry show only weak correlations between midshaft shapes ($r=-0.12$ and $r=0.33$, respectively). Inclusion of bi-iliac breadth as a covariate does not improve the correlation. Results from the 4 runners show an intriguing pattern that may help to explain the results: three of the women began training before their growth spurt and continued heavy training through junior high and high school. All three have relatively flattened femoral and tibial shafts. One runner started training in college and now runs marathons; she has a very round femoral shaft but a platycnemid tibia. These results suggest that running early in life may be essential for producing strong femoral pilasters, but that the tibia may actively model into early adulthood.

Health status vs. burial status in early China.

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It seems indisputable that the social status of an individual within his or her community can have a significant impact on that person's general well-being. Nevertheless, bioarchaeological research often does not find a clear association between burial status and skeletal health. Based on archaeologically derived skeletal collections from China's Central Plains, we examine the

relationship between burial status and health status during two distinct periods: Middle Neolithic Yangshao (5000-3000 BC) when the earliest chiefdom-level societies began to develop and a state-level society dated to the time of the Eastern Zhou dynasty (770-221 BC).

For both time periods, sex of the deceased had the strongest association with burial wealth, although the direction of this relationship was diametrically opposite between the two cases. In the Neolithic series, female burials on average had a richer inventory, while the majority of male burials had minimal or no grave goods. In the Eastern Zhou case, the proportion of male skeletons increased with an increase in burial rank. Age at death was a significant factor in determining burial status for the Eastern Zhou only.

Late onset skeletal markers showed a more direct association with burial status than did those attributes developing during childhood. The collection likely representative of Neolithic farmers, evidenced a significant association between burial status and DJD, and with rates of traumatic injury. In the Eastern Zhou collection, which probably represents urban dwellers, higher status burials were associated with significantly greater frequencies of carious lesions, calculus accretion, and antemortem tooth loss.

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New age constraints on the early Miocene faunas from Rusinga and Mfangano Islands (Lake Victoria, Kenya).

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More than 90 species of mammals, including the stem hominoid *Proconsul*, have been documented from early Miocene deposits on Rusinga and Mfangano Islands (Lake Victoria, Kenya). These faunas form an important comparative reference for understanding the evolution of Miocene mammals in East Africa, and thus their ages are crucial to understanding Miocene mammalian paleobiology. Five select K-Ar dates

from Rusinga suggested that all of the Miocene fossiliferous beds were deposited during an interval of less than 500 kyr at ca.17.8 Ma (Drake et al., 1988, *Journal of Geological Society, London* 145: 479-491). However, the dates were from a limited stratigraphic interval, and all obtained by the conventional K-Ar bulk total-fusion technique, forestalling investigation of internal argon systematics of the samples.

Our recent field studies to clarify the paleoecological and geochronological contexts of Early Miocene catarrhine evolution have yielded new age constraints for the Rusinga/Mfangano faunas. Preliminary ⁴⁰Ar/³⁹Ar incremental heating analyses of biotite from the top of the Hiwegi Formation, and paleomagnetism analyses from the Hiwegi and Wayando Formations indicate that most of the fossiliferous deposits on both islands were likely deposited from ~18-20 Ma. These results suggest that the deposits are considerably older and represent more time than previously thought. Further, it implies that the oldest catarrhines from Rusinga/Mfangano may be closer in age to *Proconsul* species from other early Miocene localities (i.e. Songhor, Napak, and Koru). Thus taxonomic dissimilarities between the sites may be related to paleoenvironmental differences or relatively rapid (<~100 kyr) turnover in faunal composition.

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Division of labor in the jaw adductor muscles of strepsirrhines.

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If each of the jaw adductor muscles has a different biological role, then there should be anatomical differences between the muscles that correlate to dietary differences between taxa. We compared physiological cross-sectional area (PCSA) and leverage of the jaw adductor muscles in frugivorous, folivorous, and insectivorous strepsirrhines to test for division of labor among the muscles of mastication. The ratio of masseter PCSA to temporalis PCSA is greater in folivores than in frugivores and insectivores ($p=0.003$). The ratio of medial pterygoid PCSA to total adductor PCSA is greater in folivores and insectivores than in frugivores ($p=0.026$). These findings support published hypotheses. The masseter and medial pterygoid appear to be emphasized in strepsirrhines that eat tough foods. We found no significant correlation between leverage and diet, for any muscle or bite point. Within extant strepsirrhines, jaw adductor leverage

apparently does not closely track diet; this undermines the use of leverage for inferring diet in fossil strepsirrhines. Rather than making assumptions about condylar translation, we calculated leverage with the jaws in occlusion. Recalculating leverage at maximum ingestive gape would change the leverage results as would altering assumptions about bite force orientation, but the PCSA ratios would be unaffected. Dietary inference for fossil primates would benefit from a combination of techniques that infer both muscle dimensions and mechanical advantage; however, this study highlights the importance of the former over the latter. This study was funded by Duke University.

Macronutrients in leaf resources consumed by a community of monkeys in Budongo Forest Reserve, Uganda.

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Leaves comprise large portions of the diets of monkeys in Budongo Forest, Uganda. They constitute the majority of the diet of folivorous black-and-white colobus monkeys (*Colobus guereza*), and can seasonally represent up to 80% of the diets of typically frugivorous monkeys such as blue monkeys (*Cercopithecus mitis*) and red-tail monkeys (*Cercopithecus ascanius*), indicating that they may serve as an important fallback food. We analyzed crude protein (CP), lipids (CL), non-structural carbohydrates (TNC), and fiber (neutral detergent fiber; NDF, acid detergent fiber; ADF, lignin; ADL) in 67 samples from 32 species of the most commonly eaten young and mature leaves. The Budongo primates ate leaves that contain 10-42% CP, 36-80% NDF, 30-65% ADF, 7-43% ADL, 1-38% TNC and 0.5-7% CL on a dry matter basis. About 60% of the leaf samples contained condensed tannins. Young leaves were higher in CP, but similar in NDF, ADF, ADL, TNC and CL to mature leaves. When compared to leaves of the same species in nearby Kibale National Park, Uganda, which is another stronghold for primates, Budongo leaves were similar in macronutrient composition. Forest guenons are known to have longer retention times than expected based on body size, and colobus monkeys are foregut fermenters, indicating that leaves may provide an important energy source for cercopithecines. Further studies on digestive ecology and food intake are

needed but our results suggest that when eating diets comprised mainly of leaves, monkeys in the Budongo community gain adequate amounts of protein and energy to meet their estimated requirements.

Leprosy and the primate connection.

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The geographic and zoonotic origin of leprosy, one of the most ancient scourges of humanity, remains enigmatic. *Mycobacterium leprae*, the causative agent of leprosy, exhibits a very ancient parasitic lifestyle. Based upon the timing of *M. leprae*'s massive genome decay, it originated millions of years ago, well before the origins of *Homo sapiens*. However, our previous work using a genomic timescale indicates that leprosy spread in the Old World much more recently, around 10,000 years ago. How would this obligate parasite have persisted in the small, relatively isolated human and pre-human populations that peopled the world? We hypothesize that nonhuman primates harbored, and have continued over the millennia, to harbor *M. leprae*. Further, we suggest that a primate reservoir may explain the continuous or even increasing incidence of leprosy in endemic regions of the world despite prevalences below a transmission threshold. To test our hypothesis, we have collected buccal/nasal swabs from South and Southeast Asian macaques. These samples were tested for the presence of *M. leprae* DNA with a quantitative PCR assay that targets the 85b antigen, a gene unique to *M. leprae*. Out of 900 samples tested from different contexts such as temple, urban, and wild macaques, 26 were positive. The positive samples were collected in regions where human cases of leprosy are also high, supporting our hypothesis. Currently we have developed a strain typing method based on multiplex PCR followed by next generation sequencing to determine the type of strains present in macaques and compare them to the human strains.

An assessment of health and lifestyle among prehistoric Chamorro from Tinian Island in the Northern Mariana Islands.

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Earlier investigations of health and disease in the Mariana Islands suggested

the possibility that inter-island differences may be related to differences in environment and/or resource availability and natural disasters on smaller islands. Utilizing dental and skeletal indicators of health recorded in prehistoric skeletons from Tinian, the third smallest island of the southern arc group, this new study focuses on the health and lifestyle of pre-1521 Chamorro living on this island. The indicators of health investigated include cribra orbitalia (CO), linear enamel hypoplasia (LEH), stature, trauma, infection, and dental disease including AMTL, caries, abscessing, periodontal disease, and attrition. Comparisons between Tinian and Saipan Island reveal significantly lower frequencies of LEH, AMTL, and periodontal disease in the Tinian series. When the skeletal series from Tinian and Saipan are compared to those from Guam, the largest of the Mariana Islands, significantly higher frequencies of LEH, caries, and calculus were observed in the Guam skeletons suggesting more childhood stress and oral-dental disease in this series. No significant differences were found for the Mariana Islands skeletons for AMTL, abscessing, limb bone fractures, spondylolysis, infection, or stature. The frequencies of LEH, AMTL, caries, abscessing, and periodontal disease are the lowest in the Tinian skeletons suggesting that the prehistoric inhabitants of Tinian were subjected to less stress levels than those living on the larger islands of Saipan and Guam. The significantly higher prevalence of dental attrition and betel stained teeth observed in the Tinian and Saipan series and other differences are examined to explain these results.

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Striking out and digging in: a biological distance analysis of the Wari expansion and its consequences for local populations using cranial non-metric traits.

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This study focuses on the effect of Wari state sanctioned activities on gene flow in regional populations during the Middle Horizon (AD 600-1000) in Peru. The intensity of interaction between the state and regional populations in the context of an imperialist agenda is often difficult to discern from the archaeological record. Population genetic tests utilizing cranial non-metric data are used to detect increased gene flow or genetic isolation in populations identified as having Wari influence. Appreciable gene flow was likely due to attempts by the Wari to incorporate communities either through direct control or

negotiated alliances. To further address the possibility of direct administration of regional communities by the Wari the results of this study are compared to strontium isotope studies on the same populations. Identification of actual migrants interpreted with respect to the mortuary context and biological distance results allows for a more powerful evaluation of population interactions. Populations from different physical environments and with varying levels of existing social complexity prior to Wari contact were sampled to address questions of differential incorporation strategies. Samples include the Wari heartland in the south-central highlands, south coast, central coast, and north-central highlands.

Middle Horizon populations are also compared to those from the Late Intermediate Period (AD 1000-1400) in these regions to explore changes in social interaction associated with the Wari collapse. The results of this study are important for understanding the genetic consequences of social processes including territorial expansion, military conquest, boundary maintenance and resistance, and alliance formation. This research was supported by the William M. Bass Endowment and the Diversity Enhancement Summer Research Fellowship.

Frequency of diagonal-sequence and lateral-sequence gaits in *Saimiri sciureus* when using lateral branches.

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The widespread use of diagonal-sequence (DS) walking gaits by primates has been associated with mechanical requirements of moving on thin, flexible supports. However, Dunbar and Badam (1999) opportunistically filmed wild, juvenile bonnet macaques moving on fine-branches and branches with lateral stems and suggested that foot placement strongly influenced footfall patterns. DS gaits were more common on thick branches and lateral stems, where the base of support was wide. Lateral-sequence (LS) gaits were more common when animals were on the narrow longitudinal branch, where the base of support is narrow. To test the effect of the use of lateral stems on footfall patterns, two adult *Saimiri sciureus*, a species known to frequently use LS gaits, were prompted to walk under three conditions: (1) a single longitudinal pole, (2) a longitudinal pole with eight lateral poles spaced every 6", and (3) a flat wooden board representing terrestrial conditions. Individuals used DS gaits 100% of the time on the single longitudinal pole (n=96), 98.2% of the time in the lateral pole condition (n=106), and 97.5% of the time in the terrestrial con-

dition (n=39). For all DS gaits, diagonality values suggest that footfall patterns do not become more diagonal when lateral poles are used, or on the ground (single pole average diagonality: 65, lateral poles: 64, ground: 68). These data do not support the hypothesis that use of lateral stems influences footfall patterns.

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Offsetting the costs of reproduction: the role of social support in human evolution.

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Lactation is the most energetically demanding stage of human reproduction, increasing women's energy needs by 25-30%. While this is a significant increase in energy budget, it is relatively low compared to other mammalian species since human milk, like that of other primates, is relatively dilute due to a shared life history pattern that includes the birth of mostly single, slow-growing offspring that maintain close contact with their mothers and breastfeed on demand. The lower cost allows female primates greater flexibility in the strategies they can use to meet their increased energy needs (i.e. increase energy intake, reduce energy expenditure and/or draw on energy reserves). However, the ability of individual females to alter their dietary or energy expenditure patterns is affected by their physical and social environment. Energetics data collected on Amazonian women demonstrates that the social environment, particularly the availability of social support, affects maternal energy budgets, offsetting the cost of lactation. While there is evidence that social support affects lactational energetics in modern humans, the literature provides no evidence of this strategy in our closest living relatives, the great apes. Considering recent paleontological discoveries, we build on the work of others who have addressed the topic of hominin reproductive energetics. Specifically, we add to discussions regarding the role of helpers in providing offspring care and focus on how social support, directed at the woman, could impact maternal energy budgets. As energetic stress is related to fecundity, we consider the importance of offsetting the costs of lactation during hominin evolution.

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Maximal oxygen uptake among the Tsimane: role of acculturation?

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Maximal oxygen uptake (VO₂max) is frequently used as a measure of physical fitness, yet few data exist on VO₂max in non-industrialized populations. Existing work suggests that in both industrialized and non-industrialized populations, VO₂max declines with age in a similar pattern, though at a given age, non-industrialized populations tend to have higher VO₂max than industrialized populations. The Tsimane, forager-horticulturalists from Bolivia, live in both acculturated and remote communities. We hypothesized that Tsimane in remote villages would have a pattern of VO₂max decline similar to other forager-horticulturalist groups, with higher VO₂max at any given age than Tsimane in more acculturated communities. Because of the high levels of activity associated with horticulture and foraging, we predicted that both acculturated and unacculturated Tsimane would evidence higher VO₂max at any given age than the U.S. population. A step test was administered to Tsimane participants from the age of 5 to 82. Estimated VO₂max was calculated using the Astrand-Ryhming nomogram. Tsimane results were compared to data from the Ache, a forager-horticulturalist group from Paraguay, and U.S. data. As predicted, the Tsimane demonstrate higher VO₂max at any given age than the U.S. population, consistent with results collected from the Ache. Rural and acculturated Tsimane populations have far less discrepancy in VO₂max levels at any given age than that seen between the U.S. and Ache or Tsimane populations. The market integration being experienced by Tsimane affects subsistence, but has minimal effects on physical fitness levels, suggesting activity levels may not change with acculturation as much as previously thought.

Mandibular shape variation in extant platyrrhines.

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Platyrrhine species exhibit a wide range of mandibular morphologies, the variation of which has not been extensively studied. Some of this variation is likely attributable to differences in dietary regime. Here we assess mandibular outline shape variation in seven species representing five genera of extant platyrrhine. Shape variation in two different aspects of mandibular morphology was examined: the outline of the mandible in lateral view and the outline of the condyle in superior view. Outlines from digital images of ~400 male and female specimens of *Cebus*, *Chiropotes*, *Pithecia*, *Cacajao* and *Alouatta* were

acquired and normalized for size. Separate elliptical Fourier analyses were conducted to quantify and compare the shape of these aspects of mandibular morphology. The first 20 harmonics were adequate to sufficiently capture the shape of both mandibular aspects. Shape variation was summarized using principal components analysis on elliptical Fourier coefficients. Principal components scores were used to compute Euclidean distances, to assess shape variation. To test for shape differences among taxa and between sexes, univariate and multivariate ANOVAs were conducted on specimen scores. Our preliminary results distinguish *Chiropotes* from all other taxa and indicate separation of pitheciine taxa from each other. Furthermore, condyle outline shape did not exhibit sexual dimorphism in any of our sample taxa. These results demonstrate the applicability of elliptical Fourier analysis in studies of mandibular condyle shape variation and the importance of understanding mandibular shape variation in the context of dietary adaptation and sexual dimorphism in platyrrhines.

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The applicability of histological preservation measures in determining bone integrity.

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Histological preservation measures [e.g., Histological Preservation Index (HPI), Oxford Histological Index (OHI)] are diagenetic parameters used to determine the histological integrity of bone. Although these measures are considered replicable, the results of our investigation suggest that one in particular, an adaptation of the HPI, is prone to both intra- and inter-observer error, even when applied by experienced users. Using light microscopy, 266 thin sections (including 65 examples of serial sections) of the Tell Leilan skeletal material from Syria (2900 – 1900 BCE) were assigned an HPI value by Pitre and Mayne Correia. Intra-observer error was great for Pitre (25.3% error) and there was considerable inter-observer error in assigned HPI values between Pitre and Mayne Correia (24.4%). We suggest that variation in bone preservation — owing to several intrinsic (e.g., age, sex, pathological conditions) and extrinsic factors (e.g., temperature, variety and behaviour of the invading microorganism) — likely exacerbated the observer error in assignment of HPI values in single thin sections and between serial sections. The findings suggest that histological preservation measures may not be useful for determining bone integrity and as a result, not useful as a criterion for the

selection of bioarchaeological samples for subsequent chemical analyses.

Group size, female resource competition, female body size and dimorphism in primates.

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The factors that impact female body size, and how such changes impact sexual size dimorphism, are relatively poorly understood. Several studies suggest that female resource competition may favor larger female body size. Using group size as a proxy for potential female resource competition, Lindenfors (2002) finds no correlation between female body mass and group size across all primates, rejecting the hypothesis. However, female resource competition in primates is tied to resource distribution and diet, and manifests itself in female dominance hierarchies and female territorial defense. If the resource defense hypothesis is correct, and group size serves as a valid proxy for female resource competition, female body mass should be correlated with group size only in frugivores and territorial primates, but not folivores. Body mass and group size data for 155 species were gathered from recent literature. Independent contrast analysis was carried out with PDAP in Mesquite using the 10k trees consensus phylogeny supplemented with recent phylogenetic information for additional taxa. Female body mass is weakly associated with group size across all species, corroborating Lindenfors' (2002) original analysis. Female body mass is strongly correlated with female group size within frugivores and territorial insectivores, but not within folivores. The relationship is strongest among species showing matrilineal dominance hierarchies. These observations support the resource competition hypothesis as formulated in this test. However, support for the hypothesis must be tempered with the fact that the relationship between group size, female resource competition, and selection on female body size is likely far more complex.

Quantifying Palaeopathology: Using Geometric Morphometrics to Develop a Quantifiable Recording Method for Osteoarthritis.

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The current methods used in palaeopathology to record and describe lesions lack standardization, which can cause a high level of subjectivity and inter-observer error in research, making comparison of data challenging. Geometric

morphometrics is a method of analyzing shape differences in objects or organisms using statistical analysis of 2D or 3D images and has been applied to many aspects of anthropological study. This study aims to determine if palaeopathology would also benefit from these techniques. Applying this analytic method to palaeopathology will result in a standardized and quantifiable recording method and decrease the amount of subjectivity and error in palaeopathological research. This poster focuses on my preliminary finds involving the difference in joint shape between healthy and osteoarthritic proximal ulnar joints of individuals from archaeological skeletal collections. Asymmetry and sexual dimorphism were found to be factors contributing to the shape variation of proximal ulnae. Osteoarthritic joints are distinguished from the healthy control samples, with shape differences occurring in the width of the joint and the radial notch. These shape differences may represent joints which are predisposed to the development of osteoarthritis, or may be the result of the disease process on the joint. The application of geometric morphometrics on osteoarthritic joints will not only greatly increase our understanding of the disease and how it affects the skeleton, but will also objectify palaeopathological recording of joint changes.

HapMap-based study of cytosolic GSTs: SNP diversity of xenobiotic-metabolizing genes among human populations.

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Xenobiotic-metabolizing enzymes are involved in interactions between living organisms and their environments. Therefore, it is probably that the evolution of these proteins responds to and reflects changes in environment. Glutathione S-Transferase enzymes (GSTs; EC: 2.5.1.18) constitute the principal Phase II superfamily which plays a key role in cellular detoxification. GST genes are organized in chromosomal clusters; most of these genes are polymorphic, mainly due to single nucleotide substitutions. Different studies proved significant inter-ethnic differences in allelic frequencies of GST genes but, at present, no studies investigated if these genetic polymorphisms reflect random drift or rather selective pressures.

The aim of this study is to test the hypothesis that the genetic variability of GST loci is influenced by environmental changes. Making use of the HapMap database, we analyzed the population differences in the 18 cytosolic GST genes by utilizing allele frequencies of SNPs shared among eleven populations

in the International HapMap project. Comparison between GST data and variation at neutral independent loci was used to verify if GST patterns were related to selective pressures.

Our results show that most GST SNPs demonstrated different patterns among populations of African, Asian and European origin, in accordance with those observed with neutral polymorphisms. Conversely, other GST gene polymorphisms displayed divergent population relationships respect to those obtain with neutral loci, suggesting that these genetic markers may be influenced by environmental changes and therefore subjected to natural selection mechanisms.

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Brain size and endurance running in human evolution.

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Many species of *Homo* exhibited large brain size and locomotor repertoires that included endurance running. While most previous studies have focused separately on locomotor or cognitive evolution, there is increasing evidence for direct links between locomotion and both cognitive function and brain size. Here we review evidence for the association between exercise and cognition in humans and animal models, and the developmental mechanisms that underlie these associations. Several observational studies show positive associations between physical activity and cognition but they cannot evaluate whether a causal relationship exists. Meta-analyses of prospective clinical trials show clearly that exercise training improves cognition, and that the benefits are largest for executive control processes (e.g., planning, working memory, multitasking, scheduling). Exercise training has also been shown to increase the volume of grey matter in the frontal and temporal cortices, as well as in the anterior white matter, and blood flow to the dentate gyrus of the hippocampus. Animal models have been used to investigate the cellular and molecular mechanisms that underlie the effect of exercise on brain structure. These studies shown that neurotrophic molecules such as brain-derived neurotrophic factor, and IGF-1 help to regulate the effect of exercise on brain vascularity and cognitive abilities. Together, these studies suggest that increases in aerobic exer-

cise can improve cognitive function and increase brain size within species. If the cellular and molecular mechanisms are conserved across species, the adoption of endurance running may contribute to brain size increases and cognitive improvements during human evolution.

Comparative genomics of human-ness - what does your DNA tell you about what makes us human?

KATHERINE S. POLLARD. Gladstone Institutes, University of California San Francisco.

Comparative genomics is a powerful approach to investigate the genetic basis for what makes us human. The uniquely human parts of our genome can be identified by comparing rates and patterns of DNA sequence evolution to those in chimpanzee and other animals. Slow evolution suggests functional constraints, whereas rapid sequence change is a hallmark of adaptation. In recent years, our lab and others have developed statistical and computational tools that enable us to scan genomes for lineage-specific changes in the rate of DNA substitutions. Using this approach, we identified hundreds of evolutionarily conserved sequences that were extensively changed in the human genome since divergence from our common ancestor with chimpanzee. Most of these Human Accelerated Regions (HARs) do not code for proteins, but instead are located in introns and intergenic regions near protein-coding genes, suggesting that they may be regulatory sequences controlling expression of adjacent genes. Consistent with the hypothesis that these non-coding HARs contribute to human-specific phenotypes through changes in gene expression, the sequence changes in many HARs are predicted to have created or destroyed binding sites for regulatory proteins. Bioinformatics coupled with experimental follow-up have shown that (1) HAR1 is a novel RNA gene expressed in the neocortex during development; (2) HAR2 is a limb enhancer with human-specific gene expression in the embryonic hand; and (3) HAR152 is a modified binding site for NGN2, an important neurological transcription factor. HARs are promising candidates for understanding the genetic basis for human-specific biology and health.

Stature estimation in Andean skeletal populations: methods, challenges and implications for modern human variation.

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Estimating stature from the skeleton is a classic problem in anthropology. Recent years have seen a florescence of

population-specific regression equations derived from anatomically reconstructed stature (e.g. Revised Fully Technique, Raxter et. al. 2006, AJPA 130:374-384), an increasing recognition of the limitations of existing equations and the importance of inter-population variation in body proportions. Limited work has been published on stature estimation in South American populations, and Andeans present a special problem due to the widespread practice of artificial cranial modification (ACM) and the limited availability of well-preserved, complete postcranial remains. This study focuses on stature estimation in Andean populations from northern Chile (n=119) to assess: a) the applicability of published stature estimation equations to Andean populations; b) the impact of ACM on stature estimation; and c) the implications of the results for variation in modern human body proportions. Differences between anatomically-reconstructed stature (Revised Fully Technique) and estimates from published equations were assessed by matched-pairs t-tests. Of the widely-used equations from worldwide populations, only Feldesman and Fountain's (1996) White equation (both sexes) and Generic equation (males only) (AJPA 100:207-224) performed adequately. Femoral equations for male and female Native North and Central Americans and a Patagonian population (males only) gave the best results. ACM had a negligible effect on stature estimates. Equations using femoral length generally outperformed those employing tibial length, which suggests a unique pattern of body proportions among Andeans relative to other populations from the Americas and worldwide. This may reflect adaptation or random variation specific to this region.

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Homing in on stone: new insights from a virtual reconstruction of the Steinheim cranium.

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The Steinheim cranium represents one of the best-preserved Mid-Pleistocene hominins from Central Europe, but its taxonomic and phyletic status has remained a conundrum since its discovery in 1933. This is partly due to its uniquely gracile build amongst a contemporaneous sample of fairly robust specimens, and its mosaic of generalized archaic (*Homo cf. heidelbergensis*) and

derived Neanderthal features. However, a major hindrance in assessing its morphology has been the specimen's severe taphonomic deformation and partial filling with sediment. Here we present a virtual reconstruction, which attempts to infer its morphology at the time of the individual's death, and we compare variants of its restored morphology with other Mid-Pleistocene hominin crania. We use industrial cone-beam computed tomography to acquire high-resolution volumetric data, remove sediment fillings electronically, and recover all skeletal structures. Based on historical site information, we then infer a taphonomic deformation scenario, which is reversed in virtual reality. The overall morphology of the reconstructed Steinheim specimen is clearly different from that of the Neanderthals, but more closely associated with this taxon than with any other well-defined hominin taxon. This in congruence with earlier studies suggesting close phyletic relationships between *Homo cf. heidelbergensis* and the Neanderthals.

Hadza forager energetics and the evolution of the human metabolic strategy.

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Recent work suggests that daily energy expenditure, DEE (kCal spent per day), is a central element of a species' life history strategy, constraining the energy available for growth and reproduction. While hundreds of studies have measured DEE in humans living in developed, industrial economies, little is known about human DEE in the non-industrial, non-agricultural, hunting and gathering economies in which our species evolved. Here we present the first direct measurements of DEE in a foraging population, the Hadza of northern Tanzania. Using the doubly labeled water method, we measured DEE in 30 adults (17 men, 13 women; age 18–75) during two field seasons at two different camps near Lake Eyasi. We also measured resting metabolic rates and tracked daily activity by recording heart rates and travel. Surprisingly, despite highly active lifestyles typical of savannah-living foragers, DEE among the Hadza was largely similar to that of other human populations in industrial and agricultural societies. Further, Hadza men tended to expend more calories each day than did Hadza women even after controlling for body size, a result consistent with other human populations. Such similarity in DEE across

a broad range of subsistence economies suggests that human energy use may be a physiologically constrained product of our evolutionary history, with other factors such as activity level and climate playing a smaller role in DEE. We examine the implications for this human metabolic strategy in light of recent work in other primates. This study was funded by the National Science Foundation, BCS 0850815.

Foraging and spatial memory in saddleback tamarins (*Saguinus fuscicollis*).

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In this study we examined whether ranging patterns in *Saguinus fuscicollis* were more consistent with coordinate or route based mental maps. At 2 minute intervals over the course of 36 days, we observed the feeding behavior of one group of *S. fuscicollis* using point sampling and recorded the animals' locations using a GPS unit. We also recorded the location of sleeping sites (n=9) and all feeding trees of plant species that comprised $\geq 1\%$ of the group's feeding time (n=85). From these data, we calculated a circuitry index (CI = distance traveled/straight-line distance) to test the degree to which individuals move directly between sites. Based on an evaluation of 156 travel segments the CI was 2.07, indicating that the monkeys did not move directly between feeding and resting sites. We also plotted the monkey's daily movement patterns using GIS software to determine if they use a route-based system of navigation. These analyses show that the monkeys reused specific parts (14 ha) of their total home range (35.5 ha) as travel pathways. In addition, we found that on 67% of days the monkeys moved among sites in an order that most efficiently minimized total travel distance. On the remaining days, the monkeys' visitation sequences were more efficient than randomly generated sequences 93% of the time. These results indicate that *S. fuscicollis* accurately encodes the spatial relationships among feeding and sleeping sites in their home range, and use a route-based mental map to navigate. Funded by Northern Illinois University and the University of Illinois Urbana-Champaign.

Odontometric analysis of an urban population: can analysis of tooth dimensions contribute to sex estimation in a population with diverse ancestries?

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Sex estimation, critical in the identification of human skeletal remains, may be difficult when craniofacial or pelvic landmarks are missing. Teeth are resilient and sexually dimorphic and great accuracy in sex identification has been demonstrated with odontometrics in homogeneous populations. These conclusions, however, may be population specific, suggesting reduced accuracy of such applications in ethnically heterogeneous contexts. Tooth size variation in an urban sample including individuals representing multiple ethnicities was examined with the aim of determining whether significant sexual dimorphism was present. The null hypothesis of no significant sexual dimorphism, suggesting odontometrics can not be used accurately to estimate sex in heterogeneous populations, was tested. Mesiodistal and buccolingual diameters of central incisors through second molars were collected from 60 mixed sex dental casts. Statistical analysis was completed on 28 dimensions for 14 teeth from the left maxilla and mandible and composite measures including Crown Area, Crown Shape Index, Crown Module, and Summary Tooth size. Student's *t*-tests and discriminant function analyses were used to investigate sexual dimorphism. Male tooth size was significantly larger in 12 dimensions and 7 composite measurements. Four discriminant functions had sex prediction accuracies of 0.80 and 0.81. Although accuracy is lower when estimating sex based on tooth dimensions within a heterogeneous population, these data indicate that significant sexual dimorphism is present and may contribute to sex estimation in the forensic context.

The Smithsonian Institution's Human Origins Program Database: development, accessibility, and goals for research and education.

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The Smithsonian Institution's Human Origins Program Database (HOP-DB) is a collaborative effort to make data from the published records of paleoanthropology and related disciplines web-accessible to interested students and researchers as well as the general public. This effort presents numerous issues and challenges, on both theoretical and practical levels. These include issues of compatibility of data collected by different researchers, the use of alternative methods or naming conventions, and the challenges of maintaining the most flexible database design to ensure maximum data reliability and usefulness into the future. Here we discuss these and other issues and challenges encountered during development of the HOP-DB, and we present the implemented solutions and discuss the problems that still remain. In particular, we emphasize the need to design a highly modular structure of back-end data relationships such that front-end interfaces and web-applications can easily evolve to meet the needs of current and future users while the continual refinements of scientific data are accommodated smoothly and efficiently. By following this approach, the HOP-DB contains artificial-like intelligence built into its internal structure, increasing the likelihood that this database and its many modular components will remain a reliable and useful source of scientific information for years to come. We highlight some specific examples of uses of the HOP-DB in both research and educational settings.

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Salivary measures of testosterone and functional innate immunity are directly associated in a sample of healthy young adults.

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Immune-endocrine interactions have been the subject of intense interest by evolutionary biologists due to the important life history trade-offs that are evident in the function of various hormones and immune factors. Testosterone has been considered the quintessential physiological moderator between the immune and endocrine systems. Testosterone may facilitate increased reproductive success but also compromise survivorship, particularly via immunosuppression. Because of its pleiotropic actions, testosterone levels may represent an honest signal of phenotypic quality. That is, because maintaining elevated testosterone levels

could handicap survivorship, characteristics dependent upon testosterone should be honest indications of quality. Therefore, we hypothesized that healthy adult men and women with excess energy availability (i.e., not constrained by trade-offs between immunity and other functions) should exhibit direct (positive) correlations between testosterone and a measure of innate immune function. Multiple saliva samples were obtained from each of 37 male and 57 female participants. Innate immunity (i.e., complement and lysozyme activity) was measured using a newly developed salivary assay for bactericidal properties against cultured *E. coli*. Testosterone levels were directly correlated with immune values in both the male (Spearman's rank order, $\rho = 0.45$, $p = 0.007$) and female ($\rho = 0.52$, $p = 0.000$) samples. Those individuals with higher salivary testosterone levels exhibited greater ability to kill pathogenic bacteria. These results suggest that, although testosterone levels may be inversely related to immune measures in some individuals (particularly during infection/injury), testosterone levels can also be directly associated with other immune measures in healthy individuals with excess energy availability.

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Fossil water and marsh birds, as paleoenvironmental indicators, at Olduvai Gorge, Tanzania.

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Olduvai has received countless faunal community and environmental reconstructions, but none have adequately addressed the paleoecological implications of its avifauna. Birds may provide information on environments at a finer spatial scale than mammals, especially for Pliocene deposits where many extinct mammals, but primarily extant birds, occur. Here, taxonomic analysis of water and marsh birds excavated by the Olduvai Landscape Paleoanthropology Project (OLAPP) is used to help reconstruct Olduvai's Lowermost Bed II (1.75 Ma) landscape.

Water and marsh birds, which dominate the Olduvai avifaunal assemblage, exhibit especially narrow habitat tolerances related to vegetation structure, diet, water quality and depth. Their presence may therefore provide important paleoenvironmental and -ecological information necessary for interpreting hominin land usage.

Cormorants are most common, with 79 specimens (*Phalacrocorax* and *Microcarbo*). Anatids (ducks, geese, and swan) are less common but more diverse, with 25 specimens from 8 genera. Rail, grebe, flamingo, pelican, and

various ciconiiformes (storks, herons, and egrets) are also present in smaller numbers. Most specimens can be ascribed to extant taxa, increasing the fidelity of attributed life history traits.

Bird densities and distributions suggest a persistence of wetlands and deep swamps during Lowermost Bed II times, but also the occurrence of tall nesting trees and possible flooded grasslands. In terms of hominin land usage, these birds point to locations where potable water, water plants, safety trees, and bird nests may have occurred.

This study supports the inclusion of avifaunal assemblages, when recovered at other sites of paleoanthropological significance, in any paleo-environmental or -ecological assessments.

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New 3D automatic methods for the analysis of the endocranial shape and its relationship with ectocranial structures: assessment and preliminary experiments.

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Over these last years, new computerized methods have been proposed to build virtual endocasts based on 3D CT images of extant or fossil skulls. This allows analyzing large samples automatically and then obtaining significant statistical results about the shape of the endocast and its correlation relative to other anatomical structures.

We assessed two new algorithms to segment and process virtual endocasts. The first tool allows delineating the boundary of the 3D endocranial surface without any manual interaction, even in presence of large holes (such as the foramen magnum). We compared these virtual endocasts with the corresponding plaster endocasts manually casted by one the authors. The second algorithm allows the automated measurement of 3D asymmetry on the virtual endocasts, and the computation of a mean 3D endocranial shape over several individuals on which the mean population asymmetry can be assessed.

To show the potential of such automatic tools, we propose to study the relationship between the shape of the endocast

and the external shape of the skull. For this purpose, we selected about twenty dry skulls in the Morton collection. These skulls were selected from populational samples which have been considered in the past to evince pronounced exo-cranial secondary-developing superstructures. These samples were CT-scanned and we automatically segmented both the external surface of the skull and the endocast.

We present the first results of our analysis by focusing on the exocranial versus endocranial differences at the level of the neurocranium of each individual. We also compare asymmetry patterns between individuals.

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A method for aging Scandinavian medieval sub-adults based on long bone length.

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The preferred method for aging archaeological sub-adult skeletons is by dental examination. In cases where no dental records are available age estimation may be performed according to epiphyseal union or diaphyseal lengths. Currently no data has been produced for aging Scandinavian sub-adults from the medieval period based on diaphyseal lengths. The problem with using data on Scandinavian samples which have been derived from a different population is the possibility of skewing the age estimates. In this study 58 sub-adult skeletons from three Danish medieval collections were examined, aged from approximately six years to twenty years. The samples were aged according to the dental method of Haavikko with Ubelaker acting as control. Regression formulae were then constructed for aging according to their diaphyseal lengths. This study indicated that with the regression formulae developed, estimation of age can be done with reasonable results on Scandinavian sub-adults. The Scandinavian data was then compared to data from a different archaeological sample and a modern sample. It showed that the growth pattern was comparable to that of another archaeological sample with a mean difference of nearly one year. However, there is a difference in growth pattern from the two archaeological samples to that of a modern population. The modern sample showed an underestimation that increased with age until reaching approximately 6 years. This study has showed the importance of using data for

age estimation for archaeological material which has been developed specifically for that population and have developed a possible solution for Scandinavian sub-adult material.

Shape analysis of the proximal MT 2 and MT 3 articular surfaces.

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The proximal MT 2 and MT 3 articular surfaces were analyzed using geometric morphometrics to test the hypotheses that the human articular surfaces are quantitatively different from those of apes, and that there is no difference in articular surface shape between shod and unshod humans. Shod and unshod humans are compared to *Pan*, *Gorilla*, and *Hyllobates*. The MT 2 fossil specimens include OH 8, Stw 595c, Stw 89, and SKX 247. The MT 3 fossil specimens include OH 8, Stw 387, Stw 388, Stw 435, Stw 477, and Stw 496. Shod and unshod humans are not significantly different from one another, but both human groups are significantly different from the ape groups. The human MT 2 and MT 3 surfaces are relatively narrower in the dorsal area compared to apes, but expanded in the plantar area. The human MT 2 surface tends to be slightly concave overall, whereas in apes the dorsal area is highly curved and has lateral torsion and the plantar area shows medial torsion. The human MT 3 surface is flat, while the ape surface is slightly convex. The MT 2 specimens SKX 247, Stw 89, and Stw 595c group with apes, while Stw 573 and Stw 377 group with humans. The specimen OH 8 (MT 2 and MT 3) groups with humans. The MT 3 specimens Stw 496 and Stw 387 group with humans, while Stw 388, Stw 435, and Stw 477 are intermediate in shape to humans and apes.

New Middle Pleistocene mandibles from the Sima de los Huesos (Sierra de Atapuerca, Spain).

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The sample of human fossils from the Sima de los Huesos (SH) includes a large number of mandibular remains. Previous studies of many of these specimens have highlighted numerous similarities between the Atapuerca (SH) mandibles and the later in time Neandertals and have revealed important insights into the evolutionary process in Europe. In particular, a number of derived Neandertal features in both the corpus and ramus are already present in the Atapuerca (SH) mandibles, confirming an early appearance of features related to midfacial prognathism in the Neandertal lineage. The present study provides an update on the inventory of the mandibular sample from the Sima de los Huesos. A number of mandibles are now more complete following recent discoveries and newly recognized associations between specimens. The more complete mandibles make it possible to confirm many of the details of previous studies made on more fragmentary remains. In addition, the enlarged sample has extended the known range of variation in some features and allows for a reassessment of the variation and stability proposed previously for a number of features. Finally, the recent dating of the site to >530 kya suggests a re-evaluation of the evolutionary significance of the Atapuerca (SH) collection is warranted. At this early age, it appears that features of the face and mandible are some of the first derived Neandertal features to appear in the fossil record and may even be associated with the origin of the Neandertal evolutionary lineage.

ASIP and PAX3 contribute to skin pigmentation differences between European and Native American populations.

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The variation in human skin pigmentation has long been a subject of anthropological interest and has been shown to be among the most rapidly evolving traits in many human populations. However, few studies have attempted to identify pigmentation genes that have undergone selection in Native American populations and contribute to variation in skin pigmentation between Native American and Old World populations. Four tests of selection – Locus-Specific Branch Length (LSBL), Tajima's D Difference, Cross Population Extended Haplotype Homozygosity (XP-EHH), and Log of the Ratio of Heterozygosities (lnRH) – were considered to identify signatures of selection. Of 76 pigmentation candidate genes, 14 showed compelling evidence for non-neutral patterns of

evolution in Native American populations and were prioritized as selection nominated candidate genes.

These genes were investigated using admixture linkage analysis in persons having mixed European and Native American ancestry from Popayán, Colombia (N = 173) and San Luis Valley, Colorado (N = 180). These analyses indicate for the first time that the genes *ASIP* and *PAX3*, in addition to *SLC24A5* and *MATP* (*SLC45A2*), contribute to the difference in mean constitutive skin pigmentation between European and American populations. These four genes cumulatively account for approximately 17% of the variation in mean constitutive skin between the two parental populations.

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Growth characteristics in infancy predict differences in milk composition in adulthood.

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During the immediate postnatal period, mammary growth continues in humans. By the age of two, growth of stem cell populations and the ductal system slows dramatically. Until puberty, mammary growth will keep pace with somatic growth. During this early postnatal period, when evolutionarily most infants would be receiving human milk, metabolic pathways and stem cell populations that will one day produce milk are established. Little is known about the accumulation of differences in human mammary development, but a growing body of evidence from dairy cows has shown that nutrition and growth during the immediate postnatal period can alter the lactogenic potential of the mammary gland. Specifically, in cows, rapid postnatal growth is associated with decreased milk synthesis and lower fat and protein content of milk in adulthood.

Here, we report on breast milk composition in a sample of 102 Filipino women followed longitudinally since their own births in 1983-84. Detailed collection of growth measurements (height, weight), nutrition, and illness frequency during infancy were collected at bimonthly intervals. These data were used to predict milk macronutrient composition for these individuals 25 years later, in adulthood. Infant growth velocity, measured as change in Z scores between critical periods of mammary development, positively predicted more protein and sugar in milk. There was some evidence of a U-shaped relationship with growth velocity, as poorly growing infants later produced more protein as well, possibly reflecting greater synthesis of immunoproteins such as sIgA.

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Institute for Policy Research at Northwestern University.

Identifying the source populations of African ancestry in Yemeni populations.

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Approximately 30% of mtDNA lineages in South Arabian samples are African L haplotypes, whose origin has usually been attributed to migration and assimilation of African females into the Arabian population over approximately the last 2,500 years. In contrast, few Y chromosome lineages of clear recent sub-Saharan African origin have been found in Southern Arabian populations. This bias in maternal and paternal lineages is in accord with historical accounts of the female bias in the Middle Eastern slave trade. In order to evaluate autosomal African ancestry, we collected high-resolution SNP genotype data from a geographically representative set Yemeni DNA samples. The ancestry of chromosomal segments in the Yemeni population was estimated using a haplotype-based local ancestry estimation method, HAPMIX. We estimated local ancestry in the Yemeni sample with three European-African reference population combinations. There was no significant difference between the average proportion of African ancestry in Yemenis calculated using either of the two Bantu-speaking reference populations: Yoruba (mean 0.062, sd 0.044) and Luhya (mean 0.076, sd 0.049) (p=0.13). However, the average African ancestry calculated using the Maasai reference population (mean 0.148, sd 0.060) is significantly greater from that calculated using either the Yoruba or Luhya reference populations (p < 0.0001). These data suggest that the source population for the African ancestry of the Yemeni population is more similar to the contemporary Maasai population than either the Luhya or Yoruba, and has implications for the reconstruction of the history of the slave trade between African and the Middle East.

Functional anatomy of forelimb muscles in captive Sumatran orangutans.

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Orangutans from Sumatra have specialized arboreal locomotion and posture and spend all of their time in the forest canopy, travelling in trees. In captivity however, these primates spend the majority of their time on the ground. Although more studies are investigating

the dimensions of muscles in hominoids, there is little information regarding muscle-tendon architecture (muscle mass, physiological cross-sectional area, fascicle and tendon length) and its direct relationship with muscle attachment (location, size and shape). Past research reveals the challenges of defining the boundaries of muscle attachment area in a consistent manner. The main goal of this project was to investigate whether muscle markings on the forelimbs reflect muscle size, strength and activity of captive Sumatran orangutans. Three right forelimbs of orangutans (one female and two males) from the Toronto Zoo were dissected. Bones were cleaned and scanned using a Next-Engine™ 3D scanner. During the dissections, careful attention was given to each muscle attachment, and pictures were taken before the removal of muscles to document attachment contours. This method enabled visual definition of the attachments and reduced error. Results suggest that differences in mean ratios of muscle mass-to-muscle attachment size are different between males and females. The two males show a larger absolute muscle mass-to-attachment area than is found in the female. To better quantify this tendency in muscle attachment area, site morphology and activity patterns of the muscles will be further investigated.

Focus on the freezer: the role of "Cryoethics" in the conduct of bio-specimen research.

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With the benefit of innovations in cryobiology (the study of "frosty" life) in the 1950s, biological anthropologists and epidemiologists began to rely upon technologies of cold storage to help in the building of collections of frozen tissues from a range of human and non-human populations. In the early days of anthropological genetics the freezer functioned as an important instrument in scientific practice – ensuring that samples collected in the field would not degrade before being analyzed in the lab.

In the 21st century, these same freezers have also become archives, providing opportunities for investigating historical questions about populations and environments that have since undergone dramatic change. At the same time, they have attracted critical attention. Discussion about the appropriate conduct of anthropological genetics has overwhelmingly focused on the specimens and the bodies from which they were sampled. In this paper, I seek to reframe the basis for inquiry about the ethics of research in anthropological genetics by focusing not on the specimens, but the freezer itself. I introduce the idea of "cryo-ethics" as a mode of directing attention beyond the terrain

of informed consent to a more sophisticated understanding of how technologies of preservation, themselves, serve to powerfully reconfigure social relations along with the relationship between the past, present, and future. This intervention is not meant to displace bioethics but to encourage examination of how challenges facing anthropological geneticists are (or should be) intimately linked to the conduct of biospecimen-based research in the biomedical sciences more broadly.

Different biomechanical regimes do not affect craniofacial pneumatization in fossil hominins.

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Paranasal pneumatization has been linked to biomechanical stresses and strains of the facial skeleton, particularly during mastication. A recent 'narrow allometry' test of this hypothesis (Anat Rec 291:1414-1419, 2009) found that closely related species of *Cebus* with diets of differing hardness show no significant differences in relative sinus size. Congeners, however, may not possess sufficient biomechanical differences to affect pneumatization. To this end, two fossil hominins of different genera (Sts 5, *Australopithecus africanus*; OH 5, *Paranthropus boisei*) that differ greatly in inferred diets were examined; as the difference between their masticatory morphology is near or equal to the hominid maximum, this represents a conservative test of the 'biomechanical hypothesis'.

CT scan sets of Sts 5 and OH 5 were examined using Avizo 6. Frontal and maxillary sinus volumes were compared with those from a sample of extant large-bodied hominids (*Pan*, *Homo*, *Pongo*, *Gorilla*), and scaled relative to a measure of craniofacial size. Both fossils fall within the 95% confidence limits of extant hominids. Exact randomization analysis indicates that the degree of difference between Sts 5 and OH 5 is regularly found within single extant hominid species. Thus, there seems to be no evidence to support the contention that biomechanical forces affect pneumatic volume. Other factors, such as internal sinus structuring (septa or struts), however, cannot be ruled out as possible responses to masticatory stress.

South from Alaska: an aDNA study of the genetic history of the Alaska peninsula and eastern Aleutians.

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The Aleutian Islands were colonized from the Alaskan mainland. Temporal

changes in the relative frequencies of mtDNA haplogroups in prehistoric Aleutian populations have been documented, but little is known about potential source populations for prehistoric Aleut migrants. We report mtDNA first hypervariable region (HVRI) sequences in samples from two archaeological sites on the Alaska Peninsula (the Hot Springs Site near Port Moller and from a group of sites in the Brooks River area near Katmai National Park and Preserve) and one site from Prince William Sound (Mink Island).

The ancient sequences revealed the mtDNA haplogroups typically found in Aleut populations (A2 and D2), but also haplogroups B2 and D1 in the Brooks River samples and haplogroup D3 in one Mink Islander. While mtDNA haplogroup D lineages have been reported in other northern populations, haplogroup B has not. The region V deletion in the Alaska Peninsula samples appears to be unique, being characterized by an 11bp deletion and associated upstream SNPs. Interestingly, the Brooks River area is located directly across Shelikof Strait from Kodiak Island, where a low frequency of haplogroup B has been reported in a contemporary population. The presence of this haplogroup in samples over 1500 years in age indicates a deeper history of mtDNA deleted haplotypes in the North Pacific/South Alaska region than generally assumed. These results reveal greater mtDNA diversity in prehistoric populations of south Alaska than previously observed and facilitate reconstruction of prehistoric migration scenarios from the peninsula into the Aleutian archipelago.

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Exploring the precision of facial recreation using cephalographic images from a contemporary Southwest United States orthodontic database.

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Forensic facial recreation is a common yet controversial potential aid of identification in historical and medico-legal contexts. Many facial reconstruction artists combine artistic methods and mean facial tissue thickness to model faces. This sample used 100 European American females 18 to 29 years of age from the Economides Orthodontic Database housed at the University of New Mexico. This study is a two-part analysis, (1) using ten conventional lateral cephalometric landmarks of the skull to measure soft tissue depth, and (2) using a preferred method of nose projection estimation to reconstruct a two-dimensional facial profile. Measurements were taken directly from cephalograms and drawings based on them. Cephalograms

are ideal for this purpose, showing both bone and soft tissue and can be corrected for magnification. Each measurement was taken five times each by two researchers to determine intra- and inter-observer error. Means and standard deviations were computed for each measurement. Past studies have not provided confidence intervals nor included large samples. Means of tissue thicknesses using landmarks of the skull are consistent with other studies involving geographically varied samples, though confidence intervals are highly variable. However, measurements obtained using the preferred method of nose projection resulted in mean measurements inconsistent with visible soft tissue contours and actual facial profiles. This study demonstrates poor precision in facial reconstructions that rely on mean soft tissue thicknesses in the mid-sagittal plane. Additionally, the shape and projection of noses may not be reliably predicted from the nasal skeleton.

Levy walks in hunter-gatherers: when are random walks an optimal search strategy?

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Recent work shows that a diverse group of marine and terrestrial animals use Levy walks when foraging. Levy walks describe a class of random walks that are an optimal search strategy when resources are randomly dispersed and animals have incomplete or no knowledge of the resource distribution. In a Levy walk, step lengths (continuous movements in one direction) during foraging come from a probability distribution with a power law tail (i.e., many small steps connected by fewer long steps) and the frequency distribution of step lengths (x) follows the function: $f(x) \sim x^{-\mu}$, where μ is between 1 and 3. Here we examine whether human hunter-gatherers utilize Levy walks during their foraging bouts even though they have more complete knowledge of resource distributions. We attached GPS units to a sample of hunter-gatherers from the Hadza of Northern Tanzania ($n = 8$) and calculated μ from step lengths during foraging bouts using the maximum likelihood method. A preliminary analysis suggests that Hadza men and women use Levy walks in nearly half of their foraging bouts ($\mu = 2.08 \pm .05$ when step lengths follow a power-law distribution). Thus, even with more complete knowledge of their surroundings, humans often use random walks

that are similar to those used by many other mammals. We examine correlations between habitats and search strategies and suggest that patterns of resource distribution likely drive the use of random walks in humans. Finally, we explore the implications of our results for reconstructing mobility patterns in the fossil record. This study was funded by NSF BCS 0850815.

Geometric morphometric analysis of the human innominate showing shape changes related to body mass.

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Morphological, metric, and recent geometric morphometric analyses have all demonstrated the high level of sexual dimorphism in the human pelvis. Inferences related to another relevant character, body mass, have received less attention especially in isolated innominates. Three-dimensional (3D) geometric morphometric analyses were employed to investigate shape changes in the pelvis that are related to body mass, controlling for sex. Twenty-three 3D landmarks were digitized from the innominates of 60 individuals (30 males, 30 females) from the Hamann-Todd Collection. These data were subjected to a Procrustes' fit and subsequent principle components analysis. Several principle component scores were significantly correlated with body mass suggesting that certain dimensions of the pelvis change in relation to body mass. In females, this was generally expressed through the relationship of the pubic bone to both the inferior ischium and superior acetabulum. In males, the shape change was generally related to the breadth of the pubic bone and a change in dimension between the anterior acetabulum and posterior ilium. Additionally, 253 inter-landmark distances were derived from the 3D data. A forward stepwise regression of these inter-landmark distances selected two variables for males and three variables for females in these general regions. The level of variance in body mass explained by these variables is comparable to current methods suggesting that linear measurements from an isolated innominate may be useful for the reconstruction of body mass.

The problematic hypodigm of *Homo heidelbergensis*.

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Who is *Homo heidelbergensis*? The answer is simple—the species represented by the mandible from Mauer. However, in recent years, a large number of fossils have been lumped with the Mauer mandible to constitute the hypodigm of *H. heidelbergensis*. The result renders the definition of this enigmatic species increasingly confusing and less convincing. Indeed, it is not clear whether lumping certain specimens together in this hypodigm is justified at all. In effect, the morphology of certain specimens does not accord with that of the type specimen. Obviously, the taxonomic identification of skulls lacking a mandible is problematic, but even some mandibles give rise to uncertainty regarding their assignment to the *H. heidelbergensis* hypodigm.

In our analysis, the Mauer mandible stands alone in its morphology, which appears to be the outcome of a unique constellation of characters. The claimed similarities between the characters of the Mauer specimen, on the one hand, and those of Neandertals and the Sima de los Huesos mandibles, on the other, cannot be considered homologous, and hence, they are not synapomorphies. Although some of the Mauer characters superficially resemble the ones on the Neandertal and Sima specimens, the Mauer characters stem from a different morphological configuration. On the other hand, the similarities between the Neandertal characters and those of the Sima mandibles are the outcome of identical configurations, making these characters true synapomorphies.

Dental growth in Australian aborigines.

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Works on dental growth have characterized tooth formation in hominid species and have also suggested a large variation of growth process in modern humans. However, this variation is not well defined. Ethnic groups inhabiting a well defined geographic area, with a known history and unique somatic features represent a good biological model to study variation of dental growth process in modern humans. We here present prelim-

inary results of dental growth process in Australian aborigines. Six lower M1 from archeological specimens were cut through mesial and distal cusps and thin sections were obtained. Cusp/crown formation time was obtained by counting cross-striations in the cuspal area and by multiplying counts of striae of Retzius by periodicity to calculate lateral crown formation. Daily secretion rates were measured every 100um in cuspal enamel in order to estimate possible variation through crown formation. Wilson bands were used to match the growth of cusps. Periodicity values in our sample range from 7 to 10 days with a modal value of 8. Range of cusp formation times is: protoconid 3.17-3.92 yrs, metaconid 2.88-3.11 yrs, hypoconid 3.14-3.42, entoconid 2.74. Daily secretion rates increase from the enamel-dentine junction to enamel surface in some specimens, but in several M1s, DSR values are stable (~4.5um) throughout all cuspal enamel. Australian aborigines appear as to have one of the longer values of cusp/crown formation time and higher daily secretion rates among the modern human populations. Molars form through a long period at a high rate which explains the thick enamel.

