

# PALEOANTHROPOLOGY SOCIETY MEETING ABSTRACTS, CHICAGO, IL, 31 MARCH & 1 APRIL 2009

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## Ongoing Research on the DIK-1-1 Skeleton and New Data on the Deciduous Dentition

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Since its discovery in 2000, the DIK-1-1 partial skeleton (“Selam”) has been under careful cleaning, preparation, and investigation, with preliminary results published in 2006. In addition to documenting the anatomy of the earliest and most complete infant skeleton dated to 3.3 Ma, the find enabled us to address several critical questions pertaining to the locomotion, behavior, and ontogeny of *Australopithecus afarensis* with implications for that of other early hominin species. When discovered, the upper part of the skeleton included the whole skull, scapulae, clavicles, vertebrae, and ribs, which were in a non-anatomical articulation and encased in a very compact sand stone block. Particularly, the occlusal aspect of the deciduous dentition was completely inaccessible, because the maxilla and mandible were in occlusion. Due to this, only parts of the labial and buccal sides of these teeth were examined thus far. Even though CT scan images were used to investigate growth patterns of the unerupted permanent dentition, allowing us to determine the age at death and sex of “Selam,” we were not able to capture the occlusal morphology of the milk teeth using this technique. Cleaning and preparation of this extraordinary specimen has continued and we have made remarkable progress, recently including the separation of the very delicate jaws, making it possible to study the occlusal morphology of both upper and lower deciduous dentition for the first time. In this paper I will report on preparation work accomplished since 2006 and discuss the morphology and metrics of the DIK-1-1 milk teeth, comparing them with that of *Au. afarensis*, *Au. africanus*, and other available and relevant early hominin dentition.

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## Results of the Second Field Season of the South East Ethiopia Cave Survey Project: Test Excavations, Survey, Rock Art, and Speleothems

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The South East Ethiopia Cave Survey Project conducted its second season of fieldwork in October 2008 in the Dire-Dawa, Harar, and Chiro (Asebe Teferi) areas. The team conducted test excavations to assess the potential of sites recorded in the previous field season, surveyed for additional sites of archaeological importance, documented the location, characteristics, and condition of rock art occurrences, and collected speleothems for dating and paleoenvironmental studies. Rock art was recorded at eleven sites, three of which (in western Harerghe) had not previously been discovered. Much of the art is faded and in a vulnerable state, and continued efforts to document and conserve this art are urgently needed. Test excavations were conducted at three sites near Dire-Dawa that were identified as promising during the previous season—Goda Dubeta B, Gilbo Tate, and Goda Buticha. The testing at Goda Dubeta B encountered only 50 cm of disturbed cultural material (representing the LSA or Neolithic) before reaching a sterile layer of decaying bedrock. The cultural deposits at Gilbo Tate are at least 200 cm thick and show evidence of bioturbation. The upper deposits are heavily brecciated. A 1 m<sup>2</sup> test pit, dug to a depth of 70 cm, produced an abundance of lithics characteristic of the LSA and MSA, but no faunal remains; many of the MSA lithics bore heavy encrustations. The test excavation at Goda Buticha uncovered 250cm of cultural deposits, with a stratified LSA-MSA sequence, without reaching bedrock. Lithics, large mammal remains (represented exclusively by wild taxa), microfauna, charcoal, and ostrich eggshell were found throughout the sequence. Ostrich eggshell beads and hominin remains also were recovered from the MSA levels. Goda Buticha appears to have excellent potential for a full-scale excavation, and efforts to obtain radiometric dates are underway.

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## Extended Cranial Growth and Sexual Dimorphism in *Pan troglodytes*, *Gorilla gorilla*, and *Pongo pygmaeus*: Applications for Reconstructing the Social Behavior of Extinct Hominin Species

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Patterns of adulthood growth in a fossil hominin species, *Paranthropus robustus*, in combination with high inferred levels of sexual dimorphism indicate a reproductive strategy in which males adopt a dominance hierarchy and attempt to monopolize mating access to females (Lockwood et al. 2007). Of particular relevance is the timing of maturity with respect to the attainment of full body size, in that sex differences in the timing of growth cessation are indicative of a social structure with high levels of intraspecific male competition. Although extended body mass growth has been observed in captive hominoid species (Leigh and Shea 1995), no study to date has investigated patterns of cranial growth and sexual dimorphism in light of socioecological variables. This paper examines patterns of growth in the skull and mandible around and following the attainment of dental maturity in three species of extant hominoid primates: *Pan troglodytes*, *Gorilla gorilla*, and *Pongo pygmaeus*, with a particular focus on which cranial features demonstrate change with age. Cranial growth following dental maturity is found in male chimpanzees, gorillas, and orang-utans, and in female chimpanzees and gorillas, all of whom adopt social structures characterized by dominance hierarchies. Extended cranial growth is not observed in female orang-utans. Patterns of cranial growth are interpreted in conjunction with levels of cranial dimorphism, life history characteristics, ecological factors, and the nature of intrasexual competition prevalent in these extant primate species. Results also are discussed in relation to their application to fossil hominins and the evolution of human social behavior.

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### References Cited:

- Leigh, S.R. and Shea, B.T. 1995. Ontogeny and the evolution of adult body size dimorphism in apes. *American Journal of Primatology* 36: 37–60.  
Lockwood, C.A., Menter, C.G., Moggi-Cecchi, J., and Keyser, A.W. 2007. Extended male growth in a fossil hominin species. *Science* 318: 1443–1446.

## The Ontogeny of the Great Ape Scapula as Related to Locomotion

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The discovery of an infant *Australopithecus* specimen and associated complete scapula in 2002 (Alemseged et al. 2006) prompted more questions than answers regarding the importance and degree of arboreality in *Australopithecus*. Why does this infant appear to have scapular proportions more similar to those of *Gorilla* than to *Pan* or *Homo sapiens*, which are phylogenetically closer to *Australopithecus* than is *Gorilla*? Does scapular shape reflect function or phylogeny (or both)? Studies tracking the ontogenetic development of the scapula during infancy are scarce, as are studies attempting to link muscle action (locomotion) to scapular development. The current study aims at tracking *Pan* and *Gorilla* scapular growth between 0 to 11 years (infants and juveniles) using Geometric Morphometrics. Published locomotor age classes (Doran 1992, 1997) and EMG studies were used to predict how bone may respond to changing muscle strains during development. Apart from changes at the scapular borders, the results of my project show that the glenoid fossa and the scapular spine rotate cranially at a specific stage in both species, (an unexpected and novel find). Function, therefore, may contribute more significantly to scapular shape than previously thought, albeit constrained by certain genetic boundaries.

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### References Cited:

- Alemseged, Z., Spoor, F., Kimbel, W. H., Bobe, R., Geraads, D., Reed, D., and Wynn, J. G. 2006. A juvenile early hominin skeleton from Dikika, Ethiopia. *Nature* 443: 329–301 [supplementary information pp.1–21].  
Doran, D.M. 1992. The ontogeny of chimpanzee and pygmy chimpanzee locomotor behavior: a case study of pedomorphism and its behavioral correlates. *Journal of Human Evolution* 23: 139–157.  
Doran, D. M. 1997. Ontogeny of locomotion in mountain gorillas and chimpanzees. *Journal of Human Evolution* 32: 323–344.

## A 3D Geometric Morphometric Analysis of the Morphological Evolution of the Cranial Base and Floor in *Homo*

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Until recently, basicranial shape has been mainly measured by different versions of cranial base angles, which assess angular relationships between pre-sellar and post-sellar basicranial components in the midline. These angles, however, completely ignore changes at the lateral cranial floor. Here, we present the first results of an ongoing line of research using geometric morphometrics and virtual anthropological techniques to analyze evolutionary variation of surface morphology of the cranial fossae. To this end we collected 158 3D-landmarks and sliding semilandmarks on the anterior and middle cranial fossae and the midline cranial base of modern humans and Pleistocene hominins. Preliminary results suggest different modifications of the midline base and lateral floor between the *Homo erectus* s. l. configuration and Neanderthals on the one hand and modern humans on the other. These basicranial differences appear also integrated with facial morphology. In either group the midline base becomes lowered with respect to the lateral cranial floor and the medio-lateral dimensions of the anterior and middle cranial fossae become expanded. In Neanderthals, however, the midline base is also shifted anteriorly—a shift that we do not observe in modern humans. These findings underline that understanding the evolution of the cranial base in *Homo* is important not only because morphological changes at the lateral basicranium may be related to modifications of brain morphology but also because changes in brain shape could potentially interact with facial morphology via the basicranial floor.

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## Lumbar Lordosis and the Posture of La Chapelle-aux-Saints

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Ever since the discovery of the La Chapelle-aux-Saints Neandertal, the question of its posture has been under debate. Although bipedality has never been in question, the thinking about the fine details of its posture has been swinging back and forth between two opposing interpretations. One sees the posture of La Chapelle-aux-Saints as essentially modern, associated with fully upright posture (Trinkaus 1985), and the other, as incompletely erect, with bent posture and an inefficient bipedal gait (Boule 1911–1913). As lumbar lordosis plays an important role in upright posture, calculating the lordotic angle of the lumbar spine of La Chapelle-aux-Saints can contribute to our understanding of its posture. We calculated the lumbar lordosis angle of La Chapelle-aux-Saints by using a linear regression model that was specifically developed for this specimen. The regression model is based on the close correlation between the lordotic curvature and the orientation of the articular processes in the lumbar spines of living primates (modern humans and nonhuman primates). Our findings indicate that the lumbar lordosis angle of La Chapelle-aux-Saints is at the lower spectrum of lordosis found in modern humans. This finding supports Boule's conclusion (1911–1913) that the lumbar curvature of La Chapelle-aux-Saints was less pronounced than that of the majority of modern humans. Yet, this finding alone does not indicate bent posture and insufficient bipedal gait.

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### References Cited:

Boule, M. 1911–1913. L'Homme Fossile de La Chapelle-aux-Saints. *Ann. Paleont.* 6: 11–172.  
 Trinkaus, E. 1985. Pathology and the posture of the La Chapelle-aux-Saints Neandertal. *American Journal of Physical Anthropology* 67: 19–41.

## Reevaluation of Faunal Turnovers in the Southern Levant During the Last Glacial and the Effects of Climatic-Forcing on Hominin Population Dynamics

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Evidence for faunal turnovers has been related to climatic forcing as a cause for dispersal/extinction of hominins in the Southern Levant (Shea 2008). Others (Jelinek 1980; 1982), have suggested that inter-site variation in Middle Paleolithic (MP) micromammal fauna reflects spatial differences within the region. Distinction between these hypotheses has implications for understanding continuity vs. turnover in hominin taxa during this time period. Since the original analysis of micromammal faunal turnovers in Southwest Asia (Tchernov 1998), a wealth of paleoclimatic proxies have been studied and cave sediments have been dated. This new data enables reevaluation of the hypothesis that climate-induced micromammal turnovers were a common feature in the Upper Pleistocene of the Southern Levant. This study presents a two-pronged approach to test for microfaunal turnovers in the MP of the Southern Levant. First, I developed a null model by analyzing the distribution of extant rodent communities across different habitats in correlation with climatic variables.

Second, I analyzed the distribution of taxa from micromammal assemblages in the Southern Levant spanning MIS 5–3 in comparison to the null model distribution and to local paleoclimatic proxies. Distribution of modern rodents has shown that presence-absence patterns of taxa vary along rainfall gradients in east-west and north-south trajectories and thus can be used to distinguish between Mediterranean, semi-arid, and arid regions in the Southern Levant. 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 persist during the MP throughout the Southern Levant. These results suggest that although hominin taxa show evidence of turnover during the Upper Pleistocene in the Southern Levant, we need to be more cautious about the role of climate-forcing in the process.

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#### References Cited:

- Jelinek, A. 1980. The Middle Paleolithic of the Levant. In: Sanlaville, P. and Cauvin, J. (Eds.), *Prehistoire du Levant. Chronologie et Organisation de L'espace depuis les origines jusqu'au VIIe Millénaire*. Éditions du Centre National de la Recherche Scientifique, Paris, pp. 299–304.
- Jelinek, A.J., Farrand, W.R., Haas, G., Horowitz, A., and Goldberg, P. 1973. New excavations at the Tabun Cave, Mount Carmel, Israel, 1967-1972; A preliminary report. *Paléorient* 1: 151–183.
- Shea, J.J. 2008. Transitions or turnovers? Climatically-forced extinctions of *Homo sapiens* and Neanderthals in the east Mediterranean Levant. *Quaternary Science Reviews* 27: 2253–2270.
- Tchernov, E. 1998. The Faunal Sequence of the Southwest Asian Middle Paleolithic in Relation to Hominid Dispersal Events. In: *Neandertals and Modern Humans in Western Asia*, Akazawa, T., Aoki, K., and Bar-Yosef, O. (Eds.). Plenum Press, New York, pp. 77–90.

## Variation in Holocene Khoesan Dentition

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There have been many studies of dental variation in Holocene populations of Europe and the Americas, but few of African populations. Dental analyses of the Holocene Khoesan populations of Southern Africa provide insight into the biological evolution of an anthropologically important people. Here, we present results on metric and non-metric dental analyses of this Sub-Saharan African group, including an intensive focus on Early Holocene material. Data were collected from >650 adult Khoesan individuals. When possible, standard dental measurements were taken on all teeth and cervical molar measurements compensated for teeth affected by heavy wear. Qualitative traits were also assessed for the permanent dentition using scoring procedures for key morphological traits, as outlined in the Arizona State University dental anthropology system. Metric data analyses indicate that tooth size fluctuations generally conform to the mid- to late Holocene size variations observed in other studies of cranial and post-cranial material. Teeth, during this time period, appear to be smaller than Early Holocene counterparts and discernible reductions are identified through most measurements. However, apparent tooth size fluctuations during the Early Holocene are also observed, and while these may coincide with notable climatic changes during this period, sample size constraints make firm conclusions difficult. In contrast, qualitative trait variation appears to be less variable and largely consistent throughout the sample. Although differences in trait frequencies among Southern African populations throughout the last 12,000 years do exist, there is no evidence for unique trait variation in any population, suggesting that population differences result from intrinsic factors affecting the populations, such as environmental and geographic variation, rather than gene flow from outlying areas. Taken together, these results support recent hypotheses of morphological and genetic continuity in Southern African populations during the Holocene.

## Timing the Appearance of *Homo* in the Turkana Basin

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Understanding the origin of *Homo* remains a central problem in paleoanthropology. Significant evidence relevant to this issue derives from the Omo-Turkana Basin of Kenya and Ethiopia. Here we focus on the question of when *Homo* first appears in the basin and assess the strength of first appearance data (FAD). The data derive from two databases: one for the Kenyan side of the Turkana Basin (16,500 records) and one for the lower Omo valley in Ethiopia (24,000 records). The earliest appearance of *Homo* is dated to about 2.4 Ma, but this FAD has to be assessed in relation to the abundance of paleontological samples preceding the first occurrence. In the Shungura Formation, *Homo* appears in Member E, at about 2.4 Ma. Earlier samples in the time range from 2.4 to 3 Ma include 6,244 fossil mammals that have not provided evidence of *Homo*. Thus, the earliest record of *Homo* in the Shungura Formation may be close in time to a true origination or migration event. At Koobi Fora the earliest record of *Homo* derives from the Upper Burgi Member and dates to about 2 Ma. However, at Koobi Fora there is an unconformity below the Upper Burgi Member, and lower strata dating back to 3 Ma provide a sample of only 204 fossil mammals. Thus this FAD has a large margin of error. On the west side of Lake Turkana the earliest specimen attributed to *Homo* is a molar from the base of the Kalocho Member dated to about 2.3 Ma. The sample from the Nachukui Formation is small and therefore this FAD at near 2.3 Ma also has a large margin of error. The data discussed here indicate that the critical time period for understanding the origin and dispersal of *Homo* is between about 3 and 2.4 Ma.

## Notes From the Interior: Recent Archaeological and Paleontological Investigations at Erfkroon, South Africa

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At Erfkroon, northwest of Bloemfontein, our excavations in Late Quaternary terrace deposits on the Modder River produced a lengthy depositional sequence revealing *in situ* archaeological, faunal, and charred macrobotanical remains dating to the Middle and Late Pleistocene. We identified nine pedo-stratigraphic units exposed by gully erosion, and established preliminary age control using luminescence and ESR dating. In 2006 and 2008, we recovered abundant stone artifacts and spectacular faunal remains from six locales spanning the last ~165k years. Middle Stone Age (MSA) and Later Stone Age (LSA) occupations, including a rare Early LSA component, provide a singular view of the MSA to LSA transition. Additionally, Late MSA occupations contain stone tool assemblages with unique technological and typological characteristics (alternatively beveled retouch and bifacially trimmed flake-blades) unknown from more commonly excavated coastal MSA shelters and caves. Faunal remains from current and previous projects (Churchill et al. 2000) include a partial *Megalotragus priscus* skull with horn cores, the anterior half of a fully articulated large equid skeleton, a fox skull, a fragmentary lion mandible, fish vertebrae, freshwater crab and reptile remains, and a variety of other macro- and micro-mammalian fauna. These Florisian Land Mammal Age remains reflect riverine paleoenvironments and complement the lacustrine-focused vertebrate assemblages from the nearby Florisbad and Vlakkraal spring mounds. Other locales with *in situ* materials at Erfkroon remain to be excavated and we plan to survey uninvestigated dongas upstream and downstream along the Modder River. Open sites in the grassveld with long and continuous occupational records are rarely discovered and excavated. Sites such as Erfkroon can provide a detailed and integrated record that will help us to establish the nature, tempo, and range of human adaptations in the interior during this unique period of prehistory when anatomically modern hominins first evolved and behavioral modernity emerged.

### References Cited:

Churchill, S. E., J. S. Brink, L. R. Berger, R. A. Hutchison, L. Rossouw, D. Stynder, P. J. Hancox, D. Brandt, S. Woodborne, J. C. Looock, L. Scott, and P. Ungar. 2000. Erfkroon: a new Florisian fossil locality from fluvial contexts in the western Free State, South Africa. *South African Journal of Science* 96: 161–163.

## New Middle Pleistocene Excavations on the West Coast of South Africa

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The Early-Middle Pleistocene is one of the most intriguing and understudied periods of human evolution. This time period may record the extinction of *Homo erectus* in Africa and appearance of the archaic forms of our species (*Homo sapiens*) as well as the appearance of a subsequently expansive behavioral tradition (Middle Stone Age). Yet the study of Middle Pleistocene hominin behavior has been largely focused on variation in large bifacial tool morphology. Complementary investigations of landscape scale variation in Middle Pleistocene hominin behavior are relatively limited. Here we report on new excavations in Middle Pleistocene deposits in the West Coast National Park which may help clarify major features of Middle Pleistocene hominin evolution by linking ecology and subsistence behavior to Acheulian technology. The sediments in the West Coast National Park region and surrounding private nature reserves are stratigraphically complex, yet may preserve one of the largest Middle Pleistocene land surfaces in South Africa. Here we report on evidence of hominin behavior from Acheulian artifacts and associated fossil fauna. Studies of the associated paleoenvironments are described through a variety of proxies of past environments. Initial investigations suggest that variation in landscape use may explain the diversity exhibited in Middle Pleistocene industries. Further, evidence from artifact provenance studies suggests that artifact transport played a significant role in the patterning found in Acheulian localities. This investigation hopes to expand the understanding of the Acheulian beyond simple artifact description to patterns of hominin behavioral ecology.

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## The Interior of Southern Africa as a Unique Habitat and Evolutionary Source Area for Periodic Large Mammal and Human Dispersals During the Middle and Late Pleistocene

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The interior of southern Africa is a unique, permanently open temperate grassland where an endemic set of grazing ungulates evolved during the last ~ 1.0ma, a time that spans the Cornelian and Florisian Land Mammal Ages. The black wildebeest, *Connochaetes gnou*, evolved locally from a blue wildebeest (*C. taurinus*) ancestor as a direct response to the appearance of open grasslands. It has permanent mating territories, which are visually patrolled and this behavior can only function in permanently open habitat. There is a clear distinction between the open grasslands of the interior and the closed habitat Fynbos vegetation of the Cape coastal and montane areas, which is reflected by mainly small-bodied browsing forms in the Fynbos and the grazing plains-living ungulate fauna of the interior. A surprising aspect of the Cape coastal zone is the periodic presence during the Middle and Late Pleistocene of open habitat grazing forms, such as black wildebeest and blesbok (*Damaliscus pygargus*). This phenomenon is explained as the biogeographic by-product of the glacial-interglacial cycle. During glacials, lowered sea levels exposed the continental margin to form open habitat, suitable for grazing ungulates. Glacial vicariance in coastal grazing ungulates, evident in their reduced size when compared to contemporary interior populations, suggests that the interior functioned as a source area for large grazing ungulates during glacials and that coastal populations became isolated in closed-mosaic environments during interglacials. Thus, geographic isolation of daughter populations resulted in drift, following dispersal events from the interior. Human populations may have responded similarly and it is likely that Pleistocene hominin hunting strategies would have responded to these differences too. Recently excavated Holocene large ungulate mass kill/processing sites in the interior grassland and their absence in the Cape coastal zone show that hominin hunting strategies took advantage of these structural differences in faunal resources.

