

Several investigations into intraspecific differences in patterns of growth and development of the vervet monkey (*Chlorocebus aethiops*) have found progenesis (early growth cessation) in females, but the effect of this developmental difference on the cranium has not been investigated. This study seeks to correct this deficiency by examining skeletons of 36 individuals from a single, wild population from Kibwezi, Kenya. The sample is comprised of both males (n=17) and females (n=19) that range in age from infant to adult. The specimens were placed into discrete age classes using previously established dental eruption patterns. These classes were then plotted against the distance from opisthocranium to lambda suture.

The distance from opisthocranium to lambda suture was found to shrink throughout ontogeny in both sexes, but remains relatively large in adult females who are therefore, with regard to this feature, paedomorphic when compared with adult males. For juveniles without fully erupted canines and no M3, the average distance for males (n=9) is 10.5 mm and for females (n=4) is 10.6 mm. In contrast, a statistically significant difference (p=0.00016) was found between the adult male distance (n=4, average=3.95 mm) and the adult female distance (n=10, average=8.47 mm). This cranial variable, here entitled 'opisthocranium migration,' illustrates that the developmental process of progenesis in female vervet monkeys is evinced in the morphology of the skull. Due to the consistent sexual dimorphism of this feature, it is also possible to use the degree of opisthocranium migration in adults as a tool for sex estimation in this species.

Cranio-facial variation in sub-species of *Pan*.

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Genetic evidence suggests that *Pan troglodytes troglodytes*, *Pan troglodytes schweinfurthii* and *Pan troglodytes verus* represent three different populations, with the latter possibly being a distinct species. Morphological differences, however, are not clear-cut and bear directly on questions concerning taxonomy, sexual dimorphism and phylogeny in extant hominoids and early human evolution. We re-examine *Pan* cranial variation using Procrustes-based geometric morphometrics to: 1) quantify and examine overall cranial shape variation among *Pan* species and sub-species; 2) investigate whether the face, basicranium and cranial vault can distinguish sub-species of *Pan*; this is because different regions of the cranium have shown to preserve phylogenetic information differentially.

Our dataset comprises 123 adult chimpanzees and 36 bonobos, and a total of 53 3-D landmarks. To analyze cranial shape variation, we conducted principal component (PCA) and canonical variate (CVA) analyses on Procrustes shape coordinates. The PCA of the

full cranial landmarks set shows a separation between the *Pan* species, but not the sub-species. The CVA distinguishes bonobos from chimpanzees, and also shows subtle separation among the chimpanzee sub-species. In the separate face, basicranium and cranial vault analyses, bonobos are best distinguished from chimpanzees in aspects of the face and basicranium. Among the sub-species, *P. t. verus* and *P. t. schweinfurthii* are most disparate from each other, particularly in the face. *P. t. troglodytes* consistently overlaps with *P. t. verus* and *P. t. schweinfurthii* in all three cranial regions.

These results suggest population differences between the western and eastern chimpanzees, but do not indicate consistent separation of the western chimpanzees as suggested by the genetic data.

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Is there an environmental effect on acoustic strategies of black and white ruffed lemurs (*Varecia variegata editorum*) in Ranomafana National Park, Madagascar?

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Acoustic signals convey messages about the location, behavior, and physical state of callers. Environmental factors affect vocal structure and sound transmission regardless of content. Time of day, temperature, wind speed, atmospheric pressure, and humidity affect the level of degradation and attenuation an acoustic signal endures while traveling from source to recipient. We predict that to increase the efficacy of communication, primates use acoustic signals when transmission is optimal. Therefore, call rates will vary with environmental factors.

We tested the prediction that environmental factors shape acoustic strategies of black and white ruffed lemurs (*Varecia variegata editorum*). Long calls are one of the most salient characteristics of the species, carrying over 1km. From July-August 2011 (N=544 hours), we recorded instances of *Varecia* long calls (N=172). We tested whether call rates differed across morning, mid-day or late afternoon time periods, and wet vs. dry periods (chi-square), and if call rates were associated with changes in temperature, barometric pressure and wind speed (Spearman's rho).