Auditory sensitivity of the Philippine tarsier, *Tarsius syrichta*.

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Tarsiers are central to understanding of how and why the senses evolved among primates. They are distinctive among haplorrhines in their basal phylogenetic position and as small, solitary, nocturnal species that consume insects and vertebrate prey. Of particular interest is how tarsiers are able to detect prey at night given their lack of a tapetum lucidum. Low natural population densities and the difficulty of maintaining tarsiers in captivity have not only limited our knowledge of the sensory ecology of these primates, but also prevented the construction of a traditional behavioral audiogram. Here we report use of the auditory brainstem response (ABR) method to estimate the auditory sensitivity of wild Philippine tarsiers at Motorpoll, on the island of Mindanao. We found the tarsier to be unique in its sensitivity to ultrasounds. We calculated the high-frequency limit (the highest frequency detectable at 60 dB SPL) at approximately 75 kHz, which is 30 kHz above any other haplorrhine and

10 kHz above *Galago senegalensis* (which previously had the highest known high-frequency limit among primates). In fact, such extreme sensitivity to ultrasounds is found in only a few animal lineages such as bats, rodents, cetaceans and amphibians. Additional studies including other tarsiers species and exploring the ultrasonic acoustic environment and signals and cues produced by tarsiers and their prey may shed light on selective pressures that resulted in this unique physiology. Such findings have broader relevance to understanding the evolution of ultrasound sensitivity among primates and across the animal kingdom.

This study was funded by the David and Lucile Packard Foundation and the Department of Anthropology, Dartmouth College.

Mandibular diminution between the Medieval and post-Medieval periods in London: evidence for reduced masticatory function.

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Biomechanical forces, such as those created during mastication, are considered primary stimulating agents in craniofacial growth and development. Due to the direct connection between masticatory muscle strength and craniofacial form, fluctuations in biomechanical force and muscle strength can alter the underlying bony morphology. Proposed by Carlson and Van Gerven in 1977, the Masticatory Functional Hypothesis suggests that decreases in functional stimulation of the masticatory apparatus reduce the amount of force placed on the jaws, causing diminution of mandibular and facial dimensions. The Industrial Revolution of the 18th and 19th century profoundly changed human lifestyle; advancements in food technology dramatically altered what humans ate, with food becoming more processed and softer, requiring little chewing. As suggested by the Masticatory Functional Hypothesis, decreased stimulation on the jaws leads to a reduction in size of the human mandible, but can this hypothesis be applied to the changes in diet observed in the transition to the post-industrialised era? To test this, an assemblage (n=280) of skulls from Medieval and post-Medieval London were selected for full metric analysis of the mandible, utilizing standard methods. Analysing male and female specimens separately, the results show significant reductions in mandibular dimensions for the post-Medieval group, compared to the Medieval one. These results may indicate that changes in diet observed during this period affected mandibular growth and its eventual form. Further studies focusing on the transition to the modern era can clarify the impact of con-

temporary diet on the changing form of the human mandible.

Relative contributions of internal reaction forces to stresses in the great ape mandibular symphysis.

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The relative contributions of the different internal reaction forces to stresses at the symphysis in primate mandibles is unresolved. These reaction forces arise due to occlusal forces, muscle forces and mandibular geometry. Knowledge of these contributions, in concert with ecological observations, may infer dietary habits of primate ancestors.

We determined stresses in mandibular symphyseal sections using existing finite element software (VA-BATTS) for sections with inhomogeneous elastic properties. We used sagittal sections from computed tomographic scans of *Gorilla gorilla* (3 female, 3 male) and *Pongo pygmaeus* (6 female, 3 male) mandibles. We determined internal reaction forces due to a left premolar occlusal force using free body diagrams, equilibrium, mandibular geometry and assumptions regarding masticatory muscle and joint reaction force lines of action. The internal reaction forces included an axial force and a torque perpendicular to the sagittal plane and transverse shearing forces and bending moments in the superoinferior and labiolingual directions. We applied these internal forces to the sections individually and all together and determined principal and maximum shear stresses throughout the sections.

Obviously, the greatest stresses occurred when all the loads were applied. For this load case, stresses in the males were about half those in the females for the same occlusal force regardless of species; stresses in the *Pongo* were about 25% larger than those in the *Gorilla*. Stresses for the cases of individually applied torques and axial and shear forces were an order to orders of magnitude less than when all loads or just bending moments were applied.

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Oh Grandmother, what big teeth you have!

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Mouse lemur females have long been recognized as dominant over males – win-

ning the great majority of contests over resources. However, that dominance has never before been linked to strong reverse canine dimorphism. Such canine dimorphism is manifested in *Microcebus griseorufus* in southwest Madagascar, and it occurs independently in populations inhabiting three forests at Beza Mahafaly (a gallery forest called Parcel 1, spiny forest called Parcel 2, and dry forest called Ihazoara). Females and males at these forests also differ significantly in their feeding and nesting behavior.

Between October 2006 and September 2007, the morphometrics and activities of male and female *M. griseorufus* at the above three forests were recorded using both capture/mark/recapture techniques and focal-individual follows of radiocollared individuals. Canine heights of captured individuals were systematically measured. *M. griseorufus* targets particular tree species for exudates and others for nesting. Females have greater access to gum trees throughout the year and to tree holes for nesting during the dry season and just before parturition. The soluble sugars in gums provide energy for fat storage which, with female dominance, explains female-biased seasonal torpor. Across Madagascar, only those mouse lemurs with access to sufficient soluble sugars (either from fruit or gums) will enter seasonal torpor; species and populations that rely principally on insects will not. Gum-producing trees are often uncommon in the dry habitats of the southwest where fruit is scarce and seasonally limited, so the monopolization of particular gum trees may be critically important to the reproductive success of females.

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Hydrolyzable tannins in red colobus and mountain gorilla diets.

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Hydrolyzable tannins (HT) are a class of polyphenols found in plant tissues. The effects of HT are not well-understood, but they may form insoluble complexes with proteins and minerals, thereby diminishing diet quality. While many studies focus on the role of con-

densed tannins in primate food selection, we know little about HT. We used a potassium iodate assay to assess the presence of HT in the diets of mountain gorillas (*Gorilla beringei*) in Bwindi Impenetrable National Park, Uganda, and red colobus monkeys (*Procolobus rufomitratu*s) in Kibale National Park, Uganda. While gorillas eat primarily herbaceous leaves, red colobus mainly eat tree leaves. Of 94 gorilla diet items examined, 31% contained HT, including 33% of staple foods. Conversely, of 58 red colobus diet items, 69% contained HT, including 79% of young leaves (n=14), which comprise ~80% of feeding time annually. A matched-pairs analysis revealed no difference in HT between young and mature leaves of the same species. The difference between distributions of HT in gorilla and colobus diets may be associated with the types of plant forms eaten. The mixture of plant foods in gorilla diets may reduce the impact of HT. Like ruminants, colobines may host foregut bacteria that are resistant to HT which allows them to cope with HT-rich diets, or their protein-rich diets may dilute the negative effects of HT. This study illustrates the importance of considering the differences in dietary strategies among folivorous primates, and highlights the need for more investigations into primate digestive ecology.

Egyptian body size and proportions: ecogeographic patterns in a mid-latitude population.

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Ecogeographic patterning in body size and proportions can provide important information about adaptation and population movements. This study investigated patterns in body size and proportions in a mid-latitude population. Ancient Egyptians occupied a middle latitude region at ~31-21° North. It was predicted that Egyptians would be intermediate between higher and lower latitude populations in body size and limb length ratios. The skeletal sample consisted of 492 males and 535 females, all adults from the Predynastic, Old Kingdom, Middle Kingdom, New Kingdom and Roman-Byzantine periods, a time spanning c. 5500 BCE – 600 CE. Egyptians were analyzed regionally by dividing the sample into northern and southern groups, as well as by comparison to Nubian groups. Egyptians were also assessed with respect to other populations in the world using anthropometrics from modern populations compiled by Ruff (1994) and skeletal measures from archaeologically-derived samples from Holliday (1995). Analysis of variance and Tukey's post-hoc test were used to analyze differences among groups, while bivariate scatters were used to assess changes in measures

with latitude. Results showed that region had no significant effect on male brachial index, however region did have a significant effect on female brachial index and on both male and female crural indices ($p = < 0.05$). Nubians possessed slightly higher indices compared to ancient Egyptians. Ancient Egyptian limb length indices were more characteristic of tropical populations. Other indices such as body mass/stature and bi-iliac breadth/stature to stature were intermediate between higher latitude and lower latitude populations.

Mammalian population microevolution and community and environmental change at Langebaanweg, South Africa.

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The large mammal community recovered from the Late Miocene site, Langebaanweg, South Africa, was speciose and diverse. Two contiguous fossiliferous Members (Langeberg Quartzose Sand; LQSM, and Muishond Pelletal Phosphorite; MPPM), sample 15 conspecific Carnivora and Bovidae. Dating suggests as little as ~240 ka separate the older LQSM and younger MPPM, and dietary reconstructions of several species connote changes in available resources, mammalian feeding morphology, and paleoecological context between the two deposits. Additionally, two river-bed deposits within MPPM, 3aS and 3aN, have been hypothesized as occurring relatively close in time, yet illustrative of meaningful morphological change within shared taxa.

This study tests the hypotheses of significant morphological change between specimens of taxa deposited in the LQSM and MPPM, as well as between those of the 3aS and 3aN channel beds of the MPPM, by quantifying variation in dental dimensions. Analyses included pair-wise comparisons to assess statistical significance of changes in size in individual taxa, as well as tests of multiple comparisons to maximize the included morphological variation in one species. Lastly, models of environmental change versus community-level influences, such as predation, were applied to explain significant morphological change. Using a community perspective revealed that species were not evolving in concert, yet when compared with the paleoenvironmental shifts occurring at Langebaanweg during deposition, biologically meaningful patterns can be identified. Paleoecological studies of primate and hominin fossil localities can include this type of community-level analysis to better understand not only reconstructed paleoenvironmental contexts, but also more intricate interactions of species co- and microevolution.

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Getting a grip: dynamic moment arms and potential torque for muscles of the 5th ray in five catarrhine species.

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Despite its functional importance in primate hand postures, the fifth finger remains less well studied than other regions of the hand. This study assesses the variation of selected fifth ray musculoskeletal characteristics in five catarrhine species within the framework of their differing locomotor/postural modes. Both extrinsic and intrinsic fifth finger muscles are measured for muscle weight and average fiber length. Dynamic moment arms are calculated based on tendon excursion and joint angle during passive joint motion. Muscle weights and fiber lengths are used to calculate physiological cross-sectional area (PCSA) for each muscle, which represents the potential force a muscle can develop. Application of this force to the external world, however, is modified by moment arm length. To estimate how much potential torque a muscle can exert on the external environment, PCSA is multiplied by the dynamic moment.

The muscle characteristics examined in this study reveal some interesting patterns related to hand use. Humans are characterized by very low PCSA values, but often equalize potential torque to that of nonhuman primates with longer moment arms, particularly in the Oppens digiti minimi and Flexor digiti minimi (FDM) muscles. Such a configuration achieves strength with less fatigue. Orangutans also have relatively large potential torque values for the FDM and, unexpectedly, for the extrinsic extensor muscles. Among the monkey species tested, baboons show a unique configuration of the Extensor digiti minimi muscle, which leads to its participation in metacarpophalangeal abduction/adduction. The results relating to the extensor muscles warrant further kinematic and behavioral investigations.

This study was funded by the Department of Anthropology at Arizona State University and the Philanthropic Educational Organization.

A new GPS data collection methodology and data schema for integrating multiple project databases: examples from the Dikika Research Project geodatabase.

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Integrative analyses of human evolution must overcome the independent nature of paleoanthropological data sets and in so doing face at least two key technical challenges: first, the comprehensive geospatial referencing of data relevant to paleoanthropology (geological, archeological, paleontological etc.); and second, having a common interchange format for combining data from multiple projects. This paper presents novel solutions to both challenges, and concrete examples of their implementation as applied to the paleontological collections from the Dikika Research Project area in northeastern Ethiopia.

Paleontological field methodology traditionally relies on a concept of a locality – an area for fossil collection that has a consistent spatio-temporal context – as the primary unit of data collection and data analysis. With the advent of small, fast, inexpensive and accurate GPS receivers, aggregate geo-referencing with localities is giving way to individual geo-referencing of fossils. Here we present a complete system (software, hardware, workflow and best practices) for recording the piece provenience of all paleontological occurrences efficiently.

Once collected, a common solution for disseminating data is uploading to a data repository such as the paleobiology database. In this paper we present an alternative option, that of a distributed database system where data are maintained independently, but in a format and structure that follows an established protocol. We propose a format built upon the existing Dublin Core and Darwin Core standards with added provisions for data unique to paleoanthropology.

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Analysis of cranial suture fusion using computerized tomography of living individuals.

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The biology of cranial suture closure continues to be a significant focus of research in the anthropological and biomedical sciences. Previous research has shown that computerized tomography of dry skulls can be used effectively in the analysis of the degree of closure of the sagittal suture (Reed et al. 2009). In order to continue testing these methods, a large, current data set, scans of living individuals should be obtained. To test

if scans of the crania of living individuals are as useful as dry skulls, thirty existing CT scans kept in data storage were obtained from Saint Mary's Health Care in Grand Rapids, Michigan. These 3cm helical scans were randomly retrieved from data storage by a radiological technician with all personal information removed, except for age and sex ("anonymized"). Using the image analysis software Amira 5.3, the cranium was isolated from soft tissue, with different colors representing different densities of bone in the final image. With these different densities delineated, three separate examinations of the sagittal and coronal sutures for degree of closure were completed, including tests of interobserver error. Analysis was conducted according to previously established methods (Reed et al. 2009). A correlation between the results of the analysis of suture closure and the general age of the individuals in the scans was also calculated. The results show that existing CT scans from living individuals are an effective and readily available large sample source that can be used in the analysis of human cranial suture closure.

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Early hominins through time and space: local, regional and pan-African habitats and biogeography.

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Australopithecus species have been recovered from the Pliocene (~4.2-2.0 Ma) of eastern, southern, and central Africa. Although much information is known about *Australopithecus* ecology for specific localities, such as from associated fauna or more multidisciplinary paleohabitat reconstructions, studies investigating the spatial patterning of *Australopithecus* habitats and the associated fauna at a more continental-scale are still limited. Biogeographical patterns in Africa today demonstrate that species isolation occurs in peripheral regions, and this isolation often occurs in habitats that are either very wet (forests) or dry (shrublands). The primary goal of our research is to determine if the fossil localities bearing *Australopithecus* species mirror this modern pattern or, alternatively, show either 1) abundant taxonomic interchange between regions, or 2) that each region represented distinct faunal centers with little taxonomic interchange.

Our analyses focused on spatial distributions and similarities of fauna at *Australopithecus*-bearing localities at varying scales. We began with data from the Hadar region to analyze spatial distri-

butions of fauna within Hadar and Ledi-Geraru localities. Similarity indices and cluster analyses were used to determine faunal distribution patterns locally, within an individual African region, and between regions. We also used minimum spanning trees to investigate mammalian similarity both spatially and through time at regional and pan-African scales.

Paleobiogeographic patterns demonstrate that, despite changing habitats at the locality level, most faunal communities are more similar at single localities through time than they are similar regionally across space. Faunal communities in southern and central Africa appear to mimic the modern pattern of isolation.

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The growth and development of sexual dimorphism using cranial base and post-cranial measurements.

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A current problem in skeletal biology is assessing sex in subadult skeletons since they have not undergone the pubertal changes that allow the secondary sexual characteristics to develop. Research in juvenile sexual dimorphism has usually focused on the pelvic and skull bones, which are dimorphic in adults but not juveniles or has been limited by small sample sizes. This research tests the hypothesis that the cranial base will become sexually dimorphic with the peak of brain growth which occurs around five and six years of age and the post-cranial skeleton will become dimorphic at different ages based on the typical patterns of growth and development. Measurements of the long bones and cranial base, as well as analysis of morphological traits of the skull, mandible, and ilium at four distinct phases of growth were performed on the Hamann-Todd Skeletal Collection. T-tests were used to test for dimorphism during each developmental stage. Discriminant function analysis was performed to determine which of these variables best predicted sex in each age group. Results indicate that there is indeed sexual dimorphism of the cranial base and post-cranial skeleton at each stage of development with at least 75%-100% accuracy. Each group showed different elements of the cranial base and post-cranial skeleton as dimorphic, which proves that separating individuals by their growth and development is vital in determining sex in juvenile remains. This will help us better understand when and where the skeleton becomes sexually dimorphic so that sex may be determined in individuals of known age.

Behavioral laterality and skeletal directional asymmetry in cottontop tamarins.

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Researchers have indicated behavioral laterality of *Sanguinas oedipus*, although the patterns of right or left preference vary between tasks and contexts. No population-wide handedness has been reported. An examination of directional bilateral asymmetry in *S. oedipus* long bone dimensions would provide a way to assess differential effects of laterality on bone morphology in a sample lacking population-wide laterality.

Maximum lengths, diaphyseal breadths, and articular dimensions were measured for the humeri, radii, ulnae, femora, and tibiae of 45 adult (17 female, 28 male) *S. oedipus* skeletons. Dimensions with high measurement error (>2%) were removed, and all others were converted to percent directional asymmetry (%DA). Results indicate that there is no population-level directional asymmetry. Therefore, we conclude that no genetic or behavioral predisposition for directional asymmetry exists. Sex differences in %DA were also determined to be non-significant. Magnitudes of directional asymmetry were further investigated among individuals with %DA > 0.5, and %DA magnitudes were ranked by type of dimension. As found in other studies of limb bone asymmetry, maximum lengths are the most symmetrical, followed by articular dimensions, and finally diaphyseal measures. The symmetry of long bone lengths may largely be due to locomotor constraint. These findings may further indicate that bone lengths, in general, are less susceptible to developmental perturbations or mechanical stresses than are diaphyseal or articular dimensions. A larger sample size and pedigree data will be incorporated into this study as it becomes available, which will allow us to further assess the heritability of directional asymmetry.

Evidence for advanced spatial intelligence in gibbons.

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Monitoring plants' reproductive cycles and relying on a cognitive map have been suggested effective navigation methods in territorial frugivores, such as forest primates. Environmental landmarks and travel destinations may be qualitatively linked to a route-based cognitive map or true metric parametric relations. However, even if cognition is involved, it is often unclear to which extent spatial intelligence guides daily movement.

We tested spatial intelligence in adults of eleven white-handed gibbon groups (*Hylobates lar*) at Khao Yai National Park, Thailand, over a 55 day period (Jul09 – Feb10). Daily travel paths and food sources were recorded with a GPS and plotted in ArcMap. Spatial intelligence was quantified by analyzing where significant changes in gibbon travel direction occurred using the change-point direction test (CPT). Consecutive change-points were beginning and end of travel between out-of-sight resources. We found that travel direction changes occurred overwhelmingly at food sources (78.4% of change points, n=195) and rarely during travel (6.2% of change points). Sometimes (13.3% change points), food sources at change points had no fruit, and 2% of change points occurred at intergroup encounter sites. Distances between consecutive change-points ($\bar{x} = 165\text{m}$) were far beyond gibbons' visibility radius. Finally, gibbon movement was more efficient at detecting important food sources than a random travel model predicted. We conclude that gibbons have excellent large-scale knowledge of the spatio-temporal availability of resources and that they plan daily travel with the goal to end segments at a next important food source.

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Fatty acids in mountain gorilla diets: implications for primate nutrition and human health.

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Essential fatty acids (EFA) are necessary fats that humans and other primates cannot synthesize and must be obtained through the diet. They are associated with improved cardiovascular, immune, nervous and reproductive functions, and cellular growth and maintenance. Mountain gorillas (*Gorilla beringei*) are phylogenetically one of the closest extant relatives of humans that consume diets consisting almost entirely of plant tissues, mainly herbaceous leaves, in addition to pith, peel, and fruit. We used high tem-

perature petroleum ether extraction to measure crude fat and gas-liquid chromatography to estimate fatty acid composition of all foods representing >1% the total annual diet of mountain gorillas in Bwindi Impenetrable National Park, Uganda. We expected dietary fat intake to be much lower than that of modern humans, yet supply a variety of fatty acids. The mean daily fat intake of gorillas annually was 2.2%. Staple vegetative parts contained a mean of 1.46% \pm 0.72 crude fat, but fruit contained 7.73% \pm 11.3. The predominant fatty acids were palmitic acid (31%), linoleic acid (12%), and oleic acid (10%). Of the EFAs, linoleic acid was found in all staple foods but alpha-linolenic acid was present in only one staple herbaceous leaf. Westernized modern humans consume high saturated fat diets, while these gorillas consume diets with very low overall fats and low saturated fats. Modern humans may benefit from consuming a more similar diet to their ancestors with lower overall and saturated fat intake, and developing agricultural practices that produce foods resembling the nutritional quality and composition of their wild counterparts.

Diet in Poland before the state: stable isotope evidence from the Wielbark population at Rogowo.

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We investigate diet of a 2nd c. Wielbark population from Rogowo (Pomerania area, Central Poland) using stable carbon and nitrogen isotopes. Our primary goal is to complement a growing body of research concerning Roman-era diet in Western Europe, facilitating a better understanding of the impacts of Germanic, Mediterranean and Slavic cultural heritage and geography on human diet in early history. We also investigate effects of different sociopolitical systems on diet by considering our results in relation to other time periods (Neolithic and medieval) in Poland.

Bone collagen of 30 individuals from the birch cemetery at Rogowo was prepared for isotope analysis, along with 2 Neolithic individuals for comparison. Diet at Rogowo was predominantly terrestrial, with mean $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ratios of -17.9‰ and 9.7‰ respectively. The $\delta^{13}\text{C}$ values exhibit a broad range and are higher than expected for a diet based on C_3 plants alone, suggesting consumption of millet. The $\delta^{13}\text{C}$ values of women and men differ significantly, with women exhibiting higher values than men (-17.5 vs. -18.2 ; Mann Whitney U $p=0.016$). Sex-based differences in $\delta^{15}\text{N}$ values are not significant in the sample (Mann Whitney U $p=0.109$). These observations differentiate Rogowo from our comparative medieval and Neolithic Polish samples, and from

contemporary populations elsewhere in Europe. We conclude that neither cultural affinities with Slavs nor socioeconomic links to the rest of the continent *per se* account for diet at this Roman-era site. Local ecology and food production technologies appear to have had a significant impact on subsistence strategies at Rogowo.

This research was funded by a Graduate Research Grant from The Ohio State University's Office of International Affairs and a Coca-Cola Critical Difference for Women Grant for Research on Women, Gender and Gender Equity.

Declines in primate abundance in logged forests: differentiating the impacts of guns versus logging.

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This paper explores the effects of logging and increased gun hunting on primates at Dzanga-Sangha Reserve (RDS), Central African Republic. RDS was selectively logged in the 1970s and in 2002. Human migration along with greater accessibility of arms has led to increased hunting and trade of arboreal primates. We conducted line transect sampling for *Cercocebus*, *Cercopithecus sp.*, *Colobus*, *Pan* and *Gorilla* in 2002 (n=420km) and 2009 (n=100km). Monkey presence on transects has decreased from 2002 to 2009 (t=3.88, p=0.000). To discriminate monkey presence versus cryptic behavior we compared calls and observation rates in park and reserve. Monkeys have become quiet in hunted zones, suggesting behavioral changes in response to increasing human activity in the reserve. To differentiate hunting from logging impacts, we compared primate encounter rates on transects close to and far from secondary logging roads. Monkeys' presence in logged sites and a higher use of roadside transects in 2002 (G = 10.199, p <=0.001) suggests they were not negatively impacted by logging itself and were preferentially selecting logged habitats relative to their availability (G = 22.13, p = 0.004). Recent declines in primate encounters on roads increasingly used by hunters, and in logged zones after 2002, suggest hunting rather than fragmentation might be responsible. At RDS, many primates are flexible in their ability to use logged forest and make behavioral adaptations to reduce their vulnerability to hunting, yet it is unlikely these changes can keep pace with large scale encroachment of arms and people into Central African forests.

This study was funded by National Geographic Society, World Wildlife Fund Ecoregion Grants, Primate Conservation, International Society of Primatology, American Society of Primatologists, Explorers Club and Purdue University.

Human-specific loss of an androgen receptor enhancer is associated with the loss of vibrissae and penile spines.

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Humans show numerous anatomical and physiological specializations compared to other animals, but the genotypic basis of most human-specific traits is still unknown. It has been long proposed that the striking phenotypic differences between humans and other apes may be due to regulatory changes in the human genome. To survey for likely regulatory mutations specific to the human lineage, we carried out a genome-wide search for sequences that are highly conserved between chimpanzees and other species, but are missing from the human genome. We detect 583 such human-specific deletions and confirm their presence in multiple human populations. The vast majority of the human-specific deletions fall within intergenic and intronic regions. One of the deletions resides in proximity to the *ANDROGEN RECEPTOR* gene and removes a ~5 kb region containing highly conserved non-coding sequences. To determine the possible function of loss of this region we tested the capacity of the homologous chimpanzee and mouse sequences to drive expression of an hsp68 basal promoter-*lacZ* reporter gene during normal mouse development. Both the chimpanzee and mouse constructs drove expression in facial vibrissae and the genital tubercle of multiple transgenic embryos. We also established four stable lines to test the postnatal enhancer activity of the mouse sequence that showed expression in the superficial tissue underlying epidermal spines of the mouse penis. Thus, we demonstrate that the loss of this *AR* enhancer is correlated with the anatomical loss of androgen-dependent sensory vibrissae and penile spines in the human lineage. This study was supported by a NIH Ruth L. Kirschstein NRSA post-doctoral fellowship (1 F32 HD062137-01) to P.L.R.

Morphological variation between Oldowan assemblages from Olduvai Gorge, Tanzania and Koobi Fora, Kenya and implications for Behavioral Lithic Analysis.

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Lithic analysis, as an archaeological tool, has the potential to reconstruct specific production behaviors among stone tool producers. This research

presents a methodology called Behavioral Lithic Analysis (BLA) that uses size-independent, quantitative morphological markers to identify specific stone tool production behaviors. BLA relies on a series of tests between archaeological material and experimentally-derived whole flake assemblages. The research presented here represents the archaeological stage of BLA development for Oldowan technology. If morphological markers that identify the method in which particular stone tools were created can be determined, then direct comparisons of production behaviors between archaeological sites is possible. To identify possible morphological markers, measurements that represent potentially controllable aspects of flake morphology must first be determined. Twelve such features are measured on whole flakes from Olduvai Gorge, Tanzania and Koobi Fora, Kenya. Statistical results suggest that there is significant morphological overlap between assemblages from these two localities but that there are groups of flakes from both that are unexpected outliers given the assemblage variation (MANOVA d=1, p<0.01, df=517). The identification of specific morphological features that vary from assemblage expectations warrants further experimental investigation. Large-scale replication experiments (N=6000 whole flakes) using native East African raw materials will allow for empirical identification of morphological variation among Oldowan assemblages. The implications of identifying specific production behaviors within the Oldowan are numerous and include 1) comparisons of site usage across landscapes and over time, 2) conclusions of cultural differences, and 3) raw material preference and differential use.

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Quantification of sub-condular constriction of the tibia.

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One (A.R.) measured the rate of sub-condular constriction of the tibia in *Homo*, *Pan*, and *Pongo*. The tibiae of twenty-six captive-born adult individuals were measured; nine chimpanzees, and seven orangutans were selected at random from the W.R. Adams Primate Skeletal collection and ten humans from [Della Cook's lab]. Each tibia was marked at five theoretical cross-sections, the first being at the widest part of the plateau. Subsequent cross-sections were marked as a fraction of tibial

length, beginning at 1/16 the length and progressing at the same interval. Mean area for each cross section was constructed using an *Immersion*[®] *MicroScribe MX* measurement apparatus and the software *R*. In *Pan* the most notable constriction occurred between the widest part and 1/16 the length. The mean difference in area (in mm) between these two cross sections as a proportion of the larger cross section was 0.565. In *Homo* the most notable constriction occurred between 1/16 and 2/16 the length. The mean difference in area (in mm) between these two cross sections as a proportion of the larger cross section was 0.511. In *Pongo* the most notable constriction occurred at a more gradual rate, remaining constant between the widest part and 1/16 the length, and between 1/16 and 2/16 the length. The mean difference in area (in mm) between the first two and second two cross sections as a proportion of the larger cross section was .413. Sub-condular constriction of the tibia in *Pongo* is intermediate between that of *Homo* and *Pan*.

Ontogenetic constraints on fluid and air filled spaces of the human craniofacial complex.

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Craniofacial functional matrices develop at different times and rates but not independently. The degree of constraint imposed on individual matrices by related matrices appears to depend on the nature of the substances contained within matrices. Some cranial matrices contain mainly fluid or air. To clarify the role of fluid and air filled spaces in craniofacial growth, we investigate how skeletal units containing these substances respond to abnormal growth patterns.

To investigate fluid filled spaces we examined an ontogenetic series of normal humans (7th fetal month-adulthood) and five achondroplastic adults. In the case of air filled spaces, we examined an ontogenetic series of normal infants (birth-5.0 years) and four hydrocephalic and three microcephalic individuals. Standard craniometric dimensions were recorded for all individuals, and normal and pathological individuals were compared.

Fluid and air filled spaces appear to be susceptible to constraints imposed by related matrices. By investigating skeletal units comprising the dorsal and ventral foramen magnum matrices, we confirm that CSF and arterial blood exert insufficient pressure to maintain normal distances between skeletal units in the presence of abnormal growth. In the nasal cavity, we demonstrate that air

pressure generated by breathing is also insufficient to maintain normal nasal cavity size/shape. Space occupied by air and fluid filled matrices, beyond baseline requirements, can be usurped by surrounding matrices. We conclude that fluid and air filled matrices are highly flexible and capable of absorbing variations in other less flexible matrices during ontogeny.

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New fossils from Ileret, Kenya, and the evolution of hominin hand function.

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Understanding the origins of hominin adaptations for manual dexterity and tool use requires a combination of functional analyses of the hand and evidence from the fossil record about the pattern and timing of morphological changes. In this paper, we analyze the anatomy of new elements of KNM-ER 47000, an associated fossil hominin upper limb from the site of FwJj14E in Area 1A of the Koobi Fora Fm. The fossil-bearing sediments date to approximately 1.52Ma and making it broadly contemporaneous with KNM-WT 15000. KNM-ER 47000 consists of a trapezium, several metacarpals and proximal phalanges, and large fragments of the scapula, humerus, and ulna, all from the right upper limb. We compare measurements of KNM-ER 47000 to relevant elements of other Plio-Pleistocene hominin fossils, modern humans, and great apes to test hypotheses about the evolution of hominin hand function.

Our analyses show that the levels of gracility of the KNM-ER 47000 first metacarpal and robusticity of the humerus differ significantly from those of KNM-WT 15000, suggesting that KNM-ER 47000 is not attributable to early *Homo erectus*. The KNM-ER 47000 hand generally resembles those of Pliocene *Australopithecus* in possessing a narrow first metacarpal, pronounced phalangeal flexor sheath attachments, and fairly human-like thumb:finger

length proportions. However, the trapezium is derived in having a relatively flattened trapeziometacarpal (saddle) joint, suggesting that this feature is not necessarily functionally or developmentally linked with increased thumb robusticity. Hypotheses treating these features as a functional complex for forceful precision and power grips may warrant reconsideration.

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Preferred or fallback?...it depends: exploring the link between anthropogenic habitat disturbance and food choice among Sulawesi Tonkean macaques.

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We examined the nutritional value of 13 fruit species known to be consumed by Tonkean macaques (*Macaca tonkeana*). We related these results to previously collected data on the diet, fruit availability, and habitat structure of two macaque groups living in differentially disturbed habitats in Lore Lindu National Park, Sulawesi, Indonesia to better understand how anthropogenic habitat disturbance affects food choice among primates. For both groups, food choice was independent of the frequency of plant species in the habitat, indicating that Tonkean macaques are selective feeders. The two groups differed, however, in a number of ways: 1. Fruit choice was positively related to protein levels for the undisturbed group and negatively related to fiber levels (NDF) for the anthropogenic group; 2. The undisturbed group consumed a greater percentage (30%) of highly preferred foods (selection index > 10) than the anthropogenic group (8%); 3. While multiple fig species constituted approximately 50% of the total feeding records of the undisturbed group, just one species, *Arenga pinnata*, comprised the same percentage for the anthropogenic group. Aren palm fruit was also overselected (relative to its abundance in the habitat) by the anthropogenic group, indicating that it is a preferred food. At the same time, Aren fruit fits the description of a filler fallback food: available year-round and eaten throughout the year, but never constituting 100% of the diet. These results suggest that anthropogenic habitat disturbance should be an important factor to consider when defining and evaluating the significance of preferred and fallback foods for primates.

Ethnicity does not affect reproductive outcomes in Limon, Costa Rica.

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The effect of ethnicity on reproductive outcomes in some cultural settings is well established. For example, it has been demonstrated that in the United States African American women have greater propensity to deliver low-birth weight babies, who have higher neonatal mortality (Bell et al. 2006; Brailion and Bewley 2010; Collins and David 2009; Muglia and Katz 2010). In this paper we ask if a similar effect of ethnicity on reproductive outcomes is present in Limon Costa Rica. Our data consist of the age at menarche and at first pregnancy, the number of live births, number of pregnancies, number of miscarriages, and number of surviving children at the time of interview in 241 adult women (149 belonging to the Afro-limonense -AL- ethnic group and 92 belonging to the Hispanic-limonense -HL- ethnic group). Our data show that the groups do not differ for the number of pregnancies, life births, miscarriages and surviving children at time of interview. The groups did differ in their mean age at time of interview ($X_{HL} = 53.50$, $X_{AL} = 56.76$; $t=2.12$, $p=0.0351$), which probably explains their significantly different mean age at menarche ($X_{HL} = 13.56$, $X_{AL} = 14.12$; $t=2.20$, $p=0.029$). Although the Limonense community is certainly ethnically-stratified (Madrigal 2006; Purcell 192), the reproductive outcomes of women of both ethnic groups do not differ. Public Health officials in other settings should investigate the socio-economic and cultural reasons for the health disparity of women of different ethnic groups.

The effect of humeral torsion on shoulder range-of-motion and throwing performance.

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Throwing with power and accuracy is a uniquely human behavior and has been proposed as a potential mode of early hunting. However, very little is known about how anatomical shifts in the upper body known to occur during human evolution affect throwing performance. A clear example of this is humeral torsion, defined as the angular difference between the orientation of the humeral head and the axis of the

elbow at the distal humerus. Previous studies have shown this angle is highly variable and tends to be smaller in the dominant arm of throwing athletes, but have failed to link torsion conclusively to range-of-motion at the shoulder. We currently lack good published mechanistic explanations for the role of humeral torsion in throwing performance.

This study examines the relationship between humeral torsion and shoulder range-of-motion and proposes a biomechanical explanation for the importance of torsion in the throwing action. Humeral torsion angles were calculated from computed tomography scans collected from 25 male subjects. These values were compared to predicted torsion values for the same subjects calculated from both kinematic and goniometric range-of-motion data using a method specifically developed for this study. Results show a significant and predictive relationship between shoulder range-of-motion and humeral torsion. These data lead us to propose a biomechanical model for the role of torsion in throwing performance, which we test with experimental data. These data are especially relevant to interpreting the low humeral torsion found in australopithec and early *Homo* homeri and their implications for early hunting behavior.

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Bornean loris and tarsier (*Nycticebus menagensis* and *Tarsius bancanus borneanus*) abundance and micro-habitat divergences in a degraded forest in Sabah, Malaysian Borneo.

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A dramatic loss of habitat and the illegal wildlife trade affect the survival of the Bornean slow loris (*Nycticebus menagensis*) and tarsier (*Tarsius bancanus borneanus*). As habitats dwindle, competition for diminishing resources may increase between these sympatric faunivores. An understanding of how they are coping with anthropogenic pressures and interspecific competition is needed to conserve them. For six months line transect surveys were done to estimate density in the Danau Girang Field Center, Sabah, Malaysian

Borneo. We surveyed a distance of 68.56 km but found only 8 lorises and 5 tarsiers (5.05 lorises/km²; 2.75 tarsiers/km²). For the Bornean loris the results coincide with past studies of other *Nycticebus* spp. Results compared to other *Tarsius* spp. Densities are low. Microhabitats were examined to determine niches exploited by the species. Through analysis of vegetation plots laid around species localities, we found tree heights and diameter at breast height (DBH) significantly differed between the species (median heights: loris 6.8 m; tarsier 3.6 m; median DBH: loris 17.8 cm; tarsier 6.2 cm), suggesting they occupy different niches. Tarsiers occur in the undergrowth on trees and stems less than 5 m: similar to other tarsier species. Lorises were found almost exclusively above 5 m. This result differed significantly from lorises in mainland SE Asia, where they are habitat generalists. Such results indicate competition is driving this niche divergence, but further studies are required to clarify such claims.

This study was funded by the Primate Society of Great Britain, Primate Action Fund, Primate Conservation Inc., Columbus Zoo and Aquarium, Cleveland Zoo, and The Margot Marsh Biodiversity grant. This study adhered to animal handling and observing protocols set out by the American Society of Mammalogists.

Assessing the taxonomic affinities of the Sangiran 7 *Homo erectus* molars; are they all hominins?

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Due to a lack of quantitative work on this sample, taxonomic placement of the Sangiran 7 *Homo erectus* molars remains uncertain. Debate exists as to whether several of the specimens represent *Pongo* sp. rather than *H. erectus* (Grine & Franzen, 1994). This issue requires further analysis since smaller, worn *Pongo* molars have been misidentified as *Homo* and differences between molars of the two genera have been described as 'minor' and 'less pronounced with wear' (Ciochon et al., 1996). To address this issue, we analyzed three-dimensional shape differences among these taxa using geometric morphometrics to determine whether the Sangiran specimens could be identified to genus.

We compared Sangiran lower molars (n=7) to those of fossil and extant orangutans (n=15), modern humans (n=10) and *Gigantopithecus* (n=3) to determine whether any of the Sangiran specimens could be excluded from the hominin sample. We used a laser scan-

ner to capture images of casts and merged them using Geomagic Studio 11.0 to create 3D digital replicas. We then placed dental landmarks on the digital specimens using Landmark 3.0.0.6 and conducted a Generalized Procrustes analysis of the landmark configurations in *Morpheus*. A principal components analysis clearly separated modern humans and most *Homo erectus* specimens from *Pongo* and *Gigantopithecus*. Discriminant function analysis correctly identified 100% of *Gigantopithecus*, 86% of *Homo sapiens*, and 93% of *Pongo* specimens to taxon. Two *Homo erectus* specimens, S-65 and S-76, were identified as *Pongo*, and S-61 was identified as a *H. sapiens* molar, all with over 90% confidence.

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Contribution of soy consumption to obesity worldwide.

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Obesity is now present worldwide, including China, India and developing countries. It now seems no longer acceptable to argue that obesity can simply be explained in terms of caloric consumption only using simple concept of energy in and energy out. There may be specific causes of altered metabolism that produce nutritional imbalances. Individual variation in response to food intake may also be considered. Specific substances in the food chain can influence metabolism towards increase in fat deposits. Xenoestrogens have been suggested to have such an influence. Soy contains phytoestrogens plus phytates, protease inhibitors and other anti-nutrients which block or compromise the body's uptake of essential vitamins and minerals. This may contribute to nutritional anomalies. We analyzed data from WHO and FAO for 167 countries. These contained percentage of obese individuals ($BMI > 30 \text{ kg/m}^2$), GDP, caloric consumption per capita, and sugar and soy consumption per capita. Regressions and partial correlations were used. Soy consumption correlates significantly with levels of obesity, irrespective of GDP and caloric intake. For instance, Latin America with soy consumption of 28.9 kg/person/year has more obesity (18.4%) than European Union (14.1%) consuming 16.1 kg/person/year of soy. While sugar consumption explains 30% of variation in obesity amongst countries, soy consumption seems to contribute approximately 10%-21%, depending on the method of statistical analysis. The ubiquitous presence of unfermented soy products in mass produced foods seems to be an important contributor to the obesity epidemic.

Unhealthy in different ways? Comparing 4 sub-populations of Greek children to assess the different pathways that can lead to obesity.

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Children in different countries and even sub-populations of children in the same country may differ in their rates of malnutrition. Proximate causes of overweight and obesity include eating too much and exercising too little, but the social and cultural pathways that facilitate this need to be evaluated. To examine how sub-populations within a single country can differ in rates of overweight and obesity as well as in the driving forces behind those rates, 1600 children aged 7-11 in 4 different Greek populations were measured between 2008 and 2009. The samples come from 17 schools in western, eastern, and central Thessaloniki, and the island communities of Ikaria and Fourni. This study utilized anthropometric measurements of height, weight, and waist circumference along with skinfold measures; although only data on waist circumference, height-for-age, weight-for-age, and BMI-for-age z-scores, will be presented here. Additionally, survey data from parents and food frequency questionnaires from a subsample of children were collected. ANOVA used to assess statistical differences in measurements of children by sex, location, and age indicated that while no overarching trend existed for differences in nutritional status by location, there were differences in nutritional status between locations at different ages. Correlations and regression statistics suggest that different demographic and social factors, such as foods available at school, were differentially associated with overweight and obesity in the sub-populations of Greek children. This paper reaffirms that overweight and obesity is a continuing concern in Greek populations, and that different lifestyles can be unhealthy in different ways.

This study was funded by the Fulbright Foundation.

The Beza winter itch: ticks parasitizing *Microcebus griseorufus* at Beza Mahafaly Special Reserve, Madagascar.

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In the region of the Beza Mahafaly Special Reserve (BMSR) in southwest Madagascar, *Microcebus griseorufus* are host to at least two haemaphysaline tick species, *H. lemuris* and a second species not yet identified. *M. griseorufus*

appear to be hosts to only the immature stages of both tick species, and are likely accidental hosts to the unidentified tick species.

At BMSR, larval and nymphal ticks, and few adults, are present on mouse lemurs only during the months of May through October, corresponding to the austral dry season. Male mouse lemurs have higher infestation rates than females, possibly due to a greater amount of time spent traveling and foraging on the ground. Infestation rates at the gallery forest well exceed infestation rates at two nearby forests. We relate these differences to the greater density at the gallery forest of ground cover and to higher population densities of lemurs and other, more terrestrial, mammalian species. We present evidence that the adults of these haemaphysaline species prefer larger-bodied lemurs as hosts. We also infer that these ticks have a non-continuous life cycle, likely influenced by the strong seasonality at Beza.

Finally, we relate the variation in tick infestation rates to the population dynamics of associated species, both endemic and introduced (e.g., rats and tenrecs), known to carry ticks at Beza. Human encroachment has resulted in drastic changes in the habitats and mammalian communities in which lemurs live, and these changes may have affected avenues for the transmission of ticks and tick-borne pathogens.

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Using the life history model to set the stage(s) of growth and senescence in paleodemography.

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Paleodemography, the study of demographic parameters of past human populations, relies on assumptions including biological uniformitarianism, stationary populations and the ability to determine point age estimates from skeletal material. These assumptions have been widely criticized in the literature and many solutions have been proposed. The majority of these solutions rely on statistical methods, and have not seen widespread application, resulting in a rift between theoretical paleodemography and bioarchaeology. We suggest that since our ability to assess age is inherently limited, we should concentrate on the type of age information accessible from the skeletal material which uses life stages, rather than point age estimates. The stages we propose are based in the human life history patterns, and their skeletal markers are

defined by clear endpoints. In addition to a five-stage developmental model, that recognizes only one adult stage, we suggest several possible divisions within the adult life stage, based on observed skeletal changes that recognise the specific nature of skeletal samples. Thus defined, these stages provide the basis for calculating crude death rates in archaeological populations.

Assessing manual proportions in *Australopithecus afarensis* using Monte Carlo resampling.

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Recent analyses of hand morphology in *Australopithecus afarensis* have concluded that this taxon had *Homo*-like manual proportions, with relatively long thumbs and short fingers. These conclusions are based on the AL333 composite fossil assemblage from Hadar, and are premised on the ability to assign phalanges not only to a single individual, but also to the correct digit within that individual. Neither of these assignments is secure, however, given the taphonomy and sample composition at AL333. Instead, an approach that takes into account the entire assemblage of complete hand elements at AL333, as well as the uncertainty in identifying phalanges by individual, side and digit number, provides the most conservative estimate of hand proportions in *A. afarensis*. Here, we use a Monte Carlo approach to resample hand bone lengths in *A. afarensis* and extant hominoids, and obtain confidence limits for the distributions of manual proportions. Results show that in most indices of hand morphology, *A. afarensis* is dissimilar to *Pan* and *Pongo*. However, its metacarpophalangeal and phalangeal proportions often fall beyond the statistical range of proportions in *Homo*, and within the confidence limits of the distributions of proportions in *Gorilla*. We conclude that manual proportions in *A. afarensis* are not *Homo*-like, but rather intermediate between gorillas and modern humans, with metacarpal proportions closer to the human range of variation, but phalangeal proportions that remain within the African ape range of variation. Implications for manipulative ability in *A. afarensis* are discussed.

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Molar crown size in African Pygmy hunter-gatherers and Bantu-speaking farmers.

ALEJANDRO ROMERO¹, FERNADO V. RAMIREZ ROZZI², ROBERTO DE LA

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African pygmies and Bantu farmers living in close relationship differ quite clear in genetic and in morphology. Previous works based on linear dimensions have shown that teeth are enlarged in dwarfed populations in relation to skull dimensions, but no differences were found in absolute dimensions neither in tooth scaling between pygmies and non-pygmies. Nevertheless, few studies have looked at specific morphological traits of the Pygmy's dentition. The crown base area (CBA) and cusp units (trigon-TR and hypocone or talon-TL) of the upper M1 were analyzed in a sample of Western pygmies (WPYG) (Baka, BaBinga and BaBongo, n=28), Eastern pygmies (EPYG) (Mbuti and Efe, n=7) and Bantu speakers (Bateke-Balali, Pahouin and Yakoma, n=30) inhabiting the rainforest of equatorial Africa. Univariate (ANOVA and *post-hoc* Tukey's HSD test) ($p < 0.05$) and Canonical discriminant functions analyses, were used to plot differences between groups. Results indicate that CBA, TR and TL are significant larger in Pygmies (W & E) than in Bantu, these differences can explain in themselves a negative allometry in tooth size related to cranial dimension in dwarfed populations. When WPYG and EPYG are considered separately, only WPYG show differences with Bantu in CBA and TL. Analysis of tooth scaling reveal strong allometric pattern in each group. Finally, the discriminant analysis shows greater variability among Pygmies due to important changes in the trigon. Our results, based on tooth morphology, show similar results to those based on DNA analyses.

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Skulls in the roof: a case of probable Fremont trophy heads.

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During the construction of a house in Richfield, UT the remains of Fremont pit house were discovered. Subsequent archaeological excavation by the State of Utah Antiquities Section revealed the structure had been destroyed by fire and collapsed in on itself. Three human skulls were discovered in the roof fall of the structure but no other human remains were found during the excava-

tion of the pit house and surrounding area. The skulls and first several cervical vertebrae of two children aged 3 to 5 years and 9 to 11 years, and that of a female aged 20-24 years were recovered and analyzed under Utah State NAG-PRA for repatriation. All three skulls exhibited perimortem trauma associated with decapitation and scalping including cut marks, perimortem fracturing and peeling on the crania, mandibles and vertebrae. The type and location of the trauma suggests the skulls were likely trophy skulls. While this appears to be one of the first instances of trophy skulls found among the Fremont and in this region, several rock art panels in nearby canyons depict anthropomorphic individuals holding decapitated heads. Additionally, recent osteological analyses of several nearby Fremont sites have identified possible cannibalism and other extreme interpersonal violence during the same period. This poster will present the analysis of these three skulls in comparison to other known trophy heads and in relation to the hypotheses explanation for increased interpersonal violence among the Fremont.

Defining patterns in human bone microstructure through the application of geographic information system (GIS) software.

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Geographic information system (GIS) software is typically used for mapping projects, however it has other constructive applications for physical anthropologists. The objective of this study was to assess the ability of GIS software to analyze patterns in the spatial distribution of histomorphological features in human bone. Overlapping images of the entire cross-section of a first metatarsal, taken at 100x magnification under polarized light, were assembled into a single composite image in Adobe Photoshop and imported into ArcGIS software. All remodeling points and osteon morphotypes were manually identified, and osteon area and circularity were measured by the user. The spatial distribution of these features was demonstrated with directional distribution, hotspot, and cluster/outlier analyses. Bending axes were identified using ImageJ software (NIH) and near analysis within ArcGIS was used to measure the distance of all remodeling points to bending axes. Distribution of these points was consistent with an expected pattern based on force distribution during loading. The uses for a histomorphometric application of ArcGIS stretch beyond the strategy discussed above. For example, after manual annotation of complete and fragmentary osteons on a composite image, OPD can be calcu-

lated and age-at-death estimated. This approach allows the opportunity to digitally visualize an entire cross-section with marked histomorphological features, and is therefore useful for long-term storage and inter-observer comparison. GIS software successfully allows quantifiable microstructural analysis at a macroscopic scale and has great potential for use in skeletal biology research.

A genotype-phenotype map of a mammalian pelvis using a mouse model.

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While there is widespread agreement on the importance of understanding the development of traits when testing hypotheses about evolution, little is known about the developmental genetics of the pelvis. This investigation quantified genetic variation and covariation in the os coxa of a model organism, the mouse, and applied the results to the evolution of the human pelvis. Os coxae from 985 mice genotyped for 3,200 single nucleotide polymorphisms from an advanced intercross line were subject to micro computed tomographic scanning. Eight linear combinations of pairwise distances among a subset of recorded landmarks were subject to quantitative genetic analysis. All were significantly heritable (h^2 from 0.48 to 0.81) and genetic and phenotypic covariances were highly proportional. Genotype by sex interactions were evident in a minority of traits. Tests of the constancy of allometric relationships across sibships for select traits revealed ample genetic variation in the relationship among traits, indicating that integration itself may be evolvable. A genome-wide scan for quantitative trait loci (QTL) identified 24 QTL affecting at least one trait. Each contained between 10 and 30 genes within their confidence regions. Patterns of pleiotropic effects of the QTL demonstrated a complex genotype-phenotype map. In combination with our understanding of patterns of pelvic integration in primates, these results indicate that models that emphasize simple changes in conserved developmental processes in response to selection on a small number of traits may not be adequate to explain the evolution of the human pelvis.

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Costovertebral morphology, thoracic vertebral number and last rib length in *Australopithecus africanus*.

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Unlike the lumbar vertebral column, for which there are data, the assessment of thoracic vertebral number in *Australopithecus africanus* is limited, given the paucity of sufficiently preserved specimens. Furthermore, its last rib length and pattern of articulation with the transverse processes is unknown. Here we analyze the vertebrae of Sts 14, Stw 431, and Stw H8/41, from Sterkfontein and traditionally assigned to *Australopithecus africanus*.

Our comparative sample included *H. sapiens*, *P. troglodytes*, and *G. gorilla*. We scored or measured: 1) relative last rib length, 2) thoracic vertebral number, 3) transitional vertebra position, 4) presence/absence of the tubercular facet on the five caudalmost thoracic transverse processes, and 5) relative cranio-caudal position of capitular (demi)facets on the five caudalmost thoracic vertebral bodies.

Relative (demi)facet position differs significantly among all three taxa. *H. sapiens* transitions from demifacets to single facets more cranially upon the spine than *P. troglodytes*, which makes the transition more cranially than *G. gorilla*. A more gradual change in (demi)facet position is positively correlated with the presence of tubercular facets, longer last ribs, and increased thoracic vertebral number. Sts 14, Stw 431, and Stw H8/41 have (demi)facet scores more like the African apes and less like humans, possibly indicating a longer last rib and the presence of more rib-bearing vertebrae than in *H. sapiens*. These morphologies also may be related to a higher transitional vertebra and longer functional lumbar column in *A. africanus* than typical for modern humans, and perhaps represents a unique pattern among hominoids.

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Applying spatial partitioning and *k*-means clustering to habitat occupation in *Propithecus perrieri*.

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Ecological data frequently violate the statistical assumptions of parametric tests, wherein the presence of spatial autocorrelation leads to an increased incidence of type I (false positive) errors. Positive spatial autocorrelation

is the lack of statistical independence between observations resulting from proximity in ecological space. A multitude of landscape ecology models control for the presence of spatial autocorrelation; however, evaluating the socioecological effects of spatial processes on a local scale is uncommon in primatological field studies. The purpose of our study was to consider the influence of spatial autocorrelation on behavior and habitat occupation in Perrier's sifaka (*Propithecus perrieri*). *P. perrieri* is a critically endangered lemur found exclusively in highly fragmented dry deciduous forest in northern Madagascar. Behavioral data were collected using 5-minute focal animal instantaneous sampling from *P. perrieri* in Analamera Special Reserve, Madagascar. Spatial partitioning and *k*-means clustering statistical analyses were applied to the behavioral activities of each lemur and then compared to canopy height where the activity occurred, forest disturbance (disturbed versus undisturbed), and habitat type (hill, riparian, or savanna). These analyses were then used to determine the relationship between observed behaviors and habitat occupation. Disturbance level is the most significant spatial partition and considerable interindividual variation in canopy height occupation is present. Identifying differences in habitat occupation, while simultaneously considering the effects of ecological space, captures individual responses to ecological conditions. Spatial partitioning and *k*-means clustering are effective spatial methodologies to independently measure interindividual socioecological variation in *P. perrieri*.

Nutritional geometry: protein and energy in mountain gorilla diets.