## Hadza Honey and Implications for the Evolution of Meat-Eating in Early *Homo*

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Honey is second only to meat as the most important, preferred food in Hadza society. Hunting and scavenging by Hadza men provide most meat, which is handled communally and shared extensively. Wild honey also is acquired predominantly by Hadza men, who eat most of it at points of acquisition. Hunting and scavenging for meat are high-risk foraging activities that often fail, but Hadza men, who possess the necessary technology (metal axes) to access abundant honey from hives of three significant species of wild bees, easily solve daily energy requirements by collecting and consuming prodigious quantities of honey when meat is unavailable. Honey collecting also yields a ready source of animal protein through the consumption of bee larvae. We report honey yields from over 50 days of focal person follows of wet and dry season honey collecting by Hadza men. Honey yields per hive vary from one tablespoon or less from small, stingless bees to several kilograms from large African "killer bees," which also yield edible larvae. Abundant honey mediates daily against an energy deficit from unsuccessful meat foraging. Judging from archaeological evidence of butchery extending well into the Pliocene, the incentive and the technology to acquire large animal meat were present early in our evolution, but the capability to acquire it efficiently is debated. How could early *Homo* have invested significant foraging time searching for meat when the probability of success was relatively low? For early *Homo* in savanna woodlands, honey would have had a huge ameliorating effect on daily energy budgets when depleted by failed meat foraging. Honey would have been abundant and readily accessible using Oldowan stone technology.

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## Hind Limb Loading in Primates: Insights into Locomotor Behavior of the Ape Common Ancestor

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Debate over the importance of hand-assisted bipedalism in the great ape common ancestor (Begun et al. 2007; Crompton and Thorpe 2007; Thorpe et al. 2007) may benefit from clarifying the extent to which habitually suspensory Asian apes use their hind limb in supporting body weight. Because compressive body weight and joint reaction forces are transferred through subchondral bone underlying articular surfaces of limb bones, maximum radiodensity patterns in subchondral bone may reveal habitual joint loading (Carlson and Patel 2006). If suspensory apes support substantial body weight with hind limbs, e.g., hand-assisted bipedalism occurs rather than foot-assisted forelimb suspension (c.f. Hunt et al. 1996), we predict areas of maximum radiodensity in subchondral bone of

their distal tibiae could approach the extent of areas in quadrupeds and bipeds. We compared suspensory, quadrupedal, and bipedal groups of primates ( $n=54$ ). We acquired serial computed tomography scans of their distal tibiae and analyzed subchondral bone to infer habitual tibiotalar joint loading. Although non-significant, quadrupeds exhibit larger areas of maximum radiodensity in the distal tibia compared to suspensory primates, a pattern similar to one found in the distal radius. Bipeds have surprisingly small areas of maximum radiodensity, similar to their distal radius, but opposite our predictions. Although direct comparison of radial and tibial data is not possible, significant differences between quadrupeds and suspensory primates in relative areas of maximum radiodensity at the distal radius and non-significant differences at the distal tibia suggest that hind limb compressive loading is more similar between the two groups than forelimb compressive loading. This is consistent with the hypothesis of increased compressive loading in the hind limbs of suspensory apes (e.g., weight support during forelimb-assisted bipedalism). It is premature, however, to suggest that these results prioritize a forelimb-assisted bipedal condition over a knuckle-walking condition for the common ancestor of apes.

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#### References Cited:

- Begun, D.R., Richmond, B.G., and Strait, D.S. 2007. Comment on "Origin of human bipedalism as an adaptation for locomotion on flexible branches." *Science* 318, 5853.
- Carlson, K.J. and Patel, B.P. 2006. Habitual use of the primate forelimb is reflected in the material properties of subchondral bone in the distal radius. *Journal of Anatomy* 208: 659–670.
- Crompton, R.H. and Thorpe, S.K.S. 2007. Response to comment on "Origin of human bipedalism as an adaptation for locomotion on flexible branches." *Science* 318, 5853.
- Hunt, K.D., Cant, J.G.H., Gebo, D.L., Rose, M.D., Walker, S.E., and Yulatos, D. 1996. Standardized descriptions of primate locomotor and postural modes. *Primates* 37: 363–387.
- Thorpe, S.K.S., Holder, R.L., and Crompton, R.H. 2007. Origin of human bipedalism as an adaptation for locomotion on flexible branches. *Science* 316: 1328–1331.

## 3D Endocasts Versus 3D Brains: A Test of Accuracy Using Virtual Techniques

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The use of endocasts has become an integral aspect of research in hominid evolution. While naturally occurring endocasts provide a unique source of information on hominid brain morphology, pseudo-endocasts created from latex moulds of the interior of fossil crania also have been employed. More recently the use of high resolution CT scanning on fossils also has been used to create virtual endocasts from the interior of the skull. In 2007, Schoenemann and colleagues examined the reliability of virtual versus traditional endocasts. Their study on two human and two chimpanzee skulls observed a fair degree of correlation between the two forms of endocasts. While certain areas displayed more differences than others, in general they concluded that the error was relatively small, and the "variation in the pattern of error across the surfaces appears to be generally random" (Schoenemann et al 2007: 183). The same researchers note that there has been little evidence to empirically determine if the surface morphology of the brain is adequately represented on the endocranial surface of the skull. The present study tests this assumption and looks at the congruence between: i) virtual endocasts created from the endocranial surface of the skull; and, ii) virtual models created from the brain of the same individual. Magnetic Resonance Imaging (MRI) data of living primates was used to create the two virtual models for several specimens including chimpanzees and modern humans. The two 3D models for each individual were inspected and differences compared. The results are discussed in relation to the use of virtual endocasts for future studies of primate brain evolution.

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#### References Cited:

- Schoenemann, P.T. et al. 2007. Validation of plaster endocast morphology through 3D CT image analysis. *American Journal of Physical Anthropology* 132: 183–192.

## Changes in Occupation Intensity During the Lower and Middle Paleolithic at Tabun Cave, Israel

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Considerable attention has been given to occupation intensity and settlement patterns in the Levantine Middle Paleolithic but relatively little is known about regional landscape use and site function during earlier times. Tabun Cave in Israel is an ideal place to contrast site use and mobility in the late Lower Paleolithic with the Middle Paleolithic because its deposits encompass a considerable amount of time for both periods. This study addresses these issues by examining changes in artifact density over time at Tabun in conjunction with other indicators of occupation intensity. Because density measurements were not taken during the excavation of Tabun, I used ArcGIS 9.2 and three-dimensional data obtained during the 1967 to 1972 excavations by Arthur J. Jelinek to calculate the volume for each of the stratigraphic units. The GIS-based method developed for this study can be used to obtain volumetric measurements for any site where the majority of artifacts have been plotted using three-dimensional coordinates. Variation in artifact density, retouch frequency, burning, and retouch intensity indicates that there was a significant change in how hominids utilized the site from the Lower to Middle Paleolithic. The Middle Paleolithic deposits reveal a pattern of site use that is comparable to other studies from both the Levant and Europe (Kuhn 2004; Riel-Salvatore and Barton 2004; Meignen et al. 2005). Evidence from the Lower Paleolithic deposits, however,

shows a different pattern of site use, one which indicates that these earlier groups may have organized their land use differently than later groups from both Europe and the Levant.

#### References Cited:

- Kuhn, S.L. 2004. Middle Paleolithic Assemblage Formation at Riparo Mochi. In *Processual Archaeology: Exploring Analytical Strategies, Frames of Reference, and Cultural Process*, A.L. Johnson (Ed.). Praeger Publishers, Westport, CT, pp. 31–60.
- Meignen, L., O. Bar-Yosef, J.D. Speth and M.C. Stiner. 2005. Middle Paleolithic Settlement Patterns in the Levant. In *Transitions before the Transition: evolution and stability in the Middle Paleolithic and Middle Stone Age*, E. Hovers and S. L. Kuhn, (Eds.). Plenum Press, New York, pp. 149–169.
- Riel-Salvatore, J. and C.M. Barton. 2004. Late Pleistocene Technology, Economic Behavior, and Land-Use Dynamics in Southern Italy. *American Antiquity* 69(2): 257–274.

## The Fauna of the Terminal Middle Paleolithic at Weasel Cave (Door Mouse Hall Chamber), North-Central Caucasus, North Ossetia, Russia

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This paper presents the first detailed study of faunal remains from the Door Mouse Hall (DMH) chamber of the Weasel Cave site (Caucasus Mountains, North Ossetia, Russia). The goal of the project is to investigate terminal Middle Paleolithic hominin subsistence behavior and site use in the Northern Caucasus Mountains. The relative behavioral adaptations of Middle and Upper Paleolithic hominins are central to a number of hypotheses of Neanderthal disappearance (D'Errico and Goñi 2003; Stiner and Kuhn 2006; Stringer et al. 2004). Thus, the results are directly relevant to models of the Middle to Upper Paleolithic transition. Because Weasel Cave has one of the deepest continuous Lower through Middle Paleolithic archaeological sequences in the Northern Caucasus, the site provides an unparalleled opportunity to study the long-term evolution of hominin behavior in this region, right up until the period of Neanderthal disappearance. The DMH chamber has yielded a large, well-preserved faunal assemblage, together with lithic artifacts, burnt bone, other archaeological features, and radiocarbon dates. The current analysis focuses on the final Middle Paleolithic deposits (Level 4), and provides insight into the activities of hominins as the Paleolithic occupation of the site ended. Together with the remains of hominin-butchered prey animals, the faunal assemblage from DMH Level 4 includes cave bear (*Ursus speleaus*) and hyena (*Crocuta* sp.), as well as evidence of bone modification by carnivores. Although some of these carnivores may have died naturally in the cave, at least one of the bears was processed by hominins. Untangling the complex accumulation events that resulted in this deposit is critical to understanding hominin behavior and site use. A taphonomic analysis of all bone surfaces by stereomicroscope, together with a comprehensive taxonomic analysis using the Smithsonian's (NMNH) mammal and fossil collections, allowed a comprehensive zooarchaeological analysis of the fauna from this significant locality.

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#### References Cited:

- D'Errico, F. and Goñi, M.F.S. 2003. Neandertal extinction and the millennial scale climatic variability of OIS. *Quaternary Science Reviews* 22: 769–788.
- Stiner, M.C. and Kuhn, S.L. 2006. Changes in the 'Connectedness' and Resilience of Paleolithic Societies in Mediterranean Ecosystems. *Human Ecology* 34: 693–712.
- Stringer, C., Pälke, H., van Andel, T.H., Huntley, B., Valdes, P. and Allen J.R.M. 2004. Climatic stress and the extinction of the Neanderthals. In *Neanderthal and modern humans in the European landscape of the last glaciation: archaeological results of the Stage 3 Project*, van Andel, T.H. and Davies, W. (Eds.). London, UK, Oxbow Books, pp. 233–240.

## Teeth: An Integral Part of the Paleolithic Tool Kit

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Recent hunter-gatherers, such as the Inuit of Alaska, Canada and Greenland, have been noted for the cultural use of their teeth as well as high rates of tooth wear. It has often been supposed that ancient hunter-gatherer's teeth also formed an integral part of their toolkit. It can therefore be predicted that changes in the hominin toolkit will be reflected in changes in tooth wear patterns. This paper presents the results of a study examining tooth wear patterns in Late Pleistocene and Early Holocene hominins. Permanent tooth wear was measured from digital photographs using computer image analysis software and a graphics tablet. The area of the occlusal surface and the area of exposed dentine were both measured, and a dentine proportion calculated by dividing the area of dentine by the area of occlusal surface. Wear patterns were compared independent of age, which was achieved by dividing the dentine proportions of each tooth by that of the first molar. The results showed clear differences in tooth wear patterns between hominins associated with markedly different toolkits. In general, as the toolkits become more complex over time, the amount of anterior tooth wear decreases. Similarities between tooth wear patterns in Middle Paleolithic Neanderthals and Early Modern Humans, suggest that tool technologies have a greater influence on tooth wear patterns than hominin species. Differences between males and females also were found in some groups, providing possible evidence of sexual division of labour, something that is difficult to determine from the stone tools alone.

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## The *Proconsul* Distal Antebrachial Epiphysis from KPS: First Description and New Insight in the Emergence of Hominoid Locomotor Specializations

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Between 1984 and 1985, seven distal antibrachial epiphyses of *Proconsul* were discovered at Kaswanga Primate Site (KPS), Kenya. Never before described, these specimens represent at least two subadult individuals (III and VIII) and constitute the richest documentation to date of the distal forearm of a Mio-Pliocene taxon. The morphological variability they highlight makes them a reference sample for the Mio-Pliocene hominoids. We describe seven distal epiphyses representing three ulnae (KNM-KPS U1, U2, U5) and four radii (KNM-KPS R5, R6, R11, R12), focusing on musculoligamentous attachments and joint areas. The comparative sample is comprised of 309 extant anthropoids (ceboids, n=13; cercopithecoids, n=86; hominoids, n=210) and original fossil ulnae (n=9) and radii (n=9) assigned to Miocene anthropoids (*Proconsul heseloni*, *Turkanapithecus*), and Pliocene hominoids (*Australopithecus*, *Paranthropus*). The KPS material highlights a great morphological variability. Nevertheless, they resemble extant hominoid homologues with a deep and extended area of insertion of the palmar radiocarpal ligament (KNM-KPS R11) and a radioulnarly extended ulnar head (KNM-KPS U2, U5). With the other Mio-Pliocene specimens, they share some characters with extant apes: a globular ulnar head, large ulnar facets on the radius; distal antibrachial remains from KPS also present a marked area for the palmar radiocarpal ligament that is shared only by *Hylobates*, *Pongo*, and *Pan*. Functionally, these traits define important ranges of pronosupination and good stabilization for supination, which are related to climbing activities. The KPS *Proconsul* distal antibrachial epiphyses highlight significant pronograde climbing abilities that would preclude any form of suspension.

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## Initial Results of a Paleoanthropological Survey of the Djibouti Afar

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The Afar Depression spans northeastern Ethiopia and southwestern Djibouti, and is arguably the richest known repository of human fossils. Paleoanthropological surveys in the Ethiopian Afar have led to discoveries documenting the last six million years of human prehistory. The Djibouti Afar, in contrast, has only seen a few seasons of paleoanthropological survey in the early 1980s and is thus poorly known. In Fall 2007 we carried out a paleoanthropological survey of the Djibouti Afar. We provide here a preliminary report on the survey, as well as a description of some of the methods used (e.g., GIS, remote sensing, photo geocoding). We discovered three new sites in the Gobaad Basin that contain Oldowan lithics in apparent association with faunal remains, two sites with concentrations of Oldowan lithics but apparently lacking fauna, and several isolated large mammal skeletons. Initial examination of the lithics suggests substantial variation between the five sites in tool types and raw material. One surface concentration spans over 150m<sup>2</sup> and appears to be relatively undisturbed based on a number of refitting lithics. The presence in one basin of sites sampling different combinations of Oldowan lithics and fauna provides a testbed for hypotheses about the nature and causes of variation in the Oldowan, as well as the meat procurement behavior of early hominids. Testing of such hypotheses will, however, require additional fieldwork and excavation.

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## Actualistic Studies on Defining Traces on Stone Anvils and Implications for Recognizing Pounding and Digging Tools in the Plio-Pleistocene of East Africa

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The earliest Oldowan stone tools in the archaeological record appear at Gona, Ethiopia, at 2.6 Ma (Semaw et al. 1997). The traditional

hypothesis maintains that the sudden appearance of stone tools represents a threshold in human evolution. However, new lines of evidence presented here from our novel studies in primatology, primate archaeology (Haslam et al. in press), ethnography, functional hominin morphology, and paleoenvironmental studies argue the existence of a Pre-Oldowan pounding tool culture (see also Panger et al. 2002). Specifically, a series of actualistic field and laboratory studies (bipolar percussion, nut cracking, meat processing, marrow extraction, and digging stick manufacture) were carried out to quantitatively assess: 1) if hominin hand morphology was sufficient to carry out pounding and digging tasks; and, 2) if each pounding activity could be recognized and distinguished from one another. Experiments were conducted using basalt and phonolite from the Turkana Basin and mudstone from local sources. Afterwards, comparative analysis of Oldowan anvils was conducted in the National Museums of Kenya. Results showed the manual manipulative abilities of chimpanzees are sufficient to carry out the experimental tasks. Furthermore, the traces of various pounding and digging stick manufacture activities can be distinguished in the actualistic sample and used to identify specific tool-using behaviors in the archaeological record. This methodology was applied to analyze Plio-Pleistocene anvils from Koobi Fora and ruled out digging stick manufacture and meat butchery. Quantitative comparisons of anvil trace dimensions to those from Olduvai Gorge (Leakey 1971) show affinities to bipolar percussion and nut cracking activities. This new research methodology affords proxies for identifying pounding tools and digging sticks in the archaeological record and provides evidence towards an alternative to the threshold hypothesis, suggesting stone tool-use among hominins potentially dates as far back as our last common ancestor with chimpanzees.

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#### References Cited:

- Haslam, M., Hernandez-Aguilar, A., Ling, V., Carvalho, S., de la Torre, I., De Stefano, A., Du, A., Foley, R., Hardy, B., Harris, J., Marchant, L., Matsuzawa, T., McGrew, W., Mercader, J., Petraglia, M., Roche, H., and Visalberghi, E. in press. Primate archaeology: a new discipline. *Evolutionary Anthropology*.
- Leakey, M. 1971. *Olduvai Gorge, vol. 3. Excavations in Beds I and II, 1960-1963*. Cambridge: Cambridge University Press.
- Panger, M., Brooks, A., Richmond, B., and Wood, B. 2002. Older than the Oldowan? Rethinking the emergence of hominin tool use. *Evolutionary Anthropology* 11: 235-245.
- Semaw, S., Renne, P., Harris, J., Feibel, C., Bernor, R., Fesseha, N., and Mowbray, K. 1997. 2.5 million-year-old Stone tools from Gona, Ethiopia. *Nature* 385: 333-338.

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## Femoral Shaft Waist Distribution and its Relationship to Behavioral Reconstructions in Fossil Hominins

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Femoral midshaft is commonly used in biomechanical analyses for assessing behavior of fossil hominins. Besides the midshaft's practical advantages (its well-defined, accurate location across species, large available samples, limited impact of muscular structures), there is doubt as to how well it represents biomechanical phenomena. Here we examine the distribution of the femoral shaft waist (defined as the weakest point along the shaft and expressed as the %BML location with the smallest polar moment of area) relative to midshaft to address the question as to whether the midshaft reflects the same biomechanical phenomena in all specimens. Our sample consists of 53 recent humans of unknown sex and age. A-P and M-L diameters were measured on the left femoral shaft from 65% to 35% BML in 1% BML steps. Polar moment of area (J) was estimated following Pearson et al. (2006). The position of minimum value was then recorded. Results show that the level of femoral shaft waist is normally distributed (Shapiro-Wilk's test,  $p=0.35$ ) with mean, median, and mode located slightly proximal to midshaft. However, there is high variability in its location ( $SD=7.6$ ), with midshaft  $\pm 5\%$  BML representing minimum J for only 51% of our sample. We found no relationship between waist location and factors of bone length and body size; however, we did find a positive relationship between minimum J and M-L diameter ( $r=0.68$ ), suggesting that A-P diameter variability has less influence on waist location. We then employed a method we previously used (Sládek et al. 2008) to assess if such variability influences our ability to reconstruct midshaft J for incomplete femora. We find that J can be reliably calculated between 44% and 64% of BML assuming midshaft is its true value (the same range holds true for 53% BML level, which is the median and modal value in our sample).

#### References Cited:

- Pearson, O.M., Cordero, R.M., and Busby, A.M. 2006. How different were Neanderthals' habitual activities? A comparative analysis with diverse groups of recent humans. In: *Neanderthals Revisited: New Approaches and Perspectives*, Harvati, K. and Harrison, T. (Eds.). Springer, New York, pp. 135-156.
- Sládek, V., Berner, M., and Friedl, L. 2008. The error of midshaft cross-sectional location on human femora. Poster presented at 77th Annual Meeting of the American Association of Physical Anthropologists, Columbus, OH. April 9 - April 12, 2008.

