

A01  
24 April 2006

## **Face Value: Comparative Quantitative Genetics of the Human (*Homo sapiens*) and Baboon (*Papio hamadryas*) Craniofacial Complex**

Richard J. Sherwood, *Lifespan Health Research Center, Wright State University School of Medicine and Department of Neuroscience, Cell Biology, and Physiology, Wright State University*

Dana L. Duren, *Lifespan Health Research Center, Wright State University School of Medicine and Department of Neuroscience, Cell Biology, and Physiology, Wright State University*

John Blangero, *Department of Genetics, Southwest Foundation for Biomedical Research and Southwest National Primate Research Center*

Michael C. Mahaney, *Department of Genetics, Southwest Foundation for Biomedical Research and Southwest National Primate Research Center*

Bradford Towne, *Lifespan Health Research Center, Wright State University School of Medicine*

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Recent research has explored the application of quantitative genetic analyses to interpretations of traits frequently used in phylogenetic reconstructions of fossil hominins. Parameters such as heritability ( $h^2$ ) and genetic correlation ( $\rho_g$ ), for example, can provide critical information regarding the potential response rate of traits to evolutionary forces and the integration of trait response. Application of these parameters to the fossil record, however, may be problematic given the caveat that these parameters are population-specific statistics, and do not describe variation at the level of genus or species. The utility of heritability and genetic correlations in interpretations of the fossil record may be justified if it can be demonstrated that estimates are robust across populations and/or taxa.

To examine the genetic underpinnings of the structure and development of the primate craniofacial complex, nine craniofacial measures were taken from lateral cephalograms of 304 baboons (aged 2-8 years) at the Southwest National Primate Research Center, San Antonio, TX, and 389 humans (aged 6-24 years) from the Fels Longitudinal Study, Dayton, OH. The heritability of each trait, and the additive genetic correlation between traits, were estimated using a maximum likelihood method for pedigree data. Heritability estimates of all craniofacial traits for baboons were significant, ranging from 0.15 to 0.99; heritability estimates for human traits were also significant, ranging from 0.47 to 0.79. Confidence intervals for these heritability estimates identified seven traits exhibiting similar levels of heritability between the two taxa. Correlation analysis identified varying degrees of pleiotropic effects among craniofacial traits for both taxa. These findings are encouraging, not only in the success of the initial characterization of the underlying genetic architecture of the craniofacial complex, but in identifying the consistency of this architecture across genera. Future work will seek to identify the specific genes influencing morphological variation of the baboon and human craniofacial complexes.

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A02  
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## **The Evolutionary Significance of Canine Reduction in Hominins: Functional Links Between Jaw Mechanics and Canine Length**

W.L. Hylander, *Duke University Primate Center and Department of Biological Anthropology & Anatomy, Duke University*

C.J. Vinyard, *Department of Anatomy, NEOUCOM*

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There is no consensus as to the functional significance of canine length reduction in hominins (Plavcan, 2001). In this paper we describe functional links between canine length and jaw mechanics in catarrhines. We then hypothesize a proximate explanation for canine reduction in hominins.

Following an analysis of maximum jaw gape in sedated primates during TB testing and/or veterinary physical exams (Hylander and Vinyard, nd), we find that relative to mandibular length, adult male nonhuman catarrhines have much larger gape than do females. In contrast, male and female humans have about the same amount of maximum gape. Furthermore, there are considerable interspecific differences in the amount of gape relative to mandibular length. For example, long-tailed, lion-tailed, and pig-tailed macaques have much larger gape than do rhesus and Japanese macaques. Moreover, chimpanzees and gorillas have less relative gape than do cercopithecines, but more relative gape than humans. Furthermore, coupled with canine length data reported by Plavcan (1990), those catarrhines with relatively smaller gape have relatively shorter canines.

Relative maximum gape is a function of jaw adductor muscle-fiber length and muscle position, and there are important costs and benefits linked to modifying these muscle characteristics. Relative to muscle size, more caudally or posteriorly positioned muscles and/or longer muscle fibers have the benefit of increasing jaw gape, but the cost is a reduction in bite force. Conversely, relative to muscle size, more rostrally or anteriorly positioned muscles and/or shorter muscle fibers increase the production of bite force, but at the cost of reducing maximum gape. We suggest that in the earliest hominins, selection pressures for increased bite force exceeded those pressures for maintaining large gape linked to large canines. Thus, canine reduction was a necessary functional outcome to minimize canine interference associated with decreased gape and increased bite force along the postcanine teeth.