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Numerous studies have investigated the dietary ecology of wild primates in relation to nutrients, but little is known about the underlying motivations for choosing mixtures of dietary items. Previous studies suggest that folivorous primates, including mountain gorillas (*Gorilla beringei*), select high-protein foods, but this is puzzling because their main dietary item, terrestrial herbaceous vegetation, contains protein that greatly exceeds estimated protein requirements and the protein composition of gorilla milk. To unravel this issue, we quantified nutrient intake in mountain gorillas in Bwindi Impenetrable National Park, Uganda over one year by conducting behavioral observa-

tions (n=319 days, 1318 hrs) and analyzing the macronutrients in foods (available protein, non-structural carbohydrates, fiber, lipids, ash; N=336 samples). We analyzed gorilla diets using the geometric framework of nutrition, which identifies the fundamental variables in regulatory responses to investigate nutritional priorities. Gorillas ate fruit and leaf-based diets in different amounts and proportions seasonally, but gorillas consumed a consistent amount of energy throughout the year. While energy was relatively unchanged, protein in gorilla diets fluctuated; when leaves comprised the majority of the diet, protein intake increased, but energy intake remained constant. Our results suggest that mountain gorillas prioritize energy, rather than protein, and regulate their intake on a balance that entails the over-consumption of protein to reach their energetic needs, probably reflecting a physiology adapted to feeding on abundant, high-protein leaves.

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Nutritional incompetence and diet breadth in subadults from the Wister Valley of Southeastern Oklahoma during the Fourche Maline.

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Although a plethora of Fourche Maline (Woodland) sites have been excavated and analyzed, subsistence patterns, dietary patterns and when/how agriculture was introduced into the region, remain unclear. With permission from The Caddo Nation and The Wichita and Affiliated Tribes, thirty-three subadult burials from the Akers site (34Lf32) in southeastern Oklahoma were assessed for indicators of pathology. Examination of subadult paleopathological lesions revealed an unusual pattern consisting of high rates of cribra orbitalia, low rates of porotic hyperostosis, and moderate rates of periosteal lesions. This suggests nutritional stress, particularly Vitamin C deficiency, iron deficiency anemia, and possibly folic acid deficiency. The distribution of the skeletal lesions by age range further suggests that the nutritional deficiencies are related to a limited early childhood diet. Strong ethnographic and archaeological evidence for a diet that relied heavily on hickory nuts supports these conclusions. A diet dominated by hickory nuts would have provided good amounts of carbohydrates, fat, and protein, but very little iron and almost no Vitamin C or folic acid. It is proposed that a weanling diet that relied on hickory nut mush produced a transient nutritional incompetence in many subadults, resulting in the pattern of paleopathological lesions observed in the subadults from the Akers site. Research currently

underway on adult paleopathology will hopefully further elucidate patterns of nutritional stress.

Genome-wide investigation into variation of common infections among Mexican Americans.

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Populations and individuals differ in susceptibility to infectious disease due to numerous factors, including genetic variation. We previously demonstrated that differences in antibody titer, which reflect infection history, are significantly heritable. Here we investigate whether it is possible to identify genetic factors influencing variation in these serological phenotypes. Blood samples from >1300 Mexican Americans were quantified for antibody titer to 13 common infections: Chlamydia pneumoniae; Helicobacter pylori; Toxoplasma gondii; cytomegalovirus; Epstein-Barr virus (EBV); herpes simplex I virus; herpes simplex II virus; human herpesvirus 6; varicella zoster virus; adenovirus 36 (Ad-36); hepatitis A; influenza A; and influenza B. The quantitative antibody titer and discrete (seropositive/seronegative) phenotypes were analyzed for each pathogen. Genome-wide variance components linkage and measured genotype association analyses (using >500,000 SNPs) were performed with SOLAR software. Linkage analysis yielded LOD scores >3.0 for EBV (on chromosome 6), influenza A (on chromosome 6), and Ad-36 (on chromosome 18). Joint linkage and association analyses produced genome-wide significant results for C. pneumoniae discrete trait (p=2.2x10⁻⁵) and EBV (p=3.5x10⁻⁹ and p=3.5x10⁻¹¹, for quantitative and discrete traits, respectively). Gene expression data (for >16,000 transcripts, generated from peripheral blood lymphocytes) were also analyzed, and significantly correlated transcripts were identified for approximately half the pathogens. Further investigation of EBV indicates this trait is influenced by multiple genetic factors within the human leukocyte antigen (HLA) complex, which are specific to EBV and not infection in general. Our study shows that individual loci regulating the above serological meas-

ures exist and can be localized by statistical gene mapping approaches.

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Osteological evidence of trauma and intergroup hostility at the Aztalan site, (47JE1), Jefferson County, Wisconsin.

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The Aztalan site is a nine hectare, palisaded Late Woodland/ Middle Mississippian (A.D. 1000-1200) archaeological site located on the west bank of the Crawfish River in Jefferson County, Wisconsin. Human remains at Aztalan are classified into two burial categories. Formal burial includes primary, in-flesh inhumations, secondary bundle burials and charnel structure cremations. Informal burial designates the over 2,500 scattered, isolated and processed specimens recovered from refuse pits, fire pits, along the palisade and strewn across the habitation area. Interpretation of informal burial at Aztalan has been cannibalism, secondary processing related to mortuary ritual and intergroup hostility. Intergroup hostility had not been formally investigated prior to this research.

Taphonomic methods were used to examine perimortem and postmortem modification to the Aztalan human remains as a means to identify what processes affected the remains and to characterize the Aztalan skeletal assemblage. Cutmarks, chopmarks and perimortem fracturing are distinguished from other forms of observed taphonomy as the three most frequent forms of cultural taphonomic modification present. Perimortem processing associated with these modifications is recorded on men, women and children of all ages. Patterns of perimortem processing on the crania suggest that scalping, decapitation and ear removal took place. Postcranially, long bones are fractured at the superior and inferior one-quarter of the diaphysis and at midshaft. Furthermore, postcranial elements show evidence of in-flesh burning. Combined with archaeological correlates of intergroup hostility and the social milieu present at Aztalan, the cultural taphonomic modification of human remains supports an interpretation of violent interaction at the site.

Interpreting skeletal growth in the past within a functional and physiological perspective.

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Studies of skeletal growth and development in past populations have tended to focus on a few easily quantified traits,

such as long bone lengths, and have generally deemphasized variability in growth between different skeletal regions or in more complex morphological characteristics. However, growth is not monotonic or consistent throughout the skeleton, and may reflect environmental and genetic influences that vary depending on the type of feature and its functional and physiological constraints. These factors must be considered when interpreting variation in skeletal growth patterns.

Several examples of such an approach from both paleoanthropological and bioarchaeological contexts are presented. Skeletal contrasts considered include limb bone strength versus length, diaphyseal vs. articular size, and periosteal vs. endosteal dimensions. In each case, different patterns of growth are observed that result in constantly changing skeletal proportions. Furthermore, environmental perturbations – changes in activity level, mode of locomotion, nutritional level – have different effects on different skeletal features and are in part age-dependent as well. Thus, in order to correctly interpret variability in skeletal growth patterns as well as final adult morphology, it is necessary to understand both the constraints on normal growth trajectories and their degree of environmental sensitivity across the entire pre-adult age range. Evaluation of a variety of different skeletal features can give important insights into these processes that are not apparent from more traditional analyses of a few limited traits.

Fiber length determination and methodology in *Galago moholi* (Lorisiformes: Primates).

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Knowing fiber length is crucial to understanding variation in muscle strength and excursions capacity. However, a key methodological difference splits the available data sets, complicating comparison among studies. Our study focuses on the right and left masseter muscles of three *Galago moholi* specimens. One masseter from each specimen was selected for chemical treatment in ten percent sulfuric acid at 60°C for 1-2 hours allowing connective tissue to be dissolved and the fibers to be gently teased apart and subsequently measured. In the remaining masseter, three sampling sites were chosen for sectioning along fiber orientation. Fasciculi distributed evenly across the entire sectioned surface were then selected for measurement in order to properly represent variation in that part of the muscle. In all cases, measurements of fiber length gathered from chemical treatment were greater than those taken in sectioned muscle. This suggests that

fibers are likely damaged during sectioning due to imperfect sectioning technique and variation in fiber orientation within the muscle. Thus, direct comparisons between data obtained via these different methods would benefit from the use of a correction factor.

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To clone or not to clone: method analysis for retrieving consensus sequences in ancient DNA samples.

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The strength of ancient DNA (aDNA) evidence in the study of evolution is tempered by its challenging retrieval and authentication, principally because of post-mortem damage to the molecules. As a result, aDNA studies are particularly prone to contamination from “modern” DNA sources. These unique characteristics of aDNA have led many researchers to adopt the recommendations for authentication provided by Cooper and Poinar in 2000. One of their recommendations, sequencing clones of aDNA amplicons (i.e. “Cloning”), has become a gold standard in the field. However, beyond the recommendation to “clone” there is no standardization as to the number of clones that need to be sequenced and/or how the results should be reported in the literature. Researchers use variable approaches in deriving a consensus from such data, and there has been no systematic demonstration that directly sequencing aDNA would provide a different sequence than one determined from a consensus of clones.

We extracted DNA from the remains of five ancient northern fur seal (*Callorhinus ursinus*) ribs. Results from direct sequencing and cloning of a portion of the mitochondrial cytochrome B gene were compared. In total we observed damage at 23 of the 139 base pairs sequenced from clones. However, in no case did the consensus of clones differ from the direct sequence. Our study questions the notion that aDNA results necessarily need to be cloned and sequenced in all cases, especially when this practice adds time and cost to studies where it may be superfluous.

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ematical Sciences (UBM) grant EF-0531870.

Sex estimation using anterior sacral curvature: a geometric morphometric approach.

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Biological anthropologists have often utilized the sacrum in sex estimation because of its perceived sexual dimorphism. Historically, this was accomplished through standardized measures and indices to represent its overall shape and size (Trotter, 1926; Flander, 1978). However, the anterior curvature of the sacrum, which is a commonly used sex indicator, is poorly represented by these measurements. Furthermore, the use of sacral curvature for sex estimation is often qualitatively expressed as either “more” or “less” curved without any quantifiable measure of certainty (Bass, 1995).

To examine and quantify the relationship between anterior sacral curvature and sex, six landmarks on the midline of the sacrum were digitized from 197 individuals of known sex and ancestry at the Hamann-Todd Osteological Collection. Using MorphoJ (Klingenberg, 2008), Geometric Morphometric (GM) methods were used to assess shape differences between male and female curvature. Interlandmark distances (ILDs) were also calculated to examine differences in size and shape. Discriminant function analysis (DFA) of the Procrustes Coordinates and the ILDs was performed using FORDISC 3.0 (Jantz and Ousley, 2005). Classification accuracy rates ranged from 63 to 77.3% cross-validated, depending on the variables and groups included in each analysis.

These results demonstrate that sacral curvature is of limited utility for sex estimation, in contrast to previous assertions. However, differences in curvature were more pronounced in American blacks than American whites in the sample, whereas American whites displayed more size dimorphism than American blacks.

Ontogeny of caudal vertebral structure in capuchin monkeys (*Cebus albifrons* and *C. apella*).

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Ontogenetic studies of long bone cross-sectional properties in capuchins demonstrate that juveniles have relatively strong limbs for their body size. Here,

we investigate this ontogenetic trend in another region of the capuchin locomotor skeleton: the tail. We hypothesized that young capuchins would have relatively robust caudal vertebrae, predicting that measures of caudal vertebral bending strength (polar section modulus[Zp]) would scale with negative allometry. Linear measurements on three caudal vertebrae (transitional[TV], longest[LV], and mid-distal[MdV]) were obtained from 336 radiographs of 13 individuals (*C. albifrons*=12; *C. apella*=1). TV Zp, LV Zp and MdV Zp, regressed against body mass, scale with negative allometry; TV, LV and MdV craniocaudal lengths scale to body mass with positive allometry; and TV Zp, LV Zp, and MdV Zp, regressed against the product of body mass and bone length (a proxy for bending moments), scale with negative allometry. Capuchin caudal vertebrae thus share a scaling pattern with limb bones. However, caudal vertebral bending strength scales with stronger negative allometry than has been observed for humeri or femora. Behavioral studies show that juvenile capuchins employ their tails significantly more often than adults, perhaps as an added safety measure during refinement of adult-like positional behaviors. Tail growth in capuchins may therefore reflect an ontogenetic pattern present throughout the skeleton, the functional demands of greater prehensile tail use early in life, or a combination of both. Further morphological and behavioral data on taxa that differ in prehensile tail use during ontogeny will be required to test these non-mutually exclusive hypotheses.

Orangutan fishing and the evolution of human diets.

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This paper reports orangutan innovations for fish eating and catching and their implications for questions of when and how ancestral hominins incorporated fish and other aquatic foods into their diets. These questions are significant given the established view that early hominins were mainly carnivorous, because aquatic foods are the more likely to have enabled hominin brain and cognitive enhancements. Evidence on orangutan fish eating and catching derives from 2 years' focal and incidental observations (1400 hr, 2004-06) plus 1 year's photographic and video documentation (2006-07) of behavior in rehabilitant orangutans living on forested islands in Central Kalimantan, Indonesia. This database revealed 15 events of orangutan fish eating and/or catching. This paper describes the fishing methods used, fishing contexts (ecological, seasonal, social) and fish species eaten, and then uses the chronology of the methods and contexts observed to

suggest how these orangutans discovered and elaborated fish eating/catching. The fishing patterns identified in these orangutans closely mirror those hypothesized in ancestral hominins, including the ecological conditions in which fish eating and catching originated, the fish species caught and eaten, and the manual and simple tool techniques used. These orangutan findings add credence to models of the conditions that enabled fishing to originate in ancestral hominins. They also show that great ape brains are powerful enough to innovate simple technology-based forms of fishing. This orangutan evidence then suggests that aquatic foods could have been included in primate diets before the hominins diverged.

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Energetics and life history plasticity in callitrichine primates: a view within and across generations.

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Life history characteristics have deep roots in developmental processes, particularly those related to maternal ecology. The marmosets and tamarins are energetically flexible reproducers such that maternal mass is the best predictor of ovulation number and litter size. Using demographic data from hundreds of captive common marmosets from the Southwest National Primate Research Center, we examine the long term life history consequences of litter size at birth. We specifically address whether triplets, which have lower birth weights than twins, exhibit a) a faster life history pace and or b) evidence of higher reproductive quality, which could trade off the assumed maternal energetic cost of producing larger litters. Compared to twins, triplets do grow at a rate that is 10.3% faster (p=0.0006) and are marginally larger at maturity, indicative of an accelerated life history. However, the reproductive outcomes for individuals based on birth condition are stark: while triplets and twins do not differ in the total number of offspring produced in a lifetime (9 v. 10.23, p=0.53), triplets produce a significantly higher proportion of stillborn offspring (24.9% v. 10.7%, p=0.02). If a female were to bear only triplet litters she could reduce at least one aspect of fitness – number of grandoffspring; however, even in captivity females exhibit “local” flexibility in litter size. The benefit of a system that produces triplet litters in flush ecological contexts in the wild is potentially

the speeding up of offspring life history timing, in an environment where the threat of predation and sudden energetic shortfalls is prevalent.

How do differences in dietary composition affect diet nutrient concentrations? A test with colobus monkeys in Kibale National Park, Uganda.

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Within a primate species diet can be highly variable in composition, even at small scales within the same forest, or seasonally, suggesting that monkeys use different plant species and parts to meet similar nutritional needs. To test whether differences in dietary composition affects the nutrient concentrations ingested by primates, we studied the diets of two groups of black-and-white colobus monkeys (*Colobus guereza*; N=6, N=9), and two groups of red colobus monkeys (*Procolobus rufomitratus*; N=48, N=24) in Kibale National Park, Uganda. Based on 3,264 scans of red colobus and 2,281 scans of black-and-white colobus over 10 months, these monkeys consume many of the same plant species, but spend different amounts of time feeding on them. The majority of colobine diets were comprised of young leaves; however, they also ate mature leaves and leaf petioles. Since protein and fiber are important determinants of colobine food choice, multiple samples of 18 food species were analyzed for protein (CP) and fiber (ADF). Protein and fiber concentrations in the two different black-and-white colobus groups were both 22% CP, and 23%, 26% ADF respectively. Red colobus groups ate similar diets of ADF (27%, 25% ADF, respectively), although concentrations of CP were different (20%, 16% respectively). This difference between groups in red colobus diets may be a result of the difference in group size since bigger groups may win contests over better food resources. Our results suggest that monkeys eating diets with differing amounts of species and parts may ultimately receive similar concentrations of nutrients. This material is based upon work supported by the National Science Foundation under Grant No. 0922709.

The relationship between the mechanical and microstructural properties of trabecular bone in the anthropoid femur and humerus.

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Analyses of trabecular bone in primates assume a close correspondence between microarchitecture and bone elastic properties. The purpose of this study is to assess the relative contributions of trabecular bone structural features to the variation in the Young's modulus in the femur and humerus of anthropoid primates. High-resolution CT scans were collected for the proximal femur and humerus of five primate taxa including *Homo sapiens*, *Pan troglodytes*, *Papio sp.*, *Pongo pygmaeus*, and *Symphalangus syndactylus*. Five cubic volumes of interest (VOI) located within the femoral and humeral heads were extracted from each individual and the bone volume fraction (BV/TV), trabecular thickness (Tb.Th), trabecular spacing (Tb.Sp), trabecular number (Tb.N), structure model index (SMI), connectivity density (Conn.D), degree of anisotropy (DA), and bone surface density (BS/BV) were measured. Six voxel-based micromechanical finite element models were run for each VOI (n=630) to calculate orthotropic stiffness constants. Multiple regression analyses demonstrate that in the humerus BV/TV accounts for most of the variation in Young's modulus ($r^2=0.894$, $p<0.0001$) and that adding DA and Tb.Sp can account for up to 96% of the variation in Young's modulus ($r^2=0.966$, $p<0.0001$). In the femur, SMI, a measure of the relative proportion of plates and rods, accounts for 87% of the variation in Young's modulus ($r^2=0.872$, $p<0.0001$); the addition of BV/TV, DA, and Tb.N increases the r^2 to 0.937 ($p<0.0001$). These results suggest that BV/TV and SMI contribute significantly to trabecular bone stiffness but that there are site-specific differences in the structural composition of trabecular bone in the primate skeleton.

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Social dynamics and labor at Neolithic Çatalhöyük: inferring workload and activity patterns from degenerative joint disease.

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Çatalhöyük (7400-6000 BCE) is a Neolithic settlement in Turkey recognized for its importance in understanding densely-populated early farming communities. A key research focus for such sites is labor distribution throughout the population. Degenerative joint disease (DJD) is well-suited to address hypotheses regarding workload and its impact on life quality. Although multifactorial in etiology, DJD is primarily influenced by cumulative mechanical "wear-and-tear" on the major articular joints. The prevalence and severity of DJD in 154 adults are scored using a four-point ordinal scale to address the null hypothesis

that no difference in DJD patterns based on age, sex, stratigraphic level, and house type exists in this setting. Results indicate the expected trend of heightened DJD prevalence and severity with increasing age. Contrary to the nearly universal pattern of higher DJD in males, no major differences emerge between the sexes, as would be expected if a marked sexual division of labor allocated a heavier workload or more strenuous activities to males. Temporal changes in DJD patterns are observed but not to the extent expected if population growth drastically increased individual labor efforts in resource procurement. Certain houses at Çatalhöyük display a special significance in number of burials or rebuilding cycles. No differences in DJD patterns exist between individuals interred in special houses compared to other houses, suggesting that the relative social standing of these individuals did not significantly lessen their workload. Analyses of degenerative joint disease remain an invaluable tool for assessing the social dynamics influencing labor and activity in past populations.

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Vocal repertoire of wild western gorillas (*Gorilla gorilla*) at Mondika Research Center, Republic of Congo.

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Group-living animals use vocal signals as social communication, regulating social interactions and maintaining group cohesion and coordination. Little is known about how closely-related primates living in differing habitats adapt their vocal repertoire to differing needs of communication. Western and mountain gorillas live in different habitats and differ in diet, daily travel, and group composition and spread. To examine how these factors influence vocal communication, we provide the first behavioral and acoustic description of the vocal repertoire of ten wild western gorillas to compare with previously published data on mountain gorillas. Data include 1613 hours of continuous focal animal sampling of vocal behavior (and context) and digital recording of (> 1500) vocalizations. For each call we measured 10-25 acoustic parameters. Behavioral coding of vocalizations was based on previous mountain gorilla description of calls and verified through standard acoustic analysis. Close calls, used for within-group communication at short distances, included some calls that are produced only in specific contexts (e.g. aggression/cough-grunt) and other used in a variety of contexts (e.g. grunts). Results indicate that many western and mountain gorilla close calls are acoustically similar and used in similar contexts

(e.g. cough grunts, play chuckle). One long call (i.e. hoot series +/- chest beat) is used by males of both species during between-group male-male competition. However, in western gorillas both sexes also use it to coordinate group movement when group spread is large. This suggests that species may adapt to differing communication needs by using existing vocalizations in novel contexts.

This study was funded by The Leakey Foundation, Primate Conservation Inc., Conservation International Primate Action Fund, Richard Leakey and Wildlife Direct, Stony Brook University.

Paleogenomics, diet, and immune function.

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Dietary conditions such as celiac disease (CD) are prevalent in some populations despite calculable consequences for morbidity. HLA (human leukocyte antigen) and other polymorphisms associated with immune functions have recently been linked to CD. Much evidence supports the adaptive evolution of HLA genes for immune function, and any links between immune and diet related genotypes and phenotypes may suggest further connections between immune and diet pathways. We employed an evolutionary perspective on this question to identify populations with contrasting diet and disease histories, examining the relationship between HLA, genome-wide variation, and diet history. Paleogenomic evidence from an ancient Greenland native and Neandertals represented pre-agricultural populations, along with samples representing contemporary hunter-gatherers and populations with a long (5000-year) history of agriculture. We tested the null hypothesis that adaptive polymorphisms in HLA genes do not vary significantly between individuals from closely related populations with different dietary histories. Preliminary results show a subset of HLA polymorphisms vary according to dietary history, suggesting evolutionary links between diet and immune pathways in recent human populations.

This study was funded by the Robert Wood Johnson Population Health Dissertation Grant from the University of Wisconsin-Madison Department of Population Health.

The canopy effect: new carbon isotope data from an eastern lowland rainforest in Madagascar and implications for assessing primate niche partitioning.

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The carbon isotope compositions of plants that follow the C₃ photosynthetic pathway vary according to the degree of

canopy cover in the environment, due largely to the combined effects of lower light levels and ^{13}C -depleted, soil-respired CO_2 under closed canopies. This canopy effect is reflected in the tissues of consumers and has been shown to reveal gross-level differences in primate ecology across taxa from the Americas, Africa, and Madagascar. The canopy effect is also evident within closed canopy forests such that leaves growing near the base of the forest have more negative carbon isotope ($\delta^{13}\text{C}$) values than leaves growing near the canopy top, providing the possibility that primate feeding height is recorded by carbon isotopes. Here we report carbon isotope data for leaves growing at various heights within Betampona Natural Reserve (BNR), an eastern lowland rainforest in Madagascar, in order to quantify the strength and magnitude of the canopy effect in this forest, and to assess the utility of carbon isotope data in investigating niche partitioning within single closed canopy forests. Results show a wide range of $\delta^{13}\text{C}$ values ($\sim 10.5\%$), a strong positive correlation between plant $\delta^{13}\text{C}$ and sampling height ($R^2 = .49$, $p < 0.001$), and a mean difference of $\sim 6\%$ between forest floor and canopy top growth, independent of the height of the canopy at each sampling location. These results, along with carbon isotope data from five sympatric primate taxa at BNR, suggest that it is possible to assess niche partitioning by feeding height within single closed canopy forests using carbon isotopes.

This study was funded by The St. Louis Zoo WildCare Institute Field Research for Conservation Grant.

Forensic and ethnohistoric review of human remains from New Zealand.

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As part of a request by the Yale Peabody Museum of Natural History, we examined fifteen catalogued sets of human remains to verify provenience and provide descriptive and metric evaluations of the remains. Museum records for some of the remains suggest that they were associated with extinct *Diornis* sp., while other remains have almost no associated archival documents. As the museum records provided limited information, our goal was to provide additional data and documentation. Nonmetric characteristics such as the presence of "rocker jaw," cranial shape and structure, and unique "fern root" dental wear on some individuals are strong indicators of heritage/provenience, and other anthroposcopic variables support the available documentation. Metric analyses of the more complete crania using FORDISC were not as conclusive, with individuals being identified with multiple different groups outside of New Zealand/Oceanic populations. Individual variation and robusticity may have been contributing factors, as well as

the software itself. Evaluation of taphonomic indicators (i.e., exposure, weathering) provides additional information relating to ethnohistoric data on New Zealand mortuary practices. A detailed forensic/osteological review of human remains provides valuable details that augment, support, and in some cases go beyond the archival data from museum collections. In this case, the analysis provides a better understanding of individual life history and occupational/other stresses. This work was supported by the Department of Anthropology, Yale University.

Systematic implications of meningeal grooves in Sterkfontein *Australopithecus*.

E. E. SARMIENTO. Human Evolution Foundation.

Despite two genera and four or more species of apes presently inhabiting Africa, its Plio-pleistocene deposits have yet to yield their ancestors and/or any ape lineages predating human divergence. This absence may be a classificatory artifact and explained by the practice of using non-projecting canines, and non-sectorial p3s as diagnostic of hominids (in the classical sense). Because apes (e.g. *Oreopithecus*, and *Ramapithecus*) predating the Human/African ape divergence have non-projecting canines and non-sectorial p3s, use of these characters to diagnose hominids is likely to misclassify all African apes fossils as hominids, including those predating human divergence. Although during the Plio-pleistocene the exclusive human, gorilla and chimpanzee lineages may be too young to have developed complex characters that can unequivocally diagnose fossils to anyone lineage, the common human African ape lineage is older and has developed such diagnostic characters. Cadaver dissections and skeletal examination show that a large middle meningeal artery arising from the maxillary branch of the external carotid is a complex diagnostic character shared by humans and all African ape species. In Asian apes and non-hominoid catarrhines, the internal carotid supplies the meninges through the recurrent lacrimal branch of the ophthalmic artery. Because the meningeal vessels groove the skull and may pass through distinct foramina they leave a skeletal record of the condition of this character. Examination of Sterkfontein *Australopithecus* skulls reveals that not all individuals show the human/African ape condition, suggesting some predate human/African ape divergence, and australopithecines as a group are not all hominids.

Metacarpal curvature during ontogeny in wild apes.

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Diaphyseal curvature of long bone shafts has been found to respond to the loading environment (Currey 1968; Lan-

yon 1980; Robling et al. 2002). Bertram and Biewener (1988) suggested that diaphyseal curvature increases the predictability of the load environment in mammalian long bones where bending is the main loading force. During knuckle-walking in the African apes, the middle phalanges bear most of the weight. This method of locomotion puts the metacarpals nearly perpendicular to the middle phalanges, such that the metacarpals serve as load-bearing conduits subject to significant bending loads. It is therefore predicted that adult chimpanzees should have greater metacarpal curvature than younger chimpanzees, who engage in less frequent knuckle-walking, and non-knuckle-walking apes such as gibbons and orangutans.

Digital photographs of wild caught chimpanzee, orangutan, and gibbon third metacarpals were analyzed to evaluate the degree of longitudinal shaft curvature in different aged individuals using the included angle method (Susman et al. 1984). One-way ANOVA revealed significant variation in the included angle between each species ($p < 0.05$). Post hoc analyses found that adult chimpanzees possess greater metacarpal curvature than non-knuckle-walking orangutans and gibbons ($p < 0.05$). In contrast, no differences in curvature exist between orangutans and gibbons. Metacarpals were significantly less curved in infant chimpanzees compared to older subadult and adult chimpanzees ($p < 0.05$), the latter of whom engage in much higher rates of quadrupedal locomotion. These results support the idea that curvature may reduce variability in bending stresses experienced by the metacarpal shaft and thereby increase stability during knuckle-walking. This study was funded by the National Science Foundation Dissertation Improvement Grant and the Leakey Foundation.

A season of death: patterns of predation on wild lemurs at Beza Mahafaly Reserve, Madagascar using multiple methods of assessment.

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Over the years, the threat of domestic and other introduced mammals to the lemur population in and around the Beza Mahafaly Special Reserve, in Southwestern Madagascar, has been

noted but not systematically assessed. We collected data on the number and type of potential predators utilizing the reserve, identified areas where lemurs appear most vulnerable to such predation, and assessed the range of animals being preyed upon by endemic and introduced mammals. From June 2008 to July 2009 we used camera-traps, collected predator scat, and documented patterns of lemur predation to assess this.

The endemic carnivore *Cryptoprocta ferox* (fossa) is confirmed as present in the reserve, but at very low numbers. We also documented 5 cases of lemur predation that were consistent with patterns reported in fossa predation. Wild cats and feral dogs are much more prevalent and are active day and night. The abundance of wild cat sightings was positively correlated with lemur sightings ($p < .006$), indicating these carnivores are attracted to areas used by lemurs. An eyewitness account of a wild cat running from a freshly killed sifaka corroborates that they are efficient predators of larger lemurs. Scat samples document that felids are using lemurs as prey at a much higher percentage than are canids. Lemur remains collected from felid scat include the distal phalanges of fingers and toes, eyes, and hair. These results indicate that wild cats can take larger lemur prey, and strongly suggest that this species may be competing with fossa for lemur prey.

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Analysis of commingled human remains from the Mlambalasi rock shelter, Tanzania.

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Recent excavations at the Mlambalasi rock shelter in the Iringa region of southern Tanzania have yielded fragmentary, commingled human remains from at least three individuals. The site has a rich archaeological record that spans the historic period, Iron Age, and Later Stone Age (LSA). There are also Middle Stone Age (MSA) deposits on the slope in front of the rock shelter. The site was first excavated in 2002 by Dr. Paul Msemwa, and in 2006 by Dr. Pamela Willoughby. Additional excavations were conducted by Willoughby's team in 2010. Human skeletal remains were recovered during all three field seasons at the Mlambalasi site. Osteobiographical analysis of the remains from the 2006 excavation demonstrated that two individuals were present: a large proportion of an adult and the manubrium of a juvenile. In 2010, additional *in situ* remains from the same adult were recovered. The

remains excavated in 2002, which are housed at the National Museum of Tanzania, represent a third adult individual. The archaeological context suggests at least two of the skeletons could be Pleistocene Later Stone Age in origin. Snail shell fragments collected from the levels above and below these skeletons were radiocarbon dated to 11,635 – 13,295 calibrated years BCE. We will present the results of a holistic osteological analysis of the skeletal material from all three field seasons as well as new radiocarbon dates. The Mlambalasi rock shelter is a valuable new site in southern Tanzania with great potential to contribute to our understanding of the East African LSA.

This study was funded by the Social Sciences and Humanities Research Council of Canada (by a Joseph Armand Bombardier MA scholarship – #766-2009-0072 to Sawchuk and by a Standard Research Grant #410-2008-0061 to Willoughby).

Experimental analyses of intergroup encounters among tufted capuchin monkeys: effects of resource quality and female sexual behavior.

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In many species, the function of aggressive intergroup encounters (IGE) remains unclear, although between-group relations play a pivotal role in socioecological models. Game theory suggests that individuals are more likely to initiate aggression as the benefits of winning increase, providing a framework for identifying the contested resource. To test whether tufted capuchins (*Cebus apella nigrilus*) at Iguazu, Argentina, engage in intergroup aggression primarily to defend access to food resources, mates, or both, I examined individuals' initial reactions ($N=27$) to playbacks of long-distance vocalizations from neighboring groups ($N=37$ playbacks), varying the resource quality of an area through the use of provisioning platforms. I collected focal animal data of general behavior, velocity, and neighbor density, both pre- and post-stimulus, and noted whether the individuals vocalized, approached or gazed toward the playback speaker. Using generalized linear mixed models, I assessed the effects of resource quality, the presence of a proceptive female, and the focal individual's sex and dominance rank on the probability of approach and the strength of the behavioral response. Individuals were significantly more likely to begin rapid movement in the direction of the speaker when resource quality is high, although females did not respond as strongly. The presence of a proceptive female did not significantly affect the response of the focal individual. These results demonstrate that

intergroup aggression among tufted capuchins is primarily related to defending access to food resources, and that both males and females participate actively in IGEs, suggesting that between-group contest competition may be strong in this population.

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Gummivory and the Risk Aversion Hypothesis.

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This study compares the relative growth rates of *Galago senegalensis* and *Otolemur garnettii* as a test of the Risk Aversion Hypothesis (RAH). RAH suggests that the low growth rate in primates is an adaptation offsetting starvation risk that is associated with seasonal food shortages. Since fruit is more seasonal in availability compared to foliage, species relying on fruit should grow slower than species relying on foliage. As gums, like foliage, are generally available year-round, the risk aversion hypothesis posits that gummivorous galagids will grow faster than frugivorous galagids. This hypothesis was tested with ontogenetic data by comparing the growth rate of *Galago senegalensis*, a gummivore, with the growth rate of *Otolemur garnettii*, a frugivore. There are no significant differences between *G. senegalensis* males and *O. garnettii* males. *G. senegalensis* females have a lower relative growth rate compared to *O. garnettii* females; therefore, the starvation risk aversion hypothesis is not supported. *O. garnettii* are weaned during the dry season while *G. senegalensis* are weaned during the wet season when food is abundant. As *G. senegalensis* females experience low feeding competition both at weaning and, presumably during adulthood due to their more reliable gum resources, they can afford to grow slowly and cease growing at a relatively smaller size. *O. garnettii* females face greater competition for food both during weaning during the dry season and as adults relying on a more seasonal fruit resource; selection for rapid growth to attain larger size at weaning could be advantageous for *O. garnettii*.

A comparison of methods used to estimate age-at-death in human mummies from South America and Europe.

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Mummy Project, Reiss-Engelhorn Museum.

The unique nature of both natural and anthropogenic mummification processes causes problems when trying to provide an accurate age-at-death estimation for a particular mummy. Published case studies about mummies appear in a wide range of anthropological, medical and other scholarly journals. Articles often provide an assessment of age, but often fail to specify the methods used to calculate the estimated age.

This study assembled data about age-of-death estimation from more than 100 published case studies of mummies, in order to determine which methods were used. Each method listed in the publications was then applied to a small group of mummies that included naturally-preserved mummies from South America, northern European bog bodies, and German crypt mummies. The results of the study showed that methods used for age estimation are rarely specified in published reports and that some standard methods of age estimation could not be applied to all types of mummies. Modifications to traditional osteological approaches for age estimation were sometimes necessary due to the presence of soft tissue and post-mortem changes to the body. Although methods of age estimation for human skeletal remains are standardized, this research clearly demonstrated that appropriate methods for the assessment of age-at-death in human mummies should be considered on an individual basis, and that the methodology used must be provided in published reports of mummy studies.

Anthropological usefulness of 15 X chromosome STR loci across four linkage groups.

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Population genetic and anthropological studies were included in a larger study of X chromosome STR markers looking at mutation rates and linkage relationships in multiple populations.

A total of over 750 meioses from mothers, children and father of non-excluded parentage cases from US European, African Americans and SW Hispanics were tested for 15 X chromosome STR loci (DXS8378, DXS9902, DXS6795 [LG1], DXS7132, DXS6803, DXS6789, DXS7424, DXS101, GATA172D05, DXS7130, GATA165B12 [LG2], HPRTB [LG3], GATA31E08, DXS10147 and DXS7423 [LG4]), yielding 137 alleles using two multiplexes developed at AFDIL for forensic purposes. The loci were individually analyzed by F_{ST} analysis across the three populations, and

aggregately analyzed using PCA followed by hierarchical cluster analysis. Linkage Disequilibrium (LD) was tested only on European segregating chromosomes to minimize confounding effects. All probability values were corrected for multiple tests using the Bonferroni correction.

The results of the F_{ST} analysis indicated that 8/15 loci had significant F_{ST} values at the $\alpha = 0.05$ level, however only 4/15 were significant after Bonferroni correction. PCA analysis yielded two Eigen vectors which accounted for 100% of the variance, and generated highly discriminating factor scores for the three populations. LD analysis did not detect any significant LD for the pairs of closely linked loci in LD1, LD2 and LD4.

Additional studies are planned to include Ghanaians, Ethiopians, Southeast and Northeast Asians and American Indian samples, to further test the usefulness of these X STR markers. These markers appear to be highly useful in the study of human population variation, migration and ancestry.

Disclaimer: The opinions and assertions contained herein are solely those of the authors and are not to be construed as official views of the United States Department of Defense or the United States Department of the Army.

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Human sacrifice as royal mortuary ritual at the Classic Maya site of El Zotz, Guatemala.

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In 2010, the Proyecto Arqueológico El Zotz excavated an intact royal tomb, Burial 9, at the Classic Maya site of El Zotz, Guatemala. Architectural chronology and analysis of ceramic vessels from within the tomb indicate that the deposit dates between AD 350 and 400. Seven individuals were identified within the tomb, and at least two other individuals are represented by human elements recovered in deposits outside of the tomb. By integrating archaeological information from the field with human osteological data obtained in the laboratory, the original position of each of the seven bodies was identified and the mortuary ritual was reconstructed. This rite involved the sacrifice of six children within the tomb, each of whom was briefly exposed to fire. The seventh individual, the primary tomb occupant, was

painted with both specular hematite and cinnabar, wrapped in a burial covering, and placed upon a bier. Outside of the tomb, another child was sacrificed and burned, and fingers from at least one adult individual were cut off and placed within ceramic vessels. Dental morphology suggests a lack of a close genetic relationship among the tomb occupants. Analysis of human remains recovered from a series of looted tombs at El Zotz reveals that similar rites of child sacrifice, body painting, and exposure to fire were performed in other contexts at the site. Comparison of El Zotz Burial 9 with funerary deposits at other Maya sites shows both continuities and dissimilarities in royal mortuary rites of the Early Classic period (AD 250-600). Research at El Zotz was funded by the National Science Foundation (BCS-0840930) and the National Endowment for the Humanities (RZ-50680-07).

Functional morphology of the peri-vertebral muscles in great apes – are humans unique?

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Humans are unique among primates in having a striding bipedal gait and a permanent orthograde trunk posture. Thus, the functional demands on the human trunk musculature are different from those in other great apes. To 1) increase our understanding of the functional morphology of the axial system in great apes, 2) distinguish adaptations to human bipedalism from characteristics shared with other great apes due to their common phylogenetic history, and 3) reconstruct functional transformations of the axial musculature during ape evolution, we investigated the lower thoracic and lumbar perivertebral muscles of the orangutan and chimpanzee regarding their fiber type composition and anatomical cross-sectional area (ACSA) and compared these data with results from humans. Muscle fiber type distribution was determined using immunohistochemistry; ACSA was measured in CT scans. Similar to humans, chimpanzees and orangutans did not show the segregation of specific fiber types typical for other mammals. This striking reorganization facilitates all muscles to equally contribute to trunk mobilization and stabilization. Furthermore, our results show that compared to the chimpanzee and human, which were fairly similar in the slow fiber proportion, orangutans showed overall higher proportions of slow fibers; likely related to their slow, cautious locomotor behavior. Non-human great apes have a relatively small lateral epaxial muscle tract com-

pared to their body mass, while all other perivertebral muscles have the ACSAs as predicted by body mass. This smaller lateral tract points to a decreased need for mobilization, likely correlated with the comparatively short, stiff trunk of non-human apes.

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Direction and intensity of sexual dimorphism in European and Chinese mandibles' outer contour.

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Analysing sexual dimorphism is a crucial task in palaeoanthropological, forensic and ecological studies of human remains. The mandible as a very prominent feature in a person's physique is known to be a sexual marker. Our goal was to show if there are common linear combinations of shape vectors explaining the differences between the sexes and to compare the amount of sexual dimorphism between different populations.

We used CT-Scans of 925 European and 960 Chinese individuals. Only pathologically unaffected mandibles were included.

The data consists of 18 anatomical and mathematically constructed landmarks along the mandible's outer contour.

We used geometric morphometrics to extract shape data and remove information about orientation, location and size. The resulting data was analysed applying several multivariate statistical methods, including parametric testing and permutation tests.

Sexual dimorphism in shape as well as in size was significant within both populations: discriminant analysis on shape data shows a distinct separation between the sexes. To test differences in direction and intensity of sexual dimorphism between populations, vector angles and lengths were compared and tested using permutation testing. The results implicate that there is no common shape trajectory dividing males from females within both populations. This means that shape changes associated with sexual dimorphism are highly population dependent. Also, the lengths of those shape vectors dividing the sexes differ significantly, indicating differences in the intensity of the expression of gender specific patterns between populations – at least as far as the landmark configuration in question is concerned.

Dental microwear texture analysis of Natufian hunter-gatherers and Neolithic farmers from Northern Israel.

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Dental microwear texture analysis (DTA) reconstructs dietary hardness and toughness using a white light confocal profiler to generate 3D surface representations and data clouds that are processed with scale sensitive fractal analysis software. Here, we employ DTA to search for dietary differences between sixteen Natufian hunter-gatherers (12,500–10,250 BP) and fifteen late Neolithic farmers (10,250–7,500 BP), recovered from archaeological sites in northern Israel.

Resin casts of molar occlusal facets 9 and 10 were produced. Data were collected using a 100X objective lens and the extended topography option, which allowed for four contiguous data sets to be taken and stitched together automatically by the microscope. The resulting surface representations were leveled and occlusal debris was digitally removed prior to analysis. Toothfrax[®] and Sfrax[®] software were used to calculate anisotropy (the degree to which microwear features are similarly oriented), heterogeneity (the extent to which microwear features are the same over the area of interest), complexity (the surface relief), and the textural fill volume (the amount of surface removed by microwear). Data were log transformed and variation between the hunter-gatherers and farmers was identified using ANOVA.

No differences were found between facets 9 and 10. One variable, anisotropy, differed significantly between Natufian and Neolithic groups (df=1, F=5.954, p=0.024), indicating that the microwear was more similarly oriented within the Neolithic. This finding supports the idea that food processing changed over time as agriculture emerged in northern Israel (e.g., Mahoney, 2006).

This study was funded by a grant from the National Science Foundation (BCS-0922930 to CWS).

Is there biomechanical equivalence when comparing mobility, activity levels, and limb loading across individuals and species?

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Discussions of mobility and functional anatomy often assume that higher activity levels increase bone loading in all animals in all contexts. But it is worth asking whether two animals moving at the same speed and distance produce the same loading pattern and whether increased bone mechanical properties reflect increased activity levels? Here we examine data from a variety of our comparative laboratory-based studies on limb loading. Our findings reveal that the relationship between activity and loading is more complex than previously assumed. For example, data collected on primates compared at the same speed on arboreal and terrestrial supports show changes in contact time and center of mass (COM) movements that influence load. Cats moving at equivalent speeds to dogs must generate more muscular effort to move the COM and may load their bones more. Data on primates moving at the same speed also show that gait choices (i.e. walk compared to amble) influences peak forces and COM movements. Finally, data on hyper-muscular mice with high levels of bone robusticity indicate that these animals choose slower speeds are no more active than wild-type mice, rejecting a relatively straightforward relationship between activity, load, and bone strength. Taken together these observations suggest that the same mobility or activity level can yield different loading levels depending on substrate context, gait choice, and species. Given these caveats, definitions of mobility must be precise as to gait, substrate, anatomy, and posture, and must accommodate the notion that bone mechanical properties are not necessarily reflective of activity.

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Differences in endocranial shape between *Homo* and *Pongids* assessed through non-rigid deformation analysis of high-resolution CT images.

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Our understanding of evolutionary changes in brain anatomy, as evident in fossil specimens, is facilitated by a statistical assessment of species differences in endocranial morphology. Because the endocranial surface is morphologically complex, such comparative assessments will ideally involve rich mathematical descriptions that can be directly and easily compared between species and to fossils. Atlases representing statistical averages of species endocranial form

have been created using non-rigid deformation techniques applied to endocranial casts collected by Ralph Holloway. Point-by-point voxel-based assessments of species differences have then been constructed by morphing species' atlases into each other. This method results in detailed statistical maps of exactly where species differ endocranially, and by how much. We present the results of these methods applied to differences between *Homo sapiens*, *Pan troglodytes*, *Pan paniscus*, and *Gorilla gorilla* endocranial atlases. The analysis for *Homo* and *Pan troglodytes* suggests that the orbitofrontal surface and posterior occipital areas are the most different between these species, suggesting more than 4-fold increases in these areas, while portions of the temporal poles suggest less than 2.5-fold differences (overall, the endocranial surfaces averaged 3.1-fold differences). These findings will be compared with similar published assessments of differences between the brains of these species. Methods for making point-by-point assessments of differences between fossil specimens and extant species atlases, as well as between fossil specimens themselves, will be described. These will allow for a detailed assessment of the evolution of brain evolution as inferred from the endocranial surface.

Mandibular premolar molarization: a platyrrhine comparative model.

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Molarization of the crown of the last mandibular premolar is a distinctive feature of some extinct early *Homo* and megadont archaic hominin taxa, but there is debate about whether molarization is a shared derived character or a homoplasy. New World monkeys provide a suitable morphological and developmental sample for understanding molarization in primates. We sampled mandibular postcanine crown and root morphology and obtained proxies for body size from *c.150* callitrichid and other platyrrhine individuals from the collections of the National Museum of Natural History, Smithsonian Institution. The sample included closely-related sympatric species with known dietary niches, including individuals of *Saguinus fuscicollis*, *Saguinus labiatus*, and *Callimico goeldii*. Mandibular molar and premolar crown morphology was compared using linear and areal measurements based on enlarged occlusal photographs, and mandibular molar and premolar root morphology was compared using linear and areal measure-

ments taken from plain radiographs. Preliminary results indicate that P₄ linear and areal measurements vary independently of body size and crown area correlates more closely with root profile area in molars than in premolars. Principal components analysis of occlusal morphology suggests that sympatric species vary significantly in their mandibular premolar crown morphology. We suggest various ways in which the results of this study of premolar morphology in closely-related and sympatric New World primate species can be used to develop hypotheses about the phylogenetic significance of the mandibular premolar morphology of megadont archaic hominins.

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The positional behavior of ursine colobus (*Colobus vellerosus*) and Lowe's monkey (*Cercopithecus campbelli lowei*) in Ghana's Boabeng-Fiema Monkey Sanctuary.

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The extent to which primates vary their positional behavior in response to architecturally distinct forests continues to be a topic of active research. Here, we compare the locomotor and postural profiles of two cercopithecoid species ranging across a mosaic of forest habitats in Ghana's Boabeng-Fiema Monkey Sanctuary (BFMS). From January to October 2009, we used instantaneous time point sampling to collect positional and habitat data on multiple groups of adult female ursine colobus (*Colobus vellerosus*) and Lowe's monkey (*Cercopithecus campbelli lowei*) inhabiting either areas of unlogged, primary forest or regenerating forest. Architectural differences between forests were quantified using focal canopy density sampling methods. Significant intraspecific differences in positional behavior and habitat use profiles were identified using G-tests and Fisher Exact Tests. For the ursine colobus, postural profiles differed between forest habitats. For Lowe's monkey, both locomotor and postural profiles differed. Both species tended to frequent low forest levels more often in disturbed forest where the paucity of upper canopy pathways required that individuals use thinner supports at lower heights. We suggest that the large body size and leaping adaptations of the ursine colobus constrain its locomotion compared to that of the smaller, more generalized guenon. Nevertheless, those positional behavior differences that were observed were subtle and provide support for the notion that basic positional behavior profiles tend to be conserved across habitats.

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Bioarchaeology and climate change: a view from South Asian prehistory.

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Throughout the second millennium B.C., human populations thrived in west-central India. Deccan Chalcolithic people settled in villages employing a mixed economic strategy—farming drought-resistant barley, stockraising, hunting and foraging. After 1000 B.C., the majority of these settlements were abandoned. Only Inamgaon persisted into the Late Jorwe phase (1000-700 B.C.). Archaeologists suggested that increasing aridity and unpredictable monsoon rainfall caused the depopulation. Bioarchaeologists suggested the Late Jorwe was a time of increased dietary diversity, population mobility, lower biocultural stress levels and improvements in infant health. However, recent paleoclimate reconstructions indicate the unpredictable monsoon and reduced rainfall were well established long before these settlements were abandoned and are not likely to be directly responsible. This poster presents a new interpretation of life and death at three villages occupied during the Deccan Chalcolithic period of Indian prehistory based on new evidence from paleoecology, demography, and bioarchaeology. Paleodemography indicates high fertility and infant mortality led to high pressure population dynamics during the Late Jorwe phase at Inamgaon. The osteological paradox thus plays an important role in the interpretation of biocultural stress markers. When previous data for dental stress markers is combined with evidence of subadult skeletal emaciation, it is apparent that acute and chronic stress markers tell different stories about life at the end of agriculture in prehistoric India. These results are the basis for a new Biodemographic Model for understanding climate and culture change during this period of climate and culture change in Indian prehistory.

Genetic histories of Gwich'in and Inuvialuit populations of Northwest Territories, Canada.

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In this study, we investigate the genetic history of Dene and Inuvialuit populations from the Northwest Territories to help elucidate the history of circumarc-

tic populations, and define their genetic relationships with Amerindian populations to the south. We characterized mtDNA variation in over 400 individuals through control region and whole genome sequencing and SNP analysis, and Y-chromosome (NRY) variation through SNP and STR genotyping. Our results show that the vast majority of individuals (>94%) have mtDNAs belonging to haplogroups A2, C and D, with the rest being non-native lineages. In addition, some 60% of the male individuals belonged to Y-chromosome haplogroups C and Q, with the remainder representing native lineages, mostly haplogroup R1. Our high-resolution mtDNA and NRY data, particularly those coming from mtDNA haplogroup A2, provide new details about the phylogeography of Athapaskan (Dene) peoples, including their origins and pattern of dispersal across the circumarctic region. They also allow us to test theories about Dene prehistory based on linguistic evidence, including putative links to Ket populations in Siberia. Data from the Inuvialuit also shed light on the prehistoric and historic migrations by Inuit peoples across the Arctic over the past several thousand years, in part because genetic data from the Western Arctic have heretofore been lacking. Furthermore, by combining the genetic data with genealogical, ethnographic and historical information from the region, we will expand our understanding of the recent history of Aboriginal communities from the Mackenzie River valley.

This study was supported by funds from the National Geographic Society, IBM, the Waitt Family Foundation, and the Department of Anthropology of the University of Pennsylvania, and by in-kind support from the Gwich'in Social and Cultural Institute, the Gwich'in Tribal Council, and the Inuvialuit Regional Corporation.

Differential infant and child mortality and morbidity in Late Anglo-Saxon England.

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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) popula-

tion data provides indications or 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.

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Growth, behavior, and morphology: lessons from chimpanzees.

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The relationships among morphology, function, and behavior are complex. A better understanding of these relationships has widespread implications for anthropological research. To this end, studies of living nonhuman primate species are particularly valuable. Chimpanzees (*Pan troglodytes*), like humans, have an extended period of development, during which substantial changes take place in body size and shape. We investigated the ontogeny of body size, limb proportions, and positional behavior in captive chimpanzees in an attempt to relate gross changes in body morphology to variation in positional behavior. Body weight and linear body segment data were collected for 73 subjects between the ages of 6 months and 13 years. Positional behavior data were collected for 30 subjects within the same age range. The intermembral index, brachial index, upper limb-to-trunk index, and hindlimb-to-trunk index were calculated from the limb measurement data and plotted along with positional behavior variables against age using locally-weighted scatterplot smoothing (LOWESS). Results

indicate that as body size increases during ontogeny, the frequency of climbing and suspensory posture decreases. Following an initial increase in frequency during the first 3-4 years, suspensory locomotion, brachiation, and leaping also decrease with increasing body size. The intermembral index changes very little during ontogeny, while the brachial index decreases during the first 48 months than levels off during adolescence. Both the upper limb-to-trunk and the hindlimb-to-trunk indices decrease slightly during ontogeny. These results are consistent with other studies of positional behavior in apes and with known functional relationships between body size, limb proportions, and behavior.

A new method for the determination of post-mortem interval: citrate content of bone.

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Few accurate methods exist currently to determine the time since death (post-mortem interval, PMI) of skeletonized human remains found at crime scenes. Citrate is present as a constituent of living human and animal cortical bone at very uniform initial concentration (2.0 ± 0.1 wt %). Citrate is almost undetectable in bones recovered from >100 y old burials, suggesting that the decrease in citrate content could be used as a chronometer for PMI. Citrate can be determined easily by use of an enzymatic technique commercially available as a kit. In skeletal remains found in open landscape settings (whether buried or not), we observe that the concentration of citrate remains constant for a period of about 4 weeks, after which it decreases linearly as a function of log(time). The upper limit of the dating range is about 80 years. The rate of decay is approximately constant over a wide range of burial environments in temperate N. America and is independent of average temperature or rainfall. Citrate loss appears to stop below 0 °C. The precision of determination of PMI is a few percent of the age but decreases gradually with increasing age.

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Tales from the Crypt: tooth growth, dental development and the evolution of primate life histories.

GARY T. SCHWARTZ. Institute of Human Origins & School of Human Evolution and Social Change, Arizona State University.

For nearly three decades, Don Reid has been instrumental in helping pioneer the histological analysis of dental hard

tissues. His diligence and scrupulous attention to detail has yielded dataset after dataset detailing the timing of individual tooth formation and overall dental development in a variety of extant and extinct primate forms. More recently, his efforts have focused on producing chronologies of tooth formation in a variety of modern human populations, and these data serve as the benchmark against which dental development in all other human groups, fossil and modern, are compared. Here, I present a synthesis of existing and limited new data on primate dental development emphasizing variation in molar crown formation times, crown extension rates, root extension rates, and emergence ages to further refine our understanding of primate, and in particular, hominoid patterns of dental development and how they relate to variation in life history. Broadly speaking, across primates, the age at first molar emergence is tied to a variety of life history attributes. New data for Malagasy lemurs and extant great apes are presented that help frame estimates for ages at molar emergence and the scheduling of life history in early primates and fossil hominins, and suggest new avenues of dental developmental research that beg further exploration. These new data add to the tremendous body of work assembled throughout the career of Dr. Reid that, in conjunction with his patience and skilled mentoring, have shaped the future of research in dental biology, bioarchaeology, and paleoanthropology.

Evolutionary integration in the anthropoid masticatory system.

JEREMIAH E. SCOTT. School of Human Evolution and Social Change, Institute of Human Origins, Arizona State University.