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## Comparing Primate Crania: Differences Between Sexes and Between Species

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In his stellar, but all too short, career, Charles Lockwood made important contributions in many areas of primate and human evolution. His major areas of research interest included, in his own words, "skull anatomy .. sex differences, How does variation within species relate to variation among species? ...and a focus on quantitative techniques and geometric morphometrics, as methods of making research into these questions more rigorous." In this tribute to Charlie's life and work, we report on recent analyses of the relationship between sexual dimorphism and large scale patterns of cranial morphology in the primate skull using geometric morphometrics. In

a project aimed at quantifying primate cranial diversity across all primates, we digitized a set of 18 landmarks designed to capture overall cranial shape on male and female crania representing 66 genera of living primates. The landmark data were aligned, rotated, and isometrically scaled to common size using a Generalized Procrustes Analysis and then subjected to a Principle Components Analysis to identify the major axes of cranial variation and to create a primate cranial morphospace. We then used Discriminant Analysis based on the first 8 principle components to identify the factors distinguishing male and female crania within individual clades. In cranial shape, hominoids are the most dimorphic taxa, followed by cercopithecoids, platyrrhines, and strepsirrhines. For hominoids and cercopithecoids, the clades with the greatest amount of sexual dimorphism, PC 2 is primarily responsible for separating male and female crania. In the overall analysis, PC 2 is largely responsible for separating different genera of hominoids as well as separating colobines from cercopithecines. PC 2 also distinguishes different taxa of fossil hominins. This suggests that among catarrhines, patterns of cranial shape separating sexes within species are largely the same as those involved in separating many species, genera and subfamilies.

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## Another Look at the Lower Paleolithic of Kazakhstan: A Preliminary Description of Alpysbaev's Lithic Collections

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Resolving the antiquity and character of hominin occupation of Central Asia is central to questions concerning initial hominin dispersals across Eurasia. More specifically, the chronology of the Central Asian Lower Paleolithic and its techno-typological characteristics inform interpretations of the Movius Line and assumed cultural-historical connections between Central Asia and adjacent regions. To this end, we undertook a preliminary descriptive analysis of part of a relatively large lithic collection housed at Kazakhstan State University in Almaty, Kazakhstan. This work is better described as a reexamination of lithic material collected during two decades (1950s–70s) of extensive foot surveys of the southwestern and northeastern aspects of the Karatau Mountain range of South Kazakhstan and Zhambyl oblasts, Kazakhstan. Over this period, Alpysbaev collected surface material, conducted a handful of small-scale excavations, as well as the excavation of larger Middle Paleolithic sites in these regions bordering Uzbekistan. From these materials, we examined lithics (n=2,234) that Alpysbaev described as examples of the Clactonian tradition because of what he interpreted to be an absence of bifacial technology. Although this collection is temporally and spatially diverse, our initial results indicate that the descriptions of Alpysbaev dramatically under-represented the techno-typological variability and complexity expressed in the collection. While a lack of detailed documentation of the localities and sites from which the material was collected prohibits conclusive interpretations, Alpysbaev's collection offers important insights into the Lower and early Middle Paleolithic of Kazakhstan.

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## The Ontogeny of Extant Hominoid and *Australopithecus afarensis* Shoulder Morphology

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Researchers have hypothesized that the hard tissue morphology of the shoulder reliably reflects locomotor behavior among extant primates, frequently linking phylogenetically distant taxa with similar locomotor styles. This study tests how well primitive shoulder traits that have been linked with suspensory climbing in early hominins (e.g., cranially-oriented glenohumeral [GH] joints and relatively broad supraspinous fossae) sort ontogenetic series of extant hominoids that employ different locomotor styles. Additionally, as some apes decrease the amount of arboreality practiced during ontogeny (chimpanzees and gorillas), while others do not (orangutans and gibbons), traits were analyzed ontogenetically to determine if they follow a phylogenetically-constrained pattern of growth or if they change within taxa that demonstrate ontogenetic differences in locomotion. Finally, this study considers the juvenile *Australopithecus afarensis* skeleton from Dikika, Ethiopia, which provides a unique opportunity to examine the implications that shoulder morphology and ontogeny has for understanding australopith locomotor behavior. Extant ape GH joint angle values (ventral bar/glenoid angle [VBG]) were lower and more cranially-oriented than in modern humans, supporting the hypothesis linking this trait with suspensory activities. Dikika's VBG cannot be directly measured as the ventral surface is embedded in matrix, but an estimate of 128.8 (127.8–129.7) degrees was derived by regressing VBG against the axillary border/glenoid angle (ABG) among the extant sample, and an ABG of 118 for Dikika. This value is slightly lower than that of A.L. 288-11 (Lucy; 131), but both individuals have significantly more cranially-oriented GH joints than modern humans at comparable ontogenetic stages, and both fall among the extant apes. Intraspecific comparisons among extant hominoids show that GH orientation does not directly correspond with reported differences in behavior between juvenile and adult chimpanzees and gorillas. Thus, while GH joint orientation distinguishes extant hominoid locomotor groups, during ontogeny, the phylogenetic signal is stronger than the functional one.

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## An Investigation of Long Bone Curvature in Neanderthals and Modern Humans: Femur, Ulna, and Radius

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Since their discovery, Neanderthals have been described as having a marked degree of anteroposterior curvature of the femoral shaft. Although initially believed to be pathological, subsequent discoveries of Neanderthal remains led to femoral curvature as well as the lateral curvature of the radius being considered derived Neanderthal features. Femoral curvature has previously been used in racial identification in modern humans but its functional significance is poorly understood. A recent study of Neanderthals and early modern humans found no differences in femoral curvature, but did not consider size-corrected curvature. Therefore, the objectives of the present study were to: 1) use 3D morphometric landmark and semi-landmark analyses to quantify bone curvature (femur, ulna, radius) in Neanderthals, Upper Paleolithic and recent modern humans; 2) compare adult bone curvature between these populations; and, 3) test hypotheses of the effects of climate, body size, and activity patterns on curvature. Comparisons between and within populations were made using geometric morphometrics (3D landmarks) and standard multivariate methods. The analysed material included all available Neanderthal and Upper Paleolithic modern human femora, ulnae, and radii, as well as archaeological (Mesolithic, Neolithic, Medieval) and recent human populations representing a wide geographical range and varied lifestyles. The study found that there are significant differences in the anatomy of the femur, ulna, and radius between Neanderthals and modern humans. Neanderthals have more curved femora and radii than modern humans. Early modern humans are most similar to recent modern humans in their anatomy. Analyses of recent modern humans indicate that femoral curvature and forearm curvature are responses to disparate influences. Femoral curvature is a good indicator of activity level and habitual loading of the lower limb. Curvature of the forearm is a consequence of cold adaptation and its purpose is to maintain biomechanical function of the forearm despite its foreshortening.

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## Virtual Chimeras in Paleoanthropology

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A chimera is a reconstruction of an incomplete fossil thanks to the preserved fragments from another fossil considered as phylogenetically close. This process has mainly been employed in a museographic aim to present a plausible reconstitution of the facial and head appearance of human fossils. Therefore, chimeras are not considered as scientific tools. A chimera of the cranium of *Sinanthropus pekinensis* was proposed by F. Weidenreich. A chimera of the Arago 21 skull was manually carried out in 1981 by mean of the Sangiran 17 temporal bone and its symmetric, and Swanscombe's occipital bone. We have used virtual reality tools to propose a new chimera of the Arago 21 skull, and a chimera of the neandertalian skull remains, Biache-Saint-Vaast 2. We proceeded to a virtual restoration of the Arago 21 distorted face, and parietal fragments (Arago 47) belonging to the same skull. We virtually compared by superposition the different lower and middle Pleistocene European hominid crania to restore Arago 21. The Ceprano skull presented the greatest morphological convergence. Temporal and occipital bones of this fossil were virtually isolated and articulated with the Arago remains. A rapid prototyping of this virtual chimera made it possible to present a new plausible museographic reconstitution of the complete cranium of this *Homo heidelbergensis*. We also used the chimera process for a virtual spatial positioning of the fragmented cranial remains of an earlier Neanderthal (Biache-Saint-Vaast 2) by superposition of Krapina cranium 3 and the La Ferrassie 1 skull. Chimeras can be done with virtual reality tools and materialized by rapid prototyping for museographic presentation. Some convergence of conformation between fossils can be noted during the process but they must be considered with a lot of caution.

## Biochronology of Eyasi, Tanzania: Implications for the Eyasi 1 Cranium and Associated Sangoan Technology

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Eyasi, Tanzania, preserves "archaic" *Homo sapiens* fossils including the cranium Eyasi 1, associated with Sangoan technology (Mehlman 1989; Reck and Kohl-Larsen 1936) and a recently discovered frontal bone associated with an early Middle Stone Age industry (Domínguez-Rodrigo et al. 2008). The Eyasi 1 cranium and Sangoan tools were recovered during the Kohl-Larsen expeditions of the 1930s along with a large collection of faunal remains. Radiometric efforts to date the older sediments of the Eyasi Basin ('lower fossiliferous unit', or beds A, B, and C), from which Eyasi 1 and the Sangoan artifacts are derived, have largely been unsuccessful (Mehlman 1987, 1989; Protsch 1981). Biochronological estimates using faunal lists published in the 1930s and 1940s (Dietrich 1942; Leakey 1936) have interpreted an Upper Pleistocene date (Cooke 1963; Howell 1979, 1982). New examination of the Kohl-Larsen faunal collection, numbering >3,600 specimens, suggests that the older Eyasi sediments are firmly of Middle Pleistocene age. The fauna includes several extinct species,

including *Hipparion*, *Theropithecus*, and *Kolpochoerus* that are not more rolled or 'derived' than the extant fauna in the collection (contra Leakey 1936). Overall the Eyasi fauna is similar in species composition to that of Bodo, Kapthurin K-3, and Olgosailie Member 10, placing it in the earlier half of the Middle Pleistocene.

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#### References Cited:

- Cooke, H.B.S. 1963. Pleistocene mammal faunas of Africa, with particular reference to Southern Africa. In: *African Ecology and Human Evolution*, Howell, F.C. and Bourlière, F. (Eds.). Aldine, Chicago, pp. 65–116.
- Dietrich, W.O. 1942. Ältestquartäre Säugtiere aus der südlichen Serengeti, Deutsch Ostafrika. *Palaeontographica Abt A* 94: 43–133.
- Dominguez-Rodrigo, M., Mabulla, A., Luque, L., Thompson, J.W., Rink, J., Bushozi, P., Diez-Martin, F., and Alcalá, L. 2008. A new archaic *Homo sapiens* fossil from Lake Eyasi, Tanzania. *Journal of Human Evolution* 54: 899–903.
- Howell F.C. 1978. Hominidae. In: *Evolution of African Mammals*, Maglio, V.J. and Cooke, H.B.S. (Eds.). Harvard University Press, Cambridge, pp. 154–248.
- Howell, F.C. 1982. Origins and evolution of African Hominidae. In: *The Cambridge History of Africa, Volume 1: from the Earliest Times to c. 500 BC*, Clark, J.D. (Ed.). Cambridge University Press, London, pp. 70–156.
- Leakey, L.S.B. 1936. A new fossil skull from Eyasi, East Africa. *Nature* 128: 1082–1084.
- Mehlman, M.J. 1987. Provenience, age and associations of archaic *Homo sapiens* crania from Lake Eyasi, Tanzania. *Journal of Archaeological Science* 14: 133–162.
- Mehlman, M.J. 1989. *Later Quaternary Archaeological Sequences in Northern Tanzania*. Ph.D. Dissertation, University of Illinois, Urbana-Champaign.
- Protsch, R. 1981. The paleoanthropological finds of the Pliocene and Pleistocene. In: *Die archäologischen und anthropologischen Ergebnisse der Kohl-Larsen-Expeditionen in Nord-Tanzania, 1933-1939*, Müller-Beck, H. (Ed.). Tübinger Monographien zur Urgeschichte 4(3).
- Reck H. and Kohl-Larsen, L. 1936. Erster Überblick über die jungdiluvialen Tier- und Menschenfunde Dr. Kohl-Larsen's im nordöstlichen Teil des Njarasa-Grabens (Ostafrika). *Geologische Rundschau* 27: 401–441.

## How Different Were Neanderthals? Stone Tool Function in Aurignacian and Middle Paleolithic Levels at Hohle Fels, Germany

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While we continue to debate the abilities (or lack thereof) of Neanderthals and the nature of their interaction with modern humans, we do so with a lack of understanding of the range of behaviors associated with stone tool function. Lithic technology changes dramatically between the Middle Paleolithic and the Aurignacian. How do these changes in technology relate to tool use? Was Aurignacian lithic technology used for a whole new set of behaviors, or is it just a matter of doing the same things with differently shaped tools? One of the difficulties in comparing Neanderthals with modern humans lies in the fact that we typically have to rely on comparisons of sites that are widely dispersed in space and time. The site of Hohle Fels in southwestern Germany offers us a unique opportunity to examine Middle Paleolithic and Aurignacian occupations at the same location. Samples of lithics (total n=78) from Middle Paleolithic (AH VI-VIII, 35,760–39,580 uncalibrated radiocarbon years b.p., n=40) and Aurignacian levels (AH Va, 31,750–32,550 uncalibrated radiocarbon years b.p., n=38) were examined microscopically for the presence of use-wear and residues. The overall pattern is similar for both levels and includes evidence for hafting of tools with resin as a mastic, impact fractures indicating thrusting/projectile use, wood and bone working, hide-working and butchery. Activities only found in one period include, for the Middle Paleolithic, perforating hide and cutting/scraping starchy plants and, for the Aurignacian, cutting/slicing bone and perforating wood. These results build on previous research which demonstrated that Aurignacian tool types did not represent specialized tool use. At Hohle Fels, even though the tool technology changes, Neanderthals and modern humans appear to be using them for similar activities.

## A Comparison of Intraspecific Skeletal Variation in *Australopithecus afarensis* and *Australopithecus africanus*

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Intraspecific skeletal variation, largely tied to sexual dimorphism, is a component of paleobiology that has implications for behavior and adaptation. Additionally, an understanding of intraspecific variation is necessary to effectively delineate species boundaries. It is common to use extant species as guides for assessing variation in fossil samples. Results of such studies based on cranial/dental and postcranial elements have often identified *Au. afarensis* as highly variable and strongly sexually dimorphic. Similar studies of *Au. africanus* samples have identified moderate postcranial variation in combination with highly variable crania and teeth. Potential sampling issues aside, the results imply different levels of sexual dimorphism in these Pliocene species, and some difference between cranial and postcranial dimorphism in *Au. africanus*. This study attempts to determine whether the difference in variation between the two species is significant and can be said to indicate discrete levels of sexual dimorphism, or is perhaps the consequence of sampling bias. The coefficient of variation is calculated for *Au. africanus* and *Au. afarensis* femoral and dental variables. In order to evaluate fossil variation, femoral and dental CVs are calculated in samples of extant taxa, including *Pan*, *Pongo*, *Homo*, and *Gorilla*. Bootstrapped distributions of CVs are generated. The probability that the difference in CV values between *Au. afarensis* and *Au. africanus* can be sampled from the differences in CV values in single taxa is assessed. Additionally, the probability that the level of fossil difference can be obtained from two subspecies or single species is assessed. In some instances the difference in variation between the fossil taxa can be sampled in single taxa. Further, the difference in variation between similarly dimorphic extant taxa sometimes exceeds that of

the difference between *Au. afarensis* and *Au. africanus*. The implications of these results for sample composition, taxonomy, and sexual dimorphism will be explored.

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## The Face of Dar-es-Soltane 5: A Re-Assessment

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Despite its richness and relevance to the evolution of modern humans, the Late Pleistocene fossil record of North Africa is not well understood. Early modern human specimens from sites characterized by the Aterian lithic industry have in the past been considered to be close in time to later Iberomaurusian samples. However, recent re-dating of Aterian sites suggests a much older age than previously thought for these remains (40–90 ka), raising the question of their possible relationship to the earlier North and sub-Saharan African, as well as the Eurasian, human fossil record. We conducted a 3-D geometric morphometric analysis of the facial morphology of the adult specimen Dar-es-Soltane 5 (DS5) aiming to decipher its affinities with earlier North African and Levantine fossils, Upper Paleolithic Eurasian (UPE) specimens, and North African Iberomaurusian populations. Our comparative sample comprised seven recent human geographic populations (African, Andaman, Asian, Australian, Inuit, European, Near Eastern; n=190); an Iberomaurusian series (n=22); and a several Middle and Late Pleistocene Eurasian and African fossil humans (n=28). Data were collected in the form of 3-D coordinates of nineteen facial landmarks, designed to best capture the morphology preserved in DS5. Coordinates were superimposed using Generalized Procrustes Analysis and then analyzed using Principal Components, Canonical Variates Analyses, Procrustes distances, Mahalanobis squared distances and cluster analysis. DS5 does not show very close affinities with the Iberomaurusian population in our analysis, but is similar to Qafzeh 9 and 6, to the Late Pleistocene North African specimen Wadi Kubaniya and to some degree also to the earlier North African specimen Jebel Irhoud 1. The Iberomaurusians show strong morphological similarities with our EUP sample, consistent with previous suggestions of shared population history for these groups. Implications of these results for the role of North Africa in modern human evolution are discussed.

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## Fossil Discoveries from Hoogland, a New Primate-Bearing Karstic System in Gauteng Province, South Africa

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In 1936, Robert Broom recovered fossil-bearing breccias from a cave system near the Hennops River, 14 miles west of Pretoria in the Schurveberg mountain region. Broom went on to describe a series of fossil specimens collected from paleocaves in the region, including the type specimen of *Papio (Dinopithecus) ingens* (SB 7). Here we report our initial interpretation of the geology, faunas, and taphonomy of the Hoogland paleocave site, located in the Schurveberg range on the farm Vlakplaats 354 JR in Gauteng Province (25°48'48.30"S, 28° 0'20.40"E). This site may represent the source for some of the 'Schurveberg' fossil materials originally published by Broom. The geology of the deposits adhering to the modern Hoogland cave walls indicate the presence of a vertical aven entrance that allowed for the introduction of exogenous clasts and skeletal materials. The current faunal assemblage is primarily composed of isolated craniodental specimens and small postcranial elements, which suggests significant peri- and/or postdepositional resorting. Despite the relatively small size of the Hoogland fossil assemblage (n=2,156), 54 individuals are represented across 8 orders; including an isolated *Parapapio* sp. (*broomi*?) canine, and a *Theropithecus oswaldi* m1. Combined paleomagnetic and biochronologic analysis indicate depositional periods between 3.0–2.0 Ma, with faunal deposition ~2.6 Ma. Processing of *ex situ* and *in situ* calcified sediments from Hoogland is ongoing, and will provide additional context for Plio-Pleistocene deposits that formed within topographically-enriched paleolandscapes of South Africa.

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## South African Plant Microfossils and the Role of USOs at Klasies River Mouth

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The role of plant underground storage organs (USOs) in human diet has been frequently debated. In South Africa in particular, Deacon (1993) noted that the plant life in the fynbos biome is lacking in consistent above-ground food resources. He argued that USOs would therefore have been the staple food source of humans in this area since at least the Middle Stone Age (MSA), and that these individuals

may have intentionally burned the fynbos in an effort to stimulate USO growth. However, we have to date very little direct material evidence for use of USOs in this area so far back in human history. Plant microfossils such as starch grains and phytoliths can be recovered from tools, soils and even dental calculus, and therefore have the potential to provide evidence for use of USOs and other plants. In order to identify ancient plant microfossils, one must first have a reference collection of modern microfossils to compare them to. We present here the beginnings of a South African plant microfossils database and its application to some preliminary data from a study of the archaeological microfossils recovered from stone tools and dental calculus from the MSA of Klasies River Mouth (KRM). These data allow us to test whether USOs were important contributors to human diet in the MSA at KRM, as well as to more broadly assess the role of plant foods during the archaic to modern human transition. The reference collection will provide a means to address questions of diet at even earlier periods of human evolution, including assessing their possible importance for the evolution of *Homo erectus* (as proposed in O'Connell et al. 1999) or australopiths (as in Laden and Wrangham 2005).

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**References Cited:**

- Deacon, H.J. 1993. Planting an idea: An archaeology of stone age gatherers in South Africa. *South African Archaeological Bulletin* 48: 86–93.  
 Laden, G. and Wrangham, R. 2005. The rise of the hominids as an adaptive shift in fallback foods: Plant underground storage organs (USOs) and australopith origins. *Journal of Human Evolution* 49: 483–498.  
 O'Connell, J.F., Hawkes, K., and Blurton-Jones, N.G. 1999. Grandmothering and the evolution of *Homo erectus*. *Journal of Human Evolution* 36: 461–485.

## The Rediscovery of Gravettian Fossils: Baouso da Torre 1 and 3 Skeletons (Italy)

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The Balzi Rossi caves (Italy) are very important Gravettian sites for several reasons, particularly for the number of burials and Venus figures. One of these caves, Baouso da Torre, was excavated by E. Rivière at the end of 19th century and he discovered three skeletons at Baouso da Torre (BT 1, 2 and 3). The human fossil remains were published by E. Rivière in 1887. Since E. Rivière died (1923), two of these skeletons have been lost (number 1 and 3). A part of Rivière's collection including human remains, shells, and lithic artifacts was rediscovered by us last year at the «Musée Lorrain» (Nancy, France). The aim of our presentation is to expose conditions of this essential rediscovery, criteria for identification of BT 1 and 3, and preliminary results on archeological context and biological features of these Upper Paleolithic fossils.

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**References Cited:**

- Rivière, E. 1887. *De l'Antiquité de l'Homme dans les Alpes-Maritimes*. Paris.