Contrary to our predictions, call rates did not significantly differ across time periods and were not associated with temperature, barometric pressure or wind speed (p > 0.05). However, call rates significantly differed between wet and dry periods (p<0.001). A longer study comparing acoustic strategies across seasons may reveal relationships between abiotic factors and *Varecia* long calls, or that the acoustic strategies of ruffed lemurs are more heavily influenced by social than abiotic factors. Investigation of the social

behaviors associated with calls may better elucidate the acoustic strategies of *Varecia*.

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Ontogenetic shape variation in the cranium of *Rungwecebus kipunji*.

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The cranial morphology of the endemic Tanzanian primate *Rungwecebus kipunji* is known only from juvenile specimens. Morphometric analyses of the first voucher specimen, an M1-stage male (FMNH-187122), identified similarities with *Lophocebus aterrimus* but supported the kipunji's generic status. The second voucher specimen, an M2-stage male (SHCP-2458), has undergone qualitative and phylogenetic analyses but has not been included in multivariate, morphometric studies. In this study, 3D geometric morphometrics was used to compare the cranial morphologies of FMNH-187122 and SHCP-2458. To facilitate comparisons, developmental simulation was used to estimate the M1-stage morphology of SHCP-2458, M2-stage morphology of FMNH-187122, and adult morphologies of both specimens. Objectives were to evaluate the affinities of SHCP-2458, characterize kipunji cranial development, and explore the impact of ontogenetic variation on estimates of adult morphology. Coordinate data were collected on 109 juvenile and adult-male crania representing five African papionin genera. The male developmental trajectory for each species was approximated by regression of Procrustes-aligned coordinates on dental stage. Juvenile and adult landmark configurations were simulated by application of developmental vectors to the juveniles' landmark coordinates. Affinities of actual and simulated kipunji crania were assessed using Procrustes distances and PCA. Next to FMNH-18722, SHCP-2458 is most similar to M2-stage *Lophocebus aterrimus*. Shape differences between FMNH-18722 and SHCP-2458—concentrated in the face and neurocranium—are greater than between M1- and M2-stage *Lophocebus* but similar in magnitude to *Papio*. Vectors of *L. aterrimus* and *Papio* provide the most accurate estimates of actual juvenile morphology. Affinities of simulated juveniles and adults will be discussed.

94. When artiodactyls lead anthropologists astray: important considerations, strengths, and limitations of comparing limb bone adaptation between artiodactyls and primates.

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Studies of adaptation of artiodactyl (e.g., sheep, deer, gazelles) limb bones are now commonly used as a means for understanding processes/mechanisms of adaptation in appendicular skeletons of primates. Benefits of

using artiodactyls include: (1) availability, (2) ease of strain gauge application on some bones, and (3) physiological and anatomical studies that have established them as experimental models for comparisons with humans (e.g., sheep). While benefits of using non-primate experimental/comparative models are clear, there are also important limitations that might not be readily apparent and could confound interpretations. In a recent book chapter (Ch. 7, *In Bone Histology: An Anthropological Perspective*, 2011; CRC Press), a systematic method is described for identifying manifestations of functional adaptation (primarily in the context of load history) in intra- and inter-specific comparisons of appendicular bones of various species. I will demonstrate how this method helps to identify strengths and limitations when considering data from artiodactyls for understanding adaptation in primate limb bones. Many examples, including important studies in the anthropological literature, will also be presented in this context. Besides obvious issues (e.g., animal size/mass, age, and gender), important considerations include: (1) importance of muscle/tendon/ligament "protection" and load sharing, and why these might evoke seemingly paradoxical modeling/remodeling events, (2) the shift from modeling- to remodeling-based adaptability at skeletal maturity, and (3) how altricial vs. precocial growth can confound interpretations, especially in terms of differences in the growth of bones that become highly osteonal more rapidly vs. those that retain larger percentages of primary histology in the adult.

Variation in mandibular condylar morphology in two Tai Forest Colobine species.

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The connections between primate mandibular morphology and dietary variation have been well-studied, but the nature of these relationships remains uncertain. Metric analysis of gross mandibular form has yielded important insights, but the internal structure of mandibular bone is not often considered. Examination of internal features, such as trabecular density and cortical bone thickness, could provide further insight since these variables may reflect modeling and remodeling activity in different loading environments.