Australopithecus boisei and *Au. robustus* are characterized by a number of craniodental features indicating that they share an ancestor to the exclusion of all other hominin species. However, it has been argued that support for this sister relationship is not as strong as many cladistic analyses have suggested. This argument is based on the fact that many of the purported synapomorphies that unite these species are functionally integrated features of the masticatory system and are thus unlikely to constitute independent lines of evidence. Some versions of this critique attribute many of these similarities to a single biological process—selection for postcanine megadontia. This study evaluates the plausibility of this argument by testing the hypothesis that the size of the postcanine dentition is tightly integrated with other components of the masticatory system across extant anthropoid species. Morphometric data collected from twenty-nine species were analyzed using phylogenetic compar-

ative methods. The results provide some support for the hypothesis. For example, there is a fairly strong relationship between relative postcanine size and the relative height of the mandibular condyle above the occlusal plane ($r=0.68$). However, correlations between relative postcanine size and skeletal proxies for masseter position and size are weak or nonsignificant ($r<0.40$). These results indicate that although atomistic approaches to character definition in the masticatory system undoubtedly confound cladistic analyses of fossil hominins, functionally related characters in this region do not necessarily evolve in a coordinated fashion. Thus, phylogenetic information is lost when mastication-related features are treated as a single character.

Dental microwear texture analysis of fossil carnivores from Langebaanweg, South Africa.

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Reconstructing the paleocommunity ecology of Miocene-Pliocene boundary sites in Africa is essential to our understanding the evolution of numerous mammalian taxa, including the hominins. The site of Langebaanweg in South Africa has produced many fossils representing a wide range of mammalian taxa and provides a unique opportunity to study guild dynamics during this important time interval. In this presentation we focus on the fossil hyaenids from Langebaanweg, specifically *Chasmaporthetes australis*, *Hyaenictus hendeyi*, *Hyaenictitherium namaquensis*, and *Ikelohyaena abronia*. Owing to a lack of canids at the site, researchers have argued that fossil hyaenids were ecological vicars to both modern hyaenids and canids, with *C. australis* and *I. abronia* consuming more bone. We test this hypothesis using dental microwear texture analysis. Previous research has demonstrated that increased durophagy results in high microwear surface texture complexity and isotropy. The microwear textures of the Langebaanweg hyaenids were compared to the extant feliforms *Crocota crocuta*, *Acinonyx jubatus*, and *Panthera leo*. Our results reveal low levels of inter-specific variation in microwear signatures among the fossil taxa, suggesting limited variability in fracture properties of foods eaten by these species. The marginal differences between fossil taxa were in surface complexity and anisotropy and are likely

the result of differences in the frequency of bone consumption among the fossil taxa. In addition, the fossil hyaenids display significantly lower surface complexity and textural fill volume values than modern bone-cracking taxa, supporting previous characterizations of the Mio-Pliocene hyaenids as occasional rather than specialist bone consumers. This project was funded by the US National Science Foundation.

Stressed out: geographic variation in linear enamel hypoplasia in northern populations.

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Linear enamel hypoplasia is often used as a generalized stress indicator in extinct and extant human populations. The horizontal growth arrest lines that characterize LEH develop during childhood and are triggered by some combination of nutritional deprivation and disease. When the Greenlandic Norse were scored for LEH, they exhibited lines on their incisors and canines to only a minor degree (ca. 25%), an unanticipated finding based on other indicators of climatic and nutritional stress. By contrast, prehistoric Inuit from St. Lawrence Island, Alaska and medieval Scandinavians from Trondheim, Norway exhibited exceptionally high frequencies (ca. 80%) and pronounced expressions of LEH on their anterior teeth. We propose the Inuit and Norwegian samples achieved the same LEH frequencies for markedly different reasons. Prehistoric St. Lawrence Islanders were susceptible to resource fluctuations but not infectious disease so the likely cause of their LEH was nutritional stress. By contrast, the Norwegians had ample food but lived in crowded conditions conducive to infectious diseases that impacted vulnerable children. Despite isolation in a subarctic environment, the modest LEH in Greenlanders is attributed to: (1) a dispersed settlement pattern that helped them avoid diseases associated with crowding, and (2) a weanling diet based on dairy products that provided sufficient calories and protein to help developing children avoid growth disruption.

An osteobiographical analysis of the Foscue plantation burial crypt, Pollocksville, Jones County, North Carolina.

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In 2010, an early 19th century crypt was excavated on Foscue Plantation in eastern North Carolina as part of a National Historic site salvage project. According to historical records, three

individuals purportedly were interred in the crypt; Simon Foscue, Sr, Simon Foscue, Jr, and his wife Christiana "Kitty" Rhem Foscue. The lack of research on "elite" 19th century rural populations in eastern North Carolina meant that remains recovered from the crypt could provide valuable information on their life histories beyond historical documents, including health, diet, disease, and burial practices.

Excavation of the crypt in fact revealed at least seven individuals: 2 adult males and 2 adult females, a 4 year (\pm 12 months) old child, and two preterm fetuses, likely twins. Cranial fragments of one of the fetuses were discovered adhering to the internal iliac blade of the young female. That and the estimated age of the fetuses suggests that she died eight months pregnant. The absence of some individuals in the crypt from the historical records could have been the result of later internment in the crypt during a period of poor record-keeping. Initial paleopathology analysis indicates that the childhood and adult health of these individuals is comparable to free landowning individuals in other areas of the Southeastern U.S, including poor dental health. These detailed osteobiographies presented in this study, along with the historical documents, provide a renewed picture of a cross-section of a rural plantation-owning family in 18th and 19th century eastern North Carolina.

Angulation of the third carpo-metacarpal joint appears to reflect vertical climbing in great apes, but not humans or their ancestors.

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In the recent description of *Ardipithecus ramidus*, the third metacarpal (MC3) long axis was compared to the capitate's articular surface for the hamate (hamate border angle [HBA]) and to the distal capitate's articular surface (distal capitate angle [DCA]). Great apes, humans and a baboon were compared to *Ar. ramidus*. These angles, along with a third, comparing the MC3 long axis with the proximal capitate articular surface (proximal surface angle [PSA]), were analyzed here with a broader anthropoid sample. HBA and PSA were both large in great apes, indicating an ulnarly deviated MC3. HBA is similar to great apes in OWMs, but PSA is nearly neutral, such that the hamate border, but not the capitate long axis, is ulnarly oriented. HBA and PSA are both radially oriented in *Ateles* and *Hyllobates*. DCA is ulnarly oriented in hominoids, radially oriented in *Ateles* and terrestrial OWMs, but neutral in

palmigrade arboreal quadrupeds. The ulnarly deviated MC3 in modern great apes may convert dorsopalmar shear to compression, as a climbing/ suspensory adaptation. This morphology is paralleled in *Ateles* and *Hyllobates*, suggesting a functional convergence for climbing and/or suspensory locomotion. Modern humans overlap with great apes in this morphology, largely due to their transposition of the styloid element from the capitate to the MC3. This morphology is not seen in *Ar. ramidus*, which is more similar to NWM palmigrade quadrupeds. This suggests that human morphology is unrelated to climbing. It may instead be a relatively late response to intensive tool use/ manufacture.

What the brains of the apes reveal about the uniqueness of the human mind.

KATERINA SEMENDEFERI. University of California, San Diego.

Fast accumulating data from the neurosciences helped shift long standing paradigms in biological anthropology with regards to the evolution of the human brain. The idea that overall brain size or the relative overgrowth of a particular gross anatomical component is the single most important variable that distinguishes apes from humans is being revisited. It is now well established that the operations of the brain take place in the form of neural systems as opposed to isolated structures and that the level of complexity, from molecular to cellular to systems, requires more sophisticated approaches to the question of human neural uniqueness. Comparative histological studies have demonstrated the presence of inter- and intra-specific variation, including in ape species that share similar absolute brain size. Studies of the brains of humans suffering from various mental neurodevelopmental and other disorders, reveal the presence of subtle changes in the neural circuitry. This suggests that differences in the relative size, morphology and make up of individual components and the neural systems they form in the developing and adult human and ape brains may prove to be critical to function. Genomic studies comparing humans to chimpanzees have identified changes in the expression levels of certain genes involved in energy metabolism and thus phenotypic studies examining cellular populations in apes and humans in connection to the molecular studies are of great promise in revealing unique neural underpinnings of the human mind. The paper will report on comparative investigations with a focus on neural structures involved in social cognition.

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The genetic history of the Karachays: Insights from mtDNA and Y-chromosome evidence.

ASLIHAN SEN, SADETTIN SEN, and THEODORE G. SCHURR. Department of Anthropology, University of Pennsylvania.

The Karachay-Malkar population of the northwestern Caucasus Mountains has an interesting but unclear history. Oral traditions indicate that they descended from the Alans, ancient Iranian tribes who entered the region starting in the 1st century BC. However, they now speak a Kipchak Turkic language, which was purportedly brought to the Caucasus by the Kumans from the Minusinsk Basin (Yenisei River-Altai Mountains). They are also allegedly related to the Hun-Bulgars, with the name Malkar/Balkar being evidence for this affiliation. Therefore, to elucidate their genetic past, we characterized genetic variation in 106 Karachay individuals using a combination of HVS1/HVS2 sequencing and SNP analysis for mtDNAs and SNP and STR analysis for Y-chromosomes. We observed a predominance of mtDNA haplogroups H and U in this population, along with a minority of East Eurasian lineages, and mostly Y-chromosome haplogroups G, I, J and R1. The mtDNA data suggest that the Karachay are most similar to the Adygei, among Caucasus populations, and have affinities with eastern Iranians, supporting the hypothesized link to Scythio-Iranians (Alans), although being quite distant to Turkic speaking indigenous Altaians. By contrast, Y-chromosome data point to genetic links with populations from Anatolia, the Near East and the Balkans, as well as the Volga-Ural region, Central Asia and Siberia, the source area for ancient Turkic populations. Using these data and associated genealogical and linguistic evidence, we attempt to reconstruct the history of the Karachay population and assess its genetic relationships to the diverse ethnolinguistic groups of the Caucasus.

Cross-species virtual reconstruction of fossil and extant hominoid crania.

SASCHA SENCK, FRED L. BOOKSTEIN and GERHARD W. WEBER. Department of Anthropology, University of Vienna.

Missing data in incomplete cranial fossils can be estimated by thin-plate splines (TPS), an example for reference-based reconstruction. The warping of complete reference crania from the same or a closely related species to an incomplete specimen produces a corresponding sample of reconstructions. However, complete reference crania from the same taxon are often absent for fossils. In order to examine the

resulting error, we computed the accuracy between original forms and intra- and cross-species reconstructions using 20 adult crania each from *Pongo*, *Pan*, and *Homo* as references. Furthermore we included fossil specimens of different form (Mladedc1, Guattari1, Petralona, and Sts5) to test the applicability of this approach in paleoanthropology.

758 (semi)landmarks were located on polygonal surface models from CT scans. In one specimens of each extant species and in each fossil specimen, we "knocked out" defined areas both in the face and the neurocranium. Missing data was then estimated by TPS, warping all specimens of each species to each "knockout" individual. Accuracy was computed as the square root of the mean squared difference (RMS) between the original and the reconstructions. RMS of intraspecies reconstructions ranged between 1.43mm and 1.73mm. Cross-species reconstructions performed worse. The lowest average RMS could be found reconstructing Sts5 by the *Pongo* sample (1.86mm) and *Pongo* by the *Pan* sample (2.13mm). When choosing a reference of similar form, the accuracy is comparable to intraspecies reconstructions. We discuss the different intra- and cross-species combinations and conclude that under certain circumstances cross-species fossil reconstructions can lead to useful results.

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Sexual selection, signalling and the MHC in mandrills, *Mandrillus sphinx*.

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According to 'good genes' paradigms, costly secondary sexual characters attract mates by indicating heritable genetic quality. Mate choice may also occur for complementary genes. MHC genes represent obvious candidates for the genetic benefits of mate choice due to their role in disease resistance. We investigated the relationship between male secondary sexual traits (facial red colour and sternal gland odour) and MHC genotype in a semi-free-ranging population of mandrills (*Mandrillus sphinx*) in Gabon. Reproduction in this species is heavily biased towards high-ranking males, but also towards males that are MHC-diverse and those that are MHC-dissimilar to the female. We found that red coloration was related to the possession of specific MHC super-types. However, colour was not related

to MHC diversity, and cannot reflect genetic dissimilarity, as this is contingent on the genotype of the receiver. In contrast, odour profile diversity was significantly related to MHC diversity, while odour similarity was significantly correlated with MHC similarity. These results suggest that mandrills may use visual traits to indicate the possession of specific genotypes, but rely on odour to facilitate mate choice for MHC diverse and MHC dissimilar partners. Our findings highlight the importance of selecting a reproductive partner of both high genetic quality and with compatible genes, emphasise the importance of multiple modes of signalling and of olfactory cues in primate reproduction, and serve to fill a deep phylogenetic gap between our detailed understanding of MHC, mate choice and signalling in rodents and what we know of the same relationships in humans.

Malaria in prehistoric Sardinia (Italy)? Using multiple lines of evidence to interpret bony responses observed on individuals from the Middle Bronze Age.

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Sardinia (Italy) was known historically as one of the most malarious islands in the Mediterranean. However, little is known about the relationship between malaria and Sardinia in prehistory. Hypotheses range from that of malaria being endemic on the island before it was populated by humans to that of it being introduced during Roman times. This research examines a skeletal collection (MNI = 239) from the Middle Bronze Age tomb of Serra 'e Sa Cauda on the island of Sardinia to the hypothesis that malaria was present during prehistory.

Because malaria does not result in a specific pattern of bony responses, multiple lines of evidence were used. These included a gross examination of the remains for the presence of conditions related to malaria (such as inherited hemolytic anemias). When high rates of bony responses suggestive of anemia were observed, additional analyses were conducted. Bone samples were collected and tested for malarial aDNA (PCR), *Plasmodium falciparum* histidine-rich protein II (western blots), and the malarial pigment hemozoin (laser desorption mass spectrometry). In addition, a review of the literature pertaining to the ecology and history of Sardinia was used with archaeological, isotopic, linguistic, and ethnographic data to evaluate the possibility that the malaria parasite was affecting humans on the island during prehistory. Although the

results of this study were not conclusive, this research demonstrates the value of using multiple lines of evidence, and an interdisciplinary approach in paleopathological studies.

Primate cognition and the origins of human language.

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Of all the traits that have been used to define human uniqueness, only language has stood the test of time – largely because it is so strikingly different from the communication of nonhuman primates. The discontinuity between language and primate communication poses a problem for evolutionary theory: how could one have evolved from the other? We suggest that, while the discontinuities are most apparent in vocal production, continuities begin to emerge when we compare the cognitive mechanisms underlying language with those that underlie primates' knowledge of their companions' social relations. Baboons' social knowledge, for example, is based on discrete-valued traits (identity, rank, kinship) that are combined to create a representation of social relations that is open-ended, rule-governed, and independent of sensory modality. Like language, it is a discrete, combinatorial system. Long before our ancestors spoke in sentences they interpreted sequences of vocalizations in terms of actors, actions, and those who are acted upon. Many of the cognitive mechanisms underlying language may therefore have evolved from the social knowledge of our pre-linguistic primate ancestors.

Brain size and foraging behavior of carnivoran mammals at the African land-water ecotone, with implications for australopithecine ecology.

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The durophage-ecotone model reconstructs the robust australopithecines as opportunistic consumers of hard-shelled food objects at the land-water ecotone. The model provides an ecomorphological explanation for the derived craniodental morphology of the robusts and a mechanism for the long-term coexistence of the robusts with more gracile hominins. In Africa today, the land-water ecotone is rich in bird and reptile eggs, freshwater crabs, and both aquatic and terrestrial molluscs. These high quality food resources are physically similar in the sense that they represent a soft and easily digestible food item within a brittle shell. The extant African mammals that consume these resources—including the clawless otters (*Aonyx*) and

marsh mongooses (*Atilax*)—exhibit robust skulls and dexterous hands, similar to the raccoons (*Procyon*) of North and South America. Here I present new estimates of brain size in 144 species of extant carnivoran mammals based on three external measurements of the neurocranium, a technique that has been previously applied to rodents, carnivorans, and primates. The species that forage for hard-shelled foods at the land-water ecotone, including *Aonyx* and *Atilax*, exhibit relatively and absolutely large brains. The evolution of large brain size in ecotone durophages could be related to a high quality diet, manual dexterity, or some combination of these and other factors. The implications of these results for the competing models of robust australopithecine ecology will be discussed.

What does mobility look like in the Late Pleistocene?

LAURA SHACKELFORD. Department of Anthropology, University of Illinois at Urbana-Champaign.

Abundant fossil and archaeological remains from the European Late Pleistocene indicate early modern humans underwent biological and cultural adaptations associated with the climatic changes of the last glacial maximum. Anatomical changes in the postcranial skeleton and overall gracility in the lower limb are associated with a shift towards decreased mobility in these populations. A more global perspective on the Late Pleistocene suggests similar changes towards reduced mobility occurred simultaneously in other parts of the Old World, but that variation in anatomical strategies towards this end may have been utilized.

Samples of Late Pleistocene early modern humans from Europe, Northern Africa and Asia (N=100) are analyzed to assess regional variation in postcranial trends. Cross-sectional geometric properties for the proximal and mid-shaft femora and tibiae and measures of mechanical efficiency are evaluated between samples.

Regional Late Pleistocene samples are differentiated by measures of diaphyseal robusticity. Northern African samples are uniquely robust, particularly at the level of the proximal tibia. Relative to other regional samples, the Asian sample has distinctly gracile femoral and tibial diaphyses. Although this may indicate reduced mobility, this sample also demonstrates relatively high mechanical efficiency at the knees and hips, which may point to an alternative mechanism for counteracting loading on the lower limbs. Additional evidence suggests that analyses of cortical properties at different levels of the femur and tibia give varying information, making some levels more informative about activity than others and introducing competing influences at various lev-

els of the lower limbs that can confound behavioral interpretations.

Diet and ranging behavior of bearded sakis (*Chiropotes sagulatus*) in the Upper Essequibo Conservation Concession, Guyana.

CHRISTOPHER SHAFFER. Department of Anthropology, Washington University in St. Louis.

Bearded sakis are among the most granivorous primates, with seeds composing over 60% of their diet in most studies. They also have large group sizes, with upwards of 40 individuals. These factors likely contribute to the large home and day ranges and subgrouping reported by previous researchers. Although several recent studies have been conducted on the species, data from long term studies of ranging behavior and diet in undisturbed forest is lacking.

During a 14 month study of *Chiropotes sagulatus* at a new field site in undisturbed rainforest in central Guyana, I found that sakis had a tremendously diverse diet; they used 110+ plant species, ate up to 22 in one day, and utilized some species for over 3 months. The sakis were able to exploit many of the most abundant tree species in the forest and were frequently the only primate eating these species. Their ability to masticate tough seeds and utilize the same tree species in different phenological states likely allows them to avoid competition with 7 sympatric primates. The study group consisted of over 60 animals, one of the largest group sizes reported for the genus. In addition, home range size (800ha+) and day ranges (4km+) were among the largest reported for a neotropical primate. Sakis regularly divided into subgroups, especially during times of resource scarcity.

This study sheds light on the unique behavioral adaptations to granivory of bearded sakis and represents one of the first long-term studies of the behavioral ecology of any primate in Guyana. This study was funded by the National Science Foundation (grant #0648678) and Lambda Alpha.

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This study was funded by the National Science Foundation (grant #0648678) and Lambda Alpha.

Stride length, stride frequency and ontogeny: are arboreal marsupials dynamically similar to primates?

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At a given relative speed, primates are known to have relatively longer stride lengths and lower stride frequencies than other mammals. Raichlen (2005) demonstrated that these spatiotemporal features are more exaggerated in infant primates, and concluded that notwithstanding the

stabilizing potential of reducing branch oscillations, these features could have evolved as a by-product of grasping extremities. That is, the distally concentrated limb muscle mass characterizing primates (particularly infants) leads to longer swing durations, lower stride frequencies and longer stride lengths. Arboreal grasping nonprimates should converge with primates, but few data, ontogenetic or otherwise, exist to test this prediction.

We measured hind limb stride characteristics in the sugar glider, an arboreal grasping marsupial. 428 strides were analyzed for four adults and three juveniles (1-4 months) walking across substrates of varying diameter. Controlling for size and speed, the stride lengths of all sugar gliders were as long or exceeded those of adult primates. As substrate diameter decreased, relative stride lengths increased and relative stride frequencies decreased, suggesting an active adjustment for stability. In opposition to the primate ontogenetic pattern, adult sugar gliders had relatively longer strides and lower stride frequencies than juveniles, regardless of substrate. Data on limb inertial properties in sugar gliders are needed to resolve whether adults have more distally distributed limb mass, or whether their larger relative body size necessitates kinematic adjustment. Lack of dynamic similarity between primates and sugar gliders highlights alternative strategies used by grasping, arboreal mammals that warrant further study.

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Genetic variation and evidence for selection in two serotonin genes in the genus *Macaca*.

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Research has increasingly highlighted the role that serotonin plays in shaping behavioral patterns. Serotonin is associated with impulsive and aggressive behavior and many psychiatric drugs work by manipulating the serotonin system. Moreover, numerous genetic studies show that polymorphisms in genes associated with the serotonin system correlate with behavior. Therefore, an understanding of how the serotonin system evolved is critical for understanding behavioral evolution.

The macaque genus is comprised of behaviorally and geographically diverse species, making it a useful model for studying the evolution of genes and behavior. Many genetic features of the macaque serotonin system parallel humans, possibly due to similar selective pressures acting on the serotonin system. Previously it has been shown that positive selection influenced genetic variation in the serotonin system in humans. If parallel evolution is occurring, then macaques should show evidence for positive selection in the serotonin system as well. Our own research on serotonin receptor genes shows that this is likely the

case for at least one serotonin receptor gene (*HTR1A*) in macaques. Here we present the results of our analyses on two additional genes – *TPH2* and *SLC6A4* – and compare this to our previous findings. We sequenced these genes in nine macaque species and a vervet. We also obtained human and chimp sequence data from the UCSC Genome Browser. We compared within- and between-species variation and applied several tests of selection to the data. Results of these analyses are discussed in light of the evidence for selection in humans and the evolutionary implications are addressed.

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“More than the midshaft?": mapping cross-sectional properties along the entire femoral and tibial diaphysis.

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Long bone diaphyses have been shown to adapt their morphology to the biomechanical strains imposed throughout a lifetime. The assumption underlying this relationship is that areas of increased rigidity and altered cross-sectional shape correspond with (or lie close to) the principle planes of bending. The vast majority of this work has been constrained to single cross-sectional slices, normally taken at the midshaft. Noticeably absent is a description of the variation in cross-sectional properties along the entire diaphysis. To address this, high resolution CT scans (0.11 micron voxels, 0.117 micron slice thickness) were performed (The Center for Quantitative X-Ray Imaging (CQI), Pennsylvania State University) on the entire length of the tibia and femur from 20 Native American agriculturalists (10 male, 10 female). Analysis of femoral cross-sections (20-80% of length) reveal variation among individuals, however, generally J is lowest between 40-60% of limb segment length, cortical area is higher in the proximal half of the femur and decreases distally, and diaphyseal shape (I_{max}/I_{min}) is most pronounced proximally. Comparisons of tibial cross-sections (15-85% of length) indicate a general pattern among individuals that involves a monotonic decrease in J moving distally, homogeneity in cortical area in the proximal half of the bone that decreases distally after the midshaft, and diaphyseal shape that is most pronounced proximally (30-45% segment length). In conclusion (1) across individuals, variability is higher in the femoral compared to the tibia, (2) cross-sectional measures other than those taken at the midshaft may also provide valuable information about diaphyseal rigidity and shape.

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Sexual dimorphism in the geometry of the distal humeral condyle.

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The Carrying Angle has been historically noted as a sexually dimorphic feature in the human arm, but relies on full articulation of the arm in non-skeletal context for an accurate assessment of levels of dimorphism to be made, and therefore has minimal applicability for use in determining the sex of a non-articulated or otherwise fragmentary humeri. Methods attempting to create a proxy for Carrying Angle using only non-articulated skeletal samples rely extensively on bony landmarks of undamaged humeri, while additional techniques for determining sex rely on measurements of overall size or geometric morphometric analyses relying on Type III data. In this pilot study, we have attempted to circumvent the various problems posed by the aforementioned techniques by measuring the angle of the distal humeral condyles in relation to the long axis of the humeral diaphysis with standardized imaging software and without relying exclusively on bony landmarks. We also assess the effectiveness of Baumann's angle, a traditional dimorphism detection technique, versus our newly devised, digitally acquired angle measurement. The observed results indicate that there is significant correlation between angle measurements derived from our technique and sex, with additional results indicating higher accuracy in our technique versus Baumann's. As our method does not rely solely on bony landmarks, it has applicability in cases of fragmentary remains and would be useful in both forensic and bio-archaeological studies.

An analysis of kin-structured migration by isonymy in 19th century Chemung County, New York.

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The effect of kin-structured migration on the 19th century settlement of the frontier regions of New York State was examined using the 1860 United States Federal Census records. Random isonymy was calculated within and between towns, and Fishers (and Karlin-McGregors (were calculated to measure surname diversity and rates of migration, respectively. Results

showed that kinship levels within towns negatively correlated with population levels, while Fishers (positively correlated with population levels. Between-town isonymy showed the towns of Erin and Baldwin as outliers with regard to the relationship between distance and relatedness. In addition, these populations showed relatively high scores for Karlin-McGregors (and low Fishers (, showing proportionally higher rates of migration with lower levels of surname diversity. The combination of low genetic diversity with a relatively high migration index, as well as the greater genetic differentiation of these towns as measured by isonymy, appears to be a signature of kin-structured migration operating at differential level throughout the Euroamerican settlement of the frontier regions of 19th century New York State.

The modern world as an extreme environment.

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Evolutionary perspectives on health and medicine have given rise to two prominent conceptual models and messages. The first emphasizes inherent design "flaws" in the human body arising from inevitable life history tradeoffs involved in maximizing lifetime reproductive success. The second examines physiological variation along dimensions of health in terms of phenotypic plasticity comprising a "functional continuum" of adaptive responses to environmental conditions. Both approaches recognize the mounting evidence of widespread health risks associated with the dysregulation of fundamental biological systems (cardiovascular, metabolic, reproductive) under the influence of modern environments. The modern world has been characterized typically as a "novel" environment generating a "mismatch" (also termed "dissonance" or "disconnect" or "collision") between contemporary Western lifestyles and ancestral physiology/adaptations. This talk advances the concept of the modern world as an "extreme" environment in the sense that much like climbing Everest or running a marathon in the Sahara, it requires the human body and psyche to function at the very limits of its adaptive capacity, with potential dire consequences to health. Data on the physiological, behavioral, and psychological responses to extreme environments along such gradients as temperature and altitude are evaluated to illustrate the comparison with complex physiological dysregulation of major biological systems. Health risks associated with contemporary Western lifestyle factors (diet, exercise, stress) may be more effectively conceptualized

from this standpoint and communicated as a public health message with the use of an intuitive metaphor describing the modern world as an extreme environment.

Developmental changes in the neocortical microstructure of humans and chimpanzees.

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Human cognition arises through the interaction among species-specific neurodevelopmental processes, social learning, and experience. The extent to which neocortical development in humans unfolds differently from closely related primates, however, is not well understood. At present, only data on developmental changes in brain mass and cranial capacity are available from great apes. Previous research from macaque monkeys and humans, however, indicate that humans may be distinct in displaying delayed maturation of connectivity in higher-order association regions of the prefrontal cortex, allowing for a more extended period of plasticity in the acquisition of executive cognitive functions. We have initiated a collaborative network to examine developmental changes in the microstructure of the neocortex of common chimpanzees (n = 14 from birth to sexual maturity; n = 4 adults) in comparison to humans. We are using multiple analytical approaches to characterize ontogenetic variation in the neuron/neuropil fraction, the distribution of myelinated axons, density of synapses, and the expression of synapse- and myelin-associated proteins across diverse regions of the neocortex. Our results show that chimpanzees display human-like asynchrony of prefrontal cortex development in many indicators of synaptic connectivity and function. Quantification of axon length density reveals similar rates of myelination across cortical regions in both species until the age of weaning, after which the trajectory of myelination displays region- and species-specific patterns. These findings indicate that a slowly developing prefrontal cortex characterizes the evolutionary branch of African apes, including humans, and might be related to the enhancement of social learning capabilities.

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Growth and development in physical anthropology.

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Physical anthropological research was codified in the U.S. with the creation of the American Association of Physical Anthropology (AAPA) in 1931. Two years earlier a study began in Yellow Springs, Ohio, with a goal to identify "what makes people different." The approach used to answer that question was to study the growth and development of *Homo sapiens*. That study, the Fels Longitudinal Study (FLS), is currently the longest continuous study of human growth and development in the world. While the AAPA and the FLS have existed as separate entities for 80 years now, it is not surprising, given the relationship between anatomical and developmental research, there has been considerable overlap between the two. As the field of physical anthropology has blossomed to include subdisciplines such as forensics, genetics, primatology, as well as sophisticated statistical methodologies, the importance of growth and development research has escalated.

Our work with the FLS has explored growth and development of the craniofacial complex, skeletal maturity, and childhood bone accrual. Our efforts have sought to characterize the genetic architecture of these trait complexes, and provide comparisons across populations and taxa. While current FLS research is largely directed at biomedical questions, virtually all findings are relevant to physical anthropology providing insights into basic biological processes and life history parameters. Highlighted results of this work serve as an introduction to growth and development research in physical anthropology. They demonstrate the importance, not only across the subdisciplines of physical anthropology, but to among anthropological, biological, and clinical inquiries.

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Secular change in clavicle length in the American population (1840-1970).

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Secular change in skeletal dimensions of the American population has been

documented in long bone length and proportion and in the cranio-facial skeleton (Meadows and Jantz, 1995; Jantz and Meadows Jantz, 1999; Jantz, 2001; Jantz and Meadows Jantz, 2000; Jantz and Wescott, 2002; Jantz and Meadows Jantz, 2010). Specifically, during the past 150 years femur and tibia length has increased, cranial vault height has increased, cranial breadth has decreased, and facial breadth has narrowed. In addition, secular trends have been documented in skeletal maturation of the medial clavicle (Langley-Shirley and Jantz, 2010) and distal tibia and fibula (Crowder and Austin, 2005).

This study investigates secular change in clavicle length in the American population from 1840-1970 birth cohorts. The sample includes 695 females and 1744 males from the Forensic Data Bank (including the Terry Collection) and a modern autopsy sample from East Tennessee (the McCormick Clavicle Collection). The sample was divided into 10-year birth cohorts and analyzed for secular trends using linear regression, ANOVA, and post-hoc Hotelling's two sample t-tests.

Results of the linear regression indicate that clavicle length increases in females from 1850 to 1920 and a decrease from 1920-1970. Interestingly, this decrease in length corresponds approximately with the earlier documentation of skeletal maturation. A different trend is apparent in males: clavicle length decreases slightly throughout the 20th century, but this decrease is not statistically significant. This presentation analyzes these trends and compares them to documented trends in skeletal maturation and secular changes in other skeletal dimensions.

Evolutionary dynamics of a developmental enhancer with human-specific function.

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We have shown using a mouse transgenic assay that the most rapidly evolving conserved non-coding sequence in the human genome (*HACNS1*) acts as a developmental enhancer. *HACNS1* and its chimpanzee and rhesus orthologs all drive expression in eye, ear, branchial arches and midbrain, but *HACNS1* has gained an expanded, robust expression domain in the anterior limb and lost expression in the nasal processes. 16 human-specific substitutions are sufficient to produce these expression differences.

To determine the primate and mammalian ancestral states we tested the enhancer activity of *HACNS1* orthologs from mouse, horse and bushbaby. Bushbaby shared all expression domains with chimp and rhe-

sus, except expression at the base of the limb bud that we hypothesize is a rudimentary version of the human limb pattern. Because the mouse ortholog failed to act as a developmental enhancer, we tested the horse ortholog as a mammalian outgroup. The horse shared expression domains in the eye, ear, nasal processes and midbrain with the primates, suggesting these are ancestral to mammals. Horse also failed to drive expression in the limb. *HACNS1* has therefore lost an ancient craniofacial domain and has gained a robust anterior limb domain. We test synthetic humanized mouse and bushbaby orthologs to determine if the 16 human-specific substitutions are sufficient to confer the *HACNS1* expression pattern in these sequence contexts.

The dynamic changes in enhancer activity that we observe in multiple lineages suggests that subtle sequence changes can lead to domain shifts in gene activity and are likely important in human evolution. This study was funded by NIH grant R01GM094780 and the Yale University School of Medicine.

Cranial and dental variation among human skeletal remains from the Swedish 17th century flagship *Kronan*.

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At the time of its sinking in 1676, the Swedish flagship *Kronan* was one of the largest seagoing vessels in the world. With its sinking, Sweden lost the decisive naval battle in the Scanian War and more than 800 individuals lost their lives in the Baltic Sea. In addition to the 500 sailors, the ship carried 350 infantrymen bound for the Swedish provinces in present-day Germany. The geographic origins of these individuals have so far not been investigated. In this study, geographic affinities of 24 human skulls recovered from the *Kronan* wreck were investigated through the analysis of metric and non-metric cranial data. Although the results indicate that many of the individuals aboard the ship were Scandinavian, a number of individuals exhibit cranial and dental characteristics inconsistent with European ancestry. These findings provide new information about the demographics of the Swedish military community during the seventeenth century. In addition, the study demonstrates the limitations of current cranio-metric databases for distinguishing different populations around the Baltic Sea, a situation that will hopefully improve as reference data for these populations become available in the future.

Lesion lessons: a case study of lower limb ankylosis and possible surgery from Romania.

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Paleopathological skeletal injuries offer insights into prolonged recovery and compensatory mechanisms utilized at biological, individual, and societal levels. This study examines a virtually intact skeleton of a young woman (30-35 years old) with a severe ankylosed left knee using observational analysis. The remains were recovered from the Spantov 1959 M 37 site situated in Spantov, Romania, and date from the fourth century AD. The left knee is completely fused, with the tibia projecting posterolaterally when the femur is held in the normal anatomical position. Compared with the right proximal femur, the left one presents a much more roughened gluteal muscle attachment that is narrower and situated more laterally than the one on the right. The inferior articular surfaces of both condyles are obliterated by "stretched" new bone that connects the proximal tibia to the distal femur. There is manifestation of moderate osteoarthritis of the right knee. The absence of the left tibial tuberosity and its replacement by a flattened round scar suggests that the tuberosity was avulsed and never reattached. A series of blunted thin lines extending laterally and inferiorly from the margins of the former tuberosity may be healed cut marks from a surgical procedure to remove the tuberosity and patella. The probable mechanisms of injury and the biomechanical and socio-cultural adaptations made by this woman to her unique disability are presented.

Body mass and body mass index estimation in archaeological populations from Central Europe.

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Body Mass Index (BMI) is mainly used in medicine as a diagnostic tool to identify weight problems, health risks (e.g. Eknoyan, 2006), and to assess biological standards of living within populations (Komlos et al., 2004). The prediction of body mass (BM) from skeletal material still remains problematic, nonetheless, many studies have indicated that BM can be estimated from human skeletal remains and results have been mainly acquired from early hominins (Ruff et al., 1997; Ruff et al., 2010). The present paper tests BM esti-

mation formulae (Ruff et al. 1991; McHenry 1992; Grine et al. 1995; Auerbach & Ruff 2004) on skeletal populations from central Europe (350-1500 AD; 629 males, 616 females) with the aim to reconstruct the BM and the BMI within a variable temporal setting. Parameters such as sex, age and robusticity index (Martin & Saller, 1957) are also considered. The method of Auerbach & Ruff (2004) offered the most reliable results. The mean body weight and the BMI for males was estimated 70.8 kg (sd. 6.8) and 25.4 (sd. 2.0) respectively, and for females 58.9 kg (sd. 5.4) and 24.3 (sd. 1.9) respectively. Robusticity index was correlated to body mass and BMI only at females. The BMI was slightly increasing from adult to mature and slightly diminishing afterwards. The intra-population variability was higher than variation through time. According to WHO (1995; 2000) classification these populations showed very few obese and under-weighted individuals. Although challenging, BM and BMI estimations can offer valuable information on biological welfare of past populations.

Thyroid disease at midlife: byproduct of adaptations for successful pregnancy outcome?

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Thyroid dysfunction is common, especially among women over the age of 50. It is estimated that 5% of all postmenopausal women are treated with both estrogen therapy/hormone therapy and thyroid hormone replacement. Thyroid dysfunction also affects 1-2% of pregnant women. Thyroid activity increases during pregnancy in response to human chorionic gonadotropin stimulation, and in the early weeks of pregnancy the fetal brain is dependent on maternal T₄. Achieving and maintaining high maternal thyroid activity is critical to successful birth outcomes; maternal thyroid hormone deficiency is associated with increased risks of miscarriage, low birth weight, and even mild hypothyroidism that can compromise fetal neurodevelopment. During pregnancy, increasing estrogen levels regulate thyroid hormone levels by stimulating the production of thyroxine-binding globulin (TBG). Estrogen also increases thyroid-stimulating hormone (TSH) receptor density in the pituitary. This review will use cross-species evidence to consider, from the perspective of evolutionary medicine, why women are more vulnerable to thyroid diseases than men, and why thyroid dysfunction is more likely to develop during pregnancy and post-menopause. In particular, this review will focus on the relationship between estrogen and thyroid hormones, and will investigate the hypothesis that post-menopausal disruption in thyroid function is a byproduct of a crit-

ical relationship between estrogen and thyroid hormones during pregnancy.

Ontogenetic variation in *Homo* and *Pan* mandibles: a 3D geometric morphometric approach.

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Shape variation in extant hominid mandibles has been widely investigated. However, there is still an ongoing debate on whether inter-specific morphological differences can be attributed to the direction and pattern of ontogenetic trajectories. In the present study, we re-examine patterns of ontogenetic shape change in 187 sub-adult and adult humans, bonobos and chimpanzees. We propose that ontogenetic shape differences in the mandible are influenced not only by diverging ontogenetic trajectories among taxa, but also by differing patterns of ontogenetic shape changes in the corpus and ramus.

We employ Procrustes based geometric morphometrics to quantify and analyse mandibular form. Thirty 3D landmarks were recorded on the entire mandible and these were analysed together as well as separately as corpus and ramus elements. Principal components analyses in shape-space and form space, multivariate regressions as well as taxa mean shape comparisons were used to examine patterns of ontogenetic shape variation across chimpanzees, bonobos and humans. Our results suggest that ontogenetic trajectories of shape change in *Pan* and *Homo* are linear, but not entirely parallel. Moreover, shape differences among the taxa are established early in postnatal ontogeny. Separate analyses of the corpus and ramus show that these two regions are semi-independent of each other in their pattern of ontogenetic shape changes. The latter provides support for the functional matrix hypothesis and serves as an additional explanation for divergent patterns of shape change in closely related hominid taxa. These results also emphasize the need for further research on integrative aspects of the primate mandible.

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Juvenile cranial shape variation and superstructure development in African papionins.

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The discovery of *Rungwecebus* (Cercopithecinae: Papionini), which is currently known only from juvenile voucher specimens, has spurred interest in the relationship between juvenile papionin cranial

morphology and adult cranial form. Several studies have demonstrated that diagnostic shape differences are present prior to M1 eruption, but many phylogenetic characters are difficult to evaluate in juveniles. For example, the two African papionin clades are distinguished by their temporal and nuchal line conformations, but these features, which develop in response to mechanical loading, achieve full expression only in mature adulthood. However, if the influence of the cranial musculature merely modulates existing neurocranial shape differences, shapes of the frontal and occipital bones would be expected to differ between juveniles of the two clades.

To test this hypothesis, geometric morphometric analyses of frontal and occipital shape were conducted on M1-stage crania (n=30) representing all African papionin genera except *Theropithecus*. In each analysis, 3D landmarks (21 frontal; 17 occipital) were subjected to generalized Procrustes and principal components analyses to explore taxonomic shape variation. In both analyses, the first principal shape component (PSC1) summarized allometric variation, while subsequent components reflected phylogenetic shape differences. Frontal PSC2 summarized differences between the *Cercocebus/Mandrillus* and *Lophocebus/Papio/Rungwecebus/Theropithecus* clades in coronal suture location, frontotemporal suture length, and prominence of glabella. Occipital PSC3 separated the clades on the basis of occipital proportions and inion position, but *L. aterrimus* was more similar to *Cercocebus/Mandrillus*. These results suggest that in African papionins, epigenetic influences amplify early-arising neurocranial shape differences to yield phylogenetically diagnostic adult cranial superstructures.

The role of landscape in shaping contemporary genetic structure in the chacma baboon (*Papio ursinus*).

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A published phylogeny of *Pursinus* estimates that this taxon diverged as a separate lineage at ~1.84 million years ago (Ma). Two distinct mitochondrial lineages are revealed within the sample dividing chacmas into northeastern (~1.52Ma) and southwestern (~1.22Ma) clades and suggesting an independent history for the ruacana clade from ~0.68Ma. This pattern of diversification is linked to landscape change during the climatically variable Pleistocene. These findings are used to test further hypotheses of landscape driven population differentiation within chacma baboons. The purpose of this study is to improve our understanding of the link between past and present landscapes and genetic structuring

within *Papio*. Employing phylogeographic techniques a 473bp alignment of the mitochondrial D-loop is analysed from 132 chacma baboon individuals from South Africa, Namibia, Botswana and Zambia. Here the distribution of diversity within and between modern chacma baboon populations is described and spatial structure within the dataset is investigated. We also statistically test: (1) the proposition that populations contracted into palaeo-refugia followed by expansion and possible secondary contact (2) the role of genetic drift in structuring the data set, and (3) the strength of association between haplogroups and local habitats. Results suggest that a major population divergence event within chacma baboons was followed by renewed gene flow, and further facilitated by later population expansions to current chacma distributions. The localised distribution of modern haplotypes suggest low individual dispersal distances while the geographic range of haplogroups hint that habitat specificity plays a significant role in driving contemporary population structure.

Collagen fiber orientation (CFO) variations in the hominid femoral neck are likely invalid for deciphering load history when cortical robusticity is low.

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Load history of the proximal hominid femur is central in the debate of the origins of bipedalism. This is typically inferred from structural/geometrical features of the femoral neck (FN). For example, the emergence of habitual bending across the FN is associated with arched trabecular patterns and asymmetry of cortical thickness in the plane of bending. Recent studies show that variations in predominant collagen fiber orientation (CFO) in the cortical shell are much stronger than structural features in detecting and distinguishing habitual bending from torsion. Stereotypical bipedalism is linked with bending across the FN, producing ambient tension and compression in opposing cortices. CFO data support counter-bending load history in the chimpanzee FN where lurching produces prevalent/predominant tension in the anterior-inferior aspect and compression in the superior-posterior aspect. Similar biomechanically significant CFO variations are found across the modern human FN, which are consistent with compression-adapted CFO in the superior cortex; but here counter-bending seems implausible. Paradoxical CFO data in the human FN can be reconciled by considering that: (1) cancellous-cortical bone load sharing are highly disproportionate between the

human and chimpanzee FN, (2) human FN loading is relatively more complex, and (3) the human FN cortex is so thin that load-specific regional histological adaptation (i.e., CFO and secondary osteon morphotypes) seen in the more robust chimpanzee FN is not required. It can be argued that there is a cortical robusticity threshold below which the use of histological variations are invalid in deciphering load history, which is the case in the human FN.

Mandibular P4 morphology among Plio-Pleistocene hominins: taxonomic implications and morphological trends.

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Simple metrical and non-metrical measures suggest that Plio-Pleistocene hominin mandibular pre-molar crown morphology is both taxonomically and phylogenetically informative. However, maximizing this information is complicated by the loss of original crown shape and outer enamel surface morphology due to attrition in the hypodigm of the fossil taxa. Fortunately, the enamel-dentine junction (EDJ) preserves much of the original shape of the tooth underneath the worn enamel cap. In this study we examined EDJ morphology of mandibular fourth premolars (P4) in samples of extant apes and Plio-Pleistocene hominin taxa in order to 1) assess the taxonomic distinctiveness of P4 EDJ morphology and 2) to track changes in P4 EDJ shape during hominin evolution. Premolars were subjected to micro-computed tomography (isometric voxel resolution ~30 microns) and the EDJ surface was segmented as a digital surface model. To quantify shape variation among the study taxa, a geometric morphometric analysis was conducted; placing 3D landmark coordinates around the cervix and along the marginal ridge which runs between the dentine horns of the protoconid and metaconid. Results indicate that P4 EDJ morphology discriminates reliably among hominin taxa. Taxonomically-relevant shape variation in P4 EDJ morphology includes changes to crown base shape, crown height, relative dentine horn

height and positioning, and the relative size of the anterior and posterior fovea. Trends in shape variation between hominin taxa are discussed with regard to current hominin phylogenetic hypotheses.

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Integrating geometric morphometrics and finite element analysis to assess the biomechanical implications of shape variation in chimpanzee crania.

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Finite element analysis (FEA) is a powerful tool for analyzing the biomechanical consequences of variation in shape. However, practical limitations typically preclude researchers from examining more than one or only a few individuals from any given species. This lack of knowledge concerning the mechanical significance of intraspecific shape variation limits our ability to infer the significance of interspecific differences. This study uses geometric morphometrics and FEA to examine the biomechanical implications of shape variation in chimpanzee crania, thereby providing a comparative context in which to interpret cranial variation between hominid species.

For each of 19 chimpanzees, 709 landmarks and semi-landmarks were digitized on 3D surfaces derived from CT scans. The 19 landmark configurations were converted to shape coordinates by Generalized Procrustes Analysis (GPA) and shape variability was decomposed into orthogonal components by Principal Component Analysis (PCA). FE models of the specimens lying at the extremes of the first three principal components were created from CT scans, assigned the material properties of bone, subjected to muscle forces derived from physiological cross-sectional area data, and constrained at the TMJs and bite point so as to simulate mastication. Muscle forces were scaled to remove the effect of size on strain values. Results indicate that facial projection is an important influence on feeding strains. This approach is still limited, e.g., our six

specimens are too few to talk about errors and population variation in earnest. Yet, it represents a first (and practicable) step forward to estimate the spectrum of loading scenarios within a sample.

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Late Epipaleolithic infant remains from Kaus Kozah Cave, southwestern Syria.

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Kaus Kozah Cave (Damascus Province, Syria), excavated by the Tübingen-Damascus Excavation and Survey Project, yielded two infants (Kaus Kozah 1 and 2) at the top of a geological horizon (GH4) containing Middle Paleolithic artifacts. Three overlying layers consist mainly of anthropogenic deposits from the Epipaleolithic and Neolithic. Although both individuals lack grave goods, they are spatially distinct and preserved sufficiently to suggest intrusive burials into GH4. Direct AMS radiocarbon dates on KK1 provide ages of 10,485±/-50 and 10,130±/-70 BP, at the end of the Epipaleolithic (Late Natufian).

Late Natufian burials are not rare in Israel, but these are the first from this region. Kaus Kozah 1 (KK 1) is represented by 31 teeth (17 deciduous), aged at 3.5 years. Kaus Kozah 2 (KK2) preserves 20 teeth (17 deciduous) and is approximately 14-16 months of age. Each has highly fragmented cranial and postcranial remains. No indicators of pathology or stress are observable on bones, but the dentition of KK1 exhibits large planar defects (deciduous canines) and linear hypoplasia (permanent incisors). Their position places them around the time of birth. KK2 lacks these and exhibits smaller teeth, suggesting sexual dimorphism, population differences, or both.

These individuals provide a window into the variation and general conditions among the latest hunter-gatherers

of the Levant. Evidence for hypoplasia in KK1 suggests environmental stress was a significant factor at birth. Combined with results from isotopic studies, these data indicate relatively high levels of stress in populations just before the transition to Neolithic sedentism.

Genetic variation and endurance running: comparing *ACE1* and *ACTN3* polymorphisms in marathon runners and sprinters.

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Research on functional morphology is providing mounting evidence that long-distance running has played a major role in human evolution. Compared to other mammals, humans are poor sprinters but perform well at endurance running. This capability has arguably left measurable traces on the human skeleton and hominin fossil record, and we might expect similar indications of selection for endurance running in the human genome. Along this line, the impact of genetic variation on human athletic performance has emerged as an active area of investigation, and several candidate-gene polymorphisms have been associated with physical fitness and a natural aptitude for high-performance athletics. However, previous association studies have yielded conflicting results, and many studies have focused on general athletic performance, not specifically on running. Here we examine polymorphisms at two candidate genes thought to play a role in athletic-performance phenotypes: the angiotensin-I converting enzyme (*ACE1*) and alpha-actinin-3 (*ACTN3*). We compiled published data on genetic variation at these loci across human populations, including samples of runners, other athletes and non-athletes. We also genotyped an additional 171 marathon runners, ultra-marathon runners and sprinters. We then compared genotype and allele frequencies, within a multivariate analysis, across running phenotypes. Initial results indicate no clear difference between genotype and allele frequencies in samples of sprinters vs. endurance runners. However, allele frequencies observed in the combined sample of runners differ from those of the general population. Studies such as this are a step toward understanding how genetic variation might contribute to human running propensities and capabilities.

Phylogenetic utility of developmental cranial modules in papionin primates: implications for inferring hominin phylogeny.

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The ability to draw accurate inferences regarding phylogeny and taxonomy in the hominin and non-hominin primate fossil record is contingent upon an understanding of the relationship between cranial morphology and phylogeny. The primate skull develops as three primary developmental modules, the basicranium, splanchnocranium, and neurocranium, which have been predicted to differ in the extent to which they reflect the underlying phylogenetic relationships of taxa, such that the basicranium which develops earliest in ontogeny from a cartilaginous template should be the most phylogenetically constrained. To explore this question, the phylogenetic utility of these cranial regions was compared in a test group; the papionin primates.

One hundred and seventy-five landmarks were digitized on the basicranium, splanchnocranium, and neurocranium of samples of 15 papionin species. Mahalanobis distances among taxa were calculated based on each developmental data set, and morphological phenograms were generated and compared to molecular consensus phylogenies for this clade. The phenograms based on the morphology of the basicranium, splanchnocranium, and neurocranium were all found to be significantly correlated with the molecular phylogeny, albeit with a few minor differences in topology, suggesting a close relationship between shape of each cranial module and phylogenetic relationships in papionin species. Additionally, the discovery that the intramembranously ossifying neurocranium and splanchnocranium reflect phylogeny, as does the endochondrally ossifying basicranium suggests that mode of ossification may not be the primary determining factor in the degree of phylogenetic utility of cranial form. The implications of these findings for inferring taxonomy and phylogeny in the fossil record are discussed. This study was funded by The Leakey Foundation.

Trabecular bone type and distribution in mid and upper facial skeleton of four anthropoids.

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Finite Element Analysis is a useful tool for testing hypotheses regarding the mechanical significance of primate craniofacial morphology. The input of accurate region and species specific cortical bone mechanical properties has a significant effect on the output from finite element models. However, the type and distribution of trabecular bone through-

out the craniofacial region of primates and the effect this variation has on the mechanical behavior and modeling of the primate craniofacial complex is unknown. This study quantifies the distribution of trabecular bone (quantified as a fraction of cortical plus trabecular volume) and the variation of trabecular type (rod or plate-like as characterized by a value known as structural model index, or SMI) in the supraorbital and zygomatic regions of *Homo*, *Pan*, *Gorilla*, and *Papio*. Micro-computed tomography was used to compute the trabecular bone fraction and SMI in 5 supraorbital and 5 zygomatic regions in each species. Principle component analysis of all regions (n=102) revealed 2 primary components that explain 75% of the variation: a strong negative correlation between trabecular bone fraction and cortical bone volume fraction, as well as SMI and cortical region volume. Strong correlations between trabecular and cortical properties suggest that they play an integrated mechanical role. Kruskal-Wallis tests reveal statistically significant (p<0.05) differences exist in SMI between species and trabecular fraction between regions and species. This study shows that craniofacial trabecular and cortical bone mechanical properties are linked and also species and region specific, suggesting that these variations should be incorporated into respective primate craniofacial FEMs.

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The influence of social dynamics on gestural communication in two groups of chimpanzees (*Pan troglodytes*).

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Gestural communication in primates is influenced by a number of factors, including environment, morphology, and social dynamics. This study examines how social relationships and social structure shape gestural signaling in two groups of chimpanzees (*Pan troglodytes*). Data were collected from a group of 11 individuals at the St. Louis Zoo (STLZ) from June to August 2007, and from a group of 13 individuals at the Los Angeles Zoo (LAZ) from September to December 2007. Gestures were coded from video recordings of social interactions in the subjects' outdoor enclosures whenever multiple individuals were within 4m, using a Sony DCR-DVD403 Handycam.

Twenty-six distinct gestures were recorded in the STLZ group, and twenty-eight gestures were recorded in the LAZ group, with an overlap of twenty-two gestures. In both groups, males gestured most fre-

quently to females. STLZ females gestured most frequently to other females, while LAZ females gestured most frequently to other males. In both groups, adults gestured most frequently to other adults, and juveniles gestured most frequently to adults. In all age/sex classes of both groups, gestures were used most frequently in the context of Near Others. Despite differences in group composition and environment, the two study groups showed remarkable similarities in their gestural signaling, suggesting that the influence of social dynamics is consistent across groups. A keener understanding of how social factors shape gestural communication in chimpanzees is important for investigations of the evolution of gestural communication in African apes.

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Demography, health status, and mortuary rituals of the Late Woodland Poole-Rose Ossuary, Ontario, Canada: a study of the clavicles.

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The Poole-Rose ossuary is a pre-contact (1550 A.D. \pm 50 years) native secondary burial from Ontario, Canada. This study extracts cultural information about the Poole-Rose ossuary population through analysis of the clavicle. Information on demography, health status, trauma, and cultural modification was collected on the clavicles. The minimum number of individuals is 196 based on the right acromial end of the clavicle. Results show significant degenerative joint disease was present in the acromioclavicular joint as compared to the sternoclavicular joint ($p=0.001$). Active periosteal reactions of the clavicle are more frequent than healed reactions. Clavicular lesions are significantly associated with adult individuals ($p=0.037$), but affect both left and right side of the body and both sternal and acromial joint of the bone to similar degrees. Healed clavicular fractures are infrequent in the ossuary population, appearing on nine out of 553 whole clavicles and clavicle fragments. Cut marks consist of fewer than 10 cuts on major muscle attachment sites. A significant association exists between presence of a rhomboid fossa and age of the individual ($p<0.001$). Metric analysis of the Poole-Rose ossuary clavicles includes similar correlations between length and robusticity of both left and right bones. Right bones were more variable in curvature than left bones, however, suggesting differential pressures from handedness that were generally placed on the right side more often than the left. Results of this study combined with those of previ-

ous studies of the Poole-Rose ossuary bolster a greater understanding of pre-contact culture and health in the Great Lakes region.