## Human Material and Recent Excavations at Maludong Cave, Yunnan Province, China

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Maludong (Large Deer) Cave was discovered by quarrying in 1989 and a rescue excavation occurred soon afterwards. During this excavation several hundred deer specimens were recovered along with some hominoid material and human remains, including two partial calvarii, as well as a hemi-mandible and post-crania. While the context of the human remains is known, the context of much of the faunal material has been lost, a large proportion of which was never studied after excavation. Recent excavations were undertaken to recover additional fossil material as well as material for dating and environmental analysis. All material was plotted using a total station, which also was used to create a multi-dimensional map of the cave. This research has so far identified several more human remains from the unstudied 1989 excavation finds, as well as additional hominoid specimens. It has also been noted that the human remains have undergone anthropogenic alteration, including burning. While the material falls within the range for modern human variation, the individuals show some archaic features and are robust. Only a handful of potential stone tools have been recovered from the site; many are hammer stones. However, some antler tools have been recovered. Both extant and extinct deer species have been recovered. The new excavations suggest that the larger extinct forms come from the base of the sequence, which is thought to be Late Pleistocene, while the smaller extant forms come from the upper Holocene layers.

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## Multidisciplinary Analyses of Pleistocene Occupations at Weasel Cave-Dormouse Hall Caves, North Ossetia, Russia

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More than 25 years of archaeological investigations of the Pleistocene occupations at the very large Weasel Cave-Dormouse Hall cave system reveals that it is the deepest stratigraphic context (>36 meters) in the Caucasus Mountains, and that the different chambers of the cave (of different stages of the Middle and Upper Pleistocene) were used differently by its inhabitants. Two of these occupation cycles are discussed: (1) the oldest occupation to date (and the bottom of the cave system has not yet been found) is represented by hominids (species indeterminate) with an Acheulian technology (Layers 36–29); and, (2) the youngest occupation (< 32,000 BP) in the Dormouse Hall chamber Layers 4a–4e with a Final Mousterian industry—the last two meters of cultural deposits directly below those of the Holocene. The results from traceological, planigraphical, archaeozoological, and contextual analyses reveal the compound repertory of behavioral strategies which allowed human survival in north-central Caucasia in the face of sharp fluctuations in the natural environment over these Pleistocene stages.

## A GIS-Based Approach to Documenting Large Canid Damage to Bones

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Patterns of carnivore tooth marking in archaeological bone assemblages provide important information on the taphonomic history of a site. They may allow us to infer the timing of hominin access to carcasses, as well as the extent of carnivore involvement in assemblage formation and/or modification. Experimental studies of modern carnivore tooth marking and gross damage patterns provide results that can be compared to archaeological and paleontological samples. However, bone damage data for most carnivore taxa are limited. This is particularly true for canids, which overlapped stone-tool using hominins in space and time in both Africa and Eurasia, but whose damage signal is not as well studied as that of lions (*Panthera leo*) or spotted hyenas (*Crocuta crocuta*). The bone sample analyzed here was collected from the wooded, one-acre enclosure of a pair of Mexican Gray wolves (*Canis lupus baileyi*) at the Wolf Conservation Center in South Salem, NY. These residues were derived from complete deer carcasses and individual bison limbs used in wolf provisioning. We used the image-analysis GIS approach described by Marean et al. (2001) to document bone preservation and tooth mark distribution; the first application of this approach to a carnivore-modified bone assemblage. The outline of each fragment identifiable to element was digitally recorded onto a template. Fragment outlines were overlain by element, creating a composite record of the shape and position of all fragments and facilitating MNE calculation. GIS also was used to plot tooth pit and score distribution by element, providing a composite record of all surface damage. Our results show a consistent pattern of bone portion preservation, as well as tooth mark distribution following wolf consumption. Future application of this methodology to assemblages formed by other carnivore taxa may assist in diagnosing carnivore-specific patterns of gnawing in archaeological bone assemblages.

### References Cited:

Marean, C. W., Y. Abe, P. J. Nilssen, and E. C. Stone. 2001. Estimating the Minimum Number of Skeletal Elements (MNE) in Zooarchaeology: A Review and A New Image-Analysis GIS Approach. *American Antiquity* 66: 333–348.

## Rethinking the Early Upper Paleolithic of Eastern Europe

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Integrating the Paleolithic record of Eastern Europe with that of other parts of northern Eurasia is a challenge, especially for the central plain where natural shelters are absent. The early Upper Paleolithic (EUP) presents a special problem because: (a) the Aurignacian industry is rare; (b) local EUP industries have been defined that are unknown elsewhere; and, (c) the number of EUP sites is generally low. Recent research at Kostenki-Borshchevo has yielded new information about the EUP on the central plain, and stimulated a rethinking of the EUP in Eastern Europe as a whole. The Kostenki-Borshchevo open-air sites are found along the margins of large ravine systems—where springs were active during MIS 3—incised into the high west bank of the Don River. These sites appear to represent an “EUP landscape” containing (a) locations at which large mammals (chiefly horse, but also reindeer and mammoth) were killed and/or butchered, and (b) habitation areas. The former are associated with artifacts typically found in Paleoindian kill-butchery sites of North America, which include flake scrapers and bifaces (i.e., typical Mousterian forms). Some also are associated with probable traces of long-term encampments containing typical Upper Paleolithic stone artifacts, non-stone implements, ornaments, and art. Typical Aurignacian lithic artifacts are found in several assemblages dating to 30,000–38,000 cal BP, but most have been traditionally classified as a local EUP entity (Gorodtsovskaya) because of the presence of the Mousterian forms. These assemblages are more parsimoniously

interpreted as part of an “Eastern Aurignacian” that also contain artifacts used for large-mammal butchery. Other assemblages comprising end-scrapers and Mousterian types are traditionally classified as a local “transitional” EUP industry (Streletskaya), but are more parsimoniously identified as tool kits for processing large mammal carcasses (remains of which they are associated with) and part of the same Eastern Aurignacian complex.

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## Hominoid Humeral Allometry: Implications for Human Paleontology

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In terms of its length, the humerus is perhaps the least variable of the limb bones among humans (Holliday 1999; Holliday and Ruff 2001). Similarly, humeral length : body mass ratios are similar across the African hominoids (Jungers 1991). Here we examine multivariate allometry of the humerus for five hominoid genera: *Homo*, *Pan*, *Gorilla*, *Pongo*, and *Hylobates*, and bivariate allometry among the African hominoids (including *Homo*). PCA of Procrustes shape data derived from 33 humeral pseudolandmarks for *Homo* (n=75); *Pan* (n=17); *Gorilla* (n=21); *Pongo* (n=28); *Hylobates* (n=8) reveals the following: first, in terms of the first two principal components, *Homo* and *Hylobates* are distinguished from each other and all other genera, while there is some overlap among *Pan*, *Pongo*; and, *Gorilla*. *Homo* is characterized by a straighter shaft, and a more distally-projecting trochlea than the other African hominoids. *Gorilla* is characterized by larger epicondyles and marked anteroposterior diaphyseal bowing (*Pan*'s diaphyseal bowing is intermediate). *Pongo* and *Hylobates* are characterized by straighter, narrower humeral diaphyses and much narrower condylar surfaces than the African hominoids. These shape patterns are suggestive of differences in humeral loading among hominoids, with the bowed shafts of *Pan* and *Gorilla* indicating that their weight-bearing humeri experience primarily compressive loads, whereas the shafts of *Pongo* and *Hylobates* (and likely *Homo*) experience primarily tensile loads. Bivariate allometry for a broader sample of *Homo* (n=284), *Pan* (n=24), and *Gorilla* (n=27) reveals that while humans and African apes have very different humeral length allometric trajectories (African ape humeri are strongly subisometric, while human humeri tend toward positive allometry), there is nonetheless significant overlap in humerus-to-body mass proportions among African hominoids in the chimpanzee/human/female gorilla size range.

### References Cited:

- Holliday, T.W. 1999. Brachial and crural indices of European Late Upper Paleolithic and Mesolithic humans. *Journal of Human Evolution* 36: 549–566.  
Holliday, T.W. and Ruff, C.B. 2001. Relative variation in human proximal and distal limb segment lengths. *American Journal of Physical Anthropology* 116: 26–33.  
Jungers, W.L. 1991. A pygmy perspective on body size and shape in *Australopithecus afarensis* (AL 288-1, “Lucy”). In: *Origines de la Bipédie chez les Hominidés*, Coppens, Y. and Senut, B. (Eds.). Editions du CRNS, Paris, pp. 215–224.

## Made Like a Biface, But Used Like a Scraper: Re-Assessing Middle Paleolithic Tool Variability From a Resharpener and Maintenance Point of View

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This paper will attempt to change the focus of variability studies in the Middle Paleolithic from morphological differences to the differences in the way shape changes due to resharpener and maintenance. Thus, the questions investigated here relate to how different tools were treated post-production, rather than how they were produced or how the finished product might have looked. The idea is that resharpener and maintenance relate to actual tool use more than production and initial morphology. Resharpener has been used to explain lithic variability within Paleolithic, Paleoindian, and Australian contexts, by proposing that morphological types represent stages in a continuum of re-use. Such continua can be quantitatively described and compared to each other by the changes that tool outlines undergo during reshaping and resharpener. This is similar to comparing ontogenetic trajectories in biological organisms, except that the direction of the change in size is reversed. Trajectories occupy comparable niches within the space of geometric-morphological possibilities. Results of such a comparative approach to resharpener trajectories in stone tools from the Middle Paleolithic of Europe are presented. In particular, the paper discusses differences and similarities between the trajectories of bifacial tools from Central European and Eastern Micoquian and the French Mousterian of Acheulean Traditions, and those of unifacial scrapers from the French Mousterian of Quina type. The conclusions suggest that, even though the two bifacial types are made through broadly similar concepts (façonnage or direct shaping vs. core-and-flake blank production), the Micoquian tools are treated more similarly to unifacial scrapers than they are to MTA handaxes. The final discussion concerns the question of whether classifications should be made based on production methods or on use and maintenance categories, and how the two approaches can be reconciled.

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## First Instance of a Bipartite Medial Cuneiform in the Hominin Fossil Record

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A complete bipartite medial cuneiform (BMC) (D4111), the oldest known instance in the hominin fossil record, was discovered at the Lower Paleolithic site of Dmanisi, Georgia. All known incidences of BMC in modern humans describe three morphological variations: complete and incomplete bipartition, and division only of the distal articular surface. The last variation seems to be most common. Frequency of all forms of BMC varies among populations 1:320 (Gruber 1877). Three medial cuneiforms, AL333-28, OH8, and Stw573, have been described in the fossil record of Plio-Pleistocene hominins. None of these specimens display any degree of bipartition. This suggests that a bipartite condition may have been present in early *Homo*, possibly with frequencies relatively higher than those occurring in modern humans. Comparison of size measurements of the Dmanisi BMC and bipartite samples from the grave, dating to the 9–11th centuries in Sigtuna, Sweden (Kjellström 2004), indicate that the Dmanisi specimen is relatively small. Morphology of the plantar part of the articular surface for the base of the first metatarsal is rather unique in the Dmanisi specimen in having a convex shape with a well-defined cleft. All descriptions of first metatarsals associated with all forms of BMC report division of the proximal articular surface into two facets by a ridge, forming an 8-shape. Interestingly, hominin first metatarsal bones Stw573, AL333, D2671, and D3442, the last one of which has anatomical association with BMC, have 8-shape proximal articular surfaces, exhibiting depressed areas on both the medial and lateral margins. New evidence indicates that this pattern could have been important in the evolution of the medial ray of the foot, which could have had considerable consequences during acquisition of bipedal gait.

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### References Cited:

Gruber, W. 1877. Ueber das Os cuneiforme I. bipartitum und seine secundären Stücke: Os cuneiforme I. secundarium dorsale und Os cuneiforme I. secundarium plantare. *Mémoires de l'académie impériale des sciences de Saint-Petersbourg*, VII Série-24 : 5–31.  
Kjellström, A. 2004. A case study of os cuneiforme mediale bipartum from Sigtuna, Sweden. *International Journal of Osteoarchaeology* 14: 475–480.

## Cutting Edge: A New Date for the Earliest Blade Technology

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The technological merits and behavioral implications of blade technology have been debated for the last 50 years. The organized production of blades, or standardized flakes with parallel or nearly parallel sides and a length to breadth ratio that exceeds 2:1, becomes ubiquitous in the Upper Paleolithic (UP) of Eurasia (40kyr) and the Later Stone Age (LSA) of Africa (50kyr), where blades were used primarily for the manufacture of retouched tools. However, blade technology occurs sporadically much earlier. Blades dating to ~250kyr have been reported from the Middle Paleolithic (MP) of northwestern Europe, where they were presumably made by Neanderthals. They also are known from the MP of the Levant, where they date to ~380kyr. In Africa, blades become common in the Later Stone Age (LSA) after 50kyr, and form the basis for much Middle Stone Age (MSA) technology in southern Africa. The oldest previously reported African blades are those from the middle portion of the Kapthurin Formation, Kenya, dating to >285kyr. Here we announce the discovery of blades from the lower portion of the Kapthurin Formation, dating to 545–509kyr. They add more than 150,000 years to the known lifespan of blade technology, show that it has an African origin, and suggest that the common ancestor of *H. neanderthalensis* and *H. sapiens* possessed the knowledge and skill to produce blades. Furthermore, the persistence of blades in the time interval 509–285kyr in the Kapthurin Formation shows that, in Africa, a blade-making tradition was not only established early but was also a persistent feature of African Middle Pleistocene technology.

## Reconstructing Variation in Seasonality Over the Orbital Climate Cycle in the Plio-Pleistocene Turkana Basin (Kenya, Ethiopia)

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The Plio-Pleistocene lacustrine sedimentary record in the Turkana Basin is uniquely situated to record orbitally-driven changes in monsoonal rainfall over Ethiopia. To reconstruct climatic conditions experienced by hominins in the Basin, it is vital to know if they lived during a dry or wet phase of the orbital climate cycle, and what kind of seasonality prevailed at that phase. Alternating wet-dry seasons may have provided favorable conditions while year-round aridity was probably harder to cope with. Seasonality in NE Africa is primarily expressed as monsoonal rainfall variation, which determines seasonal variation in Omo river discharge into the Turkana Basin. This is reflected in oxygen isotope ratios ( $\delta^{18}\text{O}$ ) of lake waters, with lowest  $\delta^{18}\text{O}$  values corresponding to peak discharge. Seasonal variation in  $\delta^{18}\text{O}$  of lake water is captured in growth incremental records of fossil shells, with each growth line representing about one month of shell growth. The amplitude of the  $\delta^{18}\text{O}$  signal from growth lines is considered to be a proxy for Omo discharge, and thus for

SW monsoonal strength. Alternation of periods with strong and weak SW monsoon takes place on orbital time scales. With molluscan growth incremental  $\delta^{18}\text{O}$  records obtained over the orbital cycle, we document *in situ* changes in seasonality. We have collected well-preserved fossil bivalve shells from eight stratigraphic levels in upper Burgi and KBS Members (~2–1.7 Ma), Koobi Fora Formation. Oxygen isotope analysis of molluscan growth increments shows considerable differences between shells from different levels, in signal amplitude as well as in relative depletion or enrichment of O isotopes. Using  $\delta^{18}\text{O}$  data from modern Omo and Sanderson's Gulf shells to provide a known climatic context, we interpret our results in terms of (changes in) seasonal conditions. This dataset provides insight in climate as a possible driving factor in hominin evolution and migration.

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## The Nonmammalian Fauna from the Middle Pliocene Matjhabeng Site, South Africa

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Recent excavations at Matjhabeng, a fluvial deposit in the Free State Province of South Africa, have yielded a rich fossil assemblage estimated to be ~3.5 Ma. This site fills a spatial and temporal gap in the South African record between the better known Langebaanweg (5.0 Ma) and Makapansgat (2.5 Ma) localities. Data from Matjhabeng will allow a broader understanding of the south African paleoenvironment relevant to the rate and pattern of animal evolution in the region. In addition to a diversity of recovered mammalian taxa, fossils recovered from the Matjhabeng deposit include many nonmammalian fossils attributed to avian, reptilian, amphibian, and actinoptergian taxa. As may be expected in a fluvial deposit, the most numerous of these fossils belong to Actinoptergii (ray-finned fishes). The fish taxa recovered are represented by several tooth-bearing elements and fin spines. At present, two amphibian fragments, a urostyle and a dentary, are identified as anurans (frogs and toads). Several reptilian fragments are identified as turtle, snake and lizard. Turtles are represented by carapace and plastron fragments, while snakes are represented by a single trunk vertebra. Several cranial and postcranial elements can be attributed to lizards. Among these, distinctive osteoderm impressions on one small lizard maxilla identify it as a gerrhosaur (plated lizard), making it the oldest known record of that taxon in southern Africa. Birds are represented by relatively few skeletal elements, including fragments of a tibiotarsus, a jaw, a tarsometatarsus, and a furcular symphysis. The multiple taxa recovered at Matjhabeng include the first record of a merganser (fish-eating duck) in Africa. The non-mammalian fauna from Matjhabeng bridges southern African faunas from the early and late Pliocene, demonstrating that the middle Pliocene was a distinctive period of evolutionary change among non-mammals, occurring across a background of significant climatic and mammalian faunal change.

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## Research Results from the Hadar Paleanthropology Field School (2007)

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The Ethiopian site of Hadar contains an unsurpassed record of *Australopithecus afarensis* between 3.0 and 3.4 Ma and an upper jaw of *Homo* aff. *H. habilis* and Oldowan tools at ~2.3 Ma. Recent research at the site has been conducted in the context of the Hadar Paleanthropology Field School (2007), which: 1) provides a six-week curriculum in paleoanthropological field work for US and Ethiopian students; 2) enlarges the pool of Ethiopian candidates for advanced training; and, 3) facilitates data collection for a comprehensive long-range conservation plan for Hadar. The field work augmented information from both time periods represented by Hadar sediments. Survey of fossiliferous Hadar Formation deposits yielded a small (Lucy-sized) partial adult mandible (A.L. 1180-1) and two frontal bone fragments that fit onto the adult face found at A.L. 417 in the 1990s, both from the Sidi Hakoma Member (~3.3 Ma). The frontal pieces underscore the resemblance between A.L. 417-1 and the A.L. 822-1 female skull from the KH-1 sub-member (~3.1 Ma). Targeted sieving of gullies draining the A.L. 333 hillside (Denen Dora Member) produced two intermediate pedal phalanges, both of which exhibit strong longitudinal shaft curvature. A landscape approach to the archaeology of the Maka'amitalu basin in the Busidima Formation determined that the artifact and bone concentrations at A.L. 666 and A.L. 894, both stratigraphically situated beneath the ~2.35 Ma BKT-3 tephra, were localized occurrences on their respective paleo-landscapes. Both localities are associated with crevasse splays of a meandering river, though each samples a spatially distinct facies. The large number of refits in the rich lithic assemblage from A.L. 894 is consistent with the very short duration of these depositional events. Surface collection transects in various depositional environments revealed differences in microfauna and bone breakage patterns enabling identification of landscape and taphonomic differences. These results match spatial patterns of macrofauna on the landscape.

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## Isotopic Insights into Paleoecological Interpretations at Laetoli, Northern Tanzania

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The consensus of opinion is that the Pliocene site of Laetoli in Tanzania continues to represent the more open woodland/grassland end of the spectrum of habitats occupied by early hominins. Recent paleoecological reconstructions using a variety of approaches, however, have produced varying interpretations about the specific composition of habitats and vegetation. These difficulties may relate in part to mixing of faunas along an altitudinal or ecological gradient or time averaging, but it is much more likely that they reflect the actual complexity of Laetoli paleoecosystems. Overall, aspects of the fossil record at Laetoli indicate habitat heterogeneity, making it critical to identify the specific habitats that were preferred or utilized by the hominin species at Laetoli. Isotopic approaches have contributed to recent assessments of the paleoecology at Laetoli and we report here on completed isotopic analyses of over 450 fossil herbivore tooth enamel samples and ostrich eggshells specimens from the Lower and Upper Laetolil Beds (~4.3–3.5 Ma), as well as the Upper Ndolanya Beds (~2.7–2.6 Ma). These include multiple analyses of 25 mammalian herbivore species and eggshells from horizons throughout the succession. Laetoli dietary  $\delta^{13}\text{C}$  signatures reveal complex and variable foraging patterns in African herbivore lineages, indicating significantly more generalized intermediate  $\text{C}_3/\text{C}_4$  feeding behaviors. There are no modern East African isotopic analogs for these dietary niches and associated habitat types. It is not possible to discern dietary shifts in the mixed grazing and browsing guilds in the Laetolil Beds that are independent of taxonomic differences in the assemblages. Isotopic dietary profiles of the Laetolil Beds, however, contrast with those from the younger Upper Ndolanya Beds, which include a higher proportion of obligate grazers and indicate greater availability of grassland habitats.

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## Eland, Buffalo, and Wild Pigs: Are They Equally Abundant in Middle and Later Stone Age Sites?