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A03  
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## Toward the Origins of Anthropoid Primates

Alfred L. Rosenberger, *Department of Archaeology and Anthropology, Brooklyn College, CUNY*

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While it has become widely accepted that, in a taxonomic sense, the anthropoid primates evolved from omomyids or omomyid-like euprimates, it has also become apparent that this largely Eocene family is neither monophyletic nor morphologically coherent. This poses challenges for the omomyid-anthropoid hypothesis. My reanalysis of Paleogene primate skulls based on 3D laser scanning and graphical reconstructions suggests that the Eo-Oligocene species *Rooneyia viejaensis* (from Texas), unlike other “omomyids,” shares a suite of derived homologous characters with anthropoids relating to the construction of the frontal bone and orbits which foreshadows the evolution of the enclosed eye socket that is a hallmark of Anthroidea. Others share derived cranioskeletal features with modern tarsiers, including several that have very large eyes. Thus, rather than being an archaic group of primates only loosely or ambiguously affiliated with the moderns by virtue of an ancient common ancestry, these fossils may actually embody the phylogenetic split among the haplorhine primates into its two component clades, tarsiers and anthropoids. Rather than seeing omomyids as a metaphor of what pre-anthropoids may have looked like and behaved like, *Rooneyia* and its allies (protoanthropoids) may provide specific empirical evidence of the mosaic evolution of features representing early phases in the evolution of the anthropoid eye socket, as well as a chrono-biogeographic, deep-phylogeny datum pertaining to the deployment of higher primates. These findings also have consequences for assessing the interrelationships of one new Eocene primate that has been presented as an eosiid anthropoid, *Bahinia pondaungensis* (from Myanmar). While its orbit appears to be relatively small, it was also quite laterally directed, as in strepsirhines and unlike anthropoids and protoanthropoids. The omomyid-anthropoid hypothesis, which grew to become conventional wisdom over the course of 25 years, needs to be revised in order to shed more light on the origins of anthropoid primates.

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## **The Mammalian Evidence for the Paleoenvironment of the Late Miocene Deposits of the Middle Awash, Ethiopia**

Denise F. Su, *Department of Integrative Biology, Human Evolution Research Center, University of California at Berkeley*

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The Asa Koma Member of the Adu-Asa Formation and the Kuseralee Member of the Sagantole Formation of the Middle Awash (Ethiopia) have yielded remains of the early hominid, *Ardipithecus kadabba*. These members are radiometrically dated to between 5.5 and 5.8 and between 5.2 and 5.6 Ma, respectively. At least 2,500 fossil specimens, representing 57 mammalian genera in 23 families, have been recovered from these members. The large number of mammalian taxa enables detailed paleoenvironmental analysis. Moreover, it is crucial to examine the environment of *Ardipithecus kadabba* in order to better understand potential environmental changes that might have shaped our own lineage.

In order to look at the habitat in which *Ardipithecus kadabba* lived, the ecovariable structure of the associated mammalian samples from fossil localities of the Asa Koma and Kuseralee Members were examined. The ecovariables used in this analysis consist of trophic and locomotor adaptations of each genus in the mammalian fauna. The ecovariable structures of the Asa Koma and Kuseralee Member fossil samples were compared with those of modern mammalian communities from different habitats, including desert, grassland, shrubland, bushland, woodland, and forest. Preliminary results of multivariate analyses of the ecovariable structure, including hierarchical clustering and principal components analysis (PCA), indicates that the faunal communities of the Asa Koma and Kuseralee Members are most similar to modern faunal communities found in habitats dominated by woodland with areas of grassland, particularly those bordering rivers and/or lakes. This finding agrees with previous reconstructions based on presence/absence of species and carbon isotopes, both of which suggest that woodland to grassy woodland habitats were present during the deposition of the Asa Koma and Kuseralee Members.

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A05  
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## First Fossil Chimpanzee

Sally McBrearty, *Department of Anthropology, University of Connecticut*

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There are thousands of fossils hominins, but no fossil of the chimpanzee (*Pan*), the closest relative to humans, was reported prior to the discovery in 2004 of specimens from the Kapthurin Formation, Kenya. Living chimpanzee populations are confined to wooded West and Central Africa, while most hominin fossil sites occur in the semiarid East African Rift Valley, which has led to speculation regarding causes for the divergence of the human and chimpanzee lineages at 5 to 8 Ma. A shift from wooded to savanna vegetation in East Africa, driven by climate change, has been invoked to explain the apparent separation between chimpanzee and human ancestral populations and the origin of the unique hominin locomotor adaptation, bipedalism. The Rift Valley itself is seen as an obstacle to chimpanzee occupation in some scenarios. The fossils from the Kapthurin Formation show that representatives of *Pan* were present in the East African Rift Valley during the Middle Pleistocene, where they were contemporary with an extinct species of *Homo*. Habitats suitable for both hominins and chimpanzees were clearly present there during this period, and the Rift Valley did not present an impenetrable barrier to chimpanzee occupation.