Coronoid and condylar process relationship in domestic dogs and its relevance for human evolutionary models.

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Rak et al. (2002) proposed that the relationship between the coronoid and condylar processes differed between Neanderthals and modern humans and that ramus morphology had taxonomic implications within *Homo*. Wolpoff and Frayer (2005) countered, documenting considerable variation for the proffered traits. Here we explore co-variation in mandibular characteristics in domestic dogs (*Canis familiaris*), another polytypic species displaying wide variation in jaw morphology, to elucidate relationships that may hold more broadly for hominids as well.

ImageJ was used to measure photographs of 150 mandibles from diverse adult male dogs. Mandible length (infradentale - condylion laterale) in superior view served as a size measure. Coronoid and condyle heights were measured in lateral view from their apices to a constructed baseline (sub-carnassial - angular process base). Masseter area was approximated following masseteric fossa muscle markings.

The ratio of coronoid:condyle height ranges from 1.61 to 2.08 (mean = 1.86; SD = 0.10). Log(Length) is strongly correlated ($r = 0.96$) with Log(Masseter Area). Using Log(Masseter Area) residuals to adjust for the effect of mandible length yields significant results for condyle and coronoid height separately but not for their ratio, due to similarity of slopes for the condyle and coronoid equations (Log(Condyle) vs. Masseter Residual, $B = 0.19$, $p = 0.02$; Log(Coronoid) vs. Masseter Residual, $B = 0.17$, $p = 0.04$; Coronoid:Condyle vs. Masseter Residual, $B = -0.09$, $p = 0.26$). Therefore, condyle height and coronoid height appear to scale with similar slopes in dogs, and their relative heights may not be independently informative.

Building a teaching collection and fostering the scientific method in undergraduate forensic anthropology classes.

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Forensic anthropology classes are sometimes burdened by their own popularity. One problem is the difficulty of providing enough human bone for under-

graduates to work with in a lab context. Additionally, it is necessary to provide relevant content for the students who will never pursue forensic anthropology and are simply taking the course out of a personal interest. To address these concerns, I have created experimental laboratory exercises and research projects for students that serve to 1) provide a carefully selected reference collection of animal bones with simulated trauma on them; 2) provide students with targeted excavation experience with bone by conducting excavations of animals; and 3) require original research projects that engage students broadly in the methodology of scientific anthropological experimentation.

This paper provides an overview of the class and lab exercises in which the students participate and a discussion of how these exercises simultaneously provide study material for the lab. Student success in the laboratory exercises is demonstrated with a discussion of student participation in a campus-wide Symposium for Student Scholars. The class and lab activities can be adopted and adapted easily, and are particularly useful for anthropology departments that do not have funding for expensive laboratory equipment or supplies.

Histological evidence for ontogenetic differences between modern human and Neanderthal dentitions.

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Humans have an unusual life history with an early weaning age, long childhood, late first reproduction, short interbirth intervals, and long lifespan. Despite 80 years of speculation, the origins of these developmental patterns in *Homo sapiens* remain unknown. Because they record daily growth during formation, teeth have pro-

vided important insights, revealing that australopithecids and early *Homo* had more rapid ontogenies than recent humans. Here we apply synchrotron virtual histology to a geographically and temporally diverse sample of Middle Paleolithic juveniles, including Neanderthals, to assess tooth formation and calculate age at death from dental microstructure. We quantified the following developmental variables: cuspal enamel thickness, long-period line periodicity (number of daily increments between successive lines), long-period line number, coronal extension rate, and crown formation time in 90 teeth from 28 Neanderthals and 39 teeth from 9 fossil *H. sapiens* individuals. When compared with both European and African recent humans, thinner enamel, lower long-period line periodicities, and faster extension rates typically lead to lower crown formation times in Neanderthals. We find that most Neanderthal tooth crowns grew more rapidly than modern human teeth, resulting in significantly faster dental maturation. These findings demonstrate that recent human developmental standards should not be used to assess Neanderthal ontogeny. In contrast, Middle Paleolithic *H. sapiens* juveniles show greater similarity to recent humans. When compared to earlier hominin taxa, both Neanderthals and *H. sapiens* appear to have extended the duration of dental development. This period of dental immaturity is particularly prolonged in modern humans.

This study was funded by the Max Planck Society, the European Synchrotron Radiation Facility, and Harvard University.

New findings on the vomeronasal complex of platyrrhine primates.

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Although all platyrrhine primates possess a vomeronasal organ (VNO), few species have been studied in detail. In this study, we revisit the microanatomy of the VNO and surrounding structures in platyrrhines using a sample of 55 cadaveric specimens (14 species) of mixed age. Using serially sectioned and stained samples, VNO neuroepithelial structure was described and related osteological features were measured. Selected samples were

examined using procedures to identify terminally differentiated vomeronasal receptor neurons (VRNs) via immunolabeling of olfactory marker protein (OMP). Most species possessed identifiable neuroepithelial portions of the VNO, although poor preservation in an adult *Alouatta* prevented determination. The VNO of an adult *Ateles*, described in detail for the first time, had a few rows of VRNs and nerves visible in the surrounding lamina propria. Available samples of subadults indicate that the VNO neuroepithelium is generally thinner, in terms of basal to apical rows of nuclei, at birth than in adults. Immunohistochemical findings suggest that the VNO neuroepithelium has maturational differences among adult platyrrhines. In particular, findings show *Saguinus* spp. has a paucity of mature VRNs. The cartilaginous capsule that surrounds the VNO is typically J-shaped or U-shaped, and is partially ossified in some species (most extensively in *Aotus*). The capsule articulates with a groove on the bony palate, and preliminary results indicate a correlation with socioecological variables like mating pattern. Our microanatomical findings, along with equivocal experimental evidence and mixed genetic evidence to date, indicate the need for further research bearing on functionality of the VNO in platyrrhines. This work was partially funded by grant number 01-G-022 DHS.

Adaptations to noisy environments: structure and usage of acoustic signals in Callitrichid primates.

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Communication is trade-off between reaching an appropriate recipient while minimizing detection by predators. In natural environments signals must also compete with biotic and abiotic noise (including anthropogenic noise) to be detected by recipients. We have studied pygmy marmosets (*Callithrix pygmaea*) in the Ecuadorian Amazon and measured the structure, usage and environmental transmission of vocalizations used to maintain contact among group members. Acoustic energy of calls is concentrated above the main frequency of ambient noise and above the hearing range of avian predators. Different types of calls are degraded at different distances from the caller in both spectral and temporal structure. Marmosets systematically use call types that degrade rapidly at short distances from recipients and use calls that degrade less with distance when potential recipients are further away. Calls used a greater distances have a broad frequency range and high frequencies are attenuated more than lower frequencies providing possible cues for estimating distance from the caller. Different populations have population-specific

forms of two of the three call types indicating presence of dialects, even though individual differences in call structure are found within each population. Although some of the variation in call structure can be related to differences in local habitat acoustics, other variation appears unrelated to local habitat acoustics. Studies in captivity have shown vocal convergence based on changes on social companions. Thus both the physical and social environment may influence the structure of calls in marmosets.

Testosterone and aggression in chimpanzees: novel tests of the challenge hypothesis.

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A long-standing question in behavioral endocrinology concerns the relationship between testosterone (T) and aggression. The "challenge hypothesis" proposes that T activates aggression only in the fitness-enhancing context of reproductive competition. We tested this hypothesis in three ways in an unusually large community of chimpanzees at Ngogo, Kibale National Park, Uganda. First, we showed that male chimpanzee reproductive competition varied as a function of female parity. Adult males competed more intensely for parous females than for nulliparous females. Rates of aggression and mating were higher in the presence of parous females in estrus compared with those shown around estrus nulliparas. In keeping with the challenge hypothesis, adult males had higher T levels in the presence of parous females in estrus compared to their baseline levels. In contrast, male T levels did not change when estrus nulliparas were present. Male chimpanzees competed for females not only within groups, but also between groups. In that context, competition took the form of group territorial patrols. Additionally, we demonstrated that adult male chimpanzees had higher T levels on days that they patrolled compared with their baseline levels. Finally, we took advantage of the fact that chimpanzees hunt and are thus aggressive in situations unrelated to reproduction. Male T did not increase on days that they hunted compared with their baseline levels. This study provides novel support for the challenge hypothesis by demonstrating that elevated T in male chimpanzees is associated with reproductive aggression, mate acquisition, and group territoriality and not with predatory aggression. This study was funded by NSF # 0752637, L.S.B. Leakey Foundation Grant.

A new 3D morphometric method based on a combinatorial encoding of 3D point configurations: application to skull anatomy for clinical research and physical anthropology.

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Three-dimensional (3D) shape analysis of anatomical structures is currently based either on the analysis of distances or angles between landmarks or on the computation of metric parameters which characterize the deformation of landmark configurations. However, significant differences which are not related to the normal inter-individual variation are not only metrical but also "structural". For example, in prognathism, it is a whole subset of landmarks which protrudes relative to another subset, in a correlated way. Such a deformation is not directly emphasized by the variation of the landmark coordinates and this suggests the need for additional 3D morphometric tools.

We propose to model the 3D landmark configurations by using the oriented matroid theory, a combinatorial mathematical structure which was developed over the past forty years. Oriented matroids allow one to model the relative positions of points in 3D without taking into account the distances between them. It is then possible to characterize some geometrical properties as the convexity or the alignment of subsets of landmarks and to detect structural changes as the crossing of a landmark through the plane defined by three others.

We applied this new method on sets of 133 3D cranial landmarks collected on 43 individuals presenting with varying types of coronal craniosynostosis. We computed the oriented matroid-based models and introduced a new discrete distance between two individuals. The matrix of all the distances allows differentiation among the craniosynostosis variant groups. We will also show how it could be used to compare extant and fossil skulls as STS5.

Research supported by the OMSMO (Oriented Matroids for Shape Modeling) Project, the 3D-MORPHINE Collaborative Research Initiative funded by INRIA, the United States Public Health Service grants R01 DE016886, DE018500, DE018500S1, and CDC 5R01DD000350, and the HOPE (Human Origins and Past Environments) International Program funded by the French

Embassy in South Africa and the South African Research Foundation.

New approaches to investigating ancient Maya diet: a three-isotope model for the reconstruction of dietary protein sources.

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The reconstruction of past dietary practices provides valuable information on the ethnicity, social relations, and subsistence strategies of archaeological populations. As one of the most extensively studied ancient societies, the Maya of Central America are ideal for region-wide investigations of synchronic and diachronic dietary practices. Here, by using previously-published isotope data, we apply a new dietary reconstruction model (Froehle et al., 2009, AJPA Suppl. 48:130) based on discriminant function analysis of three stable isotope variables ($\delta^{13}C_{col}$, $\delta^{13}C_{cap}$, and $\delta^{15}N_{col}$) to generate hypothetical diet end-members representing different protein sources available to the ancient Maya. We model beans, squash seeds, C3 animal, C4 animal, and 100% maize as possible dietary end-members.

Using the model, we test for differential access to these sources between status groups, sexes and regions, as well as over time within groups. Our data demonstrate that there is no clear differential access to protein types between status groups or between sexes across the entire study population, but we find regional differences between the Southern Lowlands, Belize, and the Peten. Moreover, our data reveal significant within-site temporal changes in dietary practices. The residents of Laamani, for example, switched to a heavier reliance on C4-fed animal sources in the Post-classic Period, confirming the suppositions of earlier authors (Wright and White 1996:177), and possibly representing a greater reliance on domesticated animals, such as turkeys and dogs. This study provides a more nuanced understanding of the ancient Maya and highlights the utility of applying this dietary reconstruction model to archaeological populations.

Size and shape analysis of second deciduous molars in genus *Homo*.

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In the context of understanding human evolution, dental remains are a valuable subject to study: they represent the largest part of the human fossil record

and allow comparisons between fragmentary individuals. Although juvenile hominin remains represent a large part of the fossil record, most studies in dental anthropology have focused on permanent teeth. The intraspecific variability in size and morphology is assumed to be high, which could challenge the use of deciduous teeth to assess taxonomic affinities of isolated dental remains. However, the use of geometric morphometric analysis can bring a new light on this issue.

The present study investigates second deciduous molar size and shape in the genus *Homo*, with a particular emphasis on Neandertals (n=20) and modern humans (n=218). Dental crown shapes were analysed using two-dimensional outline analysis based on Radial Fourier transforms on photographs, that allow the inclusion of worn teeth to maximize sample size. Crown size has been estimated by measuring crown base area. Multivariate analysis and resampling methods were used to assess size and shape differences between taxa.

The results show that lower and upper second deciduous molars are useful for discriminating taxa, with a low rate of misclassified Neandertal and anatomically modern human specimens. Thus, we demonstrate the taxonomic utility of deciduous molars for identifying the taxonomic affinity of isolated or problematic specimens.

Research supported by the french Ministry of Higher Education and Research, the New York Consortium in Evolutionary Primatology and the Leakey foundation.

Identifying differential patterns of activity: potentials and limits of tracing enthesal changes in archaeological populations.

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Bioarchaeological studies commonly and often too readily use musculoskeletal stress markers (MSM) to reconstruct past activities. Despite substantial progress in understanding the underlying factors of enthesal change, tracing past activities still suffers from largely subjective observation of trait formations, thus complicating inter-observer comparisons and interpretation of activity or stress impact.

The aim of this study was to apply a novel scoring method, based on clinical information and tested on documented collections (Villotte 2006), to archaeological populations as part of a research project on skeletal and archaeological indicators of identity in early medieval Alamannic populations. The skeletons of 304 adult individuals from the populations of Pleidelsheim (n=178) and Neresheim (n=126) were analysed for activity-related changes at 36 fibrocartilagenous and fibrous entheses.

The analysis revealed that prevalence of enthesopathies, i.e. pathological changes to entheses due to muscle overuse, is comparatively low, while differential identification of activity-related enthesal change is improved. Significant differences were observed in males and females within and between populations. Individuals from the more agricultural Neresheim show significantly higher prevalence of enthesal changes. Sexual dimorphism as well as an increase of MSM with age can be identified in both populations, however, with different patterns of incidence.

The study furthermore strongly indicates that muscular attachments should be evaluated in functional groups, of the upper or lower limb, in order to interpret activity patterns informed by underlying physiological rather than assumed occupational factors. This approach permits reliable tracing of general tendencies of activity in past populations, providing promising information regarding Alamannic lifestyles.

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Pairbonded adult titi monkeys of Ecuador (*Callicebus discolor*) change their affiliative relationships in the presence of infants.

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Red titi monkeys (*Callicebus discolor*) reside in socially-monogamous groups where the adult male and female form a strong pairbond and share in the care of infants. To better understand possible costs of biparental care on pairbond maintenance, we compared the relationships between pairmates with and without dependent infants. We collected 232 hours of observational data on proximity, grooming, and resting in contact by adult males and adult females in two wild groups of red titis in Yasuní National Park, Ecuador to characterize each sex's contribution to affiliative interactions. To evaluate whether the presence of a dependent infant influenced affiliative behaviors between pairmates, we compared the frequency of these behaviors in a 32-week period prior to the birth of infants with the frequency during the 16 weeks following births ($n = 5$ infants). Males contributed more to maintaining proximity than females both before and after the birth of an infant (mean Hinde's Index = 28 and 22 respectively). In the presence of infants females groomed the males more frequently than they were

groomed ($0.5\% \pm 0.6\%$ vs. $0.1\% \pm 0.2\%$). Before a birth, grooming rates were higher for both sexes, but sex differences were less pronounced (male vs. female, $1.0\% \pm .2\%$ vs. $1.2\% \pm 1.5\%$). Resting in contact was also more frequent before than after a birth ($3.0\% \pm 2.7\%$ vs. $1.3\% \pm 2.0\%$). Our results suggest that a decrease in the rate of affiliative interactions between pairmates is a potential cost of direct infant care for wild titi monkeys.

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Non-masticatory tooth wear at Grignano d'Aversa, Italy (2500-1750 BCE): the importance of macro- and microscopic analysis.

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The analysis of activity-induced dental modification (AIDM) gives clues about intra-population distribution of specific tasks by gender and age class. The occurrence and frequency of AIDM is dependent from the total time of exposure to abrasive materials, so assessment must be determined using microscopic analysis of the crown surfaces to document the earliest stages of wear and to trace the progression of the wear through time.

At the Bronze Age necropolis of Grignano d'Aversa (one of the most important, largest skeletal series for the period in Central Italy) numerous individuals show notches on the occlusal and lateral margins of anterior teeth. A total of 120 late adolescent and adult individuals were surveyed for the presence of these grooves and all teeth were macroscopically examined. High resolution epoxy, transparent casts were made of all anterior teeth and evaluated by optic and SEM microscopy.

Our results show a high occurrence of AIDM in female dentitions (54.6%; $n=44$), no AIDM cases for males ($n=38$), and 13.2% for unknown sex individuals ($n=38$). We suspect these notches are related to fiber processing and the fact that they occur only in females suggests a sex-specific task specialization. We found that microscopic analysis was indispensable for recognizing incipient traces of attrition in younger individuals (which we would have missed at the macroscopic level) as well as detecting wider and more complex patterns of tooth involvement in older individuals.

This study highlights the merit of combining macro and microscopic analysis in a systematic survey of non-occlusal tooth wear.

Neuropil asymmetry in the cerebral cortex of humans and chimpanzees: implications for the evolution of unique cortical circuitry in the human brain.

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The claim that behavioral and neuroanatomical asymmetries are unique to humans has been challenged by data from several nonhuman species. Interestingly previous studies of minicolumn lateralization revealed that humans may differ from other primates in displaying a left hemisphere bias in the neuropil space of the planum temporale, but it is not known how asymmetry in the neuropil space varies across multiple regions of the cerebral cortex and if there are any correlations with behavioral laterality. The neuropil is of functional importance as it is the portion of the cortical gray matter where synaptic connections are found. We used image analysis methods to quantify neuropil asymmetry in five cytoarchitectonically defined cortical regions of chimpanzees (6 males, 6 females) and humans (3 males, 3 females), including rostral prefrontal, inferior frontal, primary motor, agranular insular, and planum temporale. Results revealed a significant difference between species in mean neuropil asymmetry ($P = 0.023$). Humans displayed a clear directional bias in the amount of neuropil favoring the left hemisphere. Analysis of data within-species, revealed that cortical regions vary significantly in the amount of neuropil space for chimpanzees ($P < 0.001$), with agranular insular cortex showing the greatest amount of space for connectivity. In the human sample cortical regions did not differ significantly in the amount of neuropil space, however, this might be due to relatively small sample size. These results suggest that lateralization of minicolumns and neuropil space may represent an evolutionary alteration in the circuitry of the human cortex allowing for hemispheric specialization of function.

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Living hand to mouth: how marsupials can unravel the mysteries surrounding the evolution of touch acuity in primates.

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The infraorbital foramen (IOF) is located below the orbit of the eye, and transmits sensory information from the upper lip, face, and vibrissae to the brain. The IOF has been used as an informative feature to interpret the ecology and phylogeny of crown primates and pleristadapiforms. Even though the IOF has been discussed in the literature, the functional significance of its size among mammals is still unknown. A recent comparative study into IOF area suggests the relative size of the IOF indicates differences in face touch acuity. Among mammals, primates have some of the smallest IOF areas. It is hypothesized that primate IOF reduction may be a result of their increased reliance on hands, rather than their muzzles, to preprocess foods. In this study we test this hypothesis by observing the feeding behavior of marsupials. Marsupials were chosen to test this hypothesis for two reasons: (1) Marsupials converge with primates in both anatomy and ecology, and (2) unlike primates, some marsupials approach and pre-process foods only with their muzzles, while others initiate feeding and pre-processing of food with their hands. Results of this study find that marsupials that initiate feeding with their muzzles have larger IOFs than those that manipulate and pre-process foods with their hands ($p < 0.05$). These findings have implications for interpreting the fossil record. The majority of stem primates (pleristadapiforms) have relatively larger IOFs than extinct crown primates. The difference in IOF area may be an indicator of how these animals fed rather than phylogeny as previously suggested. This study was funded by NSF MU-Advance.

Detecting admixture in dental traits: implications for the role of Neandertals in human evolution.

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This study focused on the morphological expression of admixture in human populations in order to assess potential admixture in fossil remains. The Pima Native Americans have a documented small percentage of European ancestry. Here the dental metrics and morphology of the Pima were compared to those of their most likely Native American and European ancestors: pre-contact Hohokam from the American

Southwest, and Medieval Spaniards from San Pablo Monastery in Burgos, Spain. This study was a test of the hypothesis that admixture can be detected in dental traits, even with highly disproportionate levels of input from both ancestors.

The dental metrics show a consistent significant difference in tooth size between the Hohokam and San Pablo, the Spaniard means being smaller than the Hohokam. The Pima, however, have mean sizes that vary from larger than the Hohokam to smaller than the San Pablo sample. This wider variation in the Pima is consistent with previous studies of admixture in non-human primates and indicates that even small amounts of admixture are detectable in dental metrics. The results of this study can be applied to many studies of population dynamics from present day to the Pleistocene.

This study was funded by the College of Liberal Arts, Texas A&M University and the Department of Anthropology, Texas A&M University.

Geometric morphometric analysis of platyrrhine lower molar shape.

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Teeth play an important role in our understanding of taxonomic affinities and dietary adaptation in fossil primates. Innovations in shape quantification allow investigation of the relative influence of different factors on dental morphology. This study uses geometric morphometric analysis to identify axes of shape variation in platyrrhine molars. Fourteen landmarks were placed on μ CT surface renderings of lower m2s ($n=111$) from 19 species (12 genera). Following initial Procrustes superimposition, species average landmark coordinates were created. Generalized Procrustes analysis was used to align the landmark configurations and a principal components (PC) analysis was performed to identify dominant axes of shape variation.

Four PCs explained more than 5% of the variance each (80% cumulatively). PC1 (50.4%) displayed a strong dietary signal, related to relief and crest development, with positive values in more insectivorous (*Saimiri*, *Callimico*) and folivorous (*Alouatta*, *Brachyteles*) species and negative values in the seed-predating pitheciines; soft fruit specialists (e.g., *Ateles*) possessed intermediate values. PC2 (13.8%) separated the one callitrichid in the sample, *Callimico*, from other taxa. Phylogenetic Generalized Least Squares analysis showed that PC2 and PC4 were weakly correlated with centroid size (correlation coefficient = .46 for PC2, .44 for PC4, $p < 0.05$ for both). These results indicate a dominant dietary signal in molar shape but also show some shape change correlated with size but relatively

independent of obvious dietary or phylogenetic associations. The latter result deserves further attention, as it contrasts with previous work on strepsirrhines and tarsiers that showed stronger taxonomic variance and lower association between shape and size.

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A preliminary study of triangular ridge bifurcation in human maxillary premolars.

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Morphological dental variation has proven useful in examining human population origins and relationships. Most studies of dental morphology rely primarily on incisor or molar dental traits, while canines and premolars have received less attention. This study examines the utility of an understudied maxillary premolar trait, triangular ridge bifurcation (TRB).

TRB is characterized by bifurcation of the central occlusal ridge of the buccal cusp on mandibular and/or maxillary premolars. A graduated scoring system of maxillary premolar TRB was created with four possible categories of ridge form and size: no bifurcated ridge, small, medium, and large bifurcated ridge. Analysis included 502 dental casts from Bantu ($n=130$), Pima Indian ($n=126$), South African White ($n=108$), and South African Indian ($n=138$) samples. Forty-five casts were rescored to conduct inter- and intra-observer concordance tests. Sample frequency comparisons were made with Fisher's Exact tests ($\alpha = 0.05$).

Results indicate high scoring reliability in inter- and intra-observer tests with 87% and 89% concordance respectively. TRB frequencies were highest on P1. Overall, TRB occurred most frequently in the Bantu sample (P1=39.2%, P2=20.0%), followed by Pima Indians (P1=28.6%, P2=13.5%). The South African Indian (P1=16.7%, P2=13.8%), and South African White (P1=6.5%, P2=3.7%) samples were statistically similar, with significantly lower TRB frequencies than both the Bantu and Pima Indian samples. These results suggest that triangular ridge bifurcation may be a valuable addition to the battery of morphological dental traits used in anthropological studies of population variation.

How violent were the people of the Gallina Phase, really?

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Violence has long been an intriguing subject in anthropology and archaeology. The prehistoric inhabitants of the Gallina Phase (A.D. 1050 – 1250/1300) in north central New Mexico are no exception. Early publications about the Gallina Phase labeled the people as backward and excessively violent, and relatively few researchers challenge such accounts. I propose that the evidence of violence in the archaeological record is no more prevalent in the Gallina Phase than it is in other cultural groups in the area during this time period.

Using the specimens from two collections curated at Colorado State University and University of New Mexico, over 100 individuals were examined and the occurrence of trauma-related pathology documented. The data were subjected to statistical and geospatial analysis in order to identify the type, prevalence, and distribution of violence in the Gallina record. The Gallina skeletal series show that the percentage of those who died and exhibit skeletal evidence of violent trauma is comparable to surrounding contemporaneous culture groups. Given that the occurrence of violent, traumatic lesions is no more prevalent than that shown in other Puebloan populations; it seems that the inhabitants of the Gallina Phase were no more violent than other neighboring groups of the Southwest.

Chimpanzees and the reconstruction of behavior of *Ardipithecus ramidus*.

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The chimpanzee has served as a model of the behavior and ecology of earliest hominins for many decades. The recently published description and reconstruction of the fossil hominin *Ardipithecus ramidus* has sharpened this debate and been used to criticize the utility of the chimpanzee model.¹ In this paper I consider the behavior reconstruction of *Ardipithecus ramidus* in light of current information on chimpanzee behavioral ecology.

Lovejoy *et al.* (2009) argue that because their reconstruction of *A. ramidus* positional behavior indicates plantigrade locomotion, chimpanzees may be irrelevant for understanding the behavioral ecology of earliest hominins. Further, the Lovejoy *et al.* critique is based on an implicit acceptance of a knuckle-walking phase in hominin evolution, for which there is no evidence. In this paper I present data from a range of sources showing that the behavioral ecology of knuckle-walking ape or plantigrade cercopithecids are equally useful in understanding the behavior of early hominins such as *A. ramidus*. I also argue that Lovejoy *et al.* implicitly use the behavior of great apes in support of their interpretation of *A. ramidus*.

A. ramidus was a very ape-like early hominin adapted to both arboreal and terrestrial substrates. As in the 1980s, when research following the initial publications on the *A. afarensis* skeleton indicated that AL-288 was likely not an obligate terrestrial hominin, further research on the *A. ramidus* skeleton will offer new views of its posture and locomotion. The behavior of chimpanzees and other great apes will be instrumental in understanding the *Ardipithecus* fossils.

Morphological integration of the face in Down syndrome individuals and siblings.

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Down syndrome (DS), resulting from trisomy of chromosome 21, is the most common live-born human aneuploidy. The phenotypic expression of trisomy 21 produces variable, though characteristic facial morphology. We hypothesize that individual heritable facial features are changed according to particular patterns in people with DS because gene dosage imbalance alters developmental events in a similar manner. This alteration will result in changed patterns of morphological integration. To address this hypothesis we statistically compared morphological integration (MI) patterns of immature DS faces (N=52) with those of non-DS siblings (N=54), aged 6-12 yrs. Thirty-one linear distances were estimated using coordinate data representing 17 anthropometric landmarks on 3D digital photographic images. Mlboot (Cole, 2002) was used to test for local differences in MI of facial features. Our results suggest that facial features are affected differentially in DS as evidenced by statistically significant differences in MI both within and between facial features. Our findings provide a phenotypic readout in the human face of previous findings of neural crest involvement in mouse models for DS.

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Juvenile scurvy—a radiographic perspective.

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The use of radiography for assessing cases of juvenile scurvy has been a standard procedure in clinical cases of this disorder for almost a century. Despite several known pathognomonic clinical radiographic indicators of juvenile

scurvy, radiography has as yet to be employed to any significant degree in palaeopathological attempts to identify this disorder among archaeological populations.

We review the classic radiographic indicators of juvenile scurvy and compare them to radiographs of 14 sub-adult individuals from the sites of Stymphalos and Zaraka, Greece. These individuals were also examined for macroscopic indications of the condition. Several of the juveniles exhibit radiographic signs consistent with the clinical radiographic indicators of juvenile scurvy. In some, but not all, cases these indicators co-occur with macroscopic indicators of juvenile scurvy. This pattern of co-occurrence may relate to differences in the timing and visible development of lesions and their subsequent rates of healing.

Based on the significant results of the study conducted we suggest that future studies should attempt to employ radiography when assessing for juvenile scurvy. This may allow for improved standards of assessment, permitting comparisons with known clinical examples of this disorder and helping to separate cases of scurvy from other pathological disorders, especially anemia. If our interpretation of the co-occurrence pattern of lesions at Stymphalos and Zaraka is correct, it may also offer insights into the duration and recurrence of episodes of juvenile scurvy in past populations.

This study was funded by the University of Alberta, the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Wiener Laboratory of the American School of Classical Studies at Athens.

Social and regional stratification in Body Mass Index of 18- and 19-year-old Swiss conscripts 1992-2009 (N=460'887) and its secular trend since 1875.

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Overweight and obesity have reached the level of a pandemic in developed countries. BMI is not ideal measure for body fat, but it is nevertheless strongly correlated with total body fat and furthermore the only measure available in large data sets for long-termed time trends. We present unbiased, individually measured and thus highly representative annual BMI data sample on 18-20-years-old Swiss conscripts (N=460'887, universal conscription) from 1992 to 2009, representing ca. 90% of age cohorts. We trace for socioeconomic and

regional differences and aim to add historic context based on the same data source to identify the onset of current overweight pandemic.

We find that in 2009 24.2% of 19-20-year-old and 20.8% of 18-19-year-old Swiss conscripts were generally overweight (BMI > 25 kg/m²). The prevalence of obesity (BMI > 30 kg/m²) has doubled since 1992 reaching 5.7% in 2009. BMI distribution became more right-skewed since 1992, upper percentiles increased markedly, especially after 2002. Current upswing in BMI values took place in two steps, in the second half of the 1980s and again since 2002 until nowadays. We find no stagnation of BMI values in the recent past. Since 1992 regional differences in BMI disappeared more prominently than socioeconomic differences. Since 1875 Swiss conscripts changed from rather being underweight (12% BMI < 18.5 kg/m², 1.5% BMI > 25 kg/m²) to being overweight. In 1875-79 young men at the lower end of socioeconomic strata showed significantly lower BMI values compared to the upper socioeconomic classes. Nowadays social stratification in BMI has inverted, when overweight affects the lower socioeconomic classes to a higher extent.

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Why kill women? Investigating the sex ratio of violence at Orendorf.

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The Middle Mississippian site of Orendorf (~AD1150) in the central Illinois valley exhibits one of the highest frequencies of warfare-related trauma in the Southeast. Several individuals excavated from the Orendorf cemetery and village were added to the study, bringing the total number of individuals in the Orendorf skeletal sample to approximately 275. Of these, 27 adults (16% of all adults) exhibit evidence of violent encounters and include equal proportions of males and females. Few individuals survived a violent episode. Victims were killed by projectile points and blunt trauma and there is evidence of decapitation and trophy taking.

The types, bodily location and lethality of injuries suggest relatively equal treatment of the sexes during violent attacks. Given the ethnographic literature that chronicles elaborate war preparation ceremonies for males and the archaeological evidence of male warrior iconography it is perhaps surprising that females are equally represented among the victims at Orendorf and other sites in the central Illinois valley. Two hypotheses concerning why females exhibit similar risk levels for victimization are evaluated using archaeological, skeletal and ethnographic data. First, females suffered trauma that may be

more consistent with intra-group codified beatings rather than intergroup warfare. Second, the "why not?" hypothesis argues that females were perceived as enemies just as much as males and their deaths were not actively avoided during attacks. While the first hypothesis is not supported by the results, the second hypothesis reflects the current debate in the literature concerning gender construction in pre-European societies and merits further evaluation.

Stones, bones, cities, and states: a new approach to the Neolithic revolution.

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The rise of agriculture and the emergence of towns and cities transformed human activities and marked the beginning of modern human society. Social scientists have constructed various explanations on thin reeds of evidence, which can be placed into exogenous and endogenous categories such as climate change and over-hunting of a common property resource. We review these explanations and analyze skeletal evidence from the Western Hemisphere project, which shows living in early pre-Columbian urban areas was less healthy but also considerably less violent than found among hunter-gatherers. Drawing upon the theory of the natural state, in which the political system manipulates economic privilege to create social order, we hypothesize that new methods of social organization were essential for the rise of agriculture and urbanization. We argue that Neolithic societies preferred urban living built on farming despite worse health outcomes because new methods of organization created social order, enforced property rights and reduced violence. This study was funded by the National Science Foundation, grant numbers SBR-9223781 and SBR-9423435.

The exploitation of coastal resources informs on ancient human behavior and past environments: an integrated paleoecological approach to investigating modern human origins.

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Investigations into modern human origins have been challenged by identifying how behavioral changes – often marked as innovations indicative of modern human cognition – were related to the demographic changes that lead to the expansion of fully modern humans out of Africa and to environmental changes. Examination of the exploita-

tion of coastal resources, particularly mollusks, by ancient Middle Stone Age (MSA) and Middle Paleolithic (MP) humans provides an integrated paleoecological approach to addressing these questions.

Mollusks reflect past environments, which provide the context for human adaptations. Their presence or absence reflects changes in global sea levels, which can help chronologically constrain assemblages. Changes in species composition may reflect changes in the local coast, such as local fluctuations between rocky and sandy shores.

Detailed studies of recent archaeological mollusk assemblages demonstrate that mollusk samples decline in mean and median size because of increasing human predation pressure, which often coincides with increases in human population densities. Therefore, integrative studies of mollusk exploitation informs on how people exploited their environments, how technological and behavioral innovations may have increased the land's carrying capacity, and the tight relationship between these processes. MSA and MP humans also frequently exploited mollusks. MSA and MP mollusks are large, suggesting that these human populations lived at low densities. In the South African MSA record, subtle mollusk size changes during the MSA are expected to coincide with behavioral innovations that are often taken to indicate the appearance of modern human cognition; however, mollusk size remains stable and the implications are discussed here.

Testing the correlation between the anatomical structures of odorant and pheromone perception and their corresponding gene families in primates and other mammals.

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Mammals possess dual olfactory systems that function in detecting distinct types of stimuli, with the main olfactory system (MOS) detecting ecological and the vomeronasal system (VNS) detecting sociosexual cues (pheromones). Despite the importance of olfaction in this class, the development of these systems is highly variable. Recent studies on the underlying genetics and morphological components of mammalian olfaction have asserted a relationship between these components, but few have directly tested this link. This study tests hypotheses of coevolution between the pheromone perception genes (*VIR*) and the morphology of the vomeronasal organ (VNO), and olfaction genes (*OR*)

and the size of the olfactory epithelium. A regression analysis of phylogenetically independent contrasts yielded a significant correlation between VNO morphology and the percent of functional *VIR* genes but not the absolute number of *VIR* genes, and olfactory epithelium and number of *OR* genes. As predicted from their divergent function, elements of the MOS and VNS did not correlate with each other. The higher correlation of the percent of functional *VIR* genes and VNO type rather than absolute number of *VIR* genes may be due to the extreme variation of *VIR* genes among mammalian clades, and absence of correlated evolution between *OR* genes and elements of the VNS indicates these systems are under different selection pressures. These findings are relevant to primates as diurnality and trichromatic vision may have affected the VNS and MOS in differently, and these systems should not be used interchangeably when discussing the "trade-off" between olfaction and vision.

Evolution of adrenarche in *Homo* and *Pan*.

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Adrenarche, or the onset of prepubertal adrenal androgen production (specifically dehydroepiandrosterone (DHEA) and dehydroepiandrosterone sulfate (DHEAS)) after a period of adrenal quiescence, has been proposed as a shared, derived characteristic in humans and chimpanzees, since no conclusive evidence for adrenarche has been documented in other nonhuman primate species. We explore this issue in two ways: 1) we measured serum levels of DHEA/S in captive male and female chimpanzees, bonobos, gorillas and orangutans sampled throughout ontogeny, and 2) using a comparative genomic approach, we examined five genes that code for proteins involved in DHEA/S synthesis for evidence of adaptive evolution in their translated and regulatory regions. Chimpanzees and bonobos, but not gorillas and orangutans, show human-like patterns of postnatal adrenal androgen secretion, suggesting these species experience adrenarche. Our genetic analyses suggest adaptive evolution in haplorrhine cytochrome b5 (CYB5A) and in the *Pan/Homo* lineage

in cytochrome P450, family 17 subfamily A polypeptide 1 (CYP17A1). The 3-beta-hydroxysteroid dehydrogenase/Delta 5-Delta 4 (HSD3B) genes include a number of functional transcripts and pseudogenes. Interestingly, we also describe a tandem gene duplication event potentially mediated by a retrotransposon that resulted in two HSD3B genes in catarrhines (HSD3B1 and HSD3B2) with tissue specific functions. In humans, HSD3B2 is expressed primarily in the adrenals, ovary and testis, while HSD3B1 is expressed in the placenta. These data suggest the modern manifestation of adrenarche is a recent evolutionary phenomenon and that the evolutionary roots for this developmental stage may be traced back to more ancient lineages in primate phylogeny. This research was funded by NSF BCS0550209 and The George Washington University's Dilthey Faculty Fellowship.

Biology and art: kin connections partly predict the value of Southwestern pottery.

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Dissanayake notes that art is universal, requires much effort for seemingly unnecessary goals, and has biological relevance. Pottery-making was revived by a group of matriarchs from the Tewa-speakers of the San Ildefonso and Santa Clara pueblos of New Mexico in the early 1900s. Potters, often as children, learn how to process the clays, create, decorate and fire pots. The pots are not utilitarian but are sold as art to both tourists and wealthy patrons. Unusual about the on-line sales of these pots are the detailed descriptions of genealogies for artists. One must be Native American and born or married into either pueblo to participate in production of the characteristic pottery. We propose that the number of kin ties affects the values of these pots. Pot and artist traits were measured and correlations and regression analyses run using SPSS 17.

Dollar values of pots (N= 444 to 473) are significantly positively correlated with all measures of the pots (size, design elements) and artist (kinship to other potters, artist's age and "advertising" efforts). Pot values are greater when the pot is bigger, represents more effort, the artist has received more "publicity" and is more experienced with more kin ties to other potters. Preliminary regression analyses explain 38% of the variance in the dollar values of the pots. Clearly, the importance of kin ties relative to the dollar value of the pot helps reinforce group boundaries and social cohesion, a useful adap-

tation for a subculture at risk of losing its identity.

Pre-sapiens hominins, brain growth and the exploitation of freshwater environments.

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Nutritional studies report that the human brain, particularly in infants, has a large requirement for essential fatty acids, especially DHA (docosahexaenoic acid) and AA (arachidonic acid), for normal growth and maintenance. Early hominins, with their developing brains, must have also required these nutrients. DHA and AA are found in highest quantity in freshwater (and marine) fish and invertebrates, a diet which conflicts with the prevailing view that early hominins were primarily terrestrial carnivores. In support of the hypothesis that early hominins foraged along lake and river margins and procured nutrient-rich foods, data are presented here which document the procurement of fish and shellfish from early hominin sites. In particular the longterm and repeated occurrence of particular fish species with high nutritional values indicates selection by early hominins. In response to cyclical drought conditions, this paper suggests that intensified and more consistent hominin exploitation of high-quality lake and river margin resources provided sufficient food and potable water for survival, and exaptively a steady supply of essential fatty acids. This higher quality nutrition allowed energy to be redirected from inefficient gut operation to brain growth, and a consistent supply of essential fatty acids also provided the requisite nutrients to fuel the growing brain.

Mobility and diaphyseal robusticity throughout the appendicular skeleton: modern human hunter-gatherers, fossil hominins, and extant apes.

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Mobility is one of the most variable characteristics of both species and prehistoric societies. This study investigates the relationship between population level characteristics of mobility and long bone diaphyseal robusticity among modern human hunter-gatherers, fossil hominins, and extant primates. Hunter-gatherers provide a useful test of this relationship, as there is tremendous variation in habitual behaviour between populations, but individuals within populations are likely to be characterized by relatively homogenous activity patterns, often defined by sex. The robusticity of major long-bones throughout upper and lower limb are compared among a 17 hunting and

gathering populations from both historic and archaeological contexts, *Pan*, *Pongo*, *Hylobates* and selected fossil hominins. The human populations represent a broad spectrum of foraging strategies, with individuals (n=1151) from 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 peri-Arctic regions of Canada, Coastal California and the Tierra del Fuego. Variation among these populations suggests that the use of watercraft leaves a strong biomechanical 'signal' of marine mobility throughout the upper limb, while terrestrial mobility strongly influenced lower limb robusticity. Variation in terrestrial mobility appears to be correlated most strongly with femoral diaphyseal shape, and tibial rigidity, with these differences appearing relatively early in ontogeny. Intraspecific comparisons suggest that there is a strong differentiation between arboreal and terrestrial locomotion in interlimb-comparisons. While major differences in mobility are reflected in characteristics of limb morphology, more subtle patterns of variation remain challenging to interpret.

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Next generation sequencing enrichment strategies for ancient tuberculosis: pitfalls and results.

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In our research, we attempt to characterize ancient mycobacterial strains from cases of disseminated bone TB in order to understand the phylogenetic relationships between strains of tuberculosis prior to and after the Age of Exploration. DNA was extracted from over 120 samples exhibiting classic tuberculosis lesions obtained from both the New and Old Worlds and ranging in age from 5800 BCE to A.D. 1800. Then, four quantitative PCR assays were used to gauge the preservation of host and pathogen DNA. Human nuclear and mitochondrial, and mycobacterial repetitive (IS6110) and single copy (rpoB) loci were analyzed. These results show that while approximately one third of the samples contain human nuclear and/or mitochondrial DNA, only 10% were positive for mycobacterial DNA. From the samples that tested positive for host and mycobacterial DNA, we first selected two from Peru and one from Canada, for subsequent analyses using

high-throughput pyrosequencing. However, the quantity of mycobacterial sequences were low and not sufficient for phylogenetic analyses. Thus, new methods for targeting specific sequences of interest are necessary. Initial testing of the Direct Multiplex Sequencing (DMPS) method shows that size purification of small DNA fragments (~80-100 base pairs) of interest from primers and primer dimers is a challenge, which is problematic for samples in which DNA preservation is low. We are currently testing additional strategies for DNA enrichment so that we can obtain sufficient genome coverage for evolutionary analyses.

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Is the cranial base an accurate measure of growth efficiency?

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We investigated an important method for health assessment in archaeological populations by testing Angel's (1982) hypothesis that since the skull base supports head and brain weight, and nutritional deficiencies prevent adequate bone growth, cranial bases will be flatter in nutritionally-deprived populations compared with healthier populations. We focused on individuals born during nutritionally-stressful historical periods, primarily the American Civil War Era and Great Depression. Sample crania from 518 adult American white males were collected from the National Museum of Health and Medicine, Armed Forces Institute of Pathology, Terry and Hamann-Todd collections, and Forensic Anthropology Data Bank and arranged into six cohorts: [1]Pre-Civil War (pre-1855), [2] Civil War Era (1855-1877), [3] Post Reconstruction (1878-1899), [4]Pre-Great Depression (1900-1928), [5]Great Depression (1929-1941), [6] Post-Great Depression (1942-1978). Results showed that although cranial base height differed significantly across cohorts (ANOVA: $F(5,518) = 5.808$, $p < .05$), Tukey post-hoc comparisons revealed no significant differences for nutritionally-stressed cohorts. The Civil War Era cohort ($M = 12.87$, 95% CI [11.99, 13.76]) did not differ significantly from Pre-Civil War ($p = .998$) or from Post-Reconstruction ($p = .897$) cohorts; likewise, the Great Depression cohort ($M = 13.62$, 95% CI [12.99, 14.25]) did not differ significantly from the Pre-Great Depression ($p = 1.000$) or Post-Great Depression ($p = .398$) cohorts. Results showed no measurable difference in cranial base height for nutritionally-stressed individuals and do not support Angel's hypothesis of the cranial base as an indicator of childhood

stress. Future research focused on populations with skeletal evidence of nutritional stress (e.g., enamel hypoplasias), may yield additional insight into nutritional effects on cranial base growth.

The phylogeny of *Homo* and its implications for biogeography.

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Biogeographic patterns play an important role in our understanding of the evolutionary history of our genus, as it is obvious that species or populations of *Homo* dispersed between regions of the Old World at various times in the past. Certain dispersal events can be inferred simply from geography and chronology, but a more detailed assessment of biogeography requires a consideration of phylogeny; one can infer that biogeographic events must have taken place if ancestral and descendant taxa exhibit different spatial distributions. The biogeography of *Homo* was assessed here using cladistic analysis. Two ingroup taxonomies were analyzed separately (speciose vs. conservative). Eighty-one "traditional" and craniometric characters were examined, of which 35 were deemed cladistically useful. Parsimony analyses using the two taxonomies yielded broadly compatible trees, implying that phylogeny does not provide insight into the status of putative species within our genus. The speciose taxonomy produced a tree with complex biogeographic implications, including the findings that early Pleistocene hominins may have dispersed more than once out of and/or into Africa, and that representatives of Early *Homo* may have been among the earliest colonists of Eurasia. The phylogeny also corroborates the hypothesis that *H. floresiensis* is phylogenetically primitive. The phylogeny based on the conservative taxonomy is not biogeographically informative. However, if the "species" employed in the speciose taxonomy can be thought of as geographically and temporally bounded populations that were semi-isolated and that rarely reticulated, then the biogeographic implications of trees based on those taxonomic units may nonetheless be salient.

Evolution and health from infancy to adolescence in the Dogon of Mali.

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In a prospective cohort study of human biology in Mali, West Africa, I followed the development of 1700 Dogon children prospectively from 1998 to the present. At the outset of the study, the oldest children were five years old and they are now age 18 years. I will discuss the main conclu-

sions and current direction of this longitudinal study, with particular attention to the hypothesis that parental reproductive behavior is a major determinant of child health. In testing this hypothesis I used a linear mixed model in SAS with the mother of the child as a random effect, allowing me to take into account the correlation among maternal siblings as well as repeated measures. I found that: (1) Polygyny does not influence paternity certainty, but it adversely affects child survival through effects on breastfeeding, (2) Resource competition among siblings and other family members has unanticipated consequences for child health. These results have implications for the design of human life histories.

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Lapa do Santo rockshelter: new evidence of *perimortem* body manipulation in Early Holocene South America.

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There is a growing consensus that the strong emphasis on manipulation and reduction of human body in funerary rites in prehistoric South America is a typical archaic Andean pattern. However, the scarcity of Early Holocene human skeletal remains across the continent precluded scholars to study the mortuary practices of the first Americans in great depth making this assumption questionable. Here, we present evidence that those practices were by no means limited to the Andean region in this period. Lapa do Santo rockshelter is an archaeological site located in the Lagoa Santa region (central Brazil) where 26 human burials were excavated between 2001 and 2009. A sub-set of 9 burials constitutes what has been characterized as "Burial Pattern 1" comprising five individuals directly dated to between ca. 8800-8200BP. Fifty-seven radiocarbon ages from charcoal samples support this chronology as well. The burials included multiple mortuary practices such as disarticulation of anatomical parts, individualization of skulls, bundle of bones disposed according to "dichotomist" logic, amputating extremities of long bones, mandible with drills in the coronoid process, profusion of both cut marks and chopper marks, teeth extraction, selection of anatomical regions, intentional fire exposure, and ochre application. The presence of fully articu-

lated anatomical parts, including a decapitation case with fully articulated hands laid over its face, testify that the manipulation of the body happened while soft tissues were still present. These new findings force a complete re-evaluation of both geographical and chronological dispersion of the practices of body manipulation in prehistoric South America.

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Molecular paternity analyses confirm inbreeding avoidance and low reproductive skew in the northern muriqui, *Brachyteles hypoxanthus*.

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Efforts to understand the distribution of paternity in wild primates have focused on the relationship between male rank and access to fertile females. Yet, despite the wide range of demographic, reproductive, and ecological factors now known to mitigate the effects of rank on male reproduction in hierarchical societies, comparable insights into patterns of paternity in egalitarian societies have lagged behind. We investigated these patterns in one group of northern muriqui monkeys that has been the subject of long-term behavioral studies at the RPPN Feliciano Miguel Abdala (previously, the Estação Biológica de Caratinga), in Minas Gerais, Brazil. Fecal samples for DNA isolation were collected from 69 individuals, including 22 infants born from 2005-2007, the 21 different mothers, and all 26 of the potential fathers of at least one of the infants. Samples were genotyped at 12-17 microsatellite loci found to be polymorphic in muriquis from an initial set of 52 loci originally identified in either other playrhhines or humans. These multilocus genotypes were then used to assign infant paternities with $\geq 95\%$ confidence after exclusion and maximum likelihood methods. We found low reproductive skew, consistent with predictions based on the peaceful, affiliative relationships that distinguish the social dynamics of philopatric male northern muriquis from those of other primates. Our data also confirm prior behavioral evidence of inbreeding avoidance among close relatives, and raise new questions about the roles that maternal kin group size and life histories may play in the reproductive strategies of northern muriquis and other patrilocal primates.

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The chronological and evolutionary position of the Broken Hill cranium.

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The Broken Hill (Kabwe, Zambia) cranium, discovered in 1921, was the first important human fossil found in Africa. The specimen was recovered during quarrying operations in a metal-ore mine, now excavated away. However, archaeological, palaeontological and geological materials were saved from the site, some directly associated with the cranium. The excellently-preserved cranium was designated the type specimen of *H. rhodesiensis* (Woodward 1921), but more recently has been regarded as an African example of *H. heidelbergensis*. However, its precise age and taxonomic identity remain uncertain, issues which impede resolution of a number of issues in mid-late Pleistocene hominin evolution. Early studies placed the whole Broken Hill assemblage of fossils and artifacts in the late Pleistocene, but more recently, faunal comparisons made with sites such as Olduvai and Elandsfontein have suggested a middle Middle Pleistocene age, perhaps ~ 500 ka. However, assessments of the poorly associated archaeological materials have indicated a later Middle Pleistocene/early Middle Stone Age placement. New collaborative studies have attempted direct ESR and U-S dating of material from the site, some from or closely associated with the cranium, while geochemical studies have clarified its stratigraphic origins. When combined with new biostratigraphic assessments, a later Middle Pleistocene age for the cranium is favoured. A relatively late date for the Broken Hill cranium suggests a long time span for the "*rhodesiensis*/*heidelbergensis*" group and warrants caution about inferring the presence of early modern humans from the presence of early Middle Stone Age artifacts.

The use of a repeated-route system improves foraging efficiency in simulated spider monkeys.

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A variety of primates navigate their habitats via a system of repeatedly-traveled routes. Many repeated-route systems, such as those used by spider monkeys (*Ateles belzebuth*) in the Yasuní National Forest, Ecuador, follow geographical features. Route use in spider monkeys may make facilitate discovery of unknown feeding patches, improving foraging efficiency, thereby reducing information stored in memory. To test this hypothesis, we created two computer models to simulate the behavior of spider monkeys foraging in unfamiliar environments. One model simulates monkeys searching using a modified random-walk step model in which monkeys alternate 100-meter steps with turning angles derived from observed spider monkey behavior. The second model constrains travel to a route system. Simulated monkeys in each model searched among ten spatial arrays of feeding trees derived from behavioral observations (1999-2000). We compared total distance traveled, directness of travel, and correctness of starting direction for each feeding tree discovery (n=50000) for the two models. We then compared these variables to those derived from observed foraging behavior (n=250). Route-model monkeys traveled shorter distances between (T=-73.845, df= 49,999, P<0.0001) and more directly to (T=-41.3064, df= 49,999, P<0.0001) feeding trees than did randomly-foraging monkeys, and discovered trees in the direction they started more often (T=-5.33028, df=49999, P<0.0001). Results support the hypothesis that the use of a route system can improve foraging efficiency. Observed spider monkeys outperformed simulated monkeys from both models in all variables, suggesting that observed monkeys are incorporating spatial and ecological information into their foraging decisions, even when foraging along route systems.

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Juvenile stature estimation of the Arikara Plains Indians.

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Limited analysis has been conducted for estimating stature derived from the long bone lengths of juvenile skeletons. While juvenile stature estimation may be particularly beneficial in the forensic setting, it may have applications for use as a proxy for nutritional health of past populations like adult stature. Stature equations developed by Ruff (2007) and Smith (2007) were used to predict juvenile stature from long bone measurements of 1-17 year old Arikara Plains Indians from three temporally distinct burial sites spanning 1600-1832 C.E. (Extended Coalescent (EC), Post-

contact Coalescent (PC), and Disorganized Coalescent (DC) time periods). Ages were collapsed into three year age ranges: 1-3, 4-6, 7-9, 10-12, 13-15, and 16-17 year olds. T-test results revealed a significant difference in the 4-6 age range for the femoral derived statures between EC and DC (*p-value* = 0.0005) and PC and DC (*p-value* = 0.013) sites. The tibia and combined femur and tibia stature estimates also showed a significant difference during the 4-6 range for the EC and PC (tibia *p-value* = 0.03; femur and tibia *p-value* = 0.05) sites and EC and DC (tibia *p-value* = 0.01; femur and tibia *p-value* = 0.002) sites.

Changes in femoral length were noted in the DC site, while tibial changes were noted in the EC site. Interestingly, results of the combined femur and tibia stature estimates suggest a shift in bone length proportions, while juveniles maintained the same relative stature possibly reflecting the presence of environmental stressors for the Arikara juveniles in this age category.

The Black Gate cemetery, Newcastle-upon-Tyne, England: a bio-cultural approach to understanding a later Anglo-Saxon assemblage.

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The Black Gate cemetery was established within the abandoned remains of a Roman fort (*Pons Aelius*) in the 8th century and was an active burial ground until the 12th century A.D. The cemetery has yielded 663 articulated skeletons, making it one of the largest Christian skeletal assemblages recovered from later Anglo-Saxon England. Aside from the cemetery there is no physical evidence for settlement in the area from the abandonment of *Pons Aelius* in 410 A.D. until the first phase of construction of a Norman castle in 1080 A.D. Documentary evidence indicates the presence of a monastery within the immediate locality of the cemetery. However, archaeological evidence for monastic settlement at the site has yet to be established.