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Klein (1979) noted that relative to buffalo and bushpig, eland were far more common in the Last Interglacial MSA fauna of Klasies River than they were in the regional historic fauna or in the Holocene LSA fauna of nearby Nelson Bay Cave. He suggested that a lack of projectile technology in the MSA could explain the difference. Faith (2008) regressed  $\log(\text{eland MNI})$  and  $\log(\text{buffalo+pig MNI})$  on  $\log(\text{total MNI})$  in 27 MSA and 95 LSA samples scattered across southern Africa and used the MSA and LSA regression lines to argue that eland, buffalo, and pig were equally abundant in the MSA and LSA everywhere. In advance, this is an unlikely finding, because the samples originate from settings among which the relative numbers of eland, buffalo, and pig varied historically and probably also prehistorically. In addition, regression makes assumptions about the distributions of the variables, and log-transformed MNIs violate them. The result can be incorrect p-values and erroneous inferences about how the variables relate. To demonstrate that these statistical problems are not strictly theoretical, we simulated archaeological samples constrained by the sample sizes found in Faith's dataset. Simulations have the advantage over real data for testing the reliability of an approach because the relationships are known, so it is clear when a method fails to infer the correct answer. These simulations confirm that by violating the assumptions of regression, Faith's approach will produce incorrect inferences. Using appropriate methods we show that the Klasies River/Nelson Bay contrast in eland vs. buffalo+pig abundance still stands, although its significance can be debated. An identical MSA/LSA contrast is unlikely to emerge in parts of Africa that differed from the Klasies River/Nelson Bay region in climate, vegetation, and fauna.

### References Cited:

Faith, J. T. 2008. Eland, buffalo, and wild pigs: were Middle Stone Age humans ineffective hunters? *Journal of Human Evolution* 55: 24–36.  
 Klein, R. G. 1979. Stone age exploitation of animals in southern Africa. *American Scientist* 67: 151–160.

## Finite Questions and Fuzzy Answers: Exploring Neandertal/Human Admixture Through Baboon Analogues

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The phylogenetic relationship between Neandertals and modern humans continues to be debated. Some argue that two distinct species are represented, while others view Neandertals as a subspecies of modern *Homo sapiens*. Determining if patterns of variation between

Neandertals and modern humans are intra- or inter-specific is hindered by an incomplete fossil record and the difficulties inherent in resolving evolutionary relationships between closely-related taxa. Here we: (1) utilize hybridizing non-human primate morphospecies (baboons) as analogues; and, (2) employ two relatively under-utilized (in anthropology) statistical clustering methods (finite mixture analysis and fuzzy clustering) that we think may prove valuable for species recognition. Using baboons as a primate analogue not only offers larger sample sizes but provides a process by which potential admixture between Neandertals and modern humans can be detected. The two statistical methods employed not only generate posterior probabilities for group membership but also do not rely upon a priori knowledge of taxonomic classification. We therefore argue that they have the potential to help elucidate phylogenetic relationships between closely-related hybridizing allotaxa. Analyses were conducted on seventeen linear craniofacial and dental measurements taken from adult male baboons (n=223) representing four taxa (*Papio anubis*, *Papio hamadryas*, *Theropithecus gelada*, and *Mandrillus leucophaeus*). Both methods produced comparable results that reflect biologically relevant, yet not necessarily taxonomically consistent, classifications. The two *Papio* taxa consistently grouped together, reflecting not only their shared phylogenetic heritage but also their frequency of hybridization. Finite mixture analysis and fuzzy clustering each correctly assigned at least 91% of the individual baboons to the original four taxa. Future research will investigate the effects of ecology and geographical distribution on patterns of morphological variation present in baboon allotaxa to better inform our investigations of Neandertal/human admixture.

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## Behavioral Modernity in the Dreamtime: Investigating Behavioral Modernity in the Pleistocene Sahul Archaeological Record

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The archaeological record of Pleistocene Sahul, the combined landmass of Australia and Papua New Guinea, provides a record of behavioral modernity of at least 50,000 years. Oddly, this dataset has remained largely unintegrated into the wider global debate on the origins and development of behavioral modernity in human evolution despite its comparable time depth to Europe and Western Asia. Over the last century, more than 300 excavations have been undertaken at Pleistocene sites throughout Sahul, forming the basis of our understanding of the last 50,000 years of human history in this distinctive region. A new synthesis of this material provides an overview of both the matrix of the Pleistocene archaeological record and how behavioral modernity is represented in a single, geographically isolated, continent occupied exclusively by modern humans. Issues such as the temporal and geographical distribution of artifacts, artifact categories, sites, and excavations, along with sample size and preservation issues are explored. Results of this investigation highlight gaps and weaknesses in both the archaeological record of Pleistocene Sahul, and the application of current theory to the global debate. The analysis of this unique region aids in the development of more appropriate definitions and investigative techniques for studying behavioral modernity abroad.

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## Taphonomic, Taxonomic, and Isotopic Analyses of a Marine Isotope Stage 6 Carnivore Den from Pinnacle Point, Mossel Bay, South Africa

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The Pinnacle Point locality on the Western Cape coast near Mossel Bay, South Africa, includes a diversity of archaeological and paleontological sites that span several interglacial and glacial cycles. Here, we examine the paleoenvironmental implications of a naturally accumulated fossil carnivore den, Pinnacle Point Site 30 (PP30), a small cave formed in calcrete located on a plateau above the coastal cliffs. PP30 accumulated over a discrete period dated with optically stimulated thermoluminescence to ~151ka, placing it in MIS6 at a time when the coastline was ~90 km distant. PP30 contains a large faunal assemblage unaffected by hominin accumulation and thus provides a complementary perspective to that derived from the human occupation cave site of PP13B. The PP13B fauna is relatively depauperate in species relative to both PP30 and other archaeological assemblages through time in the Western Cape. Taphonomic and taxonomic analyses of the 31 mammalian species in the PP30 assemblage yield a much broader sample of the paleocommunity compared to PP13B and indicate that it was primarily accumulated by the brown hyena (*Parahyaena brunnea*). Multivariate analyses of the PP30 mammalian paleocommunity derived from craniodental fragments signal a shrubland/grassland habitat, corresponding to a mosaic of grasses and shrubby habitat associated with the rocky hills around Pinnacle Point. The carbon isotope values are almost without exception enriched in <sup>13</sup>C compared to similar modern fauna, suggesting a strong influence of glacial climate conditions on plants, possibly including lowered CO<sub>2</sub>. Values for grazers indicate that modest proportions of C<sub>4</sub> grasses occurred in the area, despite lower temperatures. Overall, we conclude that the local environment may have been a mosaic of both C<sub>4</sub> grasses and shrubland habitat, which is not unlike parts of the fynbos biome today.

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## Functional Interpretation by Use-Wear Analysis of 2-Million-Year-Old Oldowan Tools from Kanjera South, Kenya

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Use-wear analysis has proved valuable in interpreting the function of prehistoric stone tools. Nevertheless, many microscopic trace analyses have failed because of postdepositional alteration of artifact surfaces, or the unsatisfactory application of use-wear techniques developed for flint and obsidian to other types of raw materials. Here we report on a use-wear study carried out on the most common raw materials from the Kanjera South Oldowan assemblage: fenitized andesite, quartzite, quartz, and rhyolite. We began by producing flakes of these raw materials from cobbles collected from previously identified secondary sources. These flakes were used in controlled experiments to skin and deflesh carcasses, scrape hides, process tubers, cut grass stems, and work wood and bone. They provide a reference collection for interpreting use-wear on the archaeological assemblage. Observations made using stereo- and metallographic microscopes were integrated with interferometry and confocal techniques. This permitted the examination of use-wear on lithic surfaces without the reflectivity problems that traditionally plague studies of quartz-rich raw materials. Despite their great age, two-million-year-old Oldowan artifacts from Kanjera South have well-preserved edges. Careful comparison to our reference sample indicates that Kanjera artifacts were used for carcass butchery, as well as for cutting and/or scraping a variety of plant materials. The latter finding is particularly notable, as plant processing often is assumed, but has not before been demonstrated, for sites of this antiquity. The outcome of this research suggests that, using an appropriate technique, use-wear can contribute positively to the behavioral interpretation of the oldest lithic assemblages.

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## Geophytes as a Potential Food Resource for Mediterranean Hominins

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Geophytes are widespread and widely used in Africa, but are discounted as a potential resource for Neanderthals and early modern humans in Pleistocene Europe. Stable isotope and archaeological data indicate heavy reliance on meat, but nutritional considerations suggest carbohydrates were also important. Geophytes may have been a key source of such nutrients. To help resolve this issue, I conducted a literature search designed to assess the availability and dietary quality of wild geophytes in Europe today and to fuel constructive speculation and research about their potential value to Pleistocene hominins. I found that geophytes are common in Europe, especially in the Mediterranean where seasonal dryness promotes carbohydrate and water storage. Mediterranean geophyte families include Liliaceae, Umbelliferae, and Hyacinthaceae. Endemic species are concentrated on the Iberian Peninsula, in the Spanish Pyrenees, and in Turkey. Many are eaten as local specialties, some without cooking. Modern distribution, abundance, and usage combined with climate and habitat reconstruction suggest that geophytes could well have been an important resource for Pleistocene hominins. Further work is needed to assess their prehistoric distribution, nutritional qualities, processing requirements, and likely archaeological and stable isotope signatures.

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## The Isotope <sup>18</sup>O and <sup>13</sup>C Chronology and Paleoenvironments of the Spitzenskaya and Kostenki-Streletzkaya Early Upper Paleolithic Cultures of the Russian Plain

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Different multidisciplinary data (archaeological, pollen, palaeomagnetic, paleopedological, and tephrochronological) obtained for the Kostenki 12 section from the Russian plain (Anicovich 2005, 2006) allowed correlation of Paleolithic Layers 5, 4, and 3 with the well-dated <sup>18</sup>O GISP2 (Johnsen et al. 2001) and <sup>13</sup>C Willards Cave (Genty et al. 2003) isotope scales. Layers 4 and 3 of the Kostenki-

Streletzkaya Culture correspond to oscillations 12–10 of isotope stage 3 (about 46–43 kyr B.P.) on both curves. These correlations agree with the positions of Layers 4 and 3, which lie between sediments with the group of the IRSL dating from 52,340 to 43,470 years B.P. and the level with volcanic ash of the G5 stage of the catastrophic Flegrian eruption, which happened in southern Italy about 39,000 years B.P. (Melekestsev et al. 1984; Fedele et al. 2003; Pyle et al. 2005). Data on Kostenki 12 shows that archaeological layers 5 and 4 were formed during a mega stage with the domination of elm forests and wet meadows when red deer and later mammoth dominated in paleozoological complexes. But Layer 3 was formed during a period of change of paleozoological complex dominated by horse to the one dominated by reindeer (Hoffecker et al. 2005) and alternation of vegetation phases: steppes - spruce forests and wet meadows - periglacial steppes (Levkovskaya et al. 2003). Comparing pollen data (Levkovskaya et al. 2005; Fedorova 1963) from the most ancient stage of the Kostenki-Streletzkaya culture (Layer 4 of Kostenki 12) and from the Spitzenskaya Culture (Layer 2 at Kostenki 17) shows their connection with different paleoenvironments—with elm mega stage of the Streletzkaya Culture and with the more continental spruce mega stage of the Spitzenskaya Culture. The Streletzkaya Culture layers of Kostenki 14 were formed after the elm phase (Levkovskaya et al. 1983; Spiridonova 2002) although Kostenki 14 requires additional study.

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#### References Cited:

- Anikovich, M.V. (Ed.), 2005. *The problems of early Upper Palaeolithic of the Kostenki-Borschevo region and adjacent territories*. Proceedings of Kostenki-Borschevo Archaeological Expedition. Vol. 3. IIMK RAN, SPb.
- Anikovich, M.V. (Ed.), 2006. *The early Upper Palaeolithic of Eurasia: general trends, local developments*. Proceedings of Kostenki-Borschevo Archaeological Expedition. Vol. 4. Nestor-Historia, SPb.
- Fedorova, R.V. 1963. Palaeoenvironment of the Upper Palaeolithic man of the Kostenki area of Voronezh region (pollen data on Spitzenskaya site, Kostenki 17) In: *Materials and Researches on Archaeology of the USSR*, Vol. 21, Yephimenko, P.P. and Boriskovskiy, P.I. (Eds.). Moscow-Leningrad, Akademija Nauk SSSR, pp. 220–229.
- Hoffecker, J.F., Kuz'mina, I.E., Anikovich, M.V., and Popov, V.V., 2005. Taphonomy of an early Upper Palaeolithic bone bed at Kostenki 12 (Volkovskaya). In: *The problems of early Upper Palaeolithic of the Kostenki-Borschevo region and adjacent territories*. Proceedings of Kostenki-Borschevo Archaeological Expedition. Vol. 3, Anikovich, M.V. (Ed.), IIMK RAN, SPb, pp. 161–177.
- Levkovskaya, G.M., Hoffecker, G.F., Anikovich, M.V., Forman, S.L., Hollyday, V.T., Pospelova, G.A., Popov, V.V., Kartzeva, L.A., Stegantzeva, V.Ya., and San'ko, A.F., 2005. Climatic stratigraphy of the earliest palaeolithic layers at Kostenki 12 (preliminary results of palynological, palynoteratical, palaeozoological, palaeomagnetic and SEM-palaeobotanical research on archaeological layers III-V). In: *The problems of early Upper Palaeolithic of the Kostenki-Borschevo region and adjacent territories*. Proceedings of Kostenki-Borschevo Archaeological Expedition. Vol. 3, Anikovich, M.V. (Ed.), IIMK RAN, SPb., pp. 93–130.
- Spiridonova, E.A. 2002. Palynological studying of the chronology of the sediments of Kostenki 14 site (Markina gora). In: *Trends in the Evolution of the East European Palaeolithic*, Sinitzyn, A.A. (Ed.). SPb, pp. 237–246.

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## Preliminary Analysis of the Small Mammal Fauna from Matjhabeng, Free State, South Africa

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While the Province of Gauteng in South Africa is well known for its rich fossiliferous deposits, Plio-Pleistocene localities outside Gauteng are comparatively rare. Placing the fossil hominins of Gauteng in an evolutionary context, however, requires an understanding of the regional paleoenvironment. The Matjhabeng locality of the Free State of South Africa, dated to ca. 3.5 Ma, is temporally and geographically intermediate to Langebaanweg (5.0 Ma) and Makapansgat (2.5 Ma), thereby providing a data point critical in reconstructing the past habitat of southern Africa. Small mammals, long known as powerful environmental indicators, are an important part of this fauna. Matjhabeng possesses a fossiliferous riverine deposit that, after two seasons of excavation, has produced approximately 75 identifiable small mammal fossils. The majority of these specimens are either lagomorph or springhare molars, indistinguishable from modern forms. Springhares are attributed to the modern genus *Pedetes*, while the Lagomorphs are currently diagnosed to the family Leporidae. Neither taxon is associated with any particular regional habitat, although springhares generally prefer grasslands. Many isolated murine rodent teeth also are diagnosable, all to extant taxa. These include a lower third molar of *Tatera* (naked-soled gerbils). While gerbils are wide spread in southern Africa today, they are generally found in arid to savanna habitats. Several molars and incisors belong within the Otomyinae (groove-toothed rats). Otomyine dentition is particularly important, as Langebaanweg and Makapansgat each reportedly have different taxa from this group. Unfortunately, dental characters used to diagnose these different taxa are overlapping and present in modern forms, limiting their use in dating Matjhabeng. Otomyines, however, are often indicative of marsh or riverine habitats, consistent with Matjhabeng's depositional environment. In general, the small mammal fauna reflects a mixed wetland/grassland environment, consistent with the reconstruction based on the large mammal component of the assemblage.

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## A Comparative 3D Geometric Morphometric Analysis of Lower Paleolithic Victoria West Cores

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The “Victoria West” (VW) is a Lower Paleolithic (LP) prepared-core industry from South Africa, which has previously been noted to bear strong morphological resemblances with later Middle Paleolithic (MP) prepared-core technologies (i.e., “Levallois”). Indeed, from

the earliest commentaries on the VW technique, it has frequently been thought of as “a magnified and slightly distorted Levallois” (Van Riet Lowe 1929: 389). The hypothesis that VW cores are simply “large Levallois” is tested here using a comparative 3D geometric morphometric (GM) methodology. GM methods are powerful statistical tools for shape analysis that offer many advantages over traditional means of shape quantification and comparison. The use of landmarks to capture shape variation allows for the preservation of the full geometry, as well as enabling the more precise description of shape versus size. Moreover, biological studies have shown that the use of landmarks allows for a flexible approach to comparing specific aspects of overall morphology. Here, we employ GM to analyse differences in core surface morphology in a range of LP and MP core forms, including VW examples (total n=639 artifacts). In comparison with Mode 1, Acheulian handaxes, and Levallois cores, the VW share shape affinities with both Acheulian handaxes and Levallois cores. However, when compared with another group of large Levallois cores (Baker’s Hole, UK), the VW were found to more closely resemble handaxes, while the Baker’s Hole are simply isometrically-scaled Levallois cores. These analyses show that, despite qualitative similarities with Levallois cores, the VW cores are morphologically more similar to LP artifact forms, such as handaxes, and are in some respects distinct from MP Levallois cores. In line with other recent analyses, our results support suggestions that the VW technique is an extension of longstanding Acheulian traditions for the preparation of biface blanks, but with its own distinct characteristics.

#### References Cited:

Van Riet Lowe, C. 1929. Fresh light on the Prehistoric archaeology of South Africa. *Bantu Studies* 3: 385–393.

## Allometric Scaling of Infraorbital Surface Topography in *Homo*: Size Does Matter

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Infraorbital morphology is commonly included in discussions of phylogenetic relationships within *Homo*, with the presence or absence of a “canine fossa” factoring prominently in debates over the evolutionary distinctiveness of *H. sapiens* and *H. neanderthalensis*, and in the diagnosis of the controversial taxon *H. antecessor*. Some researchers (e.g., Arsuaga et al. 1997; Pearson 2008) have previously suggested a relationship between infraorbital size and shape, however, a direct link has yet to be quantitatively established. In this study, we assessed infraorbital surface topography, and its potential allometric scaling, in recent and fossil *Homo* with a modified version of Niewoehner’s (2005) grid projection method for quantifying complex curvilinear surfaces. Our results indicate important aspects of infraorbital shape are significantly correlated with infraorbital size across *Homo*. Specifically, individuals with larger infraorbital areas exhibit flatter, taller, and narrower infraorbital surfaces, with sloped inferior orbital margins and non-everted lateral nasal margins. In contrast, individuals with smaller infraorbital regions exhibit more depressed, shorter, and wider infraorbital surfaces, with projecting inferior orbital rims and everted nasal margins. Importantly, these contrasts array along a continuum, and only appear dichotomized at the ends of the infraorbital size spectrum. We conclude that the essentially flat infraorbital surfaces of Neandertals are not unique, and can be explained, in large part, as a function of possessing large infraorbital regions. Conversely, smaller infraorbital size may account for the reportedly more “modern” appearing infraorbital regions of specimens such as LH-18, Steinheim, Tangshan, Gran Dolina ATD6-69, and Liang Bua 1. Infraorbital surface topography thus joins a growing list of craniofacial traits demonstrating some degree of size-correlated shape change across *Homo*. Collectively, these features indicate that reduction in overall facial and dentognathic size was the primary influence on several secondary (and intercorrelated) aspects of craniofacial shape evolution in *Homo*.

#### References Cited:

Arsuaga, J.L., Martínez, I., Gracia, A., and Lorenzo, C. 1997. The Sima de Los Huesos crania (Sierra de Atapuerca, Spain). A comparative study. *Journal of Human Evolution* 33: 219–281.

Niewoehner, W.A. 2005. A geometric morphometric analysis of Late Pleistocene human metacarpal 1 base shape. In: *Modern Morphometrics in Physical Anthropology*, Slice, D. (ed.). Kluwer Academic/Plenum, New York, pp. 285–298.

Pearson, O.M. 2008. Statistical and biological definitions of “anatomically modern” humans: suggestions for a unified approach to modern morphology. *Evolutionary Anthropology* 17: 38–48.

## Progress Towards a Regional Tephrostratigraphic Framework for Northern Tanzania: Potential Correlations Between Olduvai, Laetoli, and Peninj

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Olduvai Gorge, Laetoli, and Peninj lie within 100 km of the Ngorongoro Volcanic Highlands (NVH), a source for Plio-Pleistocene volcanic ashes that form important stratigraphic markers. Through tephrostratigraphy, these ashes can potentially help correlate between these sites, and between individual localities within each site. Tephra samples were collected in stratigraphic context from the Upper and Lower Laetoli, Ndolanya, Naibadad, and Olpiro Beds at Laetoli, from Beds I, II, and III at Olduvai, and from the Humbu and Moinik Formations at Peninj. Volcanic glass (where present) and minerals (feldspar, augite, hornblende, titanomagnetite) were analyzed for major and minor elements by electron microprobe to identify compositional «fingerprints» for correlation. Future work will include improved stratigraphic placement and analysis of melt inclusions where glass is absent. The Pliocene Laetoli and Ndolanya tephra show no compositional overlap with Olduvai. Naibadad tephra are similar to the base of Olduvai Bed I (with rhyolitic tephra likely

derived from Ngorongoro), though no direct correlations were possible. A poorly-constrained tephra sample (initially thought to be Olpiro) is compositionally equivalent to an Upper Bed I tephra between Tuffs IE and IF. Based on age, correlation between Peninj and Olduvai Beds II and III should be possible. However, most Humbu basaltic ashes come from more local (non-NVH) sources, and the Moinik trachytes are compositionally unlike those of Olduvai. The previously proposed correlation between Olduvai Tuff IF and the basal Humbu tuff (based on age equivalence and similar appearance) is disproven based on augite composition. The only potentially correlative tephra are the Olduvai Middle Bed II Bird Print Tuff (basalt composition like Humbu basalts) and Olduvai Tuff IID (like Moinik Tuff 3). If proven correct, these correlations yield a surprisingly young age for Upper Bed II Tuff IID (between 1.19 and 1.0 Ma, Deino et al. 2006).