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A06  
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## **Chimpanzee Locomotor Biomechanics and the Evolution of Hominid Bipedalism**

David A. Raichlen, *Department of Anthropology, Harvard University*

Herman Pontzer, *Department of Anthropology, Harvard University*

Michael Sockol, *Department of Anthropology, University of California at Davis*

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Chimpanzees use more energy to walk and run compared to other mammals (including humans), however their bipedal and quadrupedal costs do not differ. Despite several attempts to include these results in explanations of early hominid evolution, there has been no systematic study of the determinants of chimpanzee energy expenditures. By examining chimpanzee bipedal and quadrupedal biomechanics, we sought to determine whether morphological changes from a chimpanzee-like ancestor could have bestowed energetic benefits on the earliest bipeds. We analyzed the determinants of chimpanzee energetics by calculating the muscular force produced to support body weight during locomotion in 5 adult and juvenile chimpanzees ( $n = 42$  stride). Several studies have shown that muscular force production determines energy costs in a wide range of animals, so we predicted that chimpanzee force production would not differ between locomotor modes and would be higher than other mammals. We calculated muscle force production as the joint moment due to the ground reaction force at the ankle, knee and hip divided by the muscle mass weighted-mean extensor muscle moment arm at each joint. Our results suggest that the similarity in costs between quadrupedal and bipedal locomotion is due to similar amounts of muscular force production. Chimpanzees' high energy costs compared to other mammals are related to high joint moments at the knee and the hip demanding high muscle force production at these joints. The results from our study suggest that relatively minor skeletal changes to improve muscle mechanical advantage could have made bipedalism more efficient than quadrupedalism in early hominids. We will discuss whether these changes are present in early hominid fossils and explore the relative importance of selection for reduced energy expenditures during the evolution of bipedalism.

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## **Lumbar Vertebral Size and Shape Variation Between Australopithecines (*A. africanus*, *A. afarensis*), *Homo ergaster*, and Modern Hominoids (*Pan troglodytes*, *Gorilla gorilla*, *Pongo pygmaeus*, and *Homo sapiens*) Reflects Differences Between Different Climbing Behaviours and Between Habitual Bipedes and Runners**

Sandra A. Martelli, *Department of Anatomy & Developmental Biology, UCL*

Paul O'Higgins, *The Hull York Medical School, University of York*

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In this study, we explore patterns of inter-specific variation in lumbar vertebral size and shape between modern hominoids (*Gorilla gorilla*, *Pan troglodytes*, *Pongo pygmaeus*, and *Homo sapiens*) and between modern and fossil hominins, namely *Australopithecus* (*A. africanus*, *A. afarensis*), and *Homo ergaster*. Geometric morphometric methods are employed to assess variations in the form (size and shape) of lumbar vertebrae and the lumbar spine as a whole. Results from comparative studies of the lumbar vertebral morphology of modern hominoid taxa indicate that inter-specific differences in vertebral size reflect differences in body weight between quadrupedal taxa and differences in habitual posture between bipedal and quadrupedal taxa. Differences in locomotor repertoires between the taxa are more strongly expressed in vertebral shape differences. Studies that include fossils indicate that patterns of vertebral size variation between individual vertebrae and along the lumbar spine of *Australopithecus* most resemble great apes but the patterns of shape variation most resemble modern humans. *A. africanus* and *A. afarensis* single lumbar vertebrae are most similar to each other. The sizes and shapes of *Homo ergaster* single vertebrae fall within the range of modern humans but the pattern of size variation along the lumbar spine resembles great apes in some aspects. In summary, similarity of vertebral shape between humans and australopithecines confirms that key adaptations facilitating habitual bipedal walking were already present as early as 3 million years ago in the hominin lineage. However, differences in vertebral form between humans (including *Homo ergaster*) and australopithecines likely reflect specific adaptations in the vertebral column to bipedal endurance running in *Homo ergaster*.

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## **Locomotor Energetics and Ranging Ecology in Early *Homo***

H. Pontzer, *Department of Anthropology, Harvard University*

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Previous researchers have suggested that locomotor energy efficiency was a driving selective force in hominid evolution, yet debate continues regarding hominid locomotor performance and its ecological relevance. To investigate these issues, I developed a biomechanical model linking limb design to the energy cost of locomotion and validated the model empirically for a range of species including humans. Using this model to estimate the energy cost of locomotion for different hominid species, I tested the hypothesis that locomotor cost in early *Homo* is significantly lower than in earlier hominids and apes. Results suggest two grade-shifts in locomotor efficiency, with australopithecines more efficient than an ape-like ancestor, and *Homo* more efficient than earlier hominids.