To determine the origin of the contributory population osteological analysis was undertaken. Investigation into the relationship between mortality and morbidity and different demographic and social components of the assemblage enabled a picture of the overall social and environmental impact on physiological stress to be assessed. This was compared with thirteen sites of known context to determine if the health profile observed amongst the Black Gate population shared characteristics with urban, rural or monastic assemblages.

A detailed picture of the health and funerary behaviour of the Black Gate cemetery was attained. However, the or-

igin of this population remains inconclusive. This research emphasises the multi-factorial nature of physiological stress and that age, diet, cultural practices and status had a greater impact upon the skeleton than settlement type in the later Anglo-Saxon period.

Obscuring limb allometry: The geometric mean and limb indices.

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It has been found repeatedly that human proximal limb elements scale with negative allometry while distal limb elements scale with positive allometry. This indicates that intralimb indices should scale allometrically, as distal elements increase in length more rapidly relative to proximal elements. Such a pattern has not, however, been substantiated by empirical findings. Here we investigate two phenomena that may contribute to this paradox: The use of the geometric mean as a size variable and the effect of other sources of limb length variation in obscuring intralimb index allometry.

Limb bone lengths and metrics necessary to estimate stature, using the Fully technique, were measured on 1007 indigenous American skeletons. Limb bone lengths were regressed in log space against both Fully stature and the geometric mean of the same bones. To investigate the contribution of unspecified sources of limb length variation in obscuring intralimb index allometry, we created limb length variation by adding modeled residuals to expected values obtained from our regression analyses. We generated 1000 populations for each of 21 different magnitudes of modeled residuals. Correlations were calculated between limb element lengths, limb element lengths and stature, and intralimb indices and total limb length for the modeled populations.

Results show the geometric mean cannot be recommended as a size variable because resulting allometry coefficients are not independent, and do not reflect values obtained when using a biologically relevant measure of size. We also determined that other sources of limb length variation are sufficient to conceal intralimb index allometry.

Ancient mtDNA analysis at Nuvuk, an ancient Thule village at Point Barrow, Alaska.

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Nuvuk, a village at Point Barrow, Alaska, was continuously inhabited for

the past 1300 years. Burials from Nuvuk available for sampling have calibrated median intercept dates between 1187-1613AD. All samples were collected *in situ* by molecular genetic analysts from burials opened by archaeologists charged with their recovery prior to loss due to coastal erosion. Genetic analyses of the mtDNA hypervariable region I indicate that the ancient Nuvuk individuals belong predominantly to mtDNA haplogroup A2. All ancient Nuvuk sequences have been replicated from independent extracts. Contemporary Inupiat/Inuit populations and ancient Thule studied to date are nearly monomorphic for mtDNA haplogroup A2. However, there is lineage heterogeneity within haplogroup A2 in arctic populations, which is reflected in the ancient samples. Individuals from Nuvuk can be confidently assigned to at least two sublineages of haplotype A2b, as well as to haplotypes A2a and D3. We have yet to identify any sample that is inconsistent with the standard view of relationships between the prehistoric Thule and modern Inupiat/Inuit populations.

These results support a population bottle-neck prior to the Thule dispersal across the North American arctic, although it need not have been severe or of long duration to result in the observed monomorphism in the modern population. This emphasizes the need to examine sequence diversity in larger numbers of samples, and to assay variation in the mtDNA coding region, Y-chromosome, and autosomal markers in order to access a richer genetic record with which to infer demographic histories of prehistoric arctic populations.

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Dental development in juvenile fossil hominins from Drimolen, South Africa using synchrotron virtual histology.

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Drimolen is one of the richest hominin-bearing sites in South Africa, yielding numerous *Homo* and *Paranthropus* infant and juvenile fossils from 2.0-1.5 mya. Here we apply non-destructive synchrotron virtual histology to seven associated juvenile dentitions and three isolated developing first molars to characterize aspects of

incremental dental development. We assessed cuspal enamel thickness, long-period line periodicity, long-period line number, crown formation time, and initiation age in permanent elements, which allowed estimation of age at death. Cuspal enamel thickness in first molars was comparable between the two taxa, averaging ~2 mm, with incisors showing cuspal enamel thickness values around 1 mm. Long-period line periodicity ranged from 7-8 days in *Homo* and 6-7 days in *Paranthropus* individuals. Several first molars (M1s) were not crown complete, prohibiting complete counts of long-period lines and crown formation time estimation. The upper M1 protocone of one early *Homo* specimen formed over 2.9-3.2 years, which is similar to *Homo sapiens*. Crown formation time for a *Paranthropus* upper M1 paracone was particularly low at 1.6 years. One enigmatic *Homo* LM1 entoconid formed over 1.9-2.2 years, displaying outer enamel secretion rates in excess of 7 microns/day. Incisor initiation age was comparable between taxa, occurring around 5-8 months of age. Age at death in most individuals occurred at approximately 2 years of age, while a few others died after 3 years of age. Integration of these results with data on cranial and post-cranial elements will provide crucial insight into hominin ontogeny, particularly for rare early *Homo* fossils.

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Sacralization is not associated with elongated cervical costal process and cervical rib.

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Cervical rib/elongated costal process of the seventh cervical vertebra (C7) and sacralization of the last lumbar vertebra are associated with clinical problems – thoracic outlet syndrome for the former and lower back/leg pain for the latter. A previous study reported an association between these morphologies, implying that presence of one trait predicts presence of the other. The present study tested three hypotheses from this association: costal process length among individuals with sacralization differs from that among individuals without sacralization for: (1) only C7, (2) only transitional presacral vertebrae – C7, twelfth thoracic, and fifth lumbar, and (3) presacral vertebrae in general. Skeletons of 961 individuals between ages 20 and 49 years from the United States were surveyed for sacralization. Costal process length was measured on 100 individuals with sacralization and 184 without sacralization for vertebrae 3 to 7 and 18 to last lumbar. Cervical rib was evaluated for 102 individuals with sacralization and 472 with-

out sacralization. Results show that 11% (105 of 961) of individuals have sacralization. Compared to individuals without sacralization, those with sacralization: (1) have significantly longer costal process for the last lumbar vertebra, but are not significantly different for costal process lengths of other vertebrae, (2) are not significantly different in prevalence of cervical rib – 2.9% with sacralization and 0.4% without sacralization, and (3) are significantly more likely to have an extra presacral vertebra. Results suggest different etiologies for sacralization and cervical rib/elongated costal process of C7; one morphology does not predict the other.

Can heterochronic change explain shape differences in the distal femora of Plio-Pleistocene hominins and humans?

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It has been proposed that the morphological differences between the distal femora of humans and early Plio-Pleistocene hominins are the result of a heterochronic shift in the human lineage towards a longer period of development. This assertion was tested using three-dimensional geometric morphometric microscribe data, collected as a series of *x, y, z* coordinates. Data were collected on an ontogenetic sample of forty-three *Pan troglodytes* individuals categorized in seven age classes and twenty-seven *Homo sapiens*, aged 2 to adult, as well as relevant original fossils. Data were subjected to a generalized procrustes analysis and multivariate statistics were subsequently performed.

The ontogenetic trajectory for *Homo* and *Pan* were significantly different. For modern humans, the major ontogenetic change in the distal femur was captured almost entirely along principal component 1 in a principal components analysis. WT 15000 and ER 1481 fell within the 95% confidence ellipse of modern humans, but all other fossils fell well outside. Major ontogenetic changes in *Pan* were captured on both PC 1 and PC 2. Distal femora from *Australopithecus afarensis*, as well as ER 1500, fell within the 95% equal frequency ellipse for the *Pan* ontogenetic trajectory, while ER 1481 and WT 15000 were furthest outside. These results indicate that shape differences between the distal femora of Plio-Pleistocene hominins and humans cannot be accounted for by heterochrony alone.

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The conditions required for an economic bipedal locomotion. Key role of the pelvic parameter: the sacral incidence angle, growth, evolution and plasticity.

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Sagittal balance of the trunk above the lower limbs is an essential component of erect posture and bipedal walking, however it is poorly studied. G. Duval Beaupère highlighted the importance of a sagittal pelvic parameter called the "angle of sacral incidence" (35°-75°) which plays a critical role in driving the changes in the sagittal spinal curvatures from one individual to another. Does this angle change during growth related to gait acquisition? We compared 50 adult, 17 infantile and 20 intact newborn pelvis. We used the software package, "DE-VISU", developed by J. Hecquet. From a set of 47 landmarks, we reconstructed the three pelvic joints, the angle of incidence and many other useful parameters.

From the neonatal to the adult state, the "angle of incidence" increases (means: newborns, 28°; infants, 40°; adults, 54°). The sacrum moves backward in the sagittal plane with respect to the acetabula, a crucial element in the economy of erect posture. A chain of correlations links the degree of the sacral slope and of the angle of incidence, which is tightly linked with the degree of lumbar lordosis.

We show the absence of sexual dimorphism for the "angle of incidence". We present its lower values in non human primates and its significant increase in young Japanese macaques trained for bipedalism.

We conclude that adequate correlations between the degree of incidence and of vertebral curvatures, ensuring an economical sagittal balance of the trunk above the lower limbs, are established progressively during growth with gait acquisition.

Growth in the marmoset monkey: toward a model of childhood obesity.

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Childhood obesity is a growing health problem. A better understanding of the developmental, behavioral and physiological factors leading to obesity in childhood would be enhanced by the availability of a nonhuman primate model of the condition. Marmoset monkeys are a potentially useful model of the effects of early life perturbations on later life health and disease, due to their relatively fast maturation and short life span. In addition, the production of litters means that the effects of the prenatal and postnatal environments may be differentiated via experimental manipulations not possible in other primates. A portion of the captive marmoset population becomes obese, even when maintained on a typical captive primate diet that is relatively low in fat and high in fiber – however these diets, for marmosets, are often high in simple carbohydrates. Excess adiposity in captive common marmosets appears to develop as early as 2 months of age, a point at which marmosets are in the process of being weaned to solid food. There is some indication that feeding behavior of infants destined to become obese may be differentiated from those remaining lean as early as the weaning period. Maternal condition and infant birth weight appear to influence adiposity, but only among infants vulnerable to obesity. Early life obesity in marmosets is often associated with impaired glucose metabolism and hypertriglyceridemia that may eventually lead to diabetes and cardiovascular disease. This research was supported by NIH grant DK77639.

Demographic analysis of an A.D. 825 ossuary context: the Gold Mine site of Northeastern Louisiana.

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Commingle mortuary contexts contribute novel information about regional culture history and burial practices. However, study of these sites is often neglected due to interpretive challenges. Mound A of the Gold Mine site represents one of the largest collections of prehistoric human remains in Louisiana and is a type site for the Baytown-Coles Creek period, a time of considerable cultural change that is poorly represented in the Lower Mississippi Valley. Demographic analysis is critical to describing this unusual context containing mostly secondary burials and will facilitate reassociation of discrete individuals. The current study tests two hypotheses: First, that atypical sex and age profiles are represented as a result of preferential burial practices related to the ceremonial significance of the site; second, that sex and age distributions differ by mound strata. Standard morphological and metric techniques were used to estimate the sex and age of remains from

Mound A. Demographic profiles are compared with "typical" prehistoric demography of the Orendorf site. Of 63 adults, at least 24 are female (50%) and 19 are male (30.6%). Mortality is highest in the 35-50 year age category, followed by the 20-35 year and 0-5 year categories. Sex and age distributions of Gold Mine do not differ significantly from Orendorf ($p > .05$) or between mound strata ($p > .05$). These results show no significant bias in age and sex representation at the site. Diverse mortuary demography and lack of burial goods suggest the mound dates to the Baytown period rather than the more stratified Coles Creek period. .

Diet, brains, and evolutionary constraints.

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Evolution is an opportunistic process that can only capitalize on features of organisms that are already in place. It is not a process of optimization; and its future directions are constrained as well as heralded by the possibilities inherent in existing structures and developmental pathways present within lineages. They are also constrained by behavioral and environmental factors that are external to the genotype and structural phenotype. In hominid phylogeny one of the most important of these external constraints has clearly been diet quality, not least because of the very particular energy requirements of the metabolically very expensive brain – the dramatic increase in the size of which has been perhaps the most notable feature of the last two million years of human evolution. In the course of hominid brain enlargement (the pattern of which may be as much a reflection of interspecific competition among hominids as it is of intraspecific selection) two unrelated elements, one extrinsic and one intrinsic to the organisms concerned, have clearly acted in concert not only as facilitators, but also as constraints. These elements are the availability of adequate environmental resources, and the behavioral capacity to exploit them. Recognizing and distinguishing the roles of each factor at various stages in the process will be essential to any complete understanding of how humans became the remarkable neural and cognitive entities they are today.

Science and Democracy: "Education" and Participation in the Genomic Era.

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This paper, based on ethnographic research in the United States, examines a range of efforts to engage ordinary

people in what I call “genetic thinking and practice.” Practices such as gene therapy, pharmacogenomics, and stem-cell therapies promise transformative interventions into human life and health. The recognition of the potential flexibility of biological material and of life itself has facilitated the establishment of a new set of research efforts and allied commercial ventures seeking to transform such potential into medical therapies. I will argue that in the gap between the contemporary reality of available therapies and the potential of future therapies we find diverse efforts aimed at imagining and building particular futures. Here significant work is being undertaken to create the material, political, economic, and conceptual means deemed necessary for facilitating the realization of a molecular medical clinic. At the heart of this work are efforts to recruit people to contribute the material means of contemporary scientific knowledge production—DNA and family and medical histories. This paper focuses on everyday practices seeking to create citizens knowledgeable about and willing to participate in genomics in order to consider the more and less democratic impulses of such efforts.

The trade-off between force and excursion capabilities of the masseter and temporalis muscles in African papionins.

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African papionins are highly sexually dimorphic and engage in intrasexual competitive displays involving relatively large maximum jaw gapes. Papionins are also opportunistic omnivores and include varying degrees of tough and hard foods in their diets. These display and feeding behaviors present competing demands with respect to the jaw musculature as maximum gape tends to increase with longer jaw-adductor fibers, while maximum muscle (and bite) forces increase with greater jaw-adductor physiologic cross-sectional areas.

Here we compare architectural features of the jaw muscles in a preliminary sample of dentally adult male and female *Cercocebus* (n=2), *Mandrillus* (n=2), *Papio* (n=3) and *Theropithecus* (n=1). Specifically, we measured muscle weight, fiber length (Lf), and pinnation angle and computed physiologic cross-sectional area (PCSA) for the masseter and temporalis. We compared relative differences in architectural variables

versus jaw length as a mechanical standard. We also examined the relationships among masseter Lf, jaw length, and relative maximum gape. Initial findings show that *Mandrillus* has the relatively longest masseter fibers but a relatively small masseter PCSA. By contrast, *Mandrillus* maintains a relatively large temporalis PCSA suggesting this muscle plays an important role in generating vertical muscle (and bite) force in this genus. Masseter Lf and jaw length are significantly correlated and relative maximum gape is correlated with jaw length across these taxa. Our findings support (1) the theoretical trade-off between maximizing muscle force (PCSA) versus excursion/contraction velocity (Lf) in muscle, and (2) hypotheses linking jaw length, relative maximum gape, and canine dimorphism in anthropoid primates (Hylander & Vinyard, 2006). This work was supported by NSF (BCS 0452160 and BCS 0962677).

Mitochondrial DNA variation in the Fijian Archipelago.

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The Fijian Archipelago plays a central role in the history of the peopling of Polynesia. To date, there has been insufficient sampling across Fijian Islands despite evidence for axes of variation in culture, language, and biology. In order to explore population structure within the Fijian Archipelago, we sampled 88 mitochondrial DNAs from five Fijian, two Melanesian, and two Polynesian islands. This study is the first to examine variation in Rotuma and among the Fijian islands.

We sequenced the Hyper Variable Region I (HVI). Our analysis of genetic diversity indicated a bottleneck in Rotuma and intermediate haplotype diversity in Fiji with respect to Polynesia and Melanesia. A multidimensional scaling plot places Fiji in the center between Melanesian and Polynesian populations. Rotuma is an outlier beyond Polynesia. We found mitochondrial haplogroup variation among Fijian islands. For example, Rotumans have a single mtDNA haplogroup—B4a1a1a (Polynesian Motif). Moreover, Kadavu had 30% M28 haplogroup frequency, suggesting that it has a closer relationship with Melanesia than elsewhere in Fiji. Interestingly, the Lau group did not show affinities preferentially with Polynesia as would be expected based on archaeological, historical, phenotypic, and geographic evidence.

Obesity in the skeleton: correlating long bone external dimensions to Body Mass Index (BMI).

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Even though body-mass index (BMI) is widely used to evaluate past populations, it is rarely applied to forensic cases. The American obesity epidemic, with a 34 % rate of obesity nationwide (CDC 2010), may provide the ability to distinguish body type from the skeleton, which then can be incorporated in forensic analyses. Based on previous studies (Godde and Wilson 2008; Knapp et al. 2009; Moore 2008; Wilson et al. 2010), it was hypothesized that significant differences in long bone external dimensions exist among varying BMI levels in the upper and lower limbs. A series of external measurements of long bones were obtained from individuals with known height and weight in the William M. Bass Donated Skeletal Collection (N=394) to calculate shape indices for approximation of the cross-sectional geometry of the diaphyses. Data were divided according to BMI and grouped into average, obese, and morbidly obese. Three analyses were conducted based on this separation: (1) average/obese/morbidly obese; (2) average+obese/morbidly obese; (3) average/obese+morbidly obese. Indices from long bones were inputted into Kruskal-Wallis ANOVA tests, along with post-hoc tests, to detect significant differences among groups; and discriminant analyses were run to determine classification error rates. Results from the ANOVA indicated the second analysis yielded three shape indices (Humerus mid-shaft, Femur mid-shaft and subtrochanteric) that were significant in relation to BMI, but with a 36% error rate. Although this produced an undesirable error rate, it suggests that external dimensions could predict BMI when combined with other skeletal indicators, a finding consistent with Moore (2008).

Patterns of mortality and group transfer explain differences in male and female longevity in *Propithecus edwardsi*, Milne-Edwards' sifaka.

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Propithecus edwardsi females live longer than males, however characteristics proposed to drive sex differences in lifespan (e.g., sexual dimorphism, male-biased aggression) are lacking. To elucidate proximate explanations for sex differences in lifespan, we explored demographic and life history patterns of a population of *P. edwardsi* in Ranomafana National Park, Madagascar. Using 80 group-years of data on births, deaths, and transfers from 41 females and 34 males collected over 23 years, we calculated sex ratios and compared sex-specific Kaplan-Meier survival curves based on mortality and group transfer. We hypothesized that sex differences in the timing of group transfer and mortality can account for differences in observed maximum lifespans (males 19y; females 32y). Sex ratios were male-biased (mean=0.48+0.06) from sexual maturity through 17y, and female-biased at birth and older ages. Prior to 10y, more females than males exited the population; exits were largely due to death, as high infant mortality rates continued one year longer in females than in males. 50% of males survived until 14.75y, whereas 50% of females survived until only 2.2y. Early mortality differences led to the male-biased sex ratio, but exit rates converged after 10y. By 18y females present in the population remained, whereas males continued to exit steadily after 10y until no males older than 19 were present. The continued exit of males at older ages was largely due to transfer. We suggest that sex differences in the timing of transfer, and the unique challenges of dispersal at older ages, may explain sex differences in lifespan. Research supported by NSF-BCS 721233.

A female skeleton with syndromic sagittal craniosynostosis from late Byzantine Priene (Turkey) – a CT investigation.

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The Hellenistic city Priene is located in today western Turkey. In Byzantine times several churches and chapels were built, surrounded by cemeteries. One of the late Byzantine cemeteries is located in the former sanctuary of the Egyptian Gods (Raeck 2008). Here, 34 burials with up to 50 individuals were excavated, and recently studied (Teegen 2010). This cemetery was, however, much larger. During the 2010 campaign, a somewhat disturbed burial was excavated at the periphery of the cemetery. The analysis revealed a young adult female with a calculated body height (Pearson 1899) of 148±3 cm. She died after a miscarriage of at least twins 8 to 9 lunar months after conception. Her skull shows premature sagittal craniosynostosis and closure of the right

occipito-mastoid suture. A CT scan was performed at Soeke Hospital, showing thickening of the left cranial vault up to 10 mm. The right temporal and sphenoid bones are also heavily thickened and deformed. Their structure is indicating a temporal lobe malformation. The occipital bone shows an abnormal structure without marked areas of the occipital poles and the posterior cranial fossae. The frontal teeth of the upper and lower jaw are protruding. In the present case, premature sagittal craniosynostosis is associated with other skull and jaw deformations, as well as limb shortening, but only on the left side. The lower leg and foot bones are not preserved. Due to this association of malformations it should be called a syndromic sagittal craniosynostosis. The differential diagnosis of this case will be discussed.

Research was funded by the German Archaeological Institute at Istanbul.

Variation in body size during the agricultural transition in prehistoric Japan.

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This study compares body size between Late/Final Jomon (4000-2300 BP) and Yayoi (2500-1700 BP) period people. Average limb lengths were compared using MANOVA with Tukey's HSD test ($P \leq .05$). Skewness of limb lengths and body mass and average body mass were compared with t-tests. Leg length is significantly reduced in Jomon compared to Yayoi males and females. Significantly longer femora are observed among Yayoi compared to Jomon males. No significant differences in tibial length are observed between Jomon and Yayoi males. Jomon and Yayoi period females do not significantly differ in any measure of average limb length. Leg length expresses significant positive skewness in Jomon females ($t = 2.45, P \leq .05$), but not males ($t = -.08$). This reflects significant positive skewness in the femora ($t = 2.44, P \leq .05$) and tibiae ($t = 5.38, P \leq .05$) of Jomon females. No significant skewness is observed among Yayoi male ($t = -.03$) or female ($t = .35$) leg length. Significantly greater body mass is observed among Yayoi compared to Jomon males ($t = -2.53, P \leq .013$) and females ($t = -7.89, P \leq .0001$). Significant skewness in body mass is not observed among Jomon ($t = -.74$) or Yayoi males ($t = .068$). Significant negative skewness is observed among Jomon ($t = -4.47, P \leq .0001$), but not Yayoi females ($t = -1.69$). This suggests greater environmental influences on size among Jomon compared to Yayoi samples. Greater plasticity in size among females is also likely.

Masseter fiber length and position influence relative maximum jaw gapes in the sexually-dimorphic *Macaca fascicularis*.

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Maximum jaw gape is influenced by several factors across primates including jaw morphology (e.g., jaw length), muscle position and fiber architecture. Maximum gape and jaw length are hypothesized to be strongly correlated across primates. Alternatively, the impact of jaw-adductor fiber length (Lf) (primarily the anterior-most masseter fibers), and muscle position is less clear. In part, this uncertainty reflects the functional trade-off in modifying Lf and muscle position. More caudally-positioned muscles and longer fibers facilitate gape, while more rostrally-positioned muscles and shorter fibers increase muscle force. We examine the influence of masseter position and Lf using an intraspecific sample of highly dimorphic *Macaca fascicularis* (n=5 males, 5 females). As *Macaca fascicularis* males have relatively larger gapes than females (Hylander and Vinyard, 2006), we predict that in this species, males will have relatively longer-fibered anterior masseter and/or relatively caudally-positioned muscles compared to females.

Mann-Whitney U-tests suggest that, relative to jaw length, males have both more caudally-positioned masseters ($p=0.016$) and longer anterior masseter fibers ($p=0.075$) compared to females. These results suggest that male *M. fascicularis* have masseters that facilitate maximum gape at some cost to masseter muscle force. Because relative canine height is correlated with maximum gape in catarrhines, and male macaques have relatively longer canines, the observed masseter configuration supports the hypothesis that male *M. fascicularis* have experienced selection pressures to increase maximum gapes at a cost to force production (Hylander and Vinyard, 2006). This musculoskeletal configuration is likely functionally significant for behaviors involving aggressive displays in male *M. fascicularis*. This study was supported by NSF (BCS 0452160 and BCS 0962677).

Rotator cuff disease in post-medieval London.

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This experiment is a cross-sectional study that examines the prevalence of

rotator cuff disease in three post-medieval assemblages, one of high status and two of low status. The examination was carried out at the Museum of London, on 137 skeletons aged between 36-45 years and over 45 years. The study also measures the areas of the rotator cuff that were affected by rotator cuff disease, and the relationship between rotator cuff disease and a hooked acromion. The study uses the occurrence of both pitting at the muscle insertion locations of the rotator cuff and new bone on or around the insertion, as the operational definition of rotator cuff disease. When rotator cuff disease was found within the population, the areas affected were recorded, along with the shape of the acromion. The prevalence rate of the disease within the population was calculated and evaluated with 95% confidence intervals. The results show that the wealthy category had a higher rate of rotator cuff disease especially in the 46+ age bracket. The results from this study are not statistically significant, however, they do show some trends which could be compared to a larger study on the same topic.

The genetic structure of the Kuwaiti population: mitochondrial DNA markers.

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In the past few decades, researchers using human mitochondrial DNA (mtDNA) have significantly contributed to our understanding of human evolution and migration. However, little attention has been paid to the Arabian Peninsula which is assumed to be one of the first inhabited regions following the expansion of early *Homo sapiens* out of Africa. Recently, a number of investigations have started to reconstruct human expansion through the archaeology and the study of the genetic structure of populations of the Arabian Peninsula. Populations of Kuwait, located in the Northeast portion of the Arabian Peninsula, have not been studied from a molecular genetic perspective.

This research investigated the mitochondrial DNA (mtDNA) genetic variation in 117 unrelated individuals to determine the genetic structure of the Kuwaiti population and compared the Kuwaiti population to their neighboring populations. Restriction fragment length polymorphism (RFLP) and mtDNA sequencing analyses were used to reconstruct the genetic structure of Kuwait. The result showed that the Kuwaiti population has a high frequency of haplogroup pre-HV (18%) and U (12%) similar to other Arabian populations. In addition, the African influence was detected through the presence of

haplogroup L (1.6%). Furthermore, the MDS plot showed that the Kuwaiti population is clustered with neighboring populations, including Iran and Saudi Arabia, but not Iraq.

To test or not to test: UC Berkeley's unfortunate incoming student genetic test program.

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In the summer of 2010, UC Berkeley's *On the Same Page* program sent out buccal swab test kits to nearly all of its incoming students with the aim of testing the students' DNA samples for three alleles. The program was ill-thought out and ethically compromised. As one of the people whose input and participation in the project was solicited, I explain the behind the scenes negotiations we engaged in to try and salvage the program, why our efforts were ultimately unsuccessful, what should be learned from this fiasco, and what a great program for students in genomics might have looked like. I draw out implications that the rise of "personalized medicine" is already beginning to have for human subjects research in general.

Social bonds in wild white-faced saki monkeys reflect male/female pair preference, despite lacking behavior and physical traits typical of primate monogamy.

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White-faced sakis lack most of the behavioral and physical traits typical of primate monogamy. In order to determine if social bonds in this species reflect patterns displayed by pair-bonded groups or larger multi-male, multi-female groups, this study draws on 17-months of data collected on wild white-faced sakis at Brownsberg Nature Park, Suriname. We analyzed within-group social bonds for three habituated groups (one two-adult and two multi-adult groups; one of which had polygamous mating) by measuring grooming time, time in proximity and approach/leave patterns between adult and subadult group members. We found that both two-adult and multi-adult groups showed significantly stronger social bonds between a single male-female dyad within each group (deemed "primary dyads"). In all three groups, primary dyads were composed of the oldest adult male and a reproductive female. This pair had significantly higher levels of grooming than other within-group dyads ($t=4.2$, $p<.001$), grooming between 4.5-11.6 times as much as the

average of other within-group dyads. Primary dyads were also in close proximity ($<1m$) more often than non-primary dyads ($t=3.0$, $p<.01$). Grooming in primary dyads was always highly non-reciprocal, with females investing more time grooming males; non-primary dyads varied in reciprocity, but were often more reciprocal. These results suggest that while white-faced sakis do not show behavioral and physical traits typical of monogamy or pair-bonding, social bonds are still strongest between a single breeding male/female pair. This study was funded by NSF (#0925122) and the International Primate Sociological Society.

Energetic costs of reproduction in wild female chimpanzees.

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Reproduction imposes significant costs to female primates living in habitats of limited and fluctuating energy availability. Females in a variety of primate species have been observed to shift foraging strategies during pregnancy and lactation, typically by increasing food intake or prioritizing high energy foods. However, little is known about metabolic changes that occur during reproductive efforts in primates and whether the energy conservation mechanisms present in humans are unique or typical of primates generally. Measurement of insulin dynamics offers a powerful way for examining the energetics of reproduction because insulin is directly involved in managing energy stores and because C-peptide, a byproduct of insulin production, can be measured non-invasively in the urine of wild primates. We studied the changes in C-peptide excretion over 26 pregnancies and 35 lactation periods in wild chimpanzees (*Pan troglodytes schweinfurthii*) in the Kanyawara community of Kibale National Park, Uganda. Pregnant chimpanzees experienced a steady increase in C-peptide concentrations over the course of gestation, paralleling the mechanism for maternal energy storage during human pregnancy. C-peptide fluctuations during lactation also showed interesting parallels to those humans in that levels dropped during the initial months of lactation and increased significantly over the following 2 years of lactational amenorrhea. C-peptide elevations were also temporally related to the resumption of cycling. C-peptide levels varied significantly with respect to maternal experience and individual resource access. However, temporal abundance of food resources had unexpectedly weak effects in these females, who experienced costs

of increased feeding competition when foraging parties were larger. This study was supported by grants from the American Association of Physical Anthropologists, the Leakey Foundation, and the National Science Foundation (SBR-9729123 and SBR-9807448).

A new bent on hominin ankle evolution.

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The hominin foot evolved from a grasping appendage to a stiff, propulsive lever during the Plio-Pleistocene. Key to this transition was the development of the longitudinal arch, a soft-tissue structure that stores elastic energy and stiffens the foot during bipedal locomotion. As soft-tissue generally does not fossilize, paleoanthropologists rely on footprints and bony correlates of arch development to infer arch evolution, though there is little consensus on when and by what pattern the arch evolved.

We present evidence from radiographs of modern humans (n=261) and a comparative study of ape tibiae (n=154) that the set of the distal tibia in the sagittal plane is related to rearfoot arching (a component of the longitudinal arch, along with the midfoot arch). Most non-human primates present a plantarflexed tibial arch angle, while most humans exhibit a dorsiflexed angle. Humans with a plantarflexed angle (n=22) have significantly lower talocalcaneal and talar declination angles – both measures of an asymptomatic flatfoot. Application of these results to the hominin fossil record illustrates that a well-developed rearfoot arch was present in *Australopithecus afarensis*, and like modern humans, *Australopithecus* populations were individually variable for this character. “Lucy” (A.L. 288-1), along with two Plio-Pleistocene tibiae from genus *Homo* (KNM-ER 1481 and StW 567), have a plantarflexed set to the distal tibiae and likely had asymptomatic flat feet. Whether asymptomatic flat feet were more common in our ancestors and if this trait followed a gradual, directional pattern of evolution remains unclear and will require additional fossil evidence.

Skeletal correlates of horse riding in Post-Medieval Britain.

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Two of the most common skeletal markers used to reconstruct activity are cross-sectional geometry and entheses. These types of markers are rarely used

together and often do not correlate. This may be the result of different forces affecting alterations to bone geometry and muscle insertion sites. However, using both types of markers may be the most effective way to identify a specific habitual activity in a generally robust and active population. This study used both types of markers to identify a suite of features for horse riding in Post-Medieval Britain. The samples that were used came from two sites: Chelsea Old Church (n=49), a cemetery from a rural community who likely rode habitually, and Farringdon (n=51), a cemetery for urban poor in London who likely did not ride. These samples did not significantly differ in either age make-up or in general skeletal robusticity. A platymeric index was calculated using anteroposterior and mediolateral measurements at the midshaft. Entheses robusticity for several leg muscles was recorded using a ranking system. The Chelsea Old Church sample was significantly rounder ($p=0.026$), possibly due to multi-directional forces acting on the femur while riding. The gluteal tuberosity and medial linea aspera were significantly more robust in the Chelsea Old Church sample ($p=0.026$ and $p=0.027$, respectively), suggesting increased use of hip abductors and adductors and knee extensors. This suite of features is consistent with English-style riding and together provides stronger evidence for horse riding in this population than either marker could alone.

Distinguishing demography from selection: parsing multiple signals within a single gene.

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Much work has been done examining population-based sequence data for the signature of selection. Generally these tests have focused on comparing characteristics of the surrounding sequence in different populations or species to infer the action of selection on a particular locus. Here we present an analysis of the geographic distribution of multiple single nucleotide polymorphisms within a single gene.

For these analyses, we selected the PR Domain-Containing Protein 16 (PRDM16), a gene involved in developmental morphogenesis and an important component in the differentiation of preadipocytes into brown fat. This rather large gene, greater than 300 kb, is found at 1p36.3 — a region with a relatively high rate of recombination. We use CEPH-HGDP data from 612 Eurasian individuals sampled from 36 populations to test whether SNPs found within the same gene give similar patterns when analyzed for geographic ani-

sotropy. The CEPH-HGDP database for PRDM16 contains 77 SNPs within the PRDM16 gene, and regional estimates of linkage disequilibrium document two separate major stretches of near complete LD. Analyzing a subset of the 77 available SNPs from within and without regions of high LD and spanning the gene reveals dissimilar patterns of anisotropy. While SNPs within LD blocks show rather similar patterns, SNPs outside of LD blocks give a different yet concordant pattern. We infer that these results may be evidence of a combination of purifying selection and demographic processes, and suggest this approach as a complementary method for understanding human genome evolution writ large.

Aching arms: extreme enthesopathies (MSMs) from the proximal ulnae of a UAE Bronze Age population (Tell Abraq).

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The Bronze Age in the Arabian Peninsula (c.2200-2000 BC), referred to as the Umm an-Nar period, is not as well understood as other regions. Over four hundred individuals were recovered from this tomb and provide the largest human skeletal population from the UAE Bronze Age. This research project examines the proximal end of the ulna for enthesopathies that reflect extension, flexion, and supination of the forearm. These muscles are related to fishing (making and using nets) and food processing (processing grains), and other fine hand movements that involve pulling objects towards and away from the coronal plane. This human skeletal population is unique because the majority of its individuals had extremely large enthesopathies. Data from this population suggest, however, differentiation in labor forces resulted in difference in expression between the *M. triceps brachii*, *M. supinator*, and *M. brachialis*. For example, individuals who have larger definition in the *M. brachialis* do not have as well defined *M. triceps brachii*. Preliminary data analyses by sex demonstrate that females used their *M. triceps brachii* more while men used their *M. brachialis* and *M. supinator* more frequently. As these muscles oppose each other, it would seem that these individuals were either exerting more force while extending or flexing the arm, but not both. Women exerted more force while extending the elbow while men exerted more force flexing and supinating the forearm. Regardless of sex and size, in this population many individuals exhibited extreme manifestations of these enthesopathies.

Genetic signatures of a Late Pleistocene demographic collapse in an Endangered forest dwelling primate (*Mandrillus leucophaeus*).

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The drill (*Mandrillus leucophaeus*) is one of the most threatened primate species in the world and is listed among the highest of priorities for African primate conservation by the IUCN. It is endemic to the Cross-Sanaga-Bioko rainforest region of Central Africa and suffers from habitat fragmentation and illegal hunting. Although recent work has shed some light upon the ecology of wild drills, other aspects of its natural history remain largely unknown. In particular, no molecular work has ever examined drill population and demographic history, which can provide valuable insight into how natural and anthropogenic changes to the environment affect rainforest species. Over 2,000 base pairs of mitochondrial DNA were amplified and sequenced in nearly 60 individuals across the drill range. The BEAST package was used in a population genetic analysis to infer a drill gene tree and coalescent times among drill mitochondrial lineages. A Bayesian Skyline Plot was then conducted to infer changes in female effective population size over time. We detected a severe demographic collapse in this species that coincides with the very end of the Pleistocene. Given the timing of this event, we propose that this population bottleneck is related to the severe climatic changes associated with the Last Glacial Maximum. We also found a relative lack of population structure among mitochondrial lineages across certain drill sub populations, with all lineages coalescing to the Mid Pleistocene. These results are discussed in relation to climate change, biogeography, recent human activity, and conservation priorities.

The evolutionary implications of significant carpal and tarsal variation among gorilla taxa.

MATTHEW W. TOCHERI. Human Origins Program, Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

Gorillas are more closely related to each other than to any other extant primate and are all terrestrial knuckle-walkers, but taxa differ in a number of morphological and behavioral features. The relative extent to which natural selection and genetic drift has influenced the evolution of gorilla taxa is still largely unexplored despite the fact that gorillas are one of the closest living relatives of modern humans. Here I show using qualitative and quantitative methods that a surprising amount of shape variation is present among the carpals and tarsals of three widely recognized taxa: western gorillas (*Gorilla gorilla gorilla*), mountain gorillas (*Gorilla beringei beringei*), and grauer gorillas (*Gorilla beringei graueri*). For example, medial cuneiform morphology clearly distinguishes among these gorilla taxa in functionally relevant variables suggesting that selection has played a significant role in shaping hallucial anatomy in response to the frequency and importance of arboreality in the behavioral repertoire. However, significant differences amongst all three taxa in trapezium, capitata, scaphoid, intermediate cuneiform, and navicular anatomy are less easily explainable under an adaptive framework and are more likely the result of genetic drift. Together, these results support a hypothesis of long-standing ecological divergence between eastern and western gorillas, and more recent, possibly non-adaptive evolution of differences between eastern taxa. In total, these data provide novel and interesting insights into gorilla evolution since the last shared common ancestor with *Pan* and *Homo* and underscore the importance of gorilla taxa as models for interpreting the fossil records of human and great ape evolution.

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Tail Length estimation in macaques from sacro-caudal skeletal morphology.

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Tail length in primates greatly varies. This morphological variation could reflect primate adaptations. However, tail length varies even in closely related taxa, and evolutionary or adaptive meaning of it is not fully understood. In order to investigate the cause and evolutionary process of tail length variation, it is necessary to devise a reliable method to estimate the tail length from partial skeletal elements. Previous studies treated tail length categorically (e.g. "long", "short", "very short", "absent") and quantitative estimation has not been conducted. This study used 89

skeletal specimens of hybrid individuals of Japanese macaque (*Macaca fuscata*) and Formosan rock macaque (*M. cyclopis*), which were produced by an illegal introduction of the latter into the natural habitat of Japanese macaques and captured by the wildlife protection office to prevent a genetic disturbance. These individuals were ideal to calculate predicting formulae to estimate relative tail length (the percentage of tail length relative to the trunk length) since their tail length varied greatly (101 to 470 mm or 18.3 to 88.8 % in relative length) depending on the degree of genetic admixture. Twenty length measurements were taken from the sacrum and proximal caudal vertebrae (~C3) and multivariate regression formulae were explored by step-wise method. The utility of the obtained formulae was tested by an application to 8 other macaque species. The result showed that these formulae generally work well to estimate tail length in macaques.

A biomechanical analysis of the aye-aye (*Daubentonia madagascariensis*) mandible in tree gnawing.

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Daubentonia has a set of behavioral and morphological adaptations that are unique among primates. Among these are craniodental adaptations facilitating the extraction of insects from wood by gnawing. They possess a downwardly oriented face relative to the cranium, which Cartmill (1972) suggested to be an adaptation for resisting large bite forces. Additionally, their teeth converge on a rodent-like condition, including banded, ever-growing incisors. Prior research found an inconsistent pattern of morphological specialization for large bite force production at the anterior dentition in other tree-gouging and scraping prosimians but did not measure *Daubentonia* (Williams et al. 2002; Vinyard et al. 2003). Given the anatomical specialization of the incisors, this study proposes that *Daubentonia* will have morphological indicators of large bite force production in comparison to tree-gouging and scraping prosimians. Shape ratios were generated from linear measurements of skulls from nine species of gouging, scraping and non-gouging prosimians. Inter-specific comparisons were made using a Kruskal-Wallis test followed by pairwise Mann-Whitney U-tests. *Daubentonia* exhibited relatively wider and deeper mandibular corpora, shorter mandibles, and larger condylar areas when compared to other species. These results suggest that the skull of *Daubentonia* may be designed to produce large anterior bite forces in comparison to other gougers and scrapers. Given these preliminary results, in vivo data are required to confirm that the anterior bite forces produced

by *Daubentonia* are higher than those of other gouging prosimians.

Isotopic identification of childhood feeding practices among the ancient Moche, Peru.

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We explore Moche infant feeding behavior at the large urban centre of Huacas de Moche (A.D. 100-700), Peru, using stable isotopic analysis of 63 individuals, including 16 subadults (<15 years) and 47 adults of both sexes from both residential and sacrificial contexts. We used collagen (dentin) and structural carbonate (enamel) from teeth, which represent infant and childhood dietary isotopic signatures, and collagen and structural carbonate from bone, which represent the last 10 to 15 years of life, to reconstruct the timing of childhood nutritional transitions. The combination of six isotopic measures ($\delta^{13}\text{C}_{\text{collagen}}$, $\delta^{13}\text{C}_{\text{structuralcarbonate}}$, $\delta^{15}\text{N}_{\text{collagen}}$, $\delta^{18}\text{O}_{\text{structuralcarbonate}}$, $\delta^{18}\text{O}_{\text{phosphate}}$, and $\Delta^{13}\text{C}_{\text{collagen-structuralcarbonate}}$) has enabled the identification of trophic level, water sources, and macronutrient shifts occurring during the transition from complete breast-feeding to complete independence of mother's milk.

Trends in results conform to expected dietary shifts in carbon- (increasing with age), nitrogen- and oxygen- (both decreasing with age) isotope compositions, and demonstrate significant changes among earlier and later -forming teeth, and bone for both collagen and structural carbonate. These data allow us to estimate that supplementation (introduction of solid foods) occurred as early as 2 years, and that weaning (cessation of mother's milk as primary food source) was completed by approximately 5 years. Variability by sex and burial context is evident. This study demonstrates the value of multi-tissue isotopic comparisons in elucidating complex changes in ancient dietary strategies for children, and provides a baseline for infant feeding behavior in ancient Peruvian populations.

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Consequences of changing numerical asymmetries on intergroup relations among tufted capuchins: a case study.

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Game theory suggests that escalation of aggression is unprofitable when competitors are able to accurately assess one another due to strong asymmetries in competitive ability or through prior interactions. Thus, changes in the resource holding potential (RHP) of one competitor may alter both the nature of interactions and each competitor's access to resources. We followed two groups of tufted capuchin monkeys (*Cebus apella nigrinus*) in Iguazú National Park, Argentina, with intermittent contact between June 2008 and August 2010. During this period, the larger group experienced a change in the male dominance hierarchy, resulting in the death or dispersal of all adult males and the ascendance of a subadult male to the dominant position. This reduced the numerical advantage in the number of males between the two groups, although the ratio of total group sizes remained constant (2:1). Following this shift, the degree of escalation during intergroup encounters increased, including reversals in the dominance relationship of the groups. These changes were associated with changes in the use of overlapping areas. In the six months following the takeover, the area of home range overlap doubled, and the formerly dominant group's area of exclusive access was reduced by half due to more frequent and longer incursions by neighboring groups. These observations suggest that RHP in tufted capuchins is related to either male group size or the competitive ability of the dominant male and that reduced competitive ability may increase both direct costs of intergroup aggression and costs of between-group scramble competition.

This study was funded by the American Society of Mammalogists; Consejo Nacional de Investigaciones Científicas y Técnicas; Idea Wild; the Leakey Foundation; the National Geographic Society; the National Science Foundation (BCS-0752683); the Wenner-Gren Foundation (7929); and Stony Brook University.

Talo-crural appositional articular shape: differences and similarities in articular morphology related to substrate preference among closely related catarrhine taxa.

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The talo-crural in primates consists of three components: tibia, talus, and their appositional joint surfaces. This study explores the relationship between tibial and talar articular shapes using geometric morphometrics in African apes.

The appositional articular shape from 30 matched specimens from *Homo sapiens*, *Gorilla sp.*, and *Pan troglodytes* (5 males and 5 females in each) formed the study group. Laser surface scans were made using a Minolta 910 and edited in Geomagic. Landmark Editor was used to place twelve landmarks on the proximal talar and fifteen landmarks distal tibial articular surfaces, respectively. Landmark configurations were then superimposed in Morphogika 2.0 and statistically analyzed with SAS. Singular warps analysis was used to explore the relationship between appositional joint surfaces. Shape differences were then visualized in specimen space, and exemplar surfaces were warped.

Results demonstrated marked clustering of articular shape by taxon, with substrate preference influencing the differences and similarities of articular shape observed between these closely related taxa. Arboreal taxa articular interfaces had increased plane with oval posterior and lateral margins, convex medial malleolar facet surface and increased lateral facet size and concavity. Terrestrial taxa had trapezoid rather than oval articular interfaces, concave medial malleolar facet, concave rather than convex medial malleolar groove and both the trochlear apex and the medial facet anteriorly displaced. Shape variations of articular interfaces were accurately observed using combined articular matrices, allowing the study of the ontogeny of joint shape, and that of fossil hominoid taxa.

This study was funded by NSF (BCS-042539) and the University of Oregon.

The ethics of collections in biological anthropology.

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Most biological anthropologists deal with collected materials. The collection can be skeletal or material remains, repositories of DNA or cells, or field notes. Because of the use of collections, anthropologists have begun to ask the following questions - what is done with them, how they are maintained and who has access to them. Many of these discussions can be subsumed under the general theme of repatriation. Repatriation of native material has been in process for years; other types of collections are currently under review, including collections held by large museums, individual's field notes and genetic databases. At this point in time, there seems to be two different approaches to the ethics of collections. On the one hand, collections of some material remains have been the topic of considerable ethical debate and are subject to the legal requirements of repatriation. On the other hand, large databases of genetic information are being deliberately col-

lected in such a way as to attempt anonymity and obviate any possibility of return. An examination of the ethics of collections, writ large, is perhaps the next challenge for biological anthropologists. In framing the ethics of collections biological anthropologists could engage with other groups who have a history of engagement with collections including museums, libraries and other groups that deal with information technology. These discussions are beginning with the formulation of principles that will govern the collection and stewardship of materials and include a clearly defined agreement between the principal investigators and the curators of the collection.

Long bone bilateral asymmetry in modern South Africans.

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Many studies utilize only one side of the skeleton, usually the left side, when available. Time is a limiting factor in most data collection, so measuring only one side of the skeleton can expedite data collection and subsequently increase sample sizes. However, several studies have discerned significant differences in size and other morphological factors (e.g., pubic symphysis score) between either side of the same individual. Ignoring these differences could affect inferences and study results. This study includes 258 modern South African individuals from the Pretoria Bone Collection, housed at the University of Pretoria, South Africa. Both White and Black South Africans and males and females are represented in the sample. Percentage of directional asymmetry was calculated for maximum length of the humerus, humeral head diameter, humeral midshaft diameter, maximum length of the femur, femoral head diameter, and femoral midshaft diameter.

Results are similar to previous studies in other populations – greater amounts of asymmetry in upper limb bones compared to lower limb bones. Maximum length of the humerus shows the greatest asymmetry (1.1246%), while femoral midshaft diameter has only a minute amount of directional asymmetry (0.000078%). Directional asymmetry is greater in the humeral head diameter than the femoral head diameter (0.997905% and -0.00018%, respectively). Humeral midshaft diameter shows very little directional asymmetry (0.00022%). Research involving long bones should consider bilateral asymmetry during method development and analysis in order to maximize sample size while still obtaining precise results. This research was funded by a research grant from the Department of Anthropology at the University of Illinois and Urbana-Champaign.

Where have all the women come from? Discrepancies in the number of male and females lineages in Mifflin County Anabaptist cemeteries.

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In earlier studies of the genetic and social structure of Amish and Mennonite cemeteries, we have constructed a unique genealogical database. The file, containing over 4000 records, consists of all individuals buried known to be buried in the seven Anabaptist cemeteries of the Big Valley, Mifflin County, Pennsylvania between initial settlement between the late 1700s and 2002, and their ancestors back to the last recorded common ancestor. Interestingly, this research has shown that while there are about eighty known male “founders” of this population, there are almost double the number of female “founders.” There are two hypotheses that may explain this discrepancy: 1) As this is a patrilineal community with only male religious leaders, it may have accepted female converts more easily than male converts, leading a larger diversity of female lineages. 2) Because adult females in the community adopt their husband's family name, the genetic relationship of females may not be recorded in written records. Many of the “founder” females may, in fact, come from the same lineage, and thus the written records may over-estimate the number of female founding lineages. The implications of the two hypotheses are significantly different in understanding the genetic diversity of these populations and the social structure of the communities and their cemeteries. Existing genetic and historical records are used to test both hypotheses, and the implications for the analysis of the cemetery structure are examined.

Metabolic regulation of postpartum fecundity in human females.

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The return to postpartum fecundity clearly reflects the often cited Current vs Future Reproduction life-history trade-off and, ultimately, represents an energy allocation problem. Lactating women face metabolic challenges even greater than pregnant ones. From an evolutionary perspective, we should expect the regulation of this transition to be tightly associated with energy availability and, consequently, to maternal ecology.

After several decades of research, at different levels of analysis (from molecular to physiological to demographic) we are beginning to obtain a more focused pic-

ture of the mechanisms behind the return to postpartum fecundity. In this presentation, I will discuss models that attempt to explain the resumption of full postpartum fecundity as the result of maternal metabolic energy allocation decisions. It is now clear that the mere amount of calories (e.g., nutritional status) is not the main regulator of these decisions. Rather, a more nuanced mechanism that involves diet quality and energy balance is emerging as a better candidate. The dynamics of insulin sensitivity during lactation, as well as other metabolic mediators, may aid in synchronizing the resumption of ovarian function with a reduction in the energy demands of milk production.

As a secondary goal, I would like to comment on the impact that lifestyle/ecological changes brought by development programs may have on the fertility and health of women in developing countries, with an emphasis on an applied view on human reproductive ecology.

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Phylogeography of brown spider monkeys (*Ateles hybridus*) in Colombia: testing the riverine hypothesis.

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The diversification and phylogeny of spider monkeys have been explained by mechanisms such as geological fluctuations and ecological changes. However, there is little evidence to support riverine barriers as drivers of speciation in the group. Nonetheless, among brown spider monkeys (*A. hybridus*), two subspecies have been recognized based on differences in pelage coloration, divided by the Magdalena River in Colombia, suggesting their divergence could have been promoted by the river acting as a barrier. This study evaluates the influence of the Magdalena River as a barrier to gene flow between the different populations of *A. hybridus* in Colombia as well as the phylogenetic relationships and the degree of genetic differentiation. Mitochondrial HV-1 and COII sequence variation from 10 populations (50 individuals) along the two banks of the Magdalena River were examined. Haplotypes were shared between populations on both banks and there wasn't an evident clustering of the samples in two supported clades, corresponding to each bank of the river. All populations

sampled weren't significantly differentiated and most of the genetic variation was observed within populations rather than between banks. Population genetic analysis showed gene flow between banks and a significant correlation between genetic and geographic distance, as would be predicted by the IBD model. There wasn't a highly structured phylogeographic pattern and based on these mtDNA data, the riverine barrier hypothesis was not an important mechanism influencing the population genetic structure of *A. hybridus*, suggesting the Magdalena River has not been a barrier to female-mediated gene flow in neutral markers.

This study was funded by Primate Action Fund - Conservation International.

The Behavioural Ecology of *Eulemur fulvus rufus*: a test of the socioecological model.

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Numerous factors influence primate grouping patterns, social interactions and mating systems, including phylogeny, demographic variables, the distribution of resources and predation pressure. The presence of *Eulemur fulvus rufus* in extremely different habitats in Madagascar provides a unique opportunity to examine the influence of ecological factors on social organization and mating systems while controlling for phylogeny. Western populations live in highly seasonal tropical dry forests, while eastern populations live in closed rainforest. Both populations have been extensively studied for over three decades, resulting in an enormous amount of long-term data on many aspects of *E.f. rufus* behaviour, ecology and morphology, including diet, ranging, life history variables, dispersal, female-female relationships, morphology, and mating systems. *E.f. rufus* thus provide a unique and valuable opportunity to evaluate extant models of primate sociality.

I summarize published data regarding *E.f. rufus* behavioural ecology, as well as generating and testing predictions for *E.f. rufus* social organization and mating systems based on the socioecological model and sexual selection theory. The socioecological model predicts patterns of social organization and behaviour of western populations of *E.f. rufus* extremely well, and yet has low predictive power with regard to the social organization and behaviour of eastern populations. This disparity partially results from the extreme unpredictability of food resources in Malagasy rainforests. The temporal availability and predictability of food resources is not explicitly accounted for in the socioecological model, and has consequences for patterns of primate grouping, mate competition, dispersal patterns and social organization.

This study was funded by the National Sciences and Engineering Research Council of Canada.

Gradient of dental wear and mandibular corpus height in Pleistocene *Homo*.

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The 2600 mandible from Dmanisi has been noted for its exceptionally tall corpus, with this feature playing a large role in discussions of the specimen's conspecificity, or lack thereof, with the remainder of the Dmanisi sample. Also exceptional in this specimen, however, is the extreme gradient of dental wear across the molars, a gradient more extreme than nearly all other Pleistocene *Homo* mandibles. This observation raises the question of whether or not these two features are related, and in particular, whether or not the latter is in some way causally linked to the former. Here we test the hypothesis that the gradient of molar wear is linked to increased corpus height in Pleistocene hominins. Our results suggest there is a positive relationship between the two, presumably relating to developmental and biomechanical constraints associated with the action of the jaw during juvenile development in these specimens. This relationship is examined in several specific cases, some of which stand out as interesting exceptions to the larger trend. In the particular case of the Dmanisi hominin sample, this effect, coupled with aspects of aging and sexual dimorphism, may partly explain the seemingly excessive amount of variation observed in the sample. Viewed in the larger lens of early *Homo* evolution, this observation raises interesting questions for the development of the masticatory environment throughout juvenile and early adult stages of life.

Brain size evolution in seasonal habitats: cognitive buffer effects and energetic constraints both apply in catarrhine primates.