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#### References Cited:

Deino, A.L., Dominguez-Rodrigo, M., and Luque, L. 2006.  $^{40}\text{Ar}/^{39}\text{Ar}$  dating of the Pleistocene Peninj Group, Lake Natron, Tanzania. *Eos Trans. AGU* 87(52), Fall Meet. Suppl., Abstract V53C-1771.

## Data Were Collected From High-Quality Casts

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For paleoanthropologists interested in morphological evolution, the sparse and patchily distributed fossil record is a limiting resource. Researchers need access to original specimens in order to obtain reliable data, but for a variety of reasons—geographical, financial, political—such access often is impossible or unfeasible. Hence, many paleoanthropological publications rely to some extent on data collected from “high-quality” or “research-quality” casts. To determine the impact of analyzing casts rather than original specimens, we compared 3D landmark data collected from Kenyan Plio-Pleistocene hominin crania to data measured on casts of the same specimens. Landmark data from fossil and cast configurations were superimposed together with cranial data from modern *Homo sapiens*, *Pan troglodytes*, and *P. paniscus* using a generalized Procrustes analysis. Aligned coordinates were then used in a series of multivariate statistical analyses to assess the differences between fossil and cast data. Results of principal components analysis illustrate substantial differences between most casts and their corresponding fossils. Procrustes distances between fossil/cast dyads also were substantial, typically similar to species-level comparisons within *Pan*. Finally, comparisons of vectors of shape differences between extant species means and the fossils and casts demonstrate that, in some cases, the use of casts can lead to incorrect conclusions about differences in shape. Together, these results argue against the use of casts for morphometric research. When possible, verifying cast dimensions from published sources may go some way toward ameliorating the problems found here. Lacking solutions for traditional hindrances to data collection, however, the best solution is probably the collection and wide dissemination of high-resolution “primary” data (e.g., CT and laser scans).

## Early Hominin Dental Remains from Drimolen, South Africa

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The Plio-Pleistocene fossil hominin site of Drimolen is located 5.5 km north of the other well-known South African Plio-Pleistocene sites (Sterkfontein, Swartkrans, Kromdraai, and Cooper's). It was discovered by A.W. Keyser in 1992. Systematic excavations led to the recovery of a remarkable number of fossil vertebrate taxa, including hominins. Most of the specimens collected consist of isolated teeth or teeth in jaws. Here we provide a first assessment of the dental specimens recovered between 1992 and 2000. The analysis confirms the occurrence of two hominin species, *Paranthropus robustus* and *Homo* sp. With over 80 fossil hominin specimens recovered so far, Drimolen becomes the second largest sample of *P. robustus* after Swartkrans. This taxon is mostly represented by cranio-dental specimens (63) among which are 47 isolated teeth while the rest consist of maxillary and mandibular fragments with teeth. These figures markedly increase the dental sample of *P. robustus*. Further, the Drimolen sample includes tooth classes not present in the Swartkrans or Kromdraai samples. These include both deciduous upper lateral incisors (DNH 31) and canines (DNH 23). In the dental sample described here, there are nine specimens probably attributable to *Homo*, although a specific attribution is not yet possible. These specimens extend the small sample of early *Homo* from South African sites. Basic dimensions (MD and BL) of the Drimolen dental remains are compared in a preliminary analysis with other hominin samples. This analysis delineates the Drimolen *P. robustus* dental sample overall as characterized by smaller teeth than the Swartkrans sample (and in some cases also the Kromdraai sample) and with a broader size range.

## *Homo heidelbergensis*: The Facial and Mandibular Evidence

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The discovery of new fossils and the recognition of a greater diversity in the mid-Pleistocene fossil record led to a reconsideration of the species *Homo heidelbergensis*. Its holotype, the Mauer mandible, bears still poorly understood anatomical traits. Besides, numerous fossils without mandibular remains have been placed in the taxon. Thus, there is no consensus concerning *Homo heidelbergensis*: an Afro-European taxon, ancestral to modern humans and Neandertals, or a strictly European species ancestral to Neandertals only. We focus on the validity of *Homo heidelbergensis*, using two complementary methods: first the basis of species recognition: anatomical description; and, second, geometric morphometrics on 36 Pleistocene jaws, 35 Pleistocene skulls and 110 extent human skulls. We provide a comparative morphological analysis using 36 mandibular traits, as well as 31 facial traits that were analysed through a multiple correspondence analysis associated with a hierarchical classification to obtain clusters corresponding to phenetic similarities between specimens. We also provide a generalized procrustes analysis based on 19 landmarks on the mandible and 20 on the face as well as a PCA and a canonical variate analysis to better segregate the groups of specimens. The phenetic analysis result points toward the validity of *Homo heidelbergensis* as a taxon. A set of mandibular and facial morphological traits can be statistically identified to define the species. Their presence in African and European specimens supports the theory of an Afro-European taxon as the last common ancestor to Neandertals and *Homo sapiens*. The results of the morphometric geometrics analysis are less clear-cut. An Afro-European mid-Pleistocene group can be identified, but only the modern specimens show a clearly different geometric pattern. The *Homo heidelbergensis* species identified in the phenetic analysis shows a particular morphological pattern but its facial and mandibular geometric structure are similar to most other *Homo* sp. identified in the fossil record.

## Reconstructing the Social Systems of Extinct Hominids Using Digit Ratios (2D:4D)

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Social systems are notoriously difficult to identify in the hominid fossil record due to difficulties in estimating body size dimorphism from fragmentary remains and, in hominins, low canine size dimorphism. Recent studies have shown that the second-to-fourth digit length ratio (2D:4D), a putative biomarker for prenatal androgen effects (PAE), co-varies with anthropoid social systems; pair-bonded taxa have significantly higher 2D:4D ratios (low PAE) than non-paired species, with the strongest relationships shown in apes. Here we attempt to reconstruct the social system of several fossil hominid taxa (*Hispanopithecus laietanus*, *Australopithecus afarensis*, and *Homo neanderthalensis*) by comparing their digit ratios to those of extant hominoids. In all taxa, ratios were based on proximal phalangeal lengths (2PP:4PP), as these ratios do not differ significantly from ratios based on full digit length in hominoids. Results suggest that fossil ratios differ significantly from each other and from those of extant taxa. Specifically, controlling for phylogenetic and substrate effects, Neanderthals group more closely with intermediate (human-like) or non-pair-bonded species, *Au. afarensis* groups with pair-bonded or intermediate species and *Hi. laietanus* ratios are within the range of species with non-pair-bonded social systems. The low ratio of *Hi. laietanus* suggests more intense levels of sexual selection than extant hominids. In Neanderthals, low ratios compared to modern humans suggest a more promiscuous social system for this species. If the phalanges of AL333 originate from the same individual, the 2PP:4PP ratio for this taxon suggests a social system similar to extant Hylobatids or modern humans. Small fossil sample sizes and possible taphonomic effects on sampling and bone length preclude drawing firm conclusions using this method. Nevertheless, results suggest that, as more fossil hand bones become available, digit ratios could augment current techniques for elucidating the social systems of fossil hominids.

## The Taxonomic Assignment of Unassociated Neandertal and Upper Paleolithic Hand Phalanges

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Can unassociated Neandertal and Upper Paleolithic human hand phalanges be accurately distinguished from each other? This analysis of 12 Neandertal and 18 Upper Paleolithic partial hand skeletons explores this question. The measurements of the proximal (PP) and middle (MP) phalanges are the area, height, width, and depth of the base, the distal articular breadth, and the articular length. The measurements of the distal phalanges (DP) include the same base and length measurements plus the distal tuft height and width. A stepwise discriminant function is used to determine the variable subsets that produce the lowest taxonomic reclassification error rates. Variable subsets are used in linear discriminant functions (with cross-validation). Each bone class (PP 1-5, MP 2-5, and DP 1-5) is analyzed separately. Additionally, combined PPs (3-4), MPs (2-4), and DPs (2-4) are analyzed. The analysis with the smallest Neandertal sample size (N=4) is for the DP 4 and 5, whereas the largest Neandertal sample size (N=19) is for the combined MPs. The Upper Paleolithic sample size is generally 50% larger than the Neandertal sample size in each analysis. The PPs, whether analyzed separately or combined, all have high reclassification error rates (ca. 12–32%). For the MPs, the MP 3, 4, and 5 have the lowest error rates

(ca. 5%), while the combined MP sample has a 6% error rate. The error rate for the DP1 is 30%, but the error rate for the DP 2, 4, and 5, and the combined DP samples are all 0%. Given these particular measurements and the small sample sizes involved, it is clear that one cannot make confident taxonomic assignments of unassociated proximal phalanges. There is, however, cause to be considerably more confident about the taxonomic assignment of most middle and, except for DP1, the distal phalanges.

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## Paleolithic Technological Evolution and the Movius Line: Demographic Perspectives From Africa and East Asia

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In recent years, an increased understanding of the effect of demography on cultural transmission has improved our understanding of the incidence, proliferation, and elaboration of technological traditions. Here, we present a generalized null model of Lower-Middle Paleolithic technological evolution, which expressly links cultural transmission theory and demographic factors (i.e., population size, density, and social interconnectedness). Consistent with our model, Africa exhibits evidence of major technological innovations during the Early to Middle Pleistocene, due to a constant source of population and growth due to accumulation through time. In comparison, Pleistocene East Asian assemblages are dominated by Mode 1-type technologies, and only a few localized occurrences of bifacial technology are currently known. We detail evidence suggesting that during much of the Pleistocene a combination of biogeographical, topographical, and dispersal factors are likely to have resulted in relatively lower effective population sizes in East Asian hominins compared with western portions of the Old World, particularly Africa. Thus, the Movius line must be examined in terms of its biogeographical context, if the divergent evolutionary trajectories of entities either side of it are to be understood. Most parsimoniously, the Movius Line *sensu lato* is thus a 'line' which represents the crossing of a demographic threshold. Under the parameters of our (testable) null model, geographically and temporally sporadic occurrences of bifacial technology in East Asia are the product of short-lived instances of technological convergence. As a consequence, the *in situ* evolution of Levallois (Mode 3) was inhibited in East Asia due to the constraints of relatively smaller effective population sizes.

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## Through the Stones We Reach the Shore: Studies of a Paleolithic Marsh in North Azraq (Jordan)

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Recent models suggest that Neandertals and AMH populations occupied the Levantine corridor alternately rather than simultaneously. The turnover in hominin populations is argued to be related to climatic deterioration and concomitant changes in the distribution and availability of faunal and floral resources. This characterization of hominin occupation of the Levant remains contentious, however, and it is within the context of this larger debate that we initiated the Druze Marsh Paleolithic Project in June 2008. The Druze Marsh site in North Azraq (Jordan) is the location of a paleomarch that expanded and contracted throughout the Pleistocene, both facilitating and constraining hominin occupation. Initial excavation has identified three periods of occupation-Late Acheulian (in excess of 200,000 BP), middle Middle Paleolithic (130,000 BP), and early Epipaleolithic (Kebaran <18,000 BP). In this poster, we detail our preliminary findings and future research directions in relation to: (1) the origins of the Levantine Levallois Mousterian as we have a Late Acheulian component with a well developed Levallois point and blade technology; (2) the chronology of the Levantine Paleolithic (based on OSL, U-series, and C14 dates); (3) 4D modeling of paleoshorelines (including the correlation of lake levels with hominin occupations); (4) food procurement strategies with an emphasis on resources of the marsh margin environment, including seasonal avifauna, mammalian megafauna, and mammalian small fauna resources; (5) the reconstruction of paleoclimatic conditions associated with geomorphic processes and faunal populations to assess both local and regional climatic patterns and to document the relationship between climate change and settlement patterns in this part of the Levant; and, (6) the debate surrounding the degree of hominin population continuity or turnover in the Levantine corridor. Finally, we will address briefly the applied component of our research by detailing our work with local animal and nature reserves in relation to our paleoenvironmental research.

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## Modeling Sahul Colonization: First Approximation

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Australia was first colonized by humans about 45,000 years ago. The process involved a series of deliberate, open-ocean voyages and the subsequent exploration of several million square miles of previously unknown continent, all in less than a thousand years. Factors motivating these developments remain unclear. Drawing on formal models of prey choice, marginal value, and 'ideal free distribution,' we propose a pattern of movement driven by women's serial depletion of high ranked foods. We test the argument by reference to archaeological data from coastal sites in Wallacea, northern Sahul, and the Bismarck Archipelago; then indicate how it might be further developed with reference to terrestrial habitats.

## The Krapina Case—New Results on the Question of Cannibalism of Neanderthals

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The human skeletal remains from Krapina of almost 900 fragments have been considered for a long time as a proof of Neanderthal cannibalism. Although this opinion was frequently criticised, the fragmentary nature and traces of manipulations on the skeletal remains were mentioned as evidence. The re-examination of the skeletal remains was carried out to provide a closer look at the breakage patterns and the cut marks. The inventory of human remains shows that certain skeletal elements like the facial skeleton, skull base, and hand- and foot bones, as well as vertebrae, are underrepresented or missing. It seems therefore unlikely that the bodies were buried in anatomical connection. The investigation also proved that the breakage patterns were not caused by human activity. Although several bones, especially the long bone diaphysis, clavicles, and pelvis fragments, display breakage patterns related to perimortem breakage like spiral fractures, any kind of human activity is absent. The breakage is most probably related to sediment pressure, particularly to rock fall, and carnivore activities. Damage on bones caused by carnivore activity is well visible by bite marks on long bone fragments and on Cranium 3. Any detailed analysis of the cut marks is problematic, since the bones were covered with shellac. Therefore, the analysis by a scanning electron microscope did not yield any significant result. The macroscopic investigation showed that the traces are not consistent regarding their orientation and location with traces commonly related to disarticulation and dismemberment activities. Several cut marks show evidence for a recent origin. The well known Cranium 3 exhibits possible cut marks on the frontal bone, which might indicate skinning activities like the removal of the scalp. Nevertheless the position and the small size of the marks fail to prove such an activity. A ritual behavior might be a possible explanation.

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## Inter- and Intra-Specific Non-Metric Dental Variation in Great Apes: Implications for the Study of the Early Hominins

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Metric, morphometric, and to a lesser extent, non-metric dental variation has proven to be informative for distinguishing great ape species and subspecies. However, non-metric studies are limited to few traits, and their full taxonomic potential in this context has not been realized. Moreover, relatively little has been done to relate great ape dental variation to fossil and recent humans. This study examines phenetic relationships among great apes, australopithecines and *H. sapiens* based on a large set of dental non-metric data. Twenty-two non-metric dental traits were examined in 104 great apes (*Pan troglodytes*, *Gorilla gorilla*, and *P. pygmaeus*), 22 australopithecines (*Au. anamensis*, *Au. afarensis*, and *Au. africanus*), and 261 pre-Hispanic South Americans in order to: 1) determine intra-specific patterns of dental variation among great apes; and, 2) assess the dental relationships among great apes, early hominins, and modern humans. The Arizona State University Dental Anthropology System was used as a starting point for assessing dental morphological variation. Because this system is inherently biased due to its emphasis on recent humans, additional dental traits were included to examine variation among apes and early hominins. Phenetic relationships were assessed using the Mean Measure of Divergence (MMD). Our results support previous studies, which suggest that *P. t. schweinfurthii* and *P. t. troglodytes* are more similar to each other (MMD=0.030) than either is to *P. t. verus* (MMD=0.258 and 0.079, respectively). Likewise, the *Gorilla* subspecies (*G. g. gorilla* and *G. g. beringei*) show considerable dental divergence (MMD=0.209). The pooled Australopithecine sample showed greatest morphological similarity to *Pan* (MMD=0.058). These two groups appear to retain many primitive features that are lost in later *Homo* (e.g., lower molar distal fovea, upper M2 cusp 6). This would indicate that: 1) dental morphological complexity is reduced in later *Homo*; and, 2) certain dental traits that characterized *Homo* species developed later in human evolution.

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## Making the Abstract Concrete: The Place of Geometric Signs in French Upper Paleolithic Cave Art

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In Paleolithic cave art, geometric signs tend to outnumber figurative images and yet, they remain relatively understudied. To address this gap in our knowledge, I compiled a digital catalogue of all known geometric signs found in parietal art in France, and then trended the results looking for patterns of continuity and change over time and space. I focused on parietal art, as I could be certain of its provenance, and picked France as my region due to its abundance of decorated sites and its natural boundaries of water and mountain ranges. The database is searchable by a variety of criteria such as sign category, method of production, date range, site type, geographical coordinates and region. It has now been converted into an online resource. To provide a visual dimension, it includes a selection of linked photographs and reproductions of the different signs. In this poster, I detail the chronological and regional patterning in sign type and frequency and the implications of these patterns for understanding where, when and why the making of these signs was meaningful to the Pleistocene peoples who created them (Conkey 1997). I will have this database available for trial during my presentation.

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### References Cited:

Conkey, M.W. 1997. Beyond Art and Between the Caves: Thinking about Context in the Interpretive Process. In: *Beyond Art: Pleistocene Image and Symbol*, Conkey, M.W., O. Soffer, D. Stratmann, and N.G. Jablonski (Eds). Berkley, University of California Press, pp. 343–367.

## New Hominin Fossils from Kanapoi, Kenya, and the Mosaic Evolution of Canine Reduction in Early Hominins

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Canine tooth size reduction is a definitive character of the hominin lineage, and appears to have occurred prior to the appearance of the genus *Australopithecus*. The exact reason for canine reduction is unknown, but the pattern of the morphological transformation of the tooth is key to developing and testing hypotheses of the ultimate transformation into the human canine. Of particular importance is testing the hypothesis that canine reduction is integrated with shape changes. New discoveries of associated dentitions of *Australopithecus anamensis* from Kanapoi, Kenya, combined with previously described remains, demonstrate clearly that hominin canine tooth size and shape reduction did not co-occur in early hominins. A near-human degree of canine crown height dimorphism is achieved through male canine size reduction by 4.1 Ma in *Au. anamensis*. A general shape transformation of the canine/premolar complex without further substantial size reduction occurs from *Au. anamensis* to its likely descendent species *Au. afarensis* (3.7–3.0 Ma). The final, dramatic reduction in the size of the canine to the modern human condition followed this basic shape change in later hominids. The new specimens demonstrate that changes in canine root size occur independently of the crowns. *Au. anamensis* shows some root length reduction but high levels intraspecific variation in root size, most similar to that of the highly dimorphic *Gorilla*, whereas *Au. afarensis* does not. These results strongly suggest a step-wise pattern of selection, with the forces that impact canine shape and root size occurring after the loss of canine dimorphism. Canine reduction exapted the canines for subsequent shape changes which were not dependent on further canine reduction. This suggests a series of independent, selective pressures. More importantly, this analysis clearly identifies *Au. anamensis* as the key taxon undergoing the transition from an ape-like to human-like canine morphology, independent of canine crown height reduction.

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## The Depositional, Paleoeological, and Behavioral Contexts of Oldowan Archeological Site Formation at Kanjera South, Kenya

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Primary context Oldowan occurrences are rare. In this paper we provide an overview of the geological and behavioral records preserved at Kanjera South, Kenya. Oldowan artifacts and associated fauna were deposited in the colluvial and alluvial sands and silts of Beds KS-1 to KS-3 of the Southern Member of the Kanjera Formation, in the margins of a lake basin. A combination of biostratigraphy and magnetostratigraphy indicate that these beds were deposited between 2.3 and 1.95 million years ago (Ma), with a likely age of ca. 2 Ma for the archeological occurrences. Stable isotopic analyses of pedogenic carbonates and fossil herbivore tooth enamel provide the

earliest evidence of a Pliocene grassland-dominated ecosystem. Taxonomic analysis of the fauna indicates the predominance of grazing ungulates, from a limited number of taxa. Lithic sourcing and raw material selectivity studies indicate that hominins preferred hard raw materials, and selectively transported favored lithologies over 10 km. Analysis of site sedimentology, fossil orientation, and bone hydraulic potential indicates that archeological materials were unlikely to have been deposited by water. Spatial association between artifacts and fauna, and zooarcheological analysis implicate hominins as the primary agent of assemblage formation, with some secondary carnivore modification of faunal remains. Rapid sedimentation, minimal bone weathering, and the vertical distribution of bones through the sequence suggests that fossils and artifacts were buried rapidly, and that hominin activities were carried out on-site for hundreds of years. These results suggest that by 2.0 Ma, Oldowan hominins used a variety of habitats including open ones, were dependent on lithic technology in their foraging, and at least occasionally had early access to substantial amounts of animal tissue. The degree of seasonality in site formation, and the affordance(s) attracting hominins to the Kanjera South locale, are currently under investigation.