To place these changes in locomotor energy cost into an ecological context, I then examined published estimates of day range, locomotor cost, and daily energy expenditure in 200 terrestrial mammals. Interspecific comparisons suggest selection for increased locomotor efficiency (i.e., lower energy cost of locomotion) is driven primarily by decreased habitat productivity and increased diet quality. These results are consistent with previous hypotheses suggesting the increased hindlimb length apparent in early *Homo* reflects an increase in diet quality and the invasion of drier habitats.

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A09  
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## **Linking Climate and Plio-Pleistocene Hominin Evolution: A Climate Driven Model of Hominin Biogeographical Distribution in River Paleoenvironments at Koobi Fora (Kenya)**

Christopher Lepre, *Department of Anthropology, Rutgers University*

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The present understanding and assessment of Plio-Pleistocene climate change and East African hominin evolution is facilitated by terrestrial isotopic studies, analysis of mammal fossils, marine geology, and other paleoenvironmental studies. However, there is little knowledge of how climate change may have influenced the distribution of habitat deterioration and hominin traits at the landscape level. In an attempt to further the study of paleoclimate and early hominin evolution in East Africa, I present a model of the responsiveness of channel and floodplain sedimentation to climate change, which provides a template for evaluating different scenarios of population connectivity and isolation, as derived from island biogeography theory, landscape ecology and the potential dispersal behaviors of Plio-Pleistocene hominin species. Although a complex paleoecological history is assured, the models indicate that the study of climatic forcing of river sedimentation can at least reveal the potential organization of landscape-scale biogeographical patterns for East African Plio-Pleistocene hominins.

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## U-Pb Isotopic Evidence for the Age of Littlefoot, Sterkfontein, South Africa

Walker, J, *School of Earth and Environment, Leeds University*

Cliff, R.A., *School of Earth and Environment, Leeds University*

Latham, A.G., *School of Archaeology, Classics and Egyptology, Liverpool University*

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The age of the hominid (*Australopithecus*) remains, dubbed Littlefoot, discovered in Member 2 of the Silberberg Grotto of Sterkfontein, South Africa, has been estimated to lie between about 2.0 Ma<sup>1,2,4</sup>, faunistically to 3.3Ma by magnetostratigraphy and faunal evidence<sup>5</sup>, and to over 4 Ma by cosmogenic isotope evidence<sup>(3)</sup>. Here we present U and Pb isotope data, corrected for initial <sup>234</sup>U-<sup>238</sup>U disequilibria, from the flowstone layers lying immediately above and below the remains that suggest an age for Littlefoot near to 2.2 Ma. This allows a re-interpretation of the palaeomagnetic data that suggests that Littlefoot lies between the two short normals Reunion 1 and Reunion 2. Our age estimate is also consistent with the evidence from the few faunal remains of M2 which indicate that there are no animals represented there that are not also represented in Member 4, which is also dated at around 2.2 Ma.

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<sup>1</sup>Berger, L. R., Lacruz, R., and de Ruiter, D. J. 2002. Brief Communication: Revised Age Estimates of *Australopithecus*-Bearing Deposits at Sterkfontein. *South Africa. Am. J. Phys. Anthropol.* 119: 192–197.

<sup>2</sup>McKee, J. K. 1996. Faunal Evidence and Sterkfontein Member 2 Foot Bones of Early Hominid. *Science* 271: 1301–1302.

<sup>3</sup>Partridge, T. C., Granger, D. E., Caffee, M. W., and Clarke, R. J. 2003. Lower Pliocene Remains from Sterkfontein. *Science* 300: 607–612.

<sup>4</sup>Turner, A. 1997. Further remains of Carnivora (Mammalia) from the Sterkfontein Hominid Site. *Palaeontol. afr.* 34: 115–126.

<sup>5</sup>Partridge, T.C., Shaw, J., Heslop, D. and Clarke, R.J. 1999. The New Hominid Skeleton from Sterkfontein, South Africa: Age and Preliminary Assessment. *J. Quat Sci.* 14: 293–298.

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## **Animal Paleocommunity Variability and Habitat Specificity of *Australopithecus robustus* in South Africa**

Darryl de Ruiter, *Department of Anthropology, Texas A&M University*

Matt Sponheimer, *Department of Anthropology, University of Colorado at Boulder*

Julia Lee-Thorp, *Department of Archaeological Science, Bradford University*

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The environments associated with *Australopithecus robustus* have generally been reconstructed as habitat mosaics: typically arid, open grasslands in the vicinity of woodlands or forests with a nearby source of permanent water. Disentangling which aspect(s) of these mosaics might have been preferred by the hominins presents a significant challenge. The aim of this study is to enhance our resolution of hominin paleocommunity structure in order to test which ecological conditions might have been favored by *A. robustus*. Faunal assemblage data were collected from a series of hominin-bearing deposits in