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When asking whether the relative brain size of species is linked to the degree of seasonality of their habitat, *ceteris paribus* two aspects are important. On the one hand, seasonality forces animals to deal with periods of food scarcity, posing an energetic constraint on the highly expensive brain. On the other hand, seasonal habitats may act as a selective pressure to increase brain size, as behavioral flexibility helps to deal with these periods of food scarcity. We expect energetic constraints to always be present in seasonal habitats, even though these might be covered by cognitive

buffer effects. In a comparative analysis of 81 species of primates, controlling for phylogeny, body mass and other confounding variables such as degree of folivory and group size, we found a strong negative relationship between experienced seasonality, as proxied by monthly variation in dietary intake, and relative brain size in both lemurs ($p=0.004$) and catarrhines ($p=0.01$). However, a cognitive buffer effect is weak in lemurs (relatively large-brained lemurs show only a weak trend ($p=0.11$) to experience less variation in their dietary intake than would be expected given the seasonality of their habitat), whereas in catarrhine primates such a cognitive buffer effect is strong ($p=0.02$), effectively masking a direct correlation between brain size and habitat seasonality ($p=0.7$). From this, we conclude that energetic constraints are more pronounced in a taxa group if a relatively large percentage of body metabolism is needed to maintain brain function, whereas a large absolute brain size may facilitate cognitive buffer effects.

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Reinterpreting cribra orbitalia etiology in a coastal North Carolina Algonkian population using CT scans.

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Criba orbitalia is visually characterized by porous lesions on the orbital roof and is often attributed to iron deficiency anemia, although other etiologies are possible. The main objective of this study is to reassess the diagnosis of iron-deficiency related cribra orbitalia in a North Carolina coastal Algonkian population ($n=50$, AD 295-1460) using non-destructive methods. Microscopic techniques such as thin-ground sectioning have successfully differentiated between diploic expansion attributed to anemia as opposed to other etiologies. Such destructive techniques often are not possible with some U.S. samples because of NAGPRA provisions. Thus, we utilize non-invasive computed tomography (CT) scanning as a viable alternative to identify diploic expansion versus other sources of porosity in the orbital roof.

Forty-five crania with varied forms of upper orbital lesions and 5 crania without lesions were selected for this analysis. The axial anterior-posterior CT images allow distinction between diploic expansion and resorption of the corre-

sponding cortical bone and cortical bone porosity. This preliminary study therefore suggests that CT scanning is a viable replacement for histological assessment of pathologies in cases where destructive analyses are prohibited. By more accurately understanding the etiology of cribra orbitalia in archaeological populations, we can better understand their dietary habits, health, quality of life, and overall adaptations to their unique environment. Reconsidering the etiology of cribra orbitalia has important implications for the current interpretations of malnutrition and infectious disease in earlier human populations. This new non-destructive methodology has implications for paleopathological methodology, archaeology, and Native American history. This study was possible because of the generosity of the Department of Cardiovascular Sciences at the Brody School of Medicine, East Carolina University for allowing us the use of their CT scanner and the help of scanning technician, Kelli West.

Nocturnal light environments in Madagascar: implications for nocturnal primate color vision.

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Recent work has highlighted the importance of vision, particularly acuity and color vision, in nocturnal primate behavior, ecology, and evolution. Comparative studies document variation in nocturnal primate visual anatomy and function, while field studies explore how vision is used behaviorally. Yet, little research has explored how nocturnal light environments vary within and between primate habitats. I examined nocturnal ambient light variation at two sites in Madagascar: dry deciduous forest at Kirindy Mitea National Park (KMNP) and rainforest at Ranomafana National Park (RNP). At KNMP, I quantified nocturnal irradiance (intensity and spectral quality) at 54 locations for 34 nights, revisiting each location every 4 nights (n=516 measurements) and recording lunar elevation and cloud cover. At RNP, I measured irradiance during crescent (n=8) and gibbous phases (n=10). I estimated foliage density with an LAIL meter at each location. Nocturnal irradiance in Madagascar was significantly affected by habitat type, lunar phase and elevation, foliage density, and cloud cover. In particular, KNMP was significantly brighter and relatively richer in shorter wavelengths than RNP. Similarly, brighter lunar phases (full, gibbous) were relatively richer in shorter wavelengths than more starlit phases (crescent, new). Even when full, moonlight intensity and spectral quality varied with lunar elevation, increasing in short-wavelength richness at lower lunar elevations. Combined, these results suggest that nocturnal

lemurs navigate complex and changing visual environments. By integrating an awareness of the light environments encountered by different nocturnal species with their color vision abilities, we can better understand the evolution of nocturnal primate color vision. This study was funded by the Wenner-Gren Foundation, the Leakey Foundation, the American Society of Mammalogists, and the American Philosophical Society.

Comparing canopy structure between modern rainforests and Miocene analogue forests using ground-based LiDAR: implications for hominoid locomotion.

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The physical structure of forests is one driving factor behind locomotor adaptations in forest-dwelling animals, including primates. Because it is difficult to reconstruct the past, locomotor adaptations in arboreal primates, both fossil and extant, are interpreted in the context of modern rainforest structure. However, such an approach may obscure the role of forest structure in the adaptive origin of primate morphology. The goal of this study is to compare the physical structure of modern rainforests and ancient Tertiary forests. To accomplish this, we employed a "Tertiary analogue" model using the laurel-dominated forests of the Canary islands, forests similar to those that once covered mainland Europe while it was inhabited by hominoids during the Miocene. We used ground-based LiDAR (light detection and ranging) to make dense measurements of the location of canopy elements and assembled these into high resolution views of structure in three dimensions. Data were collected at rainforest sites containing extant primates in Africa, South America, and Southeast Asia, as well as in the analogue Tertiary laurel forests of Garajonay National Park, Canary Islands. Results indicate clear differences in canopy structure between modern and analogue Tertiary forests. Rainforests are generally taller and exhibit stratified canopies with a dense understory, while laurel-dominated forests exhibit open and undulating, yet tightly-gathered outer canopies, with few understory elements. In light of the structural differences between these forest types, we speculate that the locomotor adaptations of European hominoids could be associated with laurel forests rather than with rainforests of modern aspect.

This work was supported by a NSF Graduate Research Fellowship.

Are gibbons built for mobility?

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Gibbons are highly versatile arboreal apes with a diverse locomotor repertoire including leaping, climbing, brachiation and bipedalism. This contrasts with modern humans, who are highly specialised for bipedalism. We hypothesize that the anatomy of gibbons maximizes mobility and speed, whereas human anatomy favours stability and force production.

The anatomy of gibbons was investigated using various methods, including medical imaging, dissection of fresh cadavers and muscle moment arm (MA) measurements, and was coupled to kinematical data of different locomotor modes collected in a free-ranging, captive environment.

The results indicate that the shoulder, hip and ankle joints have a high intrinsic mobility, which can be linked to the high angular excursions in the sagittal plane of these joints during bipedalism, leaping and brachiation. The shoulder muscles and elbow flexors are characterised by relatively long muscle fibres, providing a wide range of motion, yet are also powerful due to their large PCSA and MAs. The slender hip and knee flexors also have long muscle fibres and large MAs, and seem geared towards stabilisation. Most limb muscles are, however, short-fascicled (with long tendons), but a wide range of motion is facilitated by their relatively large MA. Only the strong wrist flexors have a restricted range of motion, which might indicate an important function in controlling wrist extension.

We conclude that the anatomy of gibbons is indeed geared towards providing maximal mobility, which is of major importance in an arboreal habitat, but this does not come at the expense of stability and force production.

A hominin first metatarsal base from Drimolen, South Africa.

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Numerous studies have focused on the description of the first metatarsal due to its importance in assessing locomotion in early hominins. Here we describe a hominin left first metatarsal base, DNH 115, from Drimolen, South Africa dated from 2.0-1.5 mya. We quantified the morphology of the base

using three-dimensional surface curvatures and compared these with a sample of modern humans, chimpanzees, gorillas, baboons and fossil hominins. The assessment of curvature of this articular surface successfully discriminates between extant taxa and suggests differences in joint mobility. Our statistical analyses indicate that this surface is most curved in chimpanzees and western gorillas, moderately curved in eastern gorillas, and relatively flat in modern humans and baboons. Highly curved surfaces suggest a more mobile hallux, whereas flatter surfaces suggest reduced joint mobility.

DNH 115 groups most closely with SKX 5017, a specimen that has been attributed to *Paranthropus robustus*, and both of these cluster most closely with eastern gorillas. AL-333-54 groups with chimpanzees, while OH 8, STW 573 and STW 562 group with each other, falling intermediate between eastern gorillas and modern humans, SK 1813 and STW 595 group together with modern humans. In total, these results indicate that of the South African fossil hominin first metatarsals, the Drimolen specimen is the most curved, closely resembling eastern gorillas, suggesting that climbing activities may have played an important role in the behavioural repertoire of *Paranthropus*.

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Analysis of mtDNA haplogroup A2 frequency, distribution and diversity among populations from North and Central America and the Caribbean.

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Native American and Amerindian populations belong to one of five major mitochondrial DNA (mtDNA) haplogroups (A2, B2, C1, D4, X2a) associated with the settlement of the Americas from Asia through the Bering Strait more than 20,000 years before present. Haplogroup A2 occurs in its highest frequency in populations across 8,000 miles, from the Northwest Territories of Canada to Mexico and Mesoamerica, around the Caribbean, to the northern and central regions of South America. The geographic range, distribution and lineage diversity of haplogroup A2 could thus be indicative of settlement patterns and subsequent migrations.

In order to infer patterns of settlement and gene flow we extracted, amplified and sequenced the mtDNA control

region of (a) 420 individuals from the Northwest Territories, (b) 150 individuals from southern Mexico, and (c) 250 individuals from eastern Puerto Rico. Haplogroups were determined for each participant and population frequencies were ascertained. Haplogroup A2 lineages were selected from each population and compared to those from twelve populations across the Americas. Eight distinct haplogroup A2 samples were then selected from each of the three geographically distinct populations, and their complete mtDNA genomes sequenced to determine mtDNA sub-haplogroups and infer finer scale patterns of settlement of post-settlement gene flow.

All three regions had a high frequency of the ancestral A2 lineage, but also exhibited geographically-specific lineages that were not shared among populations. This pattern is indicative of a rapid expansion introducing the ancestral A2 lineage across the continents, followed by the acquisition of population-specific mutations in subsequent isolation.

This project was supported by funds from the National Geographic Society and the Research Foundation (JKL) of Binghamton University.

Hounsfield Unit ranges in the CT-scans of bog bodies, cold and warm mummies.

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Mummification processes, either artificial or natural, preserve the tissues from post-mortem decay, but change them from their original state. In this study we provide the first comprehensive set of Hounsfield Unit (HU) ranges specific for tissues mummified under different environmental conditions (bog bodies, Egyptian and frozen mummies). We also analyze the impact of different museal preservation techniques on the HU ranges, as e.g. in the Tollund Man and Grauballe Man bog bodies from Denmark. The mummies were compared with forensic cases, cremated and inhumated ancient human skeletal remains, and fossil animal bones.

Knowledge of the typical HU range for the different tissues in mummies may prevent misinterpretation of increased or reduced radiodensity as evidence well as of paleopathological conditions.

Finally, we demonstrate the practical benefit of using our refined HU ranges by showing the improved results of 3D visualization from automatic segmentation in a cold Inca mummy from Mount Llullaillaco.

Sequence variation of O haplotypes in pre-Columbian Native Americans and its relevance for Native American evolution.

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The majority of Native Americans belong to the O blood group, with regards to the ABO blood group system. This sets them apart from most other populations worldwide. Our previous study suggested that the reduced diversity at the ABO locus among Native Americans predates 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 the frequency of A and B alleles. At the sequence level however, Native Americans present a variety of O haplotypes. Some haplotypes are shared with other human populations (O1 and O1v), some private to a few Native American groups (O05, Ov7, O32 and O33), and one haplotype called "O1v542" which has been found exclusively in populations from Central and South America, and may very well be an ancestry-informative marker associated with all Native Americas groups. To further address this, we sequenced O haplotypes from modern North American populations from Alaska (including samples from Athabaskan and Inuit individuals), as well as ancient DNA samples 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. If this allele proves to be wide spread in North America as it is in Central and South America, it may have originated prior to the entry of humans in to the Americas, consistent with the Beringian Incubation Model.

Paleopathology and extended care in a Bronze Age population: interpretations of severe expression of disease.

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The archaeological site of Tell Abraq is located in the UAE on the Persian Gulf. The commingled tomb (used between 2200-2000 BC) yielded an MNI of 286 adults. From those, 6 cases of severe expressions of pathology were chosen to do an extended analysis. Using differential diagnosis and clinical literature, qualitative aspects of life history were analyzed. As farmers and mariners, members of the community were dependent on good health to maintain a life-line of sustenance for themselves and each other. Their pathologies, however, suggest that they were in need of support from others during times of illness or injury. These pathologies

include osteoarthritis with eburnation, osteomyelitis, osteochondritis dissecans, partial paralysis, and healed fractures. For each case, severe expressions on bone are interpreted based on current medical notions of disability and pain. Ideas about care and functionality are provided for ailing and injured people using a biocultural model of coping and extended care. For example, severe eburnation on the posterior articular surface combined with osteoarthritis on the anterior portion of the patella suggests limited range of movement and inability to flex the knee. Severe osteomyelitis in the radius and ulna bones would have prohibited use of the arm and would have been painful at the slightest movement. Partial paralysis due to some form of neurological myopathy would have been fatal without extended care in the form of feeding and daily attention to personal hygiene. This research suggests ways of integrating the bioarchaeology of individuals within a community context.

Linking feeding ecology and jaw form in two species of wild orangutans.

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The mechanical properties of foods have long been predicted to influence many aspects of modern human and non-human primate biology, especially dental and mandibular morphology. The existence of a functional and adaptive relationship between jaw morphology, feeding behavior and diet in primates is well accepted among physical anthropologists, yet few studies have quantified the mechanical properties of the foods to support this relationship. Bornean orangutans (*Pongo pygmaeus wurmbii*) have relatively more robust mandibles compared to Sumatran orangutans (*P. abelii*). Here we test the hypothesis that there is a functional relationship between the observed differences in masticatory morphology (i.e., mandibular robusticity) and the mechanical properties of foods consumed by wild Bornean and Sumatran orangutans. Specifically we predict that the diet of the relatively more robust-jawed *P. p. wurmbii* would be more resistant to

fracture and deformation than the diet of *P. abelii*. In support of our prediction, *P. p. wurmbii* masticated several plants tissues that were significantly more resistant to fracture and deformation than those masticated by *P. abelii* (Welch ANOVA, $p < 0.01$), including unripe fruits, inner-bark, and leaves. Bornean orangutans also included a greater percentage of these items in their diets compared to Sumatran orangutans, particularly when ripe fruit availability was low. By integrating data on dietary ecology, food mechanics, and morphology, we can begin to deepen our understanding of the complex relationship between form and function in living and extinct primate species.

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Ecology and economy in the settlements of viking Haithabu and medieval Schleswig: an isotopic perspective.

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The sites of viking Haithabu (9. to 10. century AD) and medieval Schleswig (11. to 12. century AD) form a settlement continuum in an extraordinary ecological system, the estuary of the river Schlei. It is located in the immediate proximity of the main trade routes in southern Jutland during a pivotal time that witnessed the appearance of medieval towns. Performing an economic rise from a small sailor's village to an important trade centre followed by a descent to meaninglessness, both settlements represent interesting research material.

Over 300 human and 350 animal bone samples were analysed for stable light isotopes (carbon, nitrogen, oxygen, sulphur). The basis of the human food web builds up on over 60 species of birds, mammals and fish living in freshwater, brackish, marine and terrestrial habitats. The results reflect the rather complex ecosystem surrounding the estuary. First results on strontium isotopic signatures on human and animal samples ($n = 100$ each) for migratory evidence and identifying traded animals will be shown in comparison to the isotopic data of light elements.

This project will thus provide detailed insights into the social and economic features characteristic for trade centres at a turning point in the development of occidental society, and is based on archaeological bone finds from a comprehensively documented settlement continuum, situated at a prominent, yet ecologically speaking highly complex site.

This study is funded by the German Science Foundation.

A re-evaluation of the power of "standard" measurements in estimating sex and sex-specific ancestry from the innominate and sacrum.

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The goal of this presentation is to demonstrate that new two-dimensional (2D) linear measurements are more powerful than previous "Standards" measurements (Buikstra and Ubelaker 1994) for estimating sex or sex-specific ancestry from the innominate or sacrum. The accurate estimation of biological parameters is critical in physical anthropology and with the advent of new technology and statistical methods it may be time to re-evaluate what we consider necessary standard measurements in our data collection protocol.

A sample of 136 innominates and 163 sacra of European and African American males and females from the Hamann-Todd Collection were utilized to capture three-dimensional landmark data which was then used to extract 2D inter-landmark distances. These new linear measurements were subjected to a forward stepwise discriminant function analysis (FSDFA) to determine the measurements needed for the highest level of accuracy possible for the estimation of sex (2 groups) and ancestry/sex (4 groups).

The FSDFA selected seven innominate measurements producing a 99% cross-validated accuracy (CVA) for sex, and five measurements with an 83% CVA for ancestry/sex estimation. Using only the "Standards" measurements we were able to produce a 93% CVA for sex estimation and a 61.3% CVA for sex/ancestry estimation.

The FSDFA selected six new sacral measurements producing an 89% CVA for sex estimation, and eight measurements with a 65.6% CVA for ancestry/sex estimation. The data collected were unable to reproduce all three sacral "Standards" measurements however, utilizing only anterior length and anterior superior breadth, sex was estimated at 53.4% CVA and 38% CVA for ancestry/sex.

Craniometric data supports a mosaic model of demic and cultural Neolithic diffusion to outlying regions of Europe.

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The extent to which the transition to agriculture in Europe was the result of biological diffusion from the Near East or the adoption of farming practices by indigenous hunter-gatherers is subject to continuing debate. Thus far, archaeological study and the analysis of modern and ancient European DNA have yielded inconclusive results regarding these hypotheses. Here we test these ideas using an extensive craniometric dataset representing 30 hunter-gatherer and farming populations. Pairwise population craniometric distance was compared against temporally-controlled geographic models representing evolutionary hypotheses of biological and cultural transmission. The results show that, following the biological diffusion of Near Eastern farmers into central Europe, two biological lineages were established with limited gene flow between them. Farming communities spread across Europe, while hunter-gather communities located in outlying geographic regions adopted some cultural elements from the farmers. Therefore, the transition to farming in Europe did not involve the complete replacement of indigenous hunter-gather populations despite significant gene flow from the Near East. This study suggests that a mosaic process of biological and cultural diffusion was operating in outlying regions of Europe, thereby reconciling previously conflicting results obtained from genetic and archaeological studies.

Heart treatment in ancient Egyptian mummification.

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Descriptions in the popular and academic literature of the evisceration process, organ treatment, and body cavity treatment, as part of the Egyptian mummification tradition, are derived largely from accounts by Herodotus, Diodorus Siculus, Porphyry, and Plutarch. Our reliance on these normative descriptions obscures the wide range of techniques practiced, impeding the study of geographic, chronological, and socio-political variations in ancient Egyptian mortuary practice and ideology.

This line of inquiry, using detailed paleoanatomical analysis to examine mortuary practices and ideology, is part of ongoing research at the University of Western Ontario, in conjunction with the IMPACT radiological mummy database project. Using published descrip-

tions and primary computed tomography data, this poster focusses on heart treatment in Egyptian mummification, comparing the classical descriptions with patterns apparent in empirical data. These empirical data are drawn from two samples: (1) a literature-based sample of 150 adequately described mummies, and (2) a sample of 7 mummies examined directly using computed tomography.

Retention, removal, and replacement of the heart varies between time periods, sexes, and statuses, and these treatments are discussed in relation to their place in the literature and their radiological appearance. In spite of a high degree of heterogeneity in the Egyptian mummification tradition, researchers continue to focus on modern and classical stereotypes rather than on its rich variability as it evolved across Egypt over the course of more than three millennia. In particular, the dogmatic contention that the heart was nearly universally retained *in situ*, or replaced if accidentally removed, is greatly exaggerated.

Ecological influences on female chimpanzee (*Pan troglodytes schweinfurthii*) gregariousness: a test of the scramble competition hypothesis.

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Feeding competition is potentially the most important cost of grouping for social mammals, especially for females, whose reproductive success is limited mostly by foraging efficiency. Among chimpanzees, females are typically less gregarious than males, presumably due to prohibitively high feeding competition, particularly scramble competition for lactating mothers. However, female sociability varies considerably within and between populations. For example, females from the Ngogo community in Kibale NP, Uganda are highly gregarious relative to other East African sites and exhibit levels of sociability similar to West African females. This raises questions about the balance between the costs and benefits of grouping and how this is influenced ecological and demographic factors. I seek to fill an important gap in our understanding of how ecology influences social behavior by examining ecological costs associated with grouping for anestrus females at Ngogo. The Ngogo site experiences relatively high fruit production with low temporal or seasonal variation and provides a good opportunity to compare behavior under relatively favorable ecological conditions. Group randomization and multiple regression tests from 1362 hours of observation on 26 females demonstrated that variation in gregariousness was not influenced by spatial or temporal variation

in food abundance. Furthermore, I did not find evidence to support the hypothesis that gregariousness is more restricted in lactating females due to greater energetic sensitivity to the costs of scramble feeding competition. These findings demonstrate that reduced costs of feeding competition due to favorable ecological conditions allows for greater female gregariousness and enables females to form strong social bonds.

This study was funded by The Leakey Foundation and Yale University.

Territory size in *Canis lupus*: implications for Neandertal mobility.

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Neandertal settlement patterns have historically been reconstructed with reference to lithic raw material transport distances and faunal indicators of site seasonality. Settlement patterns, however, reflect residential mobility, which is only one component of overall mobility patterns. Given that Neandertals relied heavily on animal protein in the plant food-poor environments of Pleistocene Europe, their home range sizes, and levels of logistical mobility, were likely largely determined by prey abundance and distribution. Here we use data on home range size in the grey wolf (*Canis lupus*) to develop a model that relates prey biomass and climatic variables to home range size in northern latitude social carnivores. Pack size data was combined with average wolf mass values to produce mass-specific territory sizes (in km²kg⁻¹), which in turn allows for the prediction of home range areas for Neandertal groups of varying size. Results indicate that that even at fairly small social group sizes (less than 15-20 individuals) Neandertals likely required and maintained large territories (500-6000 km²), which is consistent with results of studies of lithic raw material procurement patterns. Thus the high mobility costs of predation may have been one constraint acting on maximum Neandertal social group size. Further, as in wolves, high residential mobility was likely required to fully exploit the large territories.

Intra-individual histomorphological and geometric variation in the human femur: a pilot study.

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The femur is perhaps the most highly studied bone histologically, particularly at midshaft. Intra-individual histomorphological and geometric variation within the femur has been less studied.

To elucidate intraindividual femoral variation, the right femur of a single human young adult female was serially sectioned at 10 cm. intervals from the midshaft distally. The femur is derived from the Libben site, a Late Woodland ossuary from northeast Ohio dated to ca. 900 C.E. A second goal of this study was to determine the state of histological preservation in bone from this site. While the organic matrix is highly degraded, when impregnated with epoxy and undecalcified sections prepared, haversian structures are seen to be well preserved. Eight 4 sq. mm. microscopic fields equally spaced around the perimeter of the cortex subjacent to the periosteal surface were examined in each section. All secondary osteons were counted within each field, and osteons per sq. mm. were analyzed. Total cortical and endosteal areas, area moments and polar moment of inertia were calculated at each section. Osteon density increases proximodistally and antero-posteriorly. In all ten sections, the posterior half of the cortex has significantly higher osteon density than the anterior. There is a nonsignificant trend for higher osteon densities in the more distal sections than the more proximal. Osteon density is positively correlated with polar moment of inertia and area moments of inertia. These measures reflect the distribution of bone to resist bending and torsional deformation. Thus, macromorphology must be considered when examining the micromorphology of bone. This research is supported by a grant from the New York Chiropractic College Research Department.

Physical indicators of health in children of Central Mexico.

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Latinos are particularly susceptible to type 2 diabetes, with young children increasingly affected. To provide comparison for a recently completed diabetes and obesity prevention program for Latino children in Springfield, Missouri, I collected data on physical indicators of health in urban and rural locations in Mexico from which the local study group had originated. Greater rates of overweight were expected in the urban population, due to presumed lower frequency of exercise and consumption of a diet higher in fat. The study group consisted of 210 male and female children ranging from 2 to 12 years, approximately half from urban Guadalajara and half from rural Tierranueva. A survey on family health, nutrition, and diet was followed by collection of physical data; presented here are results for body mass index (BMI) and waist circumference.

Twenty-eight percent of children had a BMI above the 85th percentile (considered overweight by the CDC). Thirty-two percent of urban children and 25% of rural children exhibited a BMI above the 85th percentile. While no norms exist for healthy ranges of waist circumference percentiles, based on Hirschler et al's (2007) study, measurements at or above the 75th percentile are considered a cutoff point. As such, 54% of the overall sample was above the 75th percentile. For the urban children, 58% were over the 75th percentile, and 51% of the rural children exceeded this cutoff. This study explores the interplay among various biological and environmental factors and contributes to the body of knowledge about causes and distribution of diabetes. This study was funded by Missouri State University Provost's Futures Incentive Grant.

An intra-cemetery craniometric assessment of biological variation and post-marital residence in the Missouri Late Mississippian.

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The Late Mississippian was a period of significant migration and social reorganization in American prehistory that left biological traces in contemporaneous skeletal remains. We used biodistance and determinant ratio analyses to assess social organization at the Campbell Site, a Late Mississippian Site located in southeast Missouri.

We tested three hypotheses using six craniofacial variables from 61 crania. The first hypothesis tests the assumption that human remains excavated from the northern and western portion of the site represent distinct burial populations, while the second hypothesis assesses the immigrant status of 13 artificially modified female crania from the western portion of the site. The third hypothesis assesses which sex is more variable from the pooled Campbell Site sample by using determinant ratio analysis.

Biodistance analysis was conducted using R-matrix methods. We found no craniometric evidence that the human remains were from distinct burial populations, and both portions of the site experienced approximately equal external gene flow. The artificially cranially modified females are closely related to the females from both the north and west portions of the site, and therefore should be considered as part of the local population, rather than immigrants to the site. Lastly, determinant ratio analysis indicated that females were more variable, which is consistent with greater female mobility and thus male-

based residence patterns such as patri-locality or virilocality. The finding of a homogenous skeletal population with a male-based residence pattern has significant implications for understanding post-Cahokia Mississippian social organization.

Do bonobos live in communities?

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The term "community" when applied to chimpanzees (*Pan troglodytes*) is defined as a multi-male/multi-female, fission-fusion social organization where members form temporary parties that fluctuate in size and composition. The male chimpanzees are philopatric, closely bonded, actively patrol the borders of their home range, and are hostile to unknown males while female chimpanzees disperse from their natal group into a new community near menarche. Once immigrated, the females are required to compete amongst themselves for food by establishing small core area for themselves and their offspring, joining larger parties at times of food abundance or peak fertility.

Bonobos (*Pan paniscus*) are also said to live in "communities" based on several shared characteristics with chimpanzees (multi-male/multi-female, fission-fusion, male philopatry). When analyzing bonobo ranging behavior more closely, however, notable differences between the two species emerge. For this study, we used geographic information systems (GIS) software to track the ranging behavior of 15 female and 6 male bonobos at the Ndeli site within the Lomako Forest Reserve, DRC. We found that, unlike with chimpanzees, females have similar sized home ranges to males (Avg. MCP; females = 92.22 ha, males = 84.63 ha, Avg. 95% fixed kernel; females = 87.49 ha, males = 115.33 ha). Additionally, females were more closely associated with each other (mean Jacob's Index = .251) than were the males (mean Jacob's Index = .0527). These results reflect the female-centric nature of bonobo social groups, suggesting that bonobos live in "cliques" rather than communities.

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The meaning of within population dimorphism for group mobility.

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In order to understand the manner in which selection shaped the locomotor morphology of extinct and extant hominins, the manner in which body size influences the cost of locomotion must be determined. This is particularly true of hominin populations which maintain substantial size dimorphism between the sexes, in addition to hominin species which maintain size dimorphism between different populations. Body size alone may influence the cost of locomotion by increasing overall cost or by changing the speeds at which locomotion is either economical or costly. Here we assessed these influences by measuring the changes in the Cost of Transport (CoT) walking curves of people (N=19, 10 males and 9 females), whom we measured free walking at four different speeds. In our sample, males were significantly bigger than females ($p < 0.01$ for mass, stature, lower limb length, bi-trochanteric breadth and bi-acromial breadth). Males showed a significantly increased metabolic cost of walking at the optimum speed of their CoT curve (27%; $p = 0.06$), but also maintained a significantly faster optimal walking speed (10% faster; $p = 0.04$) (even with the size variables in the model). Most importantly however, males showed increased curvature of their optimal walking curve (38%), suggesting that males (or large individuals in general) receive an increased energetic penalty for walking away from their optimum speed. This means that in populations which show large size dimorphism, we might expect different mobility strategies for large and small individuals.

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A preliminary analysis of post-cranial metrics from the Naton Beach Site, Island of Guam in the Marianas Islands.

CHERIE K. WALTH. SWCA Environmental Consultants.

The Naton Beach collection offers a unique opportunity to better understand the earliest occupants of Guam. The Naton Beach Site includes approximately 170 burials that are associated with the Early and Intermediate Pre-Latte Phases. Only a small number of Pre-Latte individuals have previously been documented. This study focuses on a preliminary examination of the post-cranial metric measurements from the Naton Beach burials and compares the early group to the later Latte population. This data may provide population parameters and elucidate biological relationships between the earlier and later populations of Guam. A sample of 40 Pre-Latte and 40 Latte burials was selected from Naton Beach Site. Standard non-metric techniques using the cranial and pelvic characteristics were

used to determine sex and the means and standard deviations were then calculated for a sample of post-cranial measurements. The post-cranial measurements selected were those that were well represented in both samples. The early burials were poorly preserved thus limiting the measurements available for use. A Student's T-test was used to compare the means from the two groups and found no statistically significant differences between the males and females of the two groups. This may suggest a similarity in population parameters that may also indicate a biological affinity. This hypothesis will be tested using cranial metric and non-metric data upon completion of data collection. The burials from the Naton Beach Site will continue to provide important information on biological relationships between the two populations and help to better understand the peopling of Guam.

Immunocompetence and the hygiene hypothesis.

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Early life infections may shape immune system development. Evidence for this hypothesis comes primarily from allergy epidemiology: children who experience more frequent early life intracellular infections are at lower risk of allergic disease throughout life. Early life intracellular infections may induce a bias toward the T-helper type 1 (Th1) arm of the immune system (and thus away from the Th2 arm, which mediates allergic responses). This responsiveness may have evolved to shape immune responses to the local infectious disease ecology: a Th1 bias may enhance future Th1-mediated responses to intracellular infection, improving immunocompetence. However, an association between early life infectious disease and Th1-mediated responses to pathogens has not been tested. To accomplish this, the Candin skin test for delayed-type hypersensitivity (DTH) was used to evaluate immunocompetence among 288 2-7 year old children in Kilimanjaro, Tanzania. A positive DTH response to Candin indicates competence of Th1-mediated (or cell-mediated) immunity. Controlling for age and sex, three measures of early life immune stimulation were associated with Candin positivity: large family size (>3 other children in the household), OR = 2.20, $p = 0.04$; BCG vaccination (assessed by the presence of a vaccination scar), OR = 3.06, $p = 0.03$; and hospitalization in the first year of life (most of which were reportedly with intracellular infectious diseases), OR = 2.83, $p = 0.08$. Similarly, controlling for age and sex, large family size ($\beta = 1.58$, $p = 0.03$) and BCG vaccination ($\beta = 2.52$, $p = 0.01$) were associated with larger Candin induration size.

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Impact of sutures assessed in a finite element model of a macaque cranium using dynamic simulation.

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The global biomechanical impact of cranial sutures on the face and cranium is not well understood. A recent sensitivity study using linear static finite element analysis (FEA) found that sutures had a minimal effect on global strain patterns in a macaque cranium. However, as viscoelastic structures, the manner in which sutures behave must be modeled under dynamic loading conditions. We test the hypothesis that sutures act as energy absorbers protecting skulls subjected to dynamic loads. This hypothesis predicts that [1] sutures have a significant impact on global patterns of strain and skull stiffness when analyzed using dynamic simulations, and [2] this global impact is influenced by suture material properties. A macaque FE model was created and analyzed using five different sets of suture material properties in both static and dynamic simulations of premolar biting. The static and dynamic analyses produced similar results in terms of strain patterns and reaction forces, indicating that sutures play a limited role in modulating global skull mechanics, regardless of loading design. Sutures did not absorb significant amounts of energy during dynamic simulations, regardless of loading speed. These findings are inconsistent with the functional hypothesis tested here. As an alternative, we hypothesize that sutures are mechanically significant only insofar as they are weak points on the cranium that must be shielded from unduly high stresses so as not to disrupt vitally important growth processes.

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Regional isolation and extinction? The story of mid-Pleistocene hominins in Asia.

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Over the past decade, numerous reviews of the Middle Pleistocene record have taken place in light of new fossil discoveries. However, with primary foci on the Euro-African records, much of the rich fossil evidence in Asia was sidelined and overlooked. It is thus unsurprising that in the minds of many, Asia remains *terra incognita*—and its hominin record exotic. Moreover, the accuracy of the Asian chronology remains problematic, adding another layer of impediment to our understanding of regional evolution and local adaptation.

In this context, I bring a synergistic review of the chronology of mid-Pleistocene hominins from East and South Asia, including recent new dates from key sites such as Zhoukoudian Locality 1 and Hathnora. Using 3-D geometric morphometric data, I examine cranial shape changes between *H. erectus* and mPH (post-*erectus*, non-Neandertal mid-Pleistocene *Homo*), as well as both to later Pleistocene hominins. A large number of not-often-discussed specimens are considered (e.g., Hexian, Nanjing 1, Maba, and Ngawi), many of them original fossils.

The cranial anatomy from the Asian mid-Pleistocene suggests the existence of at least two distinctive groups in the region. Additionally, a north-south (geographical) shape difference is observed, hinting the presence of paleodemes each evolving in relative isolation. The shape affinity of mPH to extra-Asian fossils is confirmed; however, depending on the fossil in question (Dali or Narmada), the said affinity to Kabwe and Petralona is exclusive. This, coupled with a limited number of good sample, warrants caution against lumping all Asian mPH within the *H. heidelbergensis* hypodigm.

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A new hominin pelvis and femur from Koobi Fora, Kenya.

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In 1980, a small femoral shaft fragment, KNM-ER 5881, was found in Area 105 at Koobi Fora. In 2009, The Koobi Fora Research Project recovered the proximal portion of the same femur, and an associated partial ilium from the opposite side. This specimen derives from the Upper Burgi Member, not far below the KBS tuff, and so is dated to

about 1.88 Ma. KNM-ER 5881 now represents the earliest known associated pelvis and femur from Koobi Fora.

The only other hominin pelvis from below the KBS Tuff at Koobi Fora is KNM-ER 3228 (1.95 Ma), generally attributed to *Homo*. Even though the KNM-ER 5881 bones are incomplete, new non-landmark based morphometric techniques using laser scan data enable meaningful quantification and comparison of morphology. KNM-ER 5881 is smaller than KNM-ER 3228, and has a broader sciatic notch. These specimens do not exceed the size range expected from a male and female of a single species, albeit a dimorphic one. Morphologically they are similar, resembling other *Homo* specimens and differing from australopiths, with a thick iliac body, concave iliac fossa, a sinusoidal anterior iliac border and a small but distinct iliac pillar. KNM-ER 5881 also has a small best-fit scaled radius of curvature of the pelvic brim. The femur also conforms to a typical *Homo* pattern, with a large head, anteroposteriorly thick neck, and a neck length similar to other Koobi Fora femora. These associated elements provide new data on the evolution of a *Homo*-like hip and pelvis in the early Pleistocene.

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Excavation of coffins from an underwater environment and embedded in a root mass.

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In 2005, skeletal remains were found on Deadman's Island, Florida. During an official search of the area, a hexagonal shaped root mass was observed floating in the intertidal zone. Nearby, more coffin shaped anomalies were located, which appeared to have been displaced by erosion from recent hurricanes. These anomalies were covered in a thick mass of dark roots and sediment and appeared to be coffin lids or bases. However, hospital radiography confirmed that they were not coffin lids but were collapsed coffins containing skeletal material. Excavations were performed on the coffins to determine how the combination of extreme root activity and water exposure affected the decomposition of human remains.

Forensic and terrestrial archaeological field methods were used to expose and document the condition of the decedents. This process involved building a pool to keep the remains wet during excavation and carefully removing the roots and sedi-

ment one centimeter at a time to prevent damage to the fragile remains. This presentation will document the recovery methods required to remove the skeletal material and artifacts from the root mass. The process revealed that although few bones remained intact, a solid mass of small roots defined their location and position. The mass of black roots was all that kept the coffins intact and held the hexagonal shape since most of the wood had decayed. This unusual case will provide insight into the damage that extended exposure to a water environment and roots can do to human remains.

Ancient bitumen use and polycyclic aromatic hydrocarbons exposure: a potential factor in the health decline of prehistoric California Indians.

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Polycyclic Aromatic Hydrocarbons (PAHs) are the main component of bitumen, a material used by human societies since ancient times. The negative health effects of PAHs are well-known for modern human populations, but have not yet been studied for prehistoric groups. This paper investigates the potential health impacts of PAHs in the prehistoric Chumash Indians of California's Santa Barbara Channel region, one of the world's most prolific regions of natural hydrocarbon seepage. Our analysis of raw bitumen from this region identified numerous toxic compounds, which corroborates previous research indicating that PAHs have compromised the health of marine life in the area. Archaeological evidence show that the Chumash used bitumen as adhesive, medicine, and waterproofing-agent, suggesting they were subjected to multiple PAH uptake pathways, including direct contact, oral uptake, and fume inhalation. As bitumen use and consumption of PAH-contaminated fish increased over time, so would have PAH exposure. Our measurements of excavated skeletons from prehistoric Channel Island cemeteries show decreasing cranial size and stature over 7,000 years. Given previous research showing that PAH uptake is related to decreased head circumference and birth length in infants, it seems plausible that increasing PAH uptake contributed to the size decrease in prehistoric Channel Islands populations.

A comparison of activity budgets in two captive white-handed gibbon groups.

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We investigate the effect of zoo habitat complexity on activity budgets of white-handed gibbons housed at two northern California zoos. The Oakland Zoo gibbon habitat is twice as large as and more complex than the Sacramento Zoo habitat. Therefore, we expected the Oakland gibbons to travel more and rest less than the Sacramento gibbons.

Each exhibit housed one male-female pair of gibbons. Data were collected using instantaneous scan sampling at 30-second intervals for 15 hours at each zoo in the spring of 2010, resulting in ~3400 observations per site. Comparisons of activity budgets were made between the individuals within each zoo as well as between the groups at the two zoos.

The females of each zoo pair feed more and travel less than do the males. Both male and female Sacramento gibbons feed twice as much as do their Oakland counterparts. The frequency of resting by males at both zoos is similar. The frequency of travel by females at both zoos is the same, but the Sacramento female rests more than does the Oakland female. The Sacramento gibbons feed, rest and autogroom more, but travel and interact socially less than do Oakland gibbons.

We conjecture that Sacramento gibbons autogroom more than do Oakland gibbons due to their fewer social interactions. As expected, Oakland gibbons travel more than do Sacramento gibbons, presumably because they have more space. Activity budgets at the larger more complex Oakland Zoo are more similar to those of wild gibbons. This has implications for zoo management practices.

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Relating pelvic shape to hip abductor mechanics and locomotor cost.

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The adoption of habitual bipedalism required major alterations in hominin pelvic shape, particularly the recruitment of the minor gluteal muscles as hip stabilizers during the single leg support phase of locomotion. Based on a static model of hip abductor mechanics, previous analyses have disagreed sharply regarding the effect of variation in pelvic width on hip abductor mechanics and locomotor cost in extinct hominins and living humans. This study examines the effect of pelvic width on hip abductor mechanics during locomotion and measures the direct contribution of the hip abductors to locomotor

energetic cost. Gait, oxygen consumption, and anatomical data from full lower body MRIs was obtained from 28 individuals who gave informed consent. The results indicate that skeletal measures alone (femoral neck length and biacetabular width) are poor predictors of hip abductor mechanics primarily because of fluctuations in the mediolateral component of ground reaction force over the course of stance phase. However, the hip abductors account for a significant portion of total lower limb force production and active muscle volume during walking and running, and the addition of hip abductor active muscle volume to a model predicting locomotor cost increases explained variance. Lower limb mechanics do not differ between males and females at any joint when adjusted for body weight. These results call into question the effectiveness of using skeletal dimensions to predict hip abductor mechanics in extinct hominins, and the assumption that a tradeoff exists between locomotion and parturition in females.

This study was supported by grants from the National Science Foundation BCS-0850841, The Leakey Foundation and The Wenner-Gren Foundation.

Phytoestrogens in the primate diet: insight from the red colobus monkey and mountain gorilla.

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Naturally occurring estrogen-mimicking compounds (i.e., phytoestrogens) are found in over 300 plant species, including human leguminous foods (e.g., soy). Consequently, much medical research has focused on the influence of phytoestrogen consumption on human health and reproduction, including studies of captive primates. Despite this interest, very little is known about the occurrence of phytoestrogens in the dietary items of wild primates. To address this, we investigated the prevalence of estrogenic plant species in the diets of endangered red colobus monkeys (*Procolobus rufomitratus*) of Kibale National Park and mountain gorillas (*Gorilla beringei*) of Bwindi National Park, both in Uganda. To determine the composition of their diets, we collected 1327 hours of behavioral observations on one red colobus group and 1318 hours on one gorilla group. To determine if any

foods had estrogenic activity, we screened 68 plant items comprising 79.7% of the annual diet of red colobus monkeys and 53 plant items comprising 85.2% of the annual diet of mountain gorillas using transient transfection assays. At least 10.8% of the red colobus diet and 8.8% of the gorilla diet were found to have estrogenic activity, mainly from three staple foods (i.e., > 1% of annual diet) eaten by the red colobus and one staple food eaten by mountain gorillas. All estrogenic plants in this study exhibited estrogen receptor subtype selectivity. These results show that phytoestrogens are regularly consumed by two wild primate species and may have important implications for primate reproductive ecology and human evolutionary biology, including reduced fertility and cancer prevention. This study was funded by the National Science Foundation, International Primatological Society, University of California-Berkeley Center for African Studies, and Chang-Lin Tien Scholars Program.

Decrease in hunting by chimpanzees in response to over-harvesting of red colobus monkeys at Ngogo, Kibale National Park, Uganda.

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Chimpanzees prey on a range of vertebrate species and preferentially hunt red colobus monkeys wherever the two taxa are sympatric. But chimpanzees have overwhelmingly plant-based diets and are not obligate carnivores; thus offtake of red colobus can apparently be sustainable even when substantial, and predator-prey cycles are unlikely. Predation pressure on red colobus by the extremely large chimpanzee community at Ngogo, Kibale National Park, Uganda, has been unusually high. Previous research has shown that offtake was unsustainable and that the local red colobus population has substantially declined. We use data on prey encounters and hunts, collected over a 16-year period, to test the hypotheses that increases in search time have led to a decline in the frequency of red colobus hunts; that relatively high predation intensity in one year has a negative feedback effect on predation in the subsequent year, which allows some population recovery; and that the chimpanzees have switched to more reliance on alternative prey. We show that over time, red colobus encounter rates have substantially declined and that encounters have occurred proportionately more often in the territory periphery; this has

increased the costs of hunting and has been associated with a substantial decrease in hunting. Some evidence for negative feedback and for prey switching exists. However, overall hunting frequency has declined, presumably because capture probabilities, thus expected returns, for other prey are considerably lower than for red colobus, and no evidence yet exists that the red colobus population is recovering. This study was funded by NSF Grants SBR-9253590, BCS-0215622, and IOB-0516644; The L.S.B. Leakey Foundation; The Wenner Gren Foundation for Anthropological Research; The National Geographic Society; Primate Conservation Inc.; and Yale University.

Sexual dimorphism of the greater sciatic notch in a circumpolar population.

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Human skeletal dimorphism and eco-geographic patterning are frequent topics of interest among physical anthropologists. Understanding both inter- and intra-population differences between the sexes can provide diagnostic information on modern skeletal material and create foundations for interpreting paleontological discoveries. The pelvis is cited as the primary region for assigning sex and the greater sciatic notch (GSN), a dimorphic feature that is well-preserved in the archaeological record, is therefore useful in sexing remains that have deteriorated due to taphonomic processes.

Previous research has established that circumpolar and temperate populations differ significantly in bi-iliac breadth, a proxy for body width. While there is a wealth of data on cold-adapted body proportions, there is insufficient research on specific features of the pelvis or circumpolar intra-population sex differences. This study compares GSN metric dimensions between a circumpolar and temperate population, to explore the range of eco-geographic variation in sexual dimorphism.

Left os coxae from Terry Black (male $n=49$, female $n=50$) and archaeological Native Alaskan (male $n=54$, female $n=51$) samples were selected for assessment. Native Alaskans exhibited significantly wider GSNs than Terry Blacks as a population ($p=0.0008$). They also displayed less symmetric GSNs, an indicator of "maleness", as compared to Terry Blacks ($p<0.0001$) as well as by sex across populations (males $p=0.0002$, females $p=0.0010$). These results indicate that wide GSNs are not inherently feminine, and climactic adaptations may affect proportions of dimorphic pelvic features.

Did a short-term event in the Middle Pleistocene give rise to modern humans?

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It is often stated that modern humans originated 250,000-150,000 years ago. This statement implies, at least implicitly, that something "special" happened at this point in the Middle Pleistocene, such as a speciation event that was perhaps triggered by, or resulted in, a bottleneck in human population size. Two pieces of evidence are usually said to support this contention: that living human mitochondrial DNA haplotypes coalesce ~200,000 years ago, and that fossil specimens classified as anatomically modern humans begin to appear shortly afterward. Alternatively, modern human origins could have been a lengthy process that lasted from the divergence of the modern human and Neandertal evolutionary lineages ~400,000 years ago to the expansion of modern humans out of Africa ~50,000 years ago, and nothing particularly "special" happened 250,000-150,000 years ago. Because this alternative model does not posit a discrete origins event, it may be better able to explain why >50,000-year-old fossils are arguably only "near modern" in anatomy. Here I use computer simulations based on theory from population and quantitative genetics to show that the alternative lengthy-process model also is consistent with a ~200,000-year-old mitochondrial DNA coalescence time and the appearance shortly afterward of fossil specimens that, at least for some traits, appear to be anatomically modern. I further discuss how these two models differ in their predictions and whether or not it is possible to distinguish between them with current fossil and genetic evidence.

Bipedalism: practice and experience in carrying a heavy unilateral load.

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To clarify unexpected results in a previous study, a new study was performed to analyze the effects of both short-term practice and lifetime experience on carrying a heavy, unilateral load. While some new results affirmed our original expectations, other results suggested that our accommodations to the load include techniques not previously observed.

Fifteen subjects walked on paper runners while wearing paint-soaked socks, first with an empty canvas bag, then three times with 21% of body weight in the bag. This set of trials was followed by several minutes of practice, then

another set of four trials. The footprint trails produced were analyzed for foot angle, step length, step width and distance from the edge of the paper.

Earlier work showed inconsistent results with regard to narrowing step width while carrying a heavy unilateral load. Our research showed that both practice and experience increased subject's tendencies to narrow step width to balance the load. New results also suggest that those with more lifetime experience meander less than those with less experience, but the effect is more pronounced in the foot opposite the load. Experience was also correlated with step length, such that those with very little experience showed shorter steps. Variation in step length also seemed to be affected by practice and experience, with short-term practice leading to a pattern of greater variation on the loaded-side foot than on the free-side foot, while lifetime experience seemed to exaggerate the difference between sides.

Mechanical and safety implications are also discussed.

Diet and mobility in the Nasca region, Peru: carbon and nitrogen isotopic analysis of archaeological hair and bone.

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The extreme topography of the Andean region results in relatively short traveling distances among isotopically and ecologically distinct production zones. Isotopic reconstruction of long-term diets and short-term dietary shifting can therefore be used to investigate individual patterns of mobility. Here, we reconstruct the temporal sequence of change in carbon and nitrogen isotopic compositions ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) along each hair sample ($n=18$) from individuals buried at Cahuachi and near Huaca del Loro in the Nasca region. These data on short-term diets are compared with long-term dietary data as indicated by bone ($n=8$) in order to explore palaeomobility and food acquisition practices among the ancient Nasca (AD100-1000). We hypothesized that it would be possible to differentiate between patterns of dietary shifting consistent with seasonally changing diet, and the exploitation of multiple production zones through mobility.

Each dataset demonstrates the complex interaction between Nasca food acquisition and palaeomobility, and together provide insight into the relationships among the Nasca and their physical and social landscapes. Paired tissues and sequential analysis of hair have revealed three major trends in the isotopic data: (1) longer, (semi-) permanent changes in residence, (2) local mobility,

and (3) stable or seasonal dietary shifting. Potential motivations, including social, economic and environmental impetuses, for these patterns of mobility will be explored. The isotopic data presented here suggest that mobility played an important role in Nasca subsistence practices, and was likely an integral part of the Nasca social landscape.

Natural experiments: suture obliteration in familial lines.

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Natural experiments including the analysis of inherited or mechanically induced cranial deformations shed light upon how we interpret cranial shape differences throughout human evolution. The literature surrounding the genetic origins of craniosynostosis, or craniostenosis, identifies the possibility of inheriting the condition via autosomal homozygous recessive or heterozygous/homozygous dominant means. We present a skeletal case from the District 17 Medical Examiner's Office of Broward County, FL, that provides insight into the relationship between craniosynostosis and genetic inheritance. This case is unique because it involves three maternally related females, a 27 year-old female and her two daughters (ages six and eight years), that evidenced premature suture fusion.

We visually examined and radiographed each cranium paying close attention to the coronal, metopic, sagittal, lambdoidal, incisive, anterior median palatine, transverse palatine, and posterior palatine sutures. The youngest child displayed scaphocephaly or premature obliteration of the sagittal suture as did her mother. The eldest daughter, from a different paternal lineage, did not present with the condition; although, she manifested an accessory sutural bone that was identical to her mother.

Our analysis of a modern natural experiment involving three maternally related young females helps to validate heuristic arguments which support the theory that cranial structure and rate of fusion may be driven by genetic factors, while minimizing the role of environmental stresses and mechanical forces in cranial formation.

Detecting a possible historical epidemic.

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In 1993, Shiloh Methodist Church Cemetery excavations yielded burials in

three rows, one row perpendicular to the others. Exhumed from this row were 11 young, African-Americans. Their position in the cemetery could indicate something about their status or the circumstances of their deaths or their status. It is hypothesized that these individuals perhaps died close from one of the epidemics known to have swept across Missouri during the 1800's.

Few methods to determine the exact year in which a historical burial took place are available, but dental cementum increment analysis at least has the potential to indicate whether all of the Shiloh individuals died within the same season. For this study, one tooth from each of the 11 burials was embedded in Buehler EpoKwik Resin under vacuum pressure. The embedded teeth were then sectioned with a Buehler low speed saw to create 300 micron thick wafers. The wafers were each mounted to a petrographic glass slide and ground to a thickness of 100 microns, polished, and viewed under an Olympus BX-41 transmitted polarized light microscope. Digital micrographs were captured using an Olympus DP70 digital camera. The outermost cementum was recorded for a majority of the teeth. The viable teeth all exhibited the same type of outer increment – a light band, indicating a spring/summer death.

Can mobility patterns be revealed through enthesopathies?

ELIZABETH WEISS. Department of Anthropology, San Jose State University.

Use of fibrous entheses to reconstruct mobility has met with difficulties due to biological confounds, but fibrocartilaginous enthesopathies may prove useful in activity reconstructions. If lower limb enthesopathies reflect mobility, then confounds with body mass should be absent, upper limbs should have more asymmetry, and proximal-distal patterns should differ between upper and lower limbs.

The present study uses 8 upper limb and 7 lower limb fibrocartilaginous enthesopathies from a sample of 105 adult prehistoric hunter-gatherer California Amerinds to determine whether enthesopathies may be utilized in mobility reconstructions. Enthesopathies are gathered using the 3-scale rating method proposed by Villotte (2006). Additionally, femoral head diameters are gathered to calculate body mass using Grine and colleagues' (1995) formula. Age and sex are determined through pelvic, cranial, and dental morphology. Individuals with DISH are excluded. All data are analyzed for statistical significance using non-parametric tests.

Only, the right ulnar *triceps brachii* insertion correlates positively with body mass ($r = 0.255$; $P = 0.004$). Asymmetry analyses reveal significant differences

between left and right upper limb sites of the *teres major* ($Z = -2.070$; $P < 0.05$), *subscapularis* ($Z = -2.070$; $P < 0.05$), and the common extensor origin ($Z = -2.496$; $P < 0.05$). No significant differences appear in lower limb sites. Significant correlations occur between most upper limb proximal and distal elements (r average = 0.404, $P < 0.01$). No significant correlations are found in proximal and distal lower limb enthesopathies. Results suggest fibrocartilaginous enthesopathies may be useful in reconstructing mobility patterns.

Who is 'informed' in informed consent?

KENNETH M. WEISS. Department of Anthropology, Penn State University.

'Informed consent' is easy to agree with. But it is far less easy to know what it means. It is the rare study in which the issues are unambiguous. Perhaps most troubling is that the ambiguity involves the investigators as much as the subjects of a study. There need be no dishonesty or ill intent, just the complexity of studies, the complexity of nature, and the complexity of perception by both parties. Informed consent is especially problematic in genetics, where the correlation between DNA sequence and ancestry or functional inference is often weak or unknown, data on study subjects reveal aspects of their relatives, and future developments of DNA-manipulation technologies cannot be predicted. Some now advocate blanket consent as the truest meaning of 'informed', but that is unlikely to work well, because no one can know what is actually being agreed to. Grievances can arise even decades later. If anyone should be aware that such agreements involve stated as well as unstated meanings, anthropologists should. But the drive for data, inconvenience at honoring even sincerely offered promises, and vested interests of both parties undermine notions of being 'informed'. How these issues should be resolved is important topic, but may have no satisfactory answers.

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A morphogenetic model of cranial interosseous suture formation.