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## Contextualizing Mammalian Microevolutionary Trends in the Fauna of Boomplaas Cave, Western Cape, South Africa

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Relationships between mammalian body size and biotic factors such as temperature and rainfall have been recognized in modern fauna and have been used to reconstruct paleoclimates. For example, variation in body size in modern hyraxes (*Procavia capensis*) is correlated with maximum average temperature, and in South Africa body size in *P. capensis* has been used to reconstruct rainfall distributions. However, if this variation in body size is not reflecting an adaptive response to climate change, and instead, is explained by neutral processes such as drift, then using body size to reconstruct climatic parameters through time is invalid. Here, we test this hypothesis using a sample of fossil *P. capensis* spanning ~80,000 years and several glacial cycles. The assemblage from the Boomplaas Cave archaeological site in the Western Cape, South Africa, is used because the nearby Congo speleothem provides a template of temperature and rainfall change in the region and is grouped into three time periods according to these climatic shifts. Standard metrics of tooth size are used as proxy for body size, and Lande's model of evolutionary change is applied. Results indicate that random genetic drift can explain the change in hyrax body size as reflected in crown area of maxillary and mandibular permanent first molars with an effective population size of fewer than three million individuals, regardless of changes in paleotemperature and rainfall. This is the first study to apply a population evolutionary adaptive model to examine South African paleofauna through time, and questions the current hypothesis that specific changes in body size are evolutionarily and climatically significant. These conclusions suggest that caution should be exercised when reconstructing paleoenvironments under the assumption that mammalian body size variation is the result of adaptive evolution. Thus, additional fossil mammalian assemblages need to be tested to determine if this pattern is universal.

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## Quantified Oldowan Lithic Artifact Production: Results and Discussion of Behavioral Lithic Classification

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Subjectivity in lithic artifact classification has long been an area of archaeological debate. Typological classification systems based on perceived morphological differences (Bordes 1961; Leakey 1971) gave way to perceived functional differences (Binford and Binford 1966) and finally to differences in technological manufacture (Toth 1985). However, even technological reconstructions provide little behavioral information regarding the producers of these stone tools. With few exceptions (Bisson 2000), this debate has recently lost momentum and classification has reverted to regional systems. These systems remain only superficially objective and do not provide concrete, replicable behavioral conclusions. I report developmental results for a system of behaviorally objective quantitative lithic classification that functions at both the individual-artifact and assemblage level. By replicating Oldowan reduction sequences in the method of Olduvai Gorge hominins, paying particular attention to behavioral variables, I propose an innovative, size-standardized system to classify lithic artifacts. Classification is based on: (1) the relative position of whole flakes in the Oldowan reduction sequence; and, (2) the behavioral forethought associated with the removal of that particular flake or series of flakes. Hypothesized behavioral variables do, in fact, provide a significant means of classification: external platform angle ( $p=0.00034$ ,  $t=4.49$ ,  $df=58$ ), flake width ( $p=0.0012$ ,  $t=3.37$ ,  $df=78$ ), platform area ( $p=0.041$ ,  $t=2.09$ ,  $df=61$ ), and absolute platform cortical amount (as well as length, thickness, bulbar thickness, and maximum dimension) accurately separate Oldowan reduction series into respective reduction stages (unifacial chopper, bifacial chopper, discoid, and polyhedron). Archaeological material from Koobi Fora, Northern Kenya, and Olduvai Gorge, Tanzania, are used to test the replication-based classification system. By utilizing controlled replication experiments, archaeological

material can be objectively organized based on the method of manufacture, thus providing direct behavioral information for site usages and differences among Oldowan hominin stone tool producers.

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#### References Cited:

- Binford, L.R. and Binford, S.R. 1966. A preliminary analysis of functional variability in the Mousterian of Levallois facies. *American Anthropologist* 68: 238–295.
- Bisson, M.S. 2000. Nineteenth century tools for twenty-first century archaeology? Why the Middle Paleolithic typology of Francois Bordes must be replaced. *Journal of Archaeological Method and Theory* 7: 1–48.
- Bordes, F. 1961. *Typologie du Paleolithique ancien et moyen*. Publications de l'Institut de Prehistoire de L'Universite de Bordeaux, Bordeaux.
- Leakey, M.D. 1971. *Olduvai Gorge*. Cambridge University Press, London.
- Toth, N. 1985. The Oldowan reassessed: A close look at early stone artifacts. *Journal of Archaeological Science* 12: 101–120.

## A New Hominin Upper Limb Skeleton from Ileret, Kenya

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Ongoing paleoanthropological research at Ileret, Kenya, has resulted in new fossil, archeological, and paleoenvironmental discoveries, including a new hominin upper limb partial skeleton. Fragments of the partial skeleton were recovered over the course of several years at the site of FwJj14E in Area 1A of the Koobi Fora Formation. The fossil-bearing sediments at the site are bounded by tuffs tephrochronologically identified as the Northern Ileret Tuff (c 1.51–1.52 Ma) and the Lower Ileret Tuff (c 1.53 Ma), indicating that the fossil dates to approximately 1.52Ma and making it broadly contemporaneous with KNM-WT 15000, the *H. ergaster/erectus* fossil skeleton from west Turkana. Extensive sieving, preparation, and refitting have now resulted in one of the most complete early hominin partial skeleton fossils from the east side of Lake Turkana that provides new insights into the evolution of hominin hand and upper limb anatomy. The find consists of large fragments of the scapula, humerus, and ulna, as well as several metacarpals and proximal phalanges, all from the right upper limb. The preserved epiphyses show no sign of unfused epiphyseal plates, indicating that the individual had reached adulthood. The fossil shows a combination of primitive and derived traits, including a narrow thumb and robust upper limb bones coupled with human-like thumb and finger length proportions. Its morphology contrasts with the relatively broad thumb metacarpal but otherwise gracile upper limb long bones seen in KNM-WT 15000, and shows that *H. ergaster/erectus* had diverged in its upper limb anatomy, in addition to cranio-dental and lower limb anatomy, from contemporaneous hominins. This fossil demonstrates how contemporaneous early Pleistocene hominins diverged in postcranial anatomy and adaptations relating to tool use, adding to the fossil and archeological evidence of the major transition from *Australopithecus* to *Homo*.

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## Neumark-Nord 2: The Current State of Knowledge

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The site of Neumark-Nord (Frankleben, Germany) has been known to Paleolithic researchers for decades. Discovered by Dietrich Mania in the 1980's, this former open-cast lignite mine has revealed a complex series of lake basins recording hundreds of thousands of years of hominid activity in the Geisel Valley. This past year (2008) witnessed the end of excavation efforts at the site which were focused on Neumark-Nord 2, the second of at least four basins. These efforts were conducted in congress with several scientific undertakings designed to gain a better understanding of the chronology as well as the depositional processes responsible for the accumulation of the sediments in this basin. The sequence of Neumark-Nord 2, more than seven meters at its deepest point, contains a rich lithic assemblage and a faunal assemblage, whose density is surpassed only by its excellent preservation. The combination of these two features makes Neumark-Nord 2 one of the largest and most well researched sites of the Middle Paleolithic. The goal of this paper is to present initial findings relevant to the formation of the basin and to reconstruct the depositional environment of the more than 150,000 artifacts and bones. Secondarily, this paper will lay the groundwork for future research designed around reconstructing Neandertal behavior during the Eemian (MIS 5e) in Central Europe.

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## Preliminary Investigation of Matjhabeng, a Pliocene Fossil Locality in the Free State of South Africa

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The middle Pliocene is a relatively poorly understood time period in southern Africa. Fossil deposits such as Langebaanweg (5.0 Ma) and Makapansgat (2.5 Ma) have each produced large and well documented faunal assemblages, and it is clear that a significant turnover of fauna occurred between the early and late Pliocene. However, the temporal separation between Langebaanweg and Makapansgat represents a significant gap in our knowledge of faunal composition and evolution in the middle Pliocene of southern Africa. In 2007 we began a program of excavation at a middle Pliocene locality referred to as Matjhabeng in the Free State of South Africa. With an estimated age of 3.5 Ma, this site represents a temporal and geographic intermediate between the better known sites. It also represents the only fluvial middle Pliocene deposit in the central interior of southern Africa, highlighting the importance of this unique locality. After two years of excavation, we have recovered a diverse fauna that includes fish, amphibians, reptiles, birds, and mammals. Recovered reptiles include lizards, turtles, and snakes. Avians are comprised of water birds, principally cormorants and ducks. Mammals range in size from small rodents to mammoths, including an array of proboscideans, perissodactyls, and artiodactyls, alongside rare carnivores. In total, we have recognized 28 taxa, including the oldest *Ancylotherium* and the oldest *Megalotragus* fossils in southern Africa. Some of the taxa from Matjhabeng are shared with Langebaanweg, and others with Makapansgat, confirming the intermediate status of this locality. The presence of extensive grasslands is indicated, though these grasslands were part of an environmental mosaic that included significant woodland, and probable wetland, components. Although none have yet been recovered, should any hominins be retrieved from the 3.5 Ma site of Matjhabeng, they will undoubtedly shed light on the issue of the origin and evolution of the South African australopiths.

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## Tubers and the Origins of the Human Lineage

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The Grandmother (Hawkes et al. 1989, In V. Standen and Foley [eds]), the cooking (Wrangham et al. 1999 *Current Anthropology* 40: 567–594), and the fallback food (Laden and Wrangham 2005 *Evolutionary Anthropology* 49: 482–498) hypotheses address the origin and uniqueness of the human lineage. All three rely wholly or partially on the role of plant underground storage organs (i.e., tubers) based largely on analogy with extant Hadza foragers in northern Tanzania. We assess these hypotheses using recovery data coupled with nutritional analyses of tubers collected by Hadza women from 56 days of wet and 36 days of dry season foraging. Energy yield varied substantially within and between tuber species. Field observations on quid size suggest that cooking does not account for this variation. Daily calorie retrieval indicates that Hadza ‘grandmothers’ barely meet their own daily requirements. Therefore, we suggest an alternative explanation for tuber dependence. Dependence on tubers occurred during both the wet and dry season with lower dependence during the dry season, commonly considered the main period of food stress in early hominins. For the Hadza, however, the dry season is a season of high meat availability, and verbal reports suggest that it was more available in the recent past. Stone tool and cutmark evidence (Semaw et al. 1997 *Nature* 385: 333–336; Dominguez-Rodrigo et al. 2005 *Journal of Human Evolution* 48: 109–121) indicates animal processing as early as the mid- to late Pliocene. We conclude that the pattern of tuber use among the Hadza today reflects a general degradation of their habitat and food resources, and emphasize a previously ignored aspect of tuber composition. Tubers are approximately 70% water, and their importance may lie in meeting daily water requirements during portions of the year. Tubers could have provided much-needed water as our early ancestors moved into open, highly seasonal environments.

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## Application of Logistic Regression Modeling to Hadza Skeletal Element Transport

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Zooarchaeologists frequently use the relative abundance of skeletal elements in faunal assemblages in conjunction with foraging theory models to infer subsistence decisions made by prehistoric hunters and gatherers. However, foraging models applied to ethnographic and ethnoarchaeological cases have had variable success understanding the tradeoffs involved in skeletal transport decisions. Rather than modeling element utility, we use the well known “Hadza data” to model skeletal element transport response to distance from

the residential hub and the number of carriers available for carcass transport. Analyses treated individual skeletal elements by prey body size as the response variable. The data were limited to the “high survival” set of skeletal elements to make predictions relevant to taphonomically biased archaeological assemblages analyzed using mid-shaft refitting techniques. Results indicate that distance does not explain a significant portion of size 2 and 3 skeletal element transport variation. However distance explains a great deal of transport variation in prey sizes 4 and 5. Conversely, variation in the number of carriers available to transport prey explains a significant portion of size 2 and 3 skeletal element transport but not size 4 and 5 skeletal elements. Based on the logistic model parameters, we develop a computer-based simulation to model the archaeological signatures of skeletal elements returned to camp and those left at kills. Variable distances, number of carriers, and prey encounter rates were specified over time and over the Hadza spatial range. The outcome of this model is a spatially explicit comparison between inferences of initially deposited assemblages and inferences generated from their archaeological high-survival-bone counter parts. The best skeletal element transport strategy is relative to prey body size and to the discard probability of each individual element. Understanding the influence of these variables provides a framework for testing archaeological element profiles against ethnographically derived transport models.

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## Sexual Dimorphism in Canine Height and Masticatory Efficiency in Anthropoid Primates

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With few exceptions, males of anthropoid species possess taller canines than females and thus require and are capable of wider gapes when using these teeth in aggressive social encounters. However, the mechanisms governing intersexual differences in gape are not well understood. In terms of the masticatory system's bony elements, wider gapes can be achieved by positioning the teeth more anteriorly relative to the temporomandibular joint and/or positioning the attachment sites for the masticatory muscles more posteriorly. Importantly, such changes have a negative impact on masticatory efficiency, as they reduce the leverage of the masticatory muscles (i.e., the ratio of muscle moment-arm length to bite-point moment-arm length). Thus, differences between males and females in canine size and gape may be associated with differences in the leverage of the masticatory musculature, with male bite-force production being less efficient than in females. This study tests this hypothesis using morphometric data describing canine height and moment-arm lengths of the first maxillary molar, the superficial masseter, and the anterior temporalis collected from a sample of thirty anthropoid species (n=826 individuals). Wilcoxon matched-pairs tests indicate that female sample means tend to be greater than those of males for masseter leverage (p=0.01727), as predicted, but not for temporalis leverage (p=0.6039). Closer inspection of the data reveals that the Cercopithecinae constitute the majority of intersexual comparisons (seven out of ten) in which female masseter leverage is statistically significantly greater than male masseter leverage. Moreover, masseter leverage and canine dimorphism are not correlated when phylogeny is controlled. These results suggest that, within the Anthroidea, intersexual differences in gape are primarily determined by soft-tissue anatomy (e.g., muscle architecture, fiber length), and that sexual dimorphism in masticatory efficiency occurs mainly in species at the upper end of the primate range of canine dimorphism and relative canine size, such as the Cercopithecinae.

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## Cranial Growth Among Late Juvenile to Young Adult *Homo erectus*

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The *Homo erectus* calvaria KNM-ER 42700, discovered in 2000 in the Ileret region of northern Kenya, is particularly small and gracile compared with the adult African and Asian hypodigm of the species (Spoor et al. 2007). Partial closure of the spheno-occipital synchondrosis suggests that the specimen is near-adult and had attained its full endocranial volume. However, further exocranial growth cannot be excluded, which raises the question of whether specific features of KNM-ER 42700 would have developed further had the individual lived. We therefore explored the nature of cranial growth in *H. erectus* from a late juvenile stage into full adulthood, and how this reflects on the morphology preserved in fossils representing this transition, including KNM-ER 42700, and among others, KNM-WT 15000 and Dmanisi 2700. Using a sample of adult *H. erectus* calvariae of up to 33 specimens we assessed if and how a series of specific cranial features scales with overall cranial size, and whether immature specimens differ significantly from the scaling trend among adults in a way that is consistent with incomplete development. The features include the supraorbital and occipital tori, the glabellar region, the supramastoid and tympanic areas, and cranial vault thickness in several areas. Results suggest that KNM-ER 42700 would likely have shown further lateral expansion in the supramastoid area, perhaps in association with increased pneumatization. On the other hand, there is no direct evidence that further growth would have occurred in the glabellar region or the midline occipital torus. These and other results obtained for KNM-ER 42700 and other immature and young adult *H. erectus* specimens provide a framework for ranking their relative developmental age. Of these specimens Zhoukoudian Skull III cannot be distinguished metrically from the adult sample for any of the features examined, which is most consistent with it being a young adult.

### References Cited:

Spoor, F., Leakey, M.G., Gathogo, P.N., Brown, F.H., Antón, S.C., McDougall, I., Kiarie, C., Manthi, F.K. and Leakey, L.N. 2007. Implications of new early *Homo* fossils from Ileret, east of Lake Turkana, Kenya. *Nature* 448: 688–691.

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## The Problem of Dichotomy of the Frontal Bone Morphology in the Late Pleistocene Hominids from Western Asia

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Frontal bones or their parts are frequent survivors of taphonomic processes in the fossil record. In palaeoanthropology, the frontal bone morphology is frequently used for the assessment of a hominin's species affiliation. A good distinction in the morphology of the frontal bone region has been recorded between modern humans (recent and Upper Paleolithic) and both Neanderthals and *Homo erectus*. In the present study an attempt is made to re-assess differences between the Western Asian Neanderthals and early modern humans with the help of the 3D geometric morphometric comparative approach. Landmarks and semilandmarks have been collected from the frontal bone surface for a comparative sample of 92 recent modern human individuals from nine populations around the world, six European and two Western Asian Neanderthals (Amud 1 and Shanidar 1), 18 Upper Paleolithic modern humans from Europe and Levant, several Early Modern humans from Levant (Qafzeh 6,9,11, Skhul 5), Zuttiyeh, and two African individuals (Singa and Broken Hill). The results confirm good differentiation between groups with the modern human and 'archaic' morphology of the frontal, where the former includes recent and Upper Paleolithic modern humans and the latter Neanderthals and Broken Hill. The morphology of the Levantine Early Modern Humans, as in many previous studies, is found to be 'intermediate.' Neanderthals however do not demonstrate homogeneity in the sample: the Western Asian Neanderthals and two of the European Neanderthals in the comparative sample considerably overlap with some of the Levantine Early Modern Humans as do Singa and Zuttiyeh in the morphology of the frontal. It therefore appears that the frontal bone alone is not the best region for discriminating between groups of the Late Pleistocene hominins other than European Neanderthals and recent/Upper Paleolithic modern humans. This result first of all points to the relatively late development of the 'typical recent modern human' morphology of the frontal bone in the human history and to a particular specialization of the European Neanderthals. This study demonstrates that other Late Pleistocene hominids do not display such a clear-cut morphological dichotomy.

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## Neanderthal Exploitation of Reindeer in the Quina Mousterian at Chez Pinaud, Jonzac (France): Zooarchaeological and Isotopic Evidence

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The site of Chez Pinaud, Jonzac (Charente-Maritime, France), preserves a rich sequence that includes Quina Mousterian, Denticulate Mousterian, and Mousterian of Acheulean Tradition artifacts. The Quina assemblage originates from a remarkably dense bone bed yielding a faunal assemblage dominated by reindeer (NISP=5232, MNI=18). Preservation is excellent, providing an exceptional opportunity to evaluate Neanderthal subsistence and ecology. Anthropogenic modifications are abundant and carnivore remains and influences are minimal, indicating that Neanderthals were the primary accumulators of the reindeer. Carcasses, likely complete animals, were transported to the site and butchered there, although the hunting location remains unknown. On-site butchery and marrow exploitation are indicated by the presence of all skeletal parts, abundant cut- and scraping-marks, numerous hammerstone percussion marks, and bone flakes that are a result of fresh breakage. Numerous examples of articulated limb portions show discard of complete distal limbs and minimal post-discard disturbance. Juvenile and old reindeer are present, but the majority of specimens are from adults. Post-cranial remains show size variation representing both males and females. The degree of tooth eruption on the youngest mandibles indicates exploitation during multiple seasons. We suggest that Neanderthals targeted reindeer during this taxon's seasonal migrations. Isotope techniques have been used to investigate the dietary and migratory behaviors of this prey species. Initial strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) data from sequentially-sampled enamel of two Jonzac reindeer individuals point to seasonal migrations between two different geological terrains. This is the first such evidence for Pleistocene reindeer and is comparable to intra-tooth isotope data from modern migratory caribou. Along with carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope data from the Jonzac reindeer, we can reconstruct the palaeoecology of this prey animal and in turn, gain insight into the paleoenvironment in which Neanderthals lived. The isotope analyses compliment the zooarchaeological data, allowing a better understanding of Quina Mousterian Neanderthal behavior.