Variation in internal mandibular condylar structure was explored using bilateral AP digital radiographs of *Procolobus badius* (n=6) and *Colobus polykomos* (n=5) from Tai Forest, Côte d'Ivoire. These sympatric colobines are similar in body size and display moderate sexual dimorphism but appear to differ in dietary habits, with *C. polykomos* presumably exploiting tougher foods. As a measure of trabecular density, mean grayscale values were taken from six areas of each condyle. In addition, the cortical thickness on the medial and lateral aspects of the condylar neck was measured.

Overall, *Procolobus badius* and *Colobus polykomos* do not differ significantly in mean

grayscale values or cortical thickness. Most of the variance in grayscale is accounted for by individual variation (41%) or sex (23%). Males tend to have higher grayscale values (i.e., denser trabecular bone) throughout the condyle, on the medial side in particular. Similarly, males exhibit significantly greater cortical thickness on the condylar neck compared to females. Whether these sex differences reflect variation in feeding ecology between males and females is currently being investigated in Tai Forest.

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Human postcranial morphology: trends in the Central European Holocene record.

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Central European (CE) Holocene is seen as the period of substantial changes in economic, social and political organization, starting from the small and flexible groups of foragers and first agriculturalists (Mesolithic, Neolithic) through secondary product revolution (Eneolithic), hierarchical settlement structures (Bronze Age) and finishing with Medieval and Historic urbanization. However, little is known about the effect of these changes on human postcranial morphology. A CE sample of 580 individuals from nine archaeological periods was analyzed here. Stature, body mass, and cross-sectional parameters of femora and tibiae were analyzed. Mean stature decreases from the Neolithic to Iron Age/Roman and increases to the Middle Ages; this observation is more prominent among males than females. During CE Holocene, male mean body mass has no temporal tendency but has higher fluctuations compared to female groups. Female mean body mass shows a slight tendency toward higher values in the later Holocene. Mean cortical area shows a slight tendency toward higher values in the later Holocene in both males and females. An index of mobility (A-P/M-L bending rigidity of the femoral and tibial shafts) decreases through the Holocene; this trend is more accentuated among males. Overall robusticity demonstrates either a slight increase through CE Holocene (Zp-femora) or remains stable (Zp-tibiae) for both males and females. In conclusion, it is surprising that the impact of socio-economic changes on postcranial features was so limited through the Holocene since the majority of the described tendencies are relatively slight.

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Battle of the sexes: Identifying victims of domestic abuse in the archaeological record.

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Domestic abuse is one of the sources, if not the most common source of injury for women today. It is a problem that has existed for millennia. Domestic abuse was also a problem at the post-medieval communities of Coach Lane, Tyne and Wear, and Fewston, North Yorkshire. For a problem which affects the daily life and health of women, little work has been done to identify victims of domestic abuse in past populations. This thesis attempts to remedy that situation. Victims of domestic abuse are identified based on the examination of fracture patterns of the ribs, sternum, facial bones and long bones. The fracture data is analyzed using Shannon Novak's predictive formula. Three women were identified who were most probably the victims of domestic abuse. All three of these victims came from the urban Coach Lane site. The rural site of Fewston did not have any female individuals with evidence of fractures common to domestic abuse. This perhaps suggests that domestic violence was more common in urban environments than rural environments.

Developmental instability and fluctuating asymmetry in the infant brain.

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Minor perturbations that occur during an organism's development are termed developmental instability (DI). DI is associated with subtle deviations in symmetry within structures, resulting in fluctuating asymmetry (FA). Increased measures of FA are thought to indicate heightened levels of DI. Studies of the skull in children with craniofacial anomalies have shown increased levels of FA, suggesting greater developmental instability. Sagittal craniosynostosis, the premature fusion of the sagittal suture, has been associated with increased FA in the skull. As the skull and brain develop as an integrated system, we hypothesize that levels of fluctuating asymmetry in the brain in infants with sagittal craniosynostosis are increased relative to those of unaffected infants.

Our study sample consisted of magnetic resonance images obtained from 10 infants with isolated sagittal synostosis, and 10 age-matched unaffected infants, aged 7-72 weeks. We collected 3D landmark coordinate data from