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The complex and highly variable shape of interosseous sutures has since long attracted the interest of anthropologists. Cranial sutures are important bone growth sites mediating cranial vault expansion, and they are thought to act as strain dissipators. Various models have been proposed to explain suture formation, and methods of fractal geometry have been used to characterize their shape. Currently available mor-

phogenetic models capture local aspects of suture formation, while global aspects remain unexplored. On the other hand, fractal dimensions only measure overall properties of suture lines, while local non-fractal properties remain unexplored.

Here we build upon standard concepts of physical interface growth to develop a new model of sutural morphogenesis, which takes into account sutural tissue mechanics and proposes bone strain gradients as major factor governing growth. We also present new morphometric methods to quantify sutural morphology in a multivariate shape space. Computer simulations of our model system produce interface morphologies which closely replicate local and global features of natural interosseous sutures. Also, patterns of sutural shape variation in an ontogenetic modern human sample coincide with ontogenetic trajectories of sutures developing "in silico". Our results identify three main sources of sutural morphological variation: variation in developmental rates along a common morphogenetic trajectory, variation in sutural tissue viscosity, and variation in response characteristics of sutural tissue to bone strain.

Comparison of gape morphology between primates and phalangeroid marsupials.

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Recently, parallels between phalangeroid marsupials and primates have been suggested with regard to morphology. Given that some species in each group consume similar diets, and that gape is potentially related to food characteristics, it is expected that we might see parallel cranial characteristics related to gape in these two mammalian groups.

Ten species of primates and nine species of marsupials were studied. First caliper measurements were taken of morphological features hypothesized to be related to gape. Each skull was photographed in a position representing maximum osteological gape. As the jaws are opened, this is the position just prior to loss of articular contact between the glenoid fossa and the mandibular condyle. From the photographs, measurements were taken of gape angle and linear gape (prosthion to the anterior edge of the mandible).

Primates consistently conformed to hypotheses more than marsupials. Some patterns are common to both groups. Gape angle increases with maxilla length and head size. Linear gape increases with skull size in primates ($R^2=0.967$) and to a lesser degree in marsupials ($R^2=0.529$); this suggests that factors other than size strongly influence gape limitations in marsupials. In both groups, folivores have

small linear gape and condyle height for their skull size, and gummivores have low condyles relative to skull size. *Daubentonia* and *Dactylopsia* displayed a greater linear gape and lower condyle than predicted for their skull size. These results offer insight into the relationships between skull morphological features and gape and the convergence of primates and phalangeroid marsupials.

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Guild shift: a unique and defining characteristic of hominin evolution.

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The hominin lineage is nearly unique among mammals in having shifted from fulfilling only a minute part of its protein requirements with animals to utilizing a significant amount of animal protein. Such an ecological trajectory in mammals has otherwise only been seen in two marsupial lineages: the thylacoleonids (marsupial lions) and propleopine kangaroos. The hominin guild shift has been extensively studied by archaeologists and anthropologists on the basis mainly of material culture and the traces of its use. This research has highlighted a number of behavioral, ecological, and physiological consequences of the shift. However, only limited attention has been paid to the top down macroecological effects on the carnivore guild, the mammal communities, and the ecosystem as a whole. We have previously emphasized the significant drop in carnivore species richness coincident with advent of derived stone tools (derived Oldowan/early Acheulean) after 2 million years ago. Here we will consider consequences to the carnivore guilds of the African Plio-Pleistocene through analysis of 16 craniodental variables reflecting the morphospace of the feeding apparatus. The analyses will be evaluated in terms of functional richness (size of morphospace) and functional evenness (distribution of taxa in morphospace). We will also explore whether the hominin disruption of the carnivore guild engendered a trophic cascade throughout the eastern African ecosystems of the early Pleistocene.

Femoral shape and terrestrial logistic mobility patterns.

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Femur diaphyseal shape is commonly used to interpret levels of terrestrial logistic mobility (TLM) in human populations. However, since femoral shape is

not size standardized, variation in it can be influenced by activity (including TLM), differences in body physique (especially body breadth), growth and development patterns, terrain type, and other factors. Therefore, similarly shaped femora can occur in populations with different levels of TLM. In this study, I investigate the influence of habitual activity, body size, and growth and development patterns on femoral shape. I do this by examining temporal trends in Native American and modern US populations, comparing diaphyseal shape between mobile and immobile individuals, and examining patterns of growth and development in femoral shape using American populations. I also investigate if using multiple biomechanical properties and multiple bones can provide a clearer picture of the pattern of activity obtained from long bone morphology. Results indicate that femoral shape is established early in life, femoral ML (but not AP) bending strength is influenced by lean body mass and body breadth, reduced mobility primarily affects ML strength, and the use of multiple properties provides a more realistic pattern of habitual activity. Examples from Native American populations and individuals such as Kennewick Man are provided to demonstrate the advantage of using multivariate analyses. While the assessment of variation in femoral shape is a valuable tool for reconstructing mobility, investigators should consider standardizing by body breadth, using multiple biomechanical properties, and examining multiple bones when interpreting mobility from long bone morphology.

Tourism in Suriname: do monkeys view tourists as predators or conspecifics?

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Nonhuman primate populations are in decline in many parts of the world. One reason for this decline is that primate conservation often clashes with the economic needs of people living in host countries. What can be done to provide for people while still protecting natural resources? Ecotourism is commonly promoted as a potential solution, but the impact of tourism on primate populations is seldom investigated. We present data comparing two field sites and multiple species of monkey in Suriname. The two sites are characterized by differences in species composition, habitat, and level of tourism. Preliminary results indicate that different species of monkey exhibit different coping mechanisms to tourist activities at the two sites. Certain species of monkey, including spider monkeys, bearded sakis, tamarins, and wedge-cap capuchins, espe-

cially in the Central Suriname Nature Reserve, seem to view tourists as potential predators and respond with alarm calls and fleeing. Other species, including brown capuchins and howler monkeys exhibit much milder responses to tourists. Red howler monkeys in more remote areas of the Brownsberg Nature Park exhibit a different pattern from the rest, occasionally responding to humans as if threatened by conspecifics. Preliminary comparisons of habitat and tourism aspects between the two sites will be explored as potential influences on monkey response. Results will contribute to our understanding of how nonhuman primates respond to human actions, and have important implications for conservation and tourism programs in tropical forests. This research 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.

Population history at the micro-scale: craniometrics of Cayo Santiago macaques.

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Several methods have been developed to infer relatedness among human or other primate populations using metric data. Of these, R-matrix methods have typically been used to approach questions of population history on global or regional scales with a time depth of tens to thousands of generations. Applications to non-human primate data are also rare.

This study uses detailed genealogical and demographic information for rhesus macaques born over four decades on Cayo Santiago along with individually matched cranial measurements. We evaluated the ability of craniometric data to recover two important patterns expected from the demographic records: individuals born in more distant time periods are less similar to each other, social groups that arose from the fissioning of a parent group will be more similar to each other than to other social groups.

Craniometric data are consistent with both expectations from the demographic data. Further research is needed to refine and test predictions about patterns in the craniometric data and relate them to larger questions of primate socioecology. Of particular interest are the influence of group fissioning along matriline boundaries and the role of male-mediated gene flow, perhaps with matriline-biased mating, among social groups.

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of Puerto Rico and National Institutes of Health (NIH).

Functions of male and female bonobo loud calls in inter and intra community interactions.

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Data on frequencies, context, and location of vocalizations were recorded for wild bonobos, *Pan paniscus*, at the Lomako Forest study site in the Democratic Republic of the Congo from 1983 to 2009. Location relative to the edge of the community range was determined by GPS for 642 calls, including 393 loud calls (88 by focal females and 47 by focal males). Loud calls differed from other vocalizations in being more common towards the periphery of the community range ($G = 32.2773$, $p < 0.001$). The frequency of loud calls by male and female focal animals differed in location ($G = 104.036$, $p < 0.001$). Females called more in the center of the range whereas loud calls by male focal animals were only observed on the edges of the community range. Both males and females participated in loud calls used for inter-party communication within the community. Calling and response rates by both males and females were higher during party fusion than party fission ($G = 6.106$, $p < 0.05$) and were common at evening nesting. Calling and party fission were also common at food patches. Calling, followed by fusion, was more frequent when a small party called from large patches. We conclude that bonobo females and males may use loud calls to bring others to large food patches but differ in that loud calling by males is important in inter-community communication.

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Evidence of violent conflict in males from Pot Creek Pueblo.

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Skeletal evidence of violence in the American Southwest is well known and both healed and peri-mortem trauma has been reported at many sites, including high rates of cranial injury supporting evidence of warfare. The present study examines the peri-mortem skeletal injuries in three young males, aged 18-22 years-at-death, from Pot Creek Pueblo (AD 1260-1320) located in the Taos Valley. Of the 88 Pot Creek Pueblo individuals analyzed, peri-mortem trauma only occurred in these three males, although healed ante-mortem injuries were present in several other

individuals. CT scans of the skulls provided an additional method of analysis of the injuries and data necessary to differentiate peri-mortem trauma from post-mortem damage in one case. The pattern of peri-mortem blunt force and chopping force trauma to the skulls and post-cranial remains suggests hand-to-hand combat occurred and these individuals died from chopping trauma to the skull possibly from warfare related activities.

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It's all in your head: heat related deformation and color change in frontal bones at Bab edh-Dhra'.

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Heat related deformations, such as warping, delamination, deformative fractures, and bone color can be used to determine whether bones were burned in a wet versus dry state. This study investigated frontal bones from charnel house A22 from the Early Bronze Age (2950-2200 BC) site of Bab edh-Dhra', Jordan. It was hypothesized that skulls would exhibit few deformations, as archaeological records indicated that fire was not a part of the site's mortuary tradition, despite the extensive burning seen in bones from the tomb. Additionally, this study hypothesized that deformations would occur more frequently with gray and white bones (colors indicating that the bone was exposed to high heat). The presence of warping, delamination, and deformative fracturing was assessed on three different landmarks (midpoint of the supraorbital tori, frontal eminence and mid-coronal suture) on 122 frontal bones. Color was also assessed with both the Munsell Color system and by using a spectrophotometer. Delamination was only found on one of 77 supraorbital tori (1.3%), while warping was found as high as 10.8% (9/83) and fracturing was as high as 12.0% (9/75). Specimens from the right side were analyzed and showed no difference among the frontal regions for warping ($p=0.41$), delamination ($p=1$), or deformative fracturing ($p=0.17$). Finally, preliminary analysis suggested deformative features appeared more often on calcined bone. The lack of directional burning in addition to a comparison of other known archaeological and forensic sites indicated that the bones were burnt in a dry state.

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Chemical communication without a vomeronasal organ: parallel evolution in primates and birds?

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Many studies of chemical communication in vertebrates focus on non-volatile compounds primarily detected by the vomeronasal organ (VNO) and accessory olfactory bulb. Adult Old World monkeys and apes lack these structures, and thus are generally assumed to have a reduced reliance on chemical communication. However, volatile compounds, which are primarily detected by the main olfactory system, may also play an important role in communication.

Birds, like these primate taxa, have no VNO as well as a small olfactory bulb, and are thought to have reduced olfactory capabilities and thus to rely on visual and vocal communication. Recent studies suggest chemical communication may play a role in avian social and reproductive behavior. Chemical, behavioral, and genetic evidence suggests that songbirds send and receive chemical cues. Volatile compounds present in preen oil, a substance secreted from the uropygial gland and used in feather grooming, contain information about species, sex, population, individual identity, and reproductive condition. Dark-eyed juncos (*Junco hyemalis*) can distinguish among preen oil odors from different species, sexes, and populations, and these odors affect behavior in the field. Finally, the recently sequenced junco transcriptome shows hundreds of transcribed olfactory receptor genes.

These data from birds suggest that the absence of a VNO does not necessarily indicate an absence of chemical communication. Instead, taxa like birds, Old World monkeys and apes may use volatile chemical signals and the main olfactory system. Birds may serve as a useful comparative group for studying chemical communication in primate species without a VNO.

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Minerals in the fruit and seed diet of the Tana River mangabey (*Cercocebus galerritus*) of Kenya.

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Minerals in primate foods can play an important role in food choice and habitat quality, yet few data exist, especially for fruits and seeds. We analyzed mineral content of diet and non-diet items of the Tana River mangabey (*Cercocebus galerritus*) by collecting data from three groups; one from August 2000 to July 2001 and two from July 2005 to June 2006. During the latter period, we collected diet and non-diet items of the same ripeness stage from trees in or under which mangabeys were eating, and additional samples during 2009. A total of 35 fruit and seeds from 18 species were analyzed for minerals by atomic emission spectroscopy according to standard methods. Based on 13,200 eating events on identified plant items, the 35 items comprise 54.3% of the annual diet. Mann-Whitney tests showed no differences in mineral content between eaten and uneaten items. There were no significant Spearman correlations between diet contribution and mineral content. The annual mineral intake (estimated from mineral concentration weighted by percent contribution to diet), when compared to the 2003 National Research Council recommendations for non-human primates, was deficient in Ca, P, Na, Zn, and Cu; almost sufficient for Mn; and exceeded the recommended amount for Mg, K (provided mainly by fruit), and Fe (provided mainly by seeds). Our data fit general nutritional profiles established from other published values, where fruits are low in Ca (with the exception of *Ficus* spp.), P, Na, Cu, and Zn, and adequate/high with respect to K, Mg, Fe, and Mn.

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Inventories, adding individuals, and tracking skeletal elements in Osteoware.

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A common difficulty in human osteology data management is in organizing records for commingled remains and bone lots catalogued under a single collection number or recovered from a single burial. Several key features of the Osteoware system for documenting human remains are designed to manage this problem: adding individuals, commingled inventories, and tracking by individual skeletal elements. Once a catalogue or field identification number is entered into the system, the user has the option of entering data for multiple

individuals under the same number. Osteoware will automatically generate a unique database record by appending a letter to that number. Adding individuals is generally reserved for cases where several major skeletal elements that are clearly associated are present in addition to the main individual.

For cases where there is no main individual, as in bone lots, or when additional elements not belonging to the main individual are present, commingled inventories can be used to enumerate individual elements under three age categories (infant, subadult and adult). Additional data for cases where age, sex, evidence of pathological changes, or unusual taphonomy needs to be recorded for single elements are stored under the main catalogue number by entering them under a tracking number. Tracked elements can be related through entries as probable antimeres or articulating tracking numbers. This presentation outlines the criteria for adding individuals or tracking elements and presents two case studies of complex sets of catalogued remains from the Smithsonian Institution collections.

Osteoware is supported by grants from the National Center for Preservation and Technology and Training (NCPTT), National Park Service, and the Smithsonian Web 2.0 Fund.

Entertaining entrainment: reconsidering the effects of respiratory constraints on the optimal running speed.

MICHAEL WILLCOCKSON and CARA WALL-SCHEFFLER. Department of Biology, Seattle Pacific University.

In Carrier's (1984) initial paper on the importance of running as a hunting strategy among *Homo*, he put forth the observation that 'running humans should display greater plasticity in the critical functions of respiration...than running quadrupeds.' He used this observation to partly explain the invariance in the Cost of Transport (CoT) of human running, and the ability of *Homo sp.* to run down prey at the prey's least optimal speed. Since it has recently been shown that the CoT of human running is not speed invariant, this leads to the obvious question of whether people actually have the plasticity in critical aspects of breathing function, such as a link between the breathing cycle and the locomotor cycle ('entrainment'). Here we measured the energetic cost of human running (N=9) at five different speeds and calculated individual CoT curves for each participant. Simultaneously, entrainment was determined by the degree to which a post-stimulus histogram (breaths per 0.05sec bin following a footfall) differed from a uniform plot. We then compared the degree of entrainment to each participant's optimal running speed and

found that while eight of our subjects clearly entrained at some speeds, entrainment was not a function of CoT ($p=0.897$). Since entrainment was also not correlated with speed ($p=0.304$), it appears that bipedalism removed the respiratory constraints associated with quadrupedalism as originally predicted by Carrier. Unlike quadrupeds, for whom respiratory constraints remain implicated for leading to a minimum CoT, constraints which lead to a minimum CoT for people must involve other variables.

Modeling species variation with nonmetrics using a fuzzy inference system.

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Species identification includes a search for autapomorphic nonmetric variables. Our ability to describe intraspecific and interspecific variation in these characters affects our ability to recognize fossil species. Nonmetric variables may present as a continuously expressed trait, such as degree of rounding of the inferolateral orbital margins. We partition continuously distributed variables into graded/bimodal character states for data collection. Sometimes multiple character states are observable in a population. Variables presenting multiple character states are problematic for determination of polarity and identification of autapomorphies, particularly if multiple character states exist in a species. Nonmetric variables are often described using linguistic variables ("large", "moderate", "small"), which are fuzzy categories. A fuzzy rule-based system allows computing with linguistic categories. Can Neandertals and early moderns be partitioned using multistate nonmetric variables? How well do multistate characters perform in group identification?

Nine nonmetric cranial variables representing three regions of the skull were collected on 14 Neandertals and 24 moderns. Nonmetric variables were limited to those having three or more character states. A Mamdani fuzzy inference rule-based system was devised using MATLAB Fuzzy Logic Toolbox. Fuzzy membership functions were defined for each variable from their graded categories. Fuzzy inference rules used these functions to calculate membership into "Neandertal" and "Modern" sets. Analysis was performed on variables individually and in aggregate, and results compared. Some variables (ex: infraorbital notch profile) performed better than others (ex: superciliary arch shape) for group identification. A better understanding of multistate nonmetric variables can advance their use for species identification and phylogeny construction.

This study was funded in part by the Institute for Human Origins and Sigma Xi.

Achieving efficiency and accuracy in Oldowan stone tool production.

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It is now clear that multiple hominin species used and/or produced stone tools, yet evidence suggests that only later *Homo* intensified and developed the behavior. This difference has been attributed to later *Homo*'s ability to execute efficient tool production, to the exclusion of earlier hominin species. The current study evaluates whether modern human upper limb anatomy contributes to energetic efficiency and/or accuracy during knapping. Knapping kinematics were captured from eight experienced knappers using a VICON motion analysis system (200Hz). Each subject produced four Oldowan choppers under two conditions: two choppers under normal conditions and two with subjects' wrists restrained to ~30° of extension to simulate one aspect of the primitive hominin condition. Under normal conditions all subjects employed a partial proximal-to-distal joint sequence, with peak segment linear velocities and peak joint angular velocities initiating at the shoulder and elbow, respectively, and progressing distally. Subjects exhibited the "dart-throwers arc," moving from wrist extension/radial deviation to flexion/ulnar deviation. Wrist extension peaked 0.037-0.075 seconds before strike, positioning the wrist to reach peak flexion velocity immediately before strike, resulting in peak hammerstone acceleration at strike. Preliminary results suggest that together these motions patterns produced significantly more work in an energetically efficient manner compared to swings when the wrist was restrained and precluded from being positioned for rapid flexion. Further, with an unrestrained wrist subjects struck their targets with significantly greater accuracy ($p < 0.05$). These results suggest that derived hominin hand and wrist anatomy contributes energetic efficiency and accuracy to stone tool production.

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Dietary proclivities in three purported terrestrial fossil catarrhines, *Procynocephalus subhimalayanus*, *Parapapio whitei* and *Oreopithecus bambolii*, from Scale-sensitive fractal analysis of enamel surface texture characteristics using white-light confocal microscopy.

FRANK L. WILLIAMS. Department of Anthropology, Georgia State University.

Terrestrial locomotion has been inferred for *Procynocephalus subhimalayanus* from its relatively large maxilla. To identify whether purported terrestriality correlates with dietary proclivities, the dental microwear of *Procynocephalus* is compared to *Parapapio whitei* from Makapansgat ($n = 4$), a Pliocene analogue with an isotopic and trace element signature indicating underground storage organs were consumed. As a parallel example of terrestrial locomotion possibly corresponding to dietary regimes, two late Miocene taxa, *Oreopithecus bambolii* ($n = 2$) and *Mesopithecus pentelicus* ($n = 12$), are sampled and all the fossils are compared to extant primates with known diets. Dental microwear was examined by scanning the protocone surface using white-light confocal microscopy at 100x, followed by Scale-sensitive fractal analysis. The four texture characteristics extracted from surface dimensions were ranked before Anova with post-hoc tests of significance and multivariate analyses were performed. *Procynocephalus* and *Parapapio* exhibit relatively complex surfaces and middle to low values for anisotropy compared to folivores such as *Trachypithecus* and *Alouatta*. *Procynocephalus* and *Parapapio* exhibit higher textural fill volumes compared to extant analogues indicating even harder and more brittle foods were consumed than observed in the diets of arboreal hard-object specialists or leaf/seed foragers. In multivariate analyses, *Procynocephalus* and *Parapapio* consistently cluster together. *Oreopithecus* resembles *Trachypithecus* and *Gorilla gorilla beringei* in a principal components analysis but is linked with *Mesopithecus* in a cluster analysis. The inferred terrestrial diets of *Procynocephalus* and *Parapapio* most closely approximate the diet signal of *Lophocebus* suggesting mixed-fruit and hard-object feeding characterized at least a portion of their diets.

Evolutionary history of the hominoid vertebral formula.

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The numerical composition of the vertebral column has generated newfound interest in recent years, particularly regarding its role in the evolution of hominoid primates, in large part due to the implications for hominin origins and the evolution of bipedalism. Recently, several different scenarios were proposed to describe the modal number of lumbar vertebrae possessed by the last common ancestor (LCA) of humans and chimpanzees. These include a "chimpanzee-like" ("short-back") ancestry, a "Proconsul-like" ("long-back") ancestry, and a "human/gibbon-like" ancestry. Initial interpretations of *Ardipithecus ramidus* support the long-back scenario, although the ARA-VP-6/500 skeleton does not preserve sufficient remains to assess vertebral counts.

I test these competing hypotheses using a combined dataset of published vertebral formulae for both extant and extinct mammals, supplemented with my own data (total N~5,600 specimens). Modal ancestral vertebral formulae are reconstructed throughout mammalian evolution and the hominoid vertebral column is placed in this large phylogenetic framework. Results suggest that a 7-13-6-3 (cervical-thoracic-lumbar-sacral) vertebral formula evolved in the ancestor of therian mammals and persisted throughout mammalian evolution, including the LCA of catarrhines. The LCA of crown hominoids achieved a 7-13-5-4 formula through a caudally-directed homeotic shift at the lumbo-sacral border, a rare occurrence among mammals. The LCA of hominids experienced a subsequent shift at this border, rendering the vertebral formula 7-13-4-5, a "great-ape-like" pattern that persisted through to the hominin-panin LCA. Therefore, this study supports a short-back, "short-trunk" scenario of hominin ancestry. Implications for orthogrady, bipedalism, and hominin evolution are discussed.

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Reproductive ecology, carious lesions, and selective mortality in late prehistoric west-central Illinois.

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Recent research by John Lukacs and colleagues has highlighted the synergistic relationship between the reproductive ecology of women and the likelihood of poor dental health in prehistoric and contemporary populations. While these findings help to explain the prevalence and patterning of carious lesions in bioarchaeological samples, few scholars to date have effectively measured the biological cost of poor dental health and subsequent probability of entry into a death assemblage. Building upon the theoretical and methodological concerns

formalized in the "Osteological Paradox" (Wood et al., 1992), results from a paleo-epidemiological analysis of dental health for the late prehistoric period in west-central Illinois are presented. This includes a reexamination of the multi-component Dickson Mounds skeletal sample using maximum likelihood methods of age estimation and hazard modeling to address the impact of selective mortality.

The co-variance of advanced carious lesions with age-at-death in females of reproductive age in all the time periods examined indicates that heterogeneity in frailty led to early entry into the death assemblages. Females with poor dental health had a significantly higher probability of death during their early reproductive years, while post-reproductive age females had considerably fewer carious lesions. By contrast, the relationship between carious lesions and age-at-death in males followed the attritional mortality profile with the probability of poor dental health increasing with age. These findings shed additional light on the relationship between fertility, subsistence, and well-being in traditional agricultural populations, while simultaneously challenging bioarchaeologists to employ analytical methods suitable for the right-censored data inherent to skeletal samples.

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Causes of intergroup aggression among chimpanzees at Gombe National Park, Tanzania.

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Since the first observations of intergroup killings among chimpanzees (*Pan troglodytes*) at Gombe National Park, Tanzania, anthropologists have used chimpanzee violence as a source of insights for explaining the origin and evolution of human warfare. Nonetheless, the causes of chimpanzee "warfare" remain only partly understood. Why, for example, are intergroup killings more common at some times and places than others? Debate continues over whether chimpanzee intergroup aggression depends mainly on the relative fighting power of neighboring groups, efforts to attract female immigrants, or competition for food resources. To better understand the relative importance of these factors, we analyzed 35 years of data from Gombe. We found considerable variation in the frequency and location of intergroup aggression. Direct physical contact

occurred infrequently, but resulted in severe injuries, including at least 17 fatalities. Intergroup interactions were hostile throughout the study period but occurred most frequently during the destruction of the Kahama community in the 1970s, and the expansion of the Kasekela community in the 1990s and 2000s. The timing and location of patrols and intergroup encounters depended on the relative size of neighboring communities, and on the abundance and location of key food resources. In the past decade, Kasekela chimpanzees directed most of their territorial effort towards the food-rich north, but gained most of their female immigrants from the south, suggesting that competition for food, rather than females, is the more common motivator for intergroup aggression in this population.

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Species differences in the rate of cognitive ontogeny among humans, chimpanzees, and bonobos.

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Patterns of cranial development vary significantly between humans and our closest living relatives, chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*). Humans have been proposed to undergo a greater degree of cranial growth postnatally in comparison to the genus *Pan*, while in turn bonobos appear to exhibit delayed development in certain aspects of their crania relative to chimpanzees. Little data currently exists to test whether these changes in cranial ontogeny are associated with changes in behavioral or cognitive ontogeny. Here we compare the cognitive ontogeny of human infants (n = 48), chimpanzees (n = 138), and bonobos (n = 50), utilizing a battery of over 10 tasks examining a wide range of cognitive abilities. We test two hypotheses: 1) human cognitive development is accelerated relative to that of *Pan* in infancy and 2) bonobo cognitive development is delayed relative to that of chimpanzees. We found that human infants show accelerated cognitive development between 2 to 4 years of age, likely owing to an early emergence of social cognition abilities relative to *Pan* infants that allows for participation in human culture. We

also found that bonobos exhibited delayed cognitive development relative to chimpanzees, though only in physical cognition skills (those employed in foraging or reasoning about objects). These results suggest that differences in cranial ontogeny in hominoids are associated with significant differences in cognitive ontogeny. Further work should integrate studies of behavioral and physiological development as part of a larger evolutionary developmental approach to understanding human evolution.

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Co-associations of subsistence strategy, non-specific infection, and congenital defects of the deciduous dentition in pre-Columbian Tennessee.

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Defects of the deciduous dentition flag prenatal stress which may predispose children to postnatal chronic health problems. These chronic health problems may be skeletally manifested as periostitic or osteoporotic changes in the cranial and postcranial skeleton, and compromised growth of the long bones. The subadults which possessed deciduous dentition (skeletally <7 years of age) from 7 sites (N=386) from the agriculture-intensive late Mississippian (AD 1300-1550) period of East Tennessee were compared to the same skeletal age cohort from 5 sites (N=111) dated to the Late Archaic (3000-100 BC) period of west-central Tennessee. Despite the problems associated with the differential preservation of skeletal material, results indicate a higher frequency of chronic health problems in the maize-dependant Late Mississippian (32 indicative cases), with 13 of those individuals also demonstrating long bone involvement (13 indicative cases). The Late Archaic hunter-gatherers demonstrate a higher frequency of long bone involvement: 9 indicative cases out of 10 subadults with chronic conditions. When the co-association of chronic infection and dental defects was examined, results indicate that 28 (7%) Late Mississippian period subadults displayed gross enamel defects, 10 of which also demonstrate chronic infection. In contrast, the Late Archaic sample indicate a much lower frequency of dental defects (3%) with only 1 case co-associated with chronic stress. These results suggest that factors which contribute to this settlement and subsistence difference, which

include fundamental community health differences linked to sedentism and population density, likely contributed to a higher co-association of non-specific infection and deciduous defects in the Late Mississippian.

Ontogeny of limb growth and locomotor behavior in *Lemur catta* and *Propithecus verreauxi*.

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Propithecus verreauxi and *Lemur catta* differ in adult locomotor behavior and morphology, especially in terms of specializations for hindlimb-dominant locomotion. However, little is known of the ontogenetic trajectories by which these adult forms are acquired. We examined changes in locomotor behavior and limb morphology from 0-2 years in *L. catta* and *P. verreauxi*. Limb segment lengths and body mass were recorded every two weeks (infants) or four weeks (yearlings) at the Duke Lemur Center (DLC). Locomotor data were collected on infants and yearlings of each species in free-ranging enclosures at the DLC using locomotor bout sampling. Bouts were classified as hindlimb, forelimb, or "all-limb" dominant locomotion. Positive allometric growth was observed in all limb segments (except *L. catta* radius) and was highest in femur length from 0-6 months in both species. No significant differences in allometric growth were found between species or age classes. *Propithecus* have significantly longer limb segment lengths than *L. catta* during infancy, and both species have relatively higher intermembral indices during 0-6 month versus 6-12 months of age. More hindlimb dominant locomotion was observed in *L. catta* infants than yearlings. No differences were observed in locomotor behaviors between *P. verreauxi* infants and yearlings. *L. catta* displayed higher frequencies of all-limb locomotion than *P. verreauxi* in all age classes. Growth trajectories were similar between species, yet initial limb segment lengths and locomotor behaviors differed between species across age classes. These data suggest that differences between species in adult body proportions may be established early in neonatal life. This study was partially funded by Sigma Xi Grants-In-Aid of Research G2009151076.

Keeping their friends close? Contrasting models of social association in Hadza hunter-gatherers.

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Because spatial proximity is necessary for most forms of social behavior, friendships and other "close" relationships are likely to be expressed in patterns of space use. While primatologists often explicitly model the social structure of a species or population in terms of space use, researchers studying human populations are much less likely to do so. Primatologists and other biologists often use observations of social interaction and grouping to create inductive models of social structure, from which individuals' preferred social partners can be inferred. In contrast, anthropologists and sociologists typically use interview data to create deductive models of social structure based on nominations of important social relationships, such as friendships. This paper will compare models of Hadza hunter-gatherer social structure derived from both methodologies: direct measures of social grouping as recorded by GPS devices worn by subjects, and the same subjects' nominations of who their friends were. 11 men and 14 women living in 2 Hadza camps in 2010 wore GPS devices daily for two weeks. We use measures of space use to model the strength of social association between individuals. The same subjects were asked to name who their closest friends in camp were. Both GPS data and interview responses reveal a strong preference for social association with same-sexed individuals. We examine the spatial correlates of strong and weak friendship ties, and test whether husbands and wives can be identified through patterns of spatial proximity. This study was funded by NSF BCS 0850815.

Phylogenetic signals in the hominoid carpus.

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The carpal skeleton has been an important region in studies of hominoid anatomy. It is the product of functional, developmental and phylogenetic processes and therefore many carpal traits would be expected to exhibit mixed 'signals'. The question asked in this study is: which carpal characters exhibit a high-level of phylogenetic structure? Nineteen metric and seven categorical characters were collected from the capitate, hamate, lunate, triquetral, pisiform and scaphoid. Ten extant anthropoid taxa (n=253), including six hominoid species, were sampled. Individual

traits were ranked by their ability to recover phylogenetic information (topology and branch lengths) independently inferred from molecular characters. Null models of tree statistics were constructed with maximum likelihood and parsimony-based algorithms (using R, Matlab and Mesquite). Null models represent hypotheses of no phylogenetic signal in a trait for the sampled taxa. Characters were ranked by their deviation from these null models. Traits of different rank were then compared in tree inference (using PAUP). For metric characters, a matrix of five highly-ranked traits performed better than matrices composed of all nineteen traits, or of eleven lowly-ranked traits. Trees of lowly-ranked traits failed to support hominoid monophyly, while those generated from all characters failed to support a *Pan-Homo* clade. Trees of highly-ranked traits succeeded on both counts, though did not completely recover the hominoid molecular topology. Tree inference is improved by excluding traits that contain little hierarchical structure (parsimonious trees have shorter lengths and greater support). Highly-ranked characters may be useful for inferring the phylogenetic relationships of closely related fossil taxa.

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Ovarian hormones and inflammation in urban Bolivians.

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Reproductive ecology has established eco-behavioral and developmental bases for variation in ovarian function within and between human populations. These same populations face immune challenges for health, yet the trade-offs between reproduction and maintenance demands across the wide range of human ecologies remains largely unexplored. C-reactive protein (CRP), a component of inflammatory response, has been implicated as a biomarker of circulatory and metabolic disease risk; moreover, variation in CRP has been linked to cyclic variations in ovarian hormones in western women. This study probes the relationship of ovarian hormones and CRP in urban non-western women living at altitude.

61 La Paz residents aged 25-35—non-pregnant, -lactating, or -contracepting—contributed 5 blood spot samples between days 6-24 of an ovarian cycle. Samples were assayed for estradiol, progesterone, and CRP, along with FSH

and LH to confirm ovulation. Although 5% of samples indicated acute infection (>4 mg/L), CRP was markedly low (median 0.28 mg/L) relative to comparable western populations. Nevertheless, the expected relationship of BMI (median 24.1) and CRP was apparent (beta 0.11, $p < .01$). The 80% of ovarian cycles that were ovulatory exhibited mid-follicular estradiol (median 86 pg/mL) and mid-luteal progesterone (14.9 ng/mL) levels similar to western populations. Even so, we detected no systematic relationships between CRP and ovarian hormones across ovulatory cycles, either in tests for direct association or in models including possible moderators (age, BMI, cycle length, socioeconomic status). In sum, interactions of CRP and ovarian hormones were not apparent in a population with very low CRP. Supported by: MH57761, NSF SBR 9506107.

Does the Dali cranium belong to *Homo heidelbergensis*?

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A comparative morphological study was undertaken in order to assess the affinity of the Dali cranium from China relative to a sample of middle and late Pleistocene Eurasian and African hominins. Specifically, the purpose was to determine if Dali was most likely to group with specimens typically classified as *Homo heidelbergensis*. Because there is not one prevailing hypodigm for this taxon, the comparative *H. heidelbergensis* sample was configured in three ways: inclusive of all Eurasian and African non-*erectus* middle Pleistocene specimens, inclusive of just European and African fossils, and inclusive of only the European ones. The affinity of Dali was assessed using discriminant function analysis. The results group Dali with *Homo erectus* in the first configuration of the comparative sample, and with the European and African middle Pleistocene hominins in latter two configurations albeit with weak (1%) typicality probabilities. These results suggest that the population from which Dali is derived is neither uniquely African/European in origin, nor is it uniquely Asian. It would be reasonable to group Dali with *H. heidelbergensis* but given this fossil's affinity with Asian *H. erectus* in the first analysis, these results call into question the notion of *H. erectus* being an evolutionary dead-end. Rather, this study suggests that *H. erectus* played a role in the emergence of later middle Pleistocene hominin morphology.

Craniofacial Ontogenetic trajectories of two subspecies of Japanese macaque (*Macaca fuscata*). From fetus to adult.

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Previous studies have suggested the postnatal craniofacial ontogeny in primates mainly establish interspecific craniofacial shape variations. But, other studies have demonstrated that such a inter-taxonomic variations are already formed before birth. Few studies, however, have induced comprehensive craniofacial trajectory from fetus to adult to identify when and how divergence of ontogenetic trajectories between closely related primates animals. In this study, we cross-sectionally analyzed the ontogenetic shape changes in crania of two subspecies of Japanese macaque to explore whether they share a common trajectory in the ontogeny.

We used a total of 137 specimens of Japanese macaque subspecies (75 *Macaca fuscata fuscata* and 62 *Macaca fuscata yakui*). We used 32 fetus samples and 105 dried crania for infants, juvenile, subadult, and adult samples. Each specimen underwent computed tomography scanning, and 54 landmark coordinates were digitized on the internal and external surfaces of the crania. We adopted a geometric morphometrics technique and principal component analysis to three-dimensionally investigate cranial ontogenetic shape changes.

Our results showed that two subspecies generally share a common size-related ontogenetic pattern from fetus to adult (PC1 and PC2). Clear cranial shape differences, such as the height of neurocranium and the shape of the orbit and occipital bone, accounted by PC3, were found to be already present by the one third of the fetal life. Our results suggested that the divergence of primate craniofacial ontogenetic trajectories probably occur at the very early stage of the fetal period even between closely related taxa.

Vaginal microbial community structure and maternal ecology in primates.

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Preterm birth serves as a severe selective agent and is a major cause of morbidity and mortality in contemporary populations. In the US alone, costs of preterm birth reach upwards of \$25B

annually. One closely associated factor is disruption of the normal microbiota of the reproductive tract. Though much is known about pathogenic bacteria, the function and diversity of commensal bacteria associated with the vaginal ecosystem are currently poorly understood, as are the mechanisms influencing microbial disruption associated with preterm birth.

From an evolutionary perspective, humans are characterized by difficult births, owing to large neonatal head size relative to pelvic dimensions. In contrast, nonhuman primates (NHPs) are characterized by easier births. Because of the nature of human birth and the close association between human vaginal bacterial microbiomes and reproductive fitness, and ultimately evolution, we predict that humans exhibit distinct microbial populations compared to non-human primates.

We analyzed vaginal swab samples from eight diverse primate species using multitag 454-pyrosequencing (GS-FLX Titanium) of 16S rRNA, including *Papio anubis*, *Papio cynocephalus*, *Propithecus diadema*, *Procolobus rufomitratu*, *Chlorocebus aethiops*, *Cercocebus atys*, *Gorilla beringei*, and *Homo sapiens*. Comparisons of microbial community structure indicate that the human vaginal microbiome is more different from the average NHP microbiome than any NHP microbiome is from another NHP microbiome. We discuss the potential implications of this for preterm birth and human evolution and suggest future research directions.

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The regional variation of maritime adaptation in prehistoric Japan.

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The dietary reconstruction of prehistoric human populations in Japan was conducted by carbon and nitrogen isotopic ratios in bone collagen. Exploitation of marine resources including marine mammals was significant in only prehistoric Hokkaido, while populations in Tohoku and other regions on main islands were relied on the combination of terrestrial C3 and marine ecosystems. The results from the southern part of Japanese Archipelago, Ryukyu Islands, showed another type dietary habit based on shellfish and smaller fish from coral reef lagoons. This regional variability of Jomon substance was clearly corresponding to ecological zones, suggest-

ing at least three different kinds of human adaptation strategies by Jomon people lived on the Holocene Japanese archipelago.

On the other hand, the temporal change of protein source during the Jomon period is not significant when we focus on a specific region. It seems that the tradition of Jomon continued from the Earliest to Latest Jomon and even in the following Yayoi period when rice paddy agriculture was introduced from China via Korean peninsula as a main part of subsistence. Hence, these continuous traditions of ancient diet suggest that the acceptance of rice agriculture at the initial Yayoi period was not the reason, but the result of cultural differentiation in prehistoric Japan.

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Paternal genetic history of the Basque population of Spain.

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This study examines the genetic variation in Basque Y chromosome lineages using data on 12 Y-STR loci in a sample of 158 males from four Basque provinces of Spain. In agreement with previous studies, the Basques are characterized by high frequencies of haplogroup R1b (83%). Five additional haplogroups were identified in this sample: E1b1b (6%), J2a (3%), I2 (3%), G2a (2%), and L (1%). Only 8% of haplotypes were found in more than one province, and the AMOVA analysis shows only a small amount of variation (1.71%, $p=0.0369$) is accounted for between provinces, demonstrating the overall homogeneity of this population. Gene and haplotype diversity levels in the Basques are on the low end of the European distribution (gene diversity: 0.4268; haplotype diversity: 0.9421). Other isolated populations in Europe, including the Swedish Saami, the Roma in Portugal, and Albanians in Kosovo, also exhibit low haplotype diversity levels. Comparison of the Garza-Williamson Index for the Basques and 36 additional European populations shows no significant impact of a recent genetic bottleneck on the continent. A bootstrapped neighbor-joining tree ($R^2 = 0.922$) of Shriver's genetic distances (D_{SW}) clusters Basque populations with other Atlantic Fringe groups (Galicia, Ireland) and the non-Indo-European Saami. Paleolithic and Neolithic contribution to the paternal Basque gene pool was estimated by measuring the proportion of proposed

Paleolithic (R1b, I2a2) and Neolithic haplogroups (E1b1b, G2a, J2a). The Basque provinces show varying degrees of post-Neolithic contribution in the paternal lineages, with 10.9% Neolithic lineages in the combined sample. This study was funded by the National Geographic Society (Project 6935-00).

New reconstruction of Skull IX, a *Homo erectus* cranium from Sangiran, Central Java.

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Skull IX (Tjg.1993.05) from Sangiran is a remarkably complete cranial specimen of *Homo erectus* from the early Pleistocene of Java, preserving substantial portions of the vault and face. However, the distortion present in the original reconstruction has hampered detailed documentation of its morphological characteristics. We here report our new re-reconstruction of Skull IX that has successfully recovered its original morphology and significantly differs from the previous reconstructions.

The specimen was unearthed from the upper stratigraphic zone (Bapang-AG levels) of the hominid-bearing sequence in Sangiran. Its endocranial volume was measured as 870 cc using micro CT technology. In overall cranial form, details of its surface structures, and facial morphology, Skull IX exhibits numerous similarities to the other Bapang-AG *H. erectus* specimens.

Along with other Asian *H. erectus* specimens from Java and China, Skull IX exhibits a narrow superior facial breadth and a low facial height, suggesting that a small face was a consistent Asian characteristic as compared to African *Homo* from ~2.0-0.5 Ma. Comparisons of Skull IX, Sangiran 17, and other fossil specimens from Java, China, Georgia, and Africa suggest that the *H. erectus* population from Sangiran had its own unique combination of facial morphology, which includes a vertically tall and transversely oriented maxillary zygomatic process, and a low, horizontal course of the zygomaticoalveolar pillar. Polarities of these and other facial characters as well as their regional variation within Afro-Asian Pleistocene *Homo* are discussed.

Standardizing the collection and analysis of cranial suture complexity data.

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ogy, University of Florida, ²Student Services, College of Education, University of Florida.

Fractal dimensions have been used as a means to quantify cranial suture complexity. However, a formalized benchmark method does not exist for collection of suture complexity data. Furthermore, there is a thorough lack of understanding of how complexity values compare to one another. As a result there is a gap in understanding how fractal dimensions generated by various software packages compare to one another or to the ratio between direct length and linear length. This study will offer a standardized method to collect and analyze complexity data. Sagittal suture morphology data was collected from 19 crania using 3 data collection methods: 1) physically tracing the suture onto clear tape then scanning the tracing; 2) using digital photography then tracing the suture within Adobe Photoshop CS4 and ImageJ; 3) digitizing the sagittal suture using a 3D Microscribe then plotting the x and y coordinates. The tracings and plots are converted into binary bitmap images from which fractal dimensions are generated for all three methods using FracLac 2.5 plugin for ImageJ, and Benoit 1.3 software. Direct length to linear length ratios will be calculated using the Straighten plugin for ImageJ and compared to Fractal Dimensions. Correlation and regression analyses are performed to examine congruency between observers as well as methods. Preliminary results for method 1 indicate that there is a strong correlation ($r = 0.760$) between fractal dimensions generated between users for ImageJ but not Benoit; additionally there is a statistical difference between the fractal dimensions calculated by the programs.

Noninvasive microstructural analysis of two late Early-Middle Pleistocene deciduous molar crowns from the Sangiran Dome, Java, Indonesia.

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The Sangiran Dome Pleistocene deposits (Central Java, Indonesia) have yielded the most abundant sample of fossil hominids in Southeast Asia, including over 200 dental elements, ten of which are deciduous. Two additional deciduous molar crowns have been recently found in the late Early-Middle Pleistocene Kabuh formation outcropping near the village of Pucung, in the southern part of the Sangiran area. The nearly unworn specimens represent an

upper left m1 (ULm1) and a lower left m2 (LLm2). While the allocation of the ULm1 to *Homo* (likely *H. erectus*) seems unquestionable, the taxonomic assessment of the lower molar, still bearing a small concretion partially masking the occlusal surface disto-lingually, is more problematic, and its belonging to a non-human fossil hominid cannot be fully discarded.

In order to characterize the two crowns in terms of tissue proportions, enamel thickness variation, enamel-dentine junction topography, and neonatal line relative position and thickness, the specimens have been detailed by microtomography (μ CT) at the Centre de Microtomographie of the University of Poitiers, France (21.64 μ m resolution), and at the Elettra Sincrotrone Trieste, Italy (6.25 μ m).

Based on a comparative deciduous dental sample of extant and fossil human molars (representing *H. heidelbergensis*, Neanderthals, and anatomically modern humans), as well as of extant *Pongo*, the endostructural conformation of the LLm2 reveals typically human. In both crowns, differently from the condition typical of Neanderthals but similarly to the penecemporary sample from Tighenif, Algeria, 2-3D dental tissue proportions and the enamel distribution pattern more closely approach the modern human figures.

Funded by French CNRS and Univ. of Poitiers (Centre de Microtomographie).

Everything you ever wanted to know about infant growth rates in prosimians but didn't have a large enough sample size to ask: analyses of infant weight data at the Duke Lemur Center.

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Prosimian primates exhibit a vast array of morphological, behavioral, dietary, ecological, and reproductive differences, and we would expect to also see related differences in infant growth. Using records collected over the 40 year history of the Duke Lemur Center for over 200 individuals, analyses of infant growth rates were conducted for 9 species (*Propithecus coquereli*, *Lemur catta*, *Daubentonia madagascariensis*, *Microcebus murinus*, *Varecia variegata/rubra*, *Eulemur mongoz*, *Eulemur macaco flavifrons*, and *Mirza coquereli*). The availability of data for large numbers of individuals allowed for statistically significant differences to be identified. We found that prosimian species exhibit a variety of growth strategies, and these are not strictly correlated with longevity, body size, or age at first reproduction. Mm have the most rapid growth, achieving adult body size at roughly 3 months of age, while the slowest growing species examined, Pc,

does not reach adult weight until nearly 3 years of age. Both Dm and Mm exhibit a declining rate of growth throughout infancy, with newborn infants gradually but immediately decreasing weight gain over time. Others, such as Lc and the Eulemurs, show relatively consistent growth throughout infancy. Not surprisingly, animals that park their young (*Varecia*, Mm, Dm) grow at a faster rate than those whose young cling (*Lc*, *Pc*, *Eulemurs*). In addition, interesting differences were identified among species within these two groups. These data not only give us insight into the relationships between growth and reproductive strategies, but can also be used as a guide for ensuring healthy infant development in captive populations.

An ontogenetic assessment of trabecular architecture at the human talocalcaneal joint.

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Absolute peak loading of the calcaneus during mature bipedalism occurs near the posterior articular facet (PAF), just inferior to the posterior talocalcaneal joint (TCJ). Supination and close-packing of the TCJ in preparation for toe-off may contribute to high compressive forces near the PAF of the calcaneus as well as the complementary PAF of the talus. This study tested the hypothesis that epigenetically-sensitive trabeculae in the talar PAF of juveniles whose immature bipedalism lacks a propulsive toe-off (prior to 2 years) differs from that of adults. High resolution computed tomography scans of 3 young juveniles (1-2 years), 3 older juveniles (2-4 years), and 3 adults were used to analyze trabecular bone structure within a volume of interest near the talar PAF. Degree of anisotropy (DA), bone volume fraction (BV/TV), and the primary trabecular orientation were calculated.

Compared to juveniles, adults had a significantly higher degree of anisotropy and a higher bone volume fraction. Among juveniles, DA and BV/TV were lowest in 1-2 year olds. Adult and juvenile trabeculae were oriented along a dorsoplantar axis. However, primary trabecular orientation in adults was anterodorsal to posteroplantar while juvenile primary trabecular orientation was more variable. Results suggest that the close-packing of the TCJ in adults is associated with highly organized, densely packed talar PAF trabeculae while the lack of a close-packing TCJ mechanism in 1-2 year olds is associated with isotropic, less densely packed talar PAF trabeculae. Results support the use of ontogenetic studies when identifying bipedal correlates using pedal trabecular architecture. This study was funded by the Leakey Foundation and NSF (BCS 1028958).

Comparison of intraspecific genetic and morphological diversity among primates.

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Neutral genetic diversity within living populations reflects patterns of drift and past demographic history, not trends of natural selection. The neutral theory of molecular evolution predicts that most neutral polymorphism is related to the stochastic sampling of alleles from generation to generation. The neutral theory has largely been applied to molecular polymorphisms, although the model should apply to any neutral variation within a population, including morphological. Here, we compare genetic diversity to cranial diversity in a series of catarrhines to test the null hypothesis that neutral molecular and morphological variation are correlated. If populations with more genetic diversity show more cranial shape diversity, then cranial variation may be governed primarily by drift and not selection. In this analysis, we compare autosomal, mitochondrial and X-chromosome genetic variation to 3D geometric morphometric cranial vault shape diversity within 10 primate populations. Our findings indicate that primate populations with more genetic diversity also show more cranial vault shape diversity. Inferring how stochastic evolutionary processes, such as drift, shape morphological diversity can inform decisions about which extant species are appropriate models for fossil species, and to what degree fossil morphology reflects adaptation. Additionally, the correlation between these two data types may serve as a predictive system for fossil species for which we have no genetic data. This analysis is particularly germane to evolutionary anthropology, given that skeletal diversity within extant primate species is used as an analog for delimiting fossil primate species, including humans.

How body composition in *Pan paniscus* challenges "the expensive tissue hypothesis".

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The Expensive Tissue Hypothesis argues that as our ancestral (human) diet shifted to meat, brain size increased and GI tract size decreased. We tested this by evaluating body composition in *Pan paniscus* and comparing

its complex body composition profile with that of *Homo sapiens*. Our unique sample consists of 15 chimpanzees (*Pan paniscus*) that range in age from newborn to about 50 years of age and includes 2 infants, 3 juveniles, and 10 adults. All individuals died at zoos or captive facilities. After necropsy each individual was dissected, and body tissues were weighed. Each major component was calculated as a percent of total body mass, which included muscle, bone, skin, fat, organs and other tissues. Body composition in chimpanzees changes through life in parallel with humans; for instance, the brain and organs (liver, heart, kidneys) comprise about 15% of body mass in infants, and 5% in adults in both species; muscle mass increases from 22% to over 40% in adults. The data demonstrate additionally a relationship between female reproduction and body composition with changes in relative muscularity and fat stores. These data sets challenge the assumption that GI tract size is significantly heavier in chimpanzees than in humans. We conclude that total muscle mass and fat stores are the key fluctuating variables during human evolution, not GI tract size.

Elevated testosterone levels in female brown mouse lemurs (*Microcebus rufus*) at Ranomafana National Park.

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In mammals, males typically maintain significantly higher testosterone levels than females, and in the case of humans females testosterone levels are one-tenth lower than in males (Longscope 1986). However, these differences are often attributed to dominance, as dominant males usually have higher testosterone than subordinates, and male dominance is "typical" among mammals, with a few exceptions. One exception is the female dominant lemurs of Madagascar. In this study we test the hypothesis that female brown mouse lemurs (*Microcebus rufus*) at Ranomafana National Park (RNP) in the eastern rainforests of Madagascar will have comparable or higher levels of testosterone than the males in the same population. To do so, fecal samples were collected from male and female mouse lemurs from September 2008 to November 2009 (n=541), which were later analysed at the Wisconsin National Primate Research Center using enzyme-linked immunoassays. Our results show that female mouse lemurs have comparable or higher testosterone levels than males throughout the study, including during the brief breeding season. This is only the third reported case of higher testosterone in mammalian females (the first being

the rock hyrax - *Procapra capensis*), and we recently discovered similar results in a species sympatric to our study subject, the Milne-Edwards' sifaka (*Propithecus edwardsi*). Both sifakas and mouse lemurs experience a pattern of high testosterone levels in females compared to males, which is not only rare among primates, but rare among mammals.

MRI-based morphometric analysis of the human vocal tract during speech formation and implications for fossil hominin vocal abilities.

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While it is evident that the human vocal tract is structurally and functionally different from that of all great apes, it is less clear exactly which differences in hard and soft tissue anatomy impinge on vocal abilities. Also, it remains unclear as to which extent craniofacial differences between extant humans and fossil hominins reflect differences in soft tissue anatomy that might be relevant for speech formation. We use here an actualistic approach to address these questions. 3D fast-MRI data from human volunteers were acquired during speech formation under various experimental conditions (different phonemes, variation in voice pitch and volume, and variation in head flexion). Landmark-based geometric morphometric analysis of these data indicates that the vocal tract of modern humans exhibits considerable inter-individual variability but also a high degree of "phonemic shape constancy". We hypothesize that this combination represents an important prerequisite for the formation of consistent phonemes with easy-to-recognize individual voice characteristics. Our approach also provides a new means to reconstruct fossil hominin vocal tracts: Identification of both hard and soft tissue structures in modern human MRI-based speech data sets permits construction of hard-soft-tissue mapping functions. These functions can be applied to fossil hard tissue in an attempt to infer soft tissue morphology of the vocal tract, and speech-related modes of soft tissue shape variation.

Premolar microwear in *Australopithecus afarensis* and *A. africanus*.

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In nonhuman apes, the P₃ functions as a honing device for the maxillary canine. The loss of canine honing and subsequent morphological transformation of the P₃ are important evidence for the "hominization" of the C/P₃ complex. For the P₃, interspecific differences among Plio-Pleistocene hominins in crown size and the degree of "molarization" (crown shape, cusp number, etc.) have been classically thought to reflect adaptations to a changing dietary resource base. While dental microwear studies have proven to be an important tool for reconstructing hominin diets and tooth-use behaviors, most research has

focused on the molars. Here we report the results of the first comparative dental microwear texture analysis of P₃ "Phase II" facets of *A. afarensis* (n=18) and *A. africanus* (n=9) taxa whose postcanine morphological diversity captures one stage of the hominin C/P₃ transformation at ca. 3.5-2.5 Ma.

White-light confocal profilometry and scale-sensitive fractal analysis were combined to generate data for five microwear texture attributes reflecting dietary use-wear (anisotropy, complexity, scale of maximum complexity, heterogeneity, and texture fill volume) for

each P₃. Results indicate that *A. africanus* has significantly higher complexity and anisotropy values than *A. afarensis*. However, as previously revealed, the molars of *A. afarensis* and *A. africanus* differ in complexity but not anisotropy. Therefore, the suite of microwear texture attributes that distinguish these species differs between P₃ and the molars. This result has important implications for understanding variation between species in both diet and degree of functional differentiation along the tooth row.

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