## Automatic Crest Lines Extraction for 3D Morphometry of Fossil Structures

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«Geometry morphometrics» methods (Bookstein 1991) use configurations of landmarks to define the shape of an anatomical structure. Coordinates of these landmarks are then processed to compute an «average» shape, to quantify the variability or to emphasize the differences between data. In general, the considered landmarks are 3D anatomical points which are located either on the real surface of the fossil or on a digital representation. Then it becomes possible to extrapolate «semi-landmarks» in order to define more precisely the shape. Nevertheless, some researchers have proposed to use 3D feature curves directly (Dean 1993) which gives much more information than sparse points. But it can be difficult to define these curves manually and the result remains user-dependent. So, some researchers in computer science have developed methods to extract such kinds of curves automatically (often called «crest» or «ridge» lines) from a 3D image and they have used them to analyse the shape of a fossil skull (Subsol et al. 2002). They also have shown that crest lines are very close to anatomical lines which are extracted under the supervision of an expert. We present the latest algorithms to compute fully automatically crest lines and we apply them on several anatomical structures (tooth, skull, endocranium) of a database of CT-Scan and microCT-Scan images of primates and hominid fossils. We show how these lines emphasize the bony structures of the skull such as the zygomatic process. We find also that crest lines on endocranium data may help to define the different lobes in a reproducible way. Lastly, we use crest lines to characterize the geometry of the grooves in the Enamel Dentine Junction. Based on these preliminary results, we aim to develop new computerized tools to study the morphological variability of anatomical structures and to compare the fossils found on the Sterkfontein site (Braga et al. 2008).

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### References Cited:

Bookstein, F. L. 1991. *Morphometric tools for landmark data: geometry and biology*. Cambridge University Press.

Dean D. 1993. *The Middle Pleistocene - H. erectus/H. sapiens Transition: New Evidence from Space Curve Statistics*. Ph.D. Dissertation, The City University of New York.

Subsol G., Mafart B., Silvestre A., and de Lumley M.A. 2002. 3D Image Processing for the Study of the Evolution of the Shape of the Human Skull: Presentation of the Tools and Preliminary Results. In: *Three-Dimensional Imaging in Paleoanthropology and Prehistoric Archaeology*, Mafart and H. Delingette with the collaboration of G. Subsol (Eds.). British Archaeological Reports International Series 1049, pp. 37–45.

Braga J., Subsol G., Thackeray F., Dasgupta G., Balter V., Dedouit F., and Telmon N. 2008. Evolution of Late Pliocene hominin midfacial morphology. An approach using three-dimensional surface registration. *American Journal of Physical Anthropology*, Suppl. 46: 72.

## Comparative Ecological Settings of *Homo* in Plio-Pleistocene East Asia and East Africa

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*Homo* dispersed to continental East Asia by 1.7 Ma, with early evidence found at Yuanmou and at Majuangou (Nihewan Basin), China. Many early Pleistocene East Asian mammalian species differ taxonomically from East African species of this time period, but it is unclear whether hominins colonized places that differed from East Africa in their ecological properties. Evidence from large mammals is used to determine whether hominin populations dispersed into areas where the fauna was similar ecologically to Africa, or whether hominins colonized substantially different environments during their initial dispersal. Large mammal specimen data were collected from East Asian early Pleistocene hominin sites. Specimens from non-hominin early Pleistocene and late Pliocene sites from Asia and from Olduvai Gorge and Lake Turkana were included for comparison. Modern faunal data drawn from Asian and African nature reserves also were analyzed. Body mass and hypsodonty were estimated from craniodental measurements. Each species was then classified into an ecological category combining body mass, diet, and substrate (terrestrial, arboreal, or aquatic). The number of species in each category at each site was used in a correspondence analysis. Results show that East Asian early Pleistocene sites had different ecological structures compared with East African sites, and that ancient sites differed ecologically from modern faunas. A greater number of grazing species tends to differentiate East African from East Asian Plio-Pleistocene sites. Browsers and carnivores were common in the East Asian fossil sites. By contrast, modern sites show a different pattern; African sites have many grazing and browsing species, while the East Asian sites have more species of omnivores and small predators. Differences in ecological structure between the Plio-Pleistocene African and Asian sites indicate that as hominins spread into East Asia, they encountered faunal communities that differed in their ecological characteristics and resource availability as well as taxonomically.

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## An Analysis of Postnatal Temporal Bone Ontogeny in *Pan* and *Homo*, with Implications for Temporal Bone Growth and Development in *Australopithecus afarensis*

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Historically, assessments of temporal bone morphology have played an important role in taxonomic and phylogenetic evaluations of fossil taxa, and more recent 3D analyses of this region have supported the utility of the temporal bone for testing taxonomic and phylogenetic hypotheses. But while several clinical analyses have examined aspects of temporal bone growth and development in humans, little is understood regarding the ontogeny of the temporal bone as a unit, or its development in non-human taxa. This study seeks to address several research questions: 1) how does temporal bone shape change during ontogeny?; 2) how do ontogenetic trajectories differ between closely related hominoid primate species?; and, 3) to what extent does *Australopithecus afarensis* exhibit similar patterns of growth to closely related extant species? Three-dimensional landmarks were digitized on an ontogenetic series of specimens of *Homo sapiens* and *Pan troglodytes*. These data were analyzed using geometric morphometric methods, and shape changes throughout ontogeny were compared. Results of these analyses indicate that, despite broadly similar patterns, *Pan* and *Homo* show marked differences in development of the mandibular fossa and tympanic portions of the temporal bone. These findings indicate divergent, rather than parallel, postnatal ontogenetic trajectories for temporal bone shape in these taxa, a finding which is consistent with analyses by O'Higgins and colleagues regarding development of the face in hominoids. Several fossil temporal bones from *Au. afarensis* were then incorporated into the analysis. These fossil specimens fell between the *Pan* and *Homo* samples in morphospace, but were more similar to *Pan* in shape, a finding that is consistent with previous descriptions of the *Au. afarensis* temporal bone. The ontogenetic trajectory for *Au. afarensis* also was intermediate between *Pan* and *Homo*, but was more similar to *Pan* earlier in development, suggesting that the species-specific characters for *Au. afarensis* appear relatively later in ontogeny.

## Ad Hoc Strategies of Tool Use by Middle Pleistocene Hominins in Member 11', Ologesailie Formation, Kenya

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Relationships between resource variability and foraging—including planning depth, tool transport, and mobility strategies—are important aspects of hominin behavior that remain poorly understood for the African Middle Pleistocene. We explore these problems through paleolandscape excavations and analyses of Member 11' of the Ologesailie Formation, southern Kenya Rift. <sup>40</sup>Ar/<sup>39</sup>Ar-dated tephra provide an age estimate of between 662ka and 625ka for >6,000 artifacts and >1,500 fossil specimens (some with cut marks) excavated from a narrow (~5-50cm thick) stratigraphic interval over ~1km of outcrop. The artifacts, made from nearby highland lavas, and the fauna, which indicate open grassland, were deposited near a permanent water source associated with a relatively low energy fault-controlled fluvial sand complex overlying older diatomaceous deposits. Our analysis of Member 11' lithic assemblages identifies stone raw material sources using a novel method of geochemical characterization by electron microprobe, estimates site-to-source distances by incorporating local topographic gradients using GIS-based cost-surface analysis, and considers distance-decay, core reduction intensity, and flake utility models. Our initial results are not consistent with the prior provisioning of places or individuals in anticipation of future needs, but rather suggest an ad hoc or immediate returns strategy for sharp-edged flakes made, used, and discarded within 3km of their geological source. Although the Member 11' archaeological sites are located close to stone sources, some raw material types decline in abundance and show greater reduction intensity with increased source distance. Comparison with older strata at Ologesailie suggests that the degree of economization may vary with local habitat structure and the availability of non-stone resources. Although Middle Pleistocene hominins did on rare occasions move artifacts distances beyond the daily foraging range, stone tools from Member 11' of the Ologesailie Formation were used and abandoned over short spatial and temporal scales.

## Perspectives of Study of the Paleolithic of Western Georgia

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Occupying an intermediate position between Africa, Asia, and Europe, the southern Caucasus has represented a northern geographic terminus for major expansions and migrations of human populations, both Archaic and Modern, throughout much of prehistory. The Main Caucasus Range protected the Transcaucasus and, in particular, Georgia, from the strong impact of glaciation. The local archaeological cultures had been forming in the territory of Georgia, which, while bearing a certain resemblance to Paleolithic cultures of neighboring regions, at the same time were different from them. In this respect, such differences determined the universality and

uniqueness of the Paleolithic existing in the territory of Georgia. More than 470 Paleolithic sites in this territory were identified. More than 200 sites are represented in the Rioni-Kvirila basin (Western Georgia). In this region, supposedly the earliest Middle Paleolithic (possibly, Tabun-D type site-Djrchula Cave 280–270,000 bp), as well as the latest Middle Paleolithic (Ortvala Klde -34,000) have been confirmed. Research on the Rioni-Kvirila basin sites gives a unique possibility to study extremely topical and up-to-date problems, not only in terms of the Caucasus, but generally for prehistoric sciences: 1) dynamics, technological and typological changes, and helpful factors of the transition periods from early to middle and Middle to Upper Paleolithic; 2) trends of various kinds of (e.g. diffusion) cultural influences and migrations; 3) raw materials, their spread and accessibility in various epochs, reasons for intensity of their use and the issues connected with it; 4) origin and basic principles of art or religion (small forms of art are represented at some sites. In one of the newly discovered caves, "Undo Cave," the existence of a 47m depth karstic pit has been established, in which faunal and anthropological remains have been discovered and which may be concerned with some rituals); 5) type of economical activities in the Upper Paleolithic (In one of the newly found sites, Bondi Cave, a large quantity of flax fibers and twisted and painted fibers, which indicates the handmade production of textile, was discovered); 6) tectonic and seismic processes (the region is located on a fault zone where approximately once every 1,500 years, strong earthquakes take place) and their influence on the geological processes, on human adaptations; and, 6) reconstruction of the paleoenvironment (fauna, flora, paleo-climate) should be implemented.

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## Re-Sampled Human Cranial Capacities Compared to Würm Neandertals

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It is often asserted that Neandertals had larger cranial capacities than living modern humans, and some publications have discussed causes of cranial capacity reduction from a putative Neandertal ancestral condition. This assertion is generally not sex specific and is not based on statistical analysis. I address these two issues here and test the hypothesis that Neandertals had larger cranial capacities than modern humans. Using a re-sampling approach, cranial capacities of Würm Neandertals (6 males, 3 females) were compared to the cranial capacities of five European modern human cemetery populations (328 males, 342 females). Males were compared to males and females to females. The human males' cranial capacities range from 1129–1870cm<sup>3</sup> and the females' cranial capacities range from 1030–1630cm<sup>3</sup>. A Microsoft Excel macro was written to compare the human and Neandertal cranial capacities by re-sampling. The main concept takes sets of humans that consist of the same number of cranial capacities as are available in the Neandertals, and compares the averages. In the male comparisons, 1000 sets of six human males were randomly selected and their averages determined. The same was done for samples of three females. For males, the human averages ranged from 1356.67–1627.33cm<sup>3</sup>. The male Neandertal average was 1541.17cm<sup>3</sup>, which was greater than or equal to the male human sets' averages 90 percent of the time. For females, the human averages ranged from 1111.67–1513.00cm<sup>3</sup>. The female Neandertal average was 1225.67cm<sup>3</sup>, which was greater than or equal to the female human sets' averages 9 percent of the time. Neandertal females tend to be smaller than the modern females while Neandertal males are larger than the modern males. However, these comparisons are not statistically significant at the 5% level. The null hypothesis of no cranial capacity difference cannot be rejected at this time.

## The Oldest Evidence for the Use of Human Bone as Tool

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The earliest evidence for the use of human bone as a raw material to produce symbolic objects in the form of personal ornaments dates back to the beginning of the Upper Paleolithic in Europe. Utilitarian objects made of human bone are not known before the late Upper Paleolithic, some 17,000 years ago. Here we describe a human skull fragment from the site of La Quina that bears clear traces of utilisation as a retoucher. This piece is a fronto-parietal fragment found in 1923 in a Mousterian level attributed to MIS 4–3. Two other skull fragments from the same level could come from the same individual. Macroscopic and microscopic analyses, including SEM observation, demonstrate that the modifications visible on this object are similar to those produced on bone fragments used experimentally to retouch flakes. The microscopic analysis also identifies ancient scraping marks possibly resulting from the cleaning of the skull prior to its utilization as a tool. The traces of utilisation and the dimensions of this object, presently the oldest tool made of human bone, are compared to those on a sample of 67 bone retouchers found in the same excavation area and layer. Results show that the tool size as well as the dimensions and location of the utilized area are well within the variation of the same attributes recorded on faunal shaft fragments from La Quina that were used as retouchers. Our analysis pushes back by more than 40,000 years the first use of human bone as a tool. The implications of this discovery, concerning Neandertal behavior, will be discussed.

## Craniofacial Shape Variation in Late Pleistocene Asian Hominins

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Numerous scholars, beginning with Franz Weidenreich in the late 1930s, have commented on the heterogeneous nature of the terminal Pleistocene Asian fossil record. However, most studies relied on comparisons between the Zhoukoudian Upper Cave specimens (UC 101 and 103), and very few have systematically examined other Asian specimens. To fill this gap and to gain a better understanding of craniofacial shape variation in Late Pleistocene Asia, we collected three-dimensional landmark data on Lijiang, Liujiang, UC 101, UC 103, and Ziyang from China, Minatogawa 1 and 4 from Japan, Wajak 1 from Indonesia, and Kanalda from Australia. We compared this fossil set to a large pool of recent human crania representing 11 regional populations from Asia, Australasia, and North America. Because of incomplete preservation and missing landmarks, we performed two separate analyses. Analysis 1 focused on the neurocranium and the base (55 landmarks, n=550 specimens), and Analysis 2 focused on the face (42 landmarks, n=484 specimens). Our results indicate that only Kanalda, Lijiang, and Wajak consistently cluster to their respective recent, regional groups. The Upper Cave and Minatogawa specimens, on the other hand, share craniofacial similarities with the Amerindian group from Point Hope, Alaska. Liujiang and Ziyang also do not show affinities to the recent Chinese group or to the East Asian group in general. Instead, they cluster more closely to South and Southeast Asian populations. Our findings agree with previous morphometric studies (e.g., Brown 1998; Cunningham and Wescott 2002; Cunningham and Jantz 2003) that there was more cranial heterogeneity in Asia during the terminal Pleistocene than in the present day.

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### References Cited:

- Brown, P. 1998. The first mongoloids? Another look at Upper Cave 101, Liujiang and Minatogawa 1. *Acta Anthropologica Sinica* 17: 255–275.  
 Cunningham, D.L. and Wescott, D.J. 2002. Within-group human variation in the Asian Pleistocene: the three Upper Cave crania. *Journal of Human Evolution* 42: 627–638.  
 Cunningham, D.L. and Jantz, R.L. 2003. The morphometric relationship of Upper Cave 101 and 103 to modern *Homo sapiens*. *Journal of Human Evolution* 45: 1–18.

## Pelvic Form and Hip Joint Function in Anthropoids with Implications for *Rudapithecus*: 3D Analysis of Continuous Surface Data

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The recently discovered partial pelvis of *Rudapithecus hungaricus* is the only middle or late Miocene hominoid pelvis except for the distorted *Oreopithecus* specimen. Because *Rudapithecus* is a member of the crown hominoid clade, this new specimen is key to understanding the evolution of hominoid body form and hip function. Provisional analyses of linear dimensions suggested overall similarity to extant hominoids, but because *Rudapithecus* is missing parts of the ilium, pubis, and ischiopubic ramus, important morphologies could not be compared metrically to extant specimens, nor could it be distinguished from lesser or great apes. Here we employ novel 3D analytic methods using laser scan data that do not rely on landmarks to quantify pelvic form, and provide novel analyses of hip joint functional anatomy in anthropoids that lend insights into this new fossil. Using polylines to mark the acetabular margin, we can calculate percentage of a best-fit sphere circumscribed by the lunate surface. Hylobatids, atelines, and *Pongo* have shallow acetabulae that cover a smaller percentage of a sphere than do cercopithecines. *Rudapithecus* most closely resembles colobines, in-between African and Asian apes in acetabular bone distribution. When scaled and aligned, surface topographic comparisons are used to quantify regions of greatest differences in the anatomical regions preserved in *Rudapithecus* with other pelvises. Flaring and curvatures of lower iliac margins, and iliac orientation relative to the acetabulum are most like that of great apes, and distinct from lesser apes. The ischium is long and less dorsally inclined. These new data provide new insights into hip joint function, as well as details of iliac form and orientation among ilium, ischium, and pubis. They demonstrate that the *Rudapithecus* pelvis retains some primitive characteristics, but overall it resembles that of great apes and displays adaptations for a below-branch arboreal lifestyle.

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## A New Age for the *Australopithecus africanus* Specimens From the Western Makapansgat Limeworks, South Africa: A Combined Magnetostratigraphy and Biochronology Approach

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The Makapansgat Limeworks, one of the oldest of the nine hominin-bearing South African cave sites, offers a unique opportunity to investigate aspects of hominin evolution such as biogeography and ecology; these sites are located several thousand miles south of the core Pliocene and Pleistocene East African hominin sites. The results of this study therefore directly impact on current hypotheses of early hominin phylogeny and behavioral ecology, and both hominin and mammalian dispersal across the African continent. Previous chronological studies at the site have been based upon incorrect stratigraphic interpretations, including the presumed superpositioning of deposits. Other methods have large age errors, or are open to several interpretations. This study presents the results of a combined magnetostratigraphy and biochronology approach to site chronology. Particular emphasis was placed upon understanding site stratigraphy and fossil provenance, in order to successfully address previous problems besetting the use of these methods at the site. Research was focused on the western cave deposits to which all of the hominin specimens, and the majority of macrofauna, have been provenanced. Magnetostratigraphic sequences from the Classic Section, Main Quarry, and Original Ancient Entrance repositories were matched to the Geomagnetic Polarity Timescale, using results from the biochronology study to constrain the match. An age of 2.58 Ma is assigned to the *in situ* hominin specimen MLD 37/38 from the Partridge Block Pink Breccia (Member 4). An earlier age of ~2.7 Ma, based upon estimated deposition rates, is suggested for the *ex situ* hominin specimens and faunal assemblage provenanced to the Classic Section Grey Breccia (Member 3). The *in situ* fauna derived from the recently recognised Member X is assigned an age in excess of 3.04 Ma. Makapansgat therefore represents the first appearance of *Australopithecus africanus* in the fossil record, and possibly the earliest appearance of any hominin species in South Africa.

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## A Preliminary Assessment of Linear Measurements for Root Growth in Permanent Molar Teeth of the Chimpanzee and Fossil Hominids

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Previous studies of comparative dental development in humans and apes suggest that interspecific differences in emergence timing of the permanent molars are largely due to variation in the timing of tooth emergence relative to root formation, which is achieved relatively earlier in apes. In contrast, crown formation times are more similar regardless of crown size. Such interspecific differences in root formation help explain differences in the overall timing and pattern of tooth emergence in these taxa, and are thus relevant to reconstructing the evolution of hominid life history. This study provides data from a cross-sectional sample (n=64) of laboratory-reared chimpanzees (*Pan troglodytes*) to examine metrical aspects of crown and root formation in mandibular molars. We documented maximum crown height, and distal and proximal root lengths of the left mandibular permanent molars from a cross-sectional series of peri-apical and lateral oblique radiographs of chimps aged between approximately 1.5 and 11 years. Measurements were obtained using ImageJ 1.39u software and statistical analysis was conducted in MS Excel and SPSS. Available tooth casts for a subsample of 23 chimpanzees were used to calculate a mean magnification correction factor of approximately 10.37% (S.D.=3.82). Regression plots of root length on age in the chimpanzee sample demonstrate different schedules of root growth among the molars. Regression slopes indicate that the pace of linear molar root growth decreases in the direction M1>M2>M3. In chimpanzees, final root length (stage 7) was first documented between 4–5 years in M1, and 7–8 years in M2. Corrected maximum root lengths were calculated and plotted against age and root development stage for different molar types, and compared to available published data for South African hominids. Though the sample is small, these findings suggest that fossil hominid molars emerge with less root formation completed relative to either chimpanzees or humans.

## The Role of Body Mass in the Evolution of the Modern Human Nasofacial Skeleton

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The emergence of anatomically modern humans involved significant reductions in facial prognathism, nasal breadth, and lean body mass. While traditionally studied independently, the evolutionary trajectories of these three traits may have been interrelated. We

assess the potential relationships among these variables using two lines of evidence: 1) the morphometric and ontogenetic relationships of nasofacial dimensions; and, 2) the bioenergetic demands of increased lean body mass and the resultant stresses placed upon upper respiratory tract anatomy. Recent research has suggested that facial prognathism and external nasal breadth are both affected by growth at the premaxillary suture; prolonged suture patency is associated with prognathic faces and broader noses, while earlier suture closure is associated with orthognathic faces and narrower noses. The evolution of modern human facial architecture appears to be due largely to a reduction in the growth rate of this region. However, this change may not have been possible without first reducing lean body mass. On average, archaic humans were substantially more massive than modern humans. This greater amount of lean body mass would have required greater daily caloric intake, which would have, in turn, necessitated the inhalation of roughly two to three times the oxygen required by the average adult modern human. Significant narrowing the nose was probably not a viable option for archaic humans, as it would have restricted the flow of oxygen to the lungs, possibly at a level below that required by their massive bodies. As lean body mass decreased, first within archaic humans and then more substantially with the emergence of modern humans, facial prognathism and nasal breadth were free to vary as a result of stochastic evolutionary change or natural selection from pressures such as those imposed by a cold climate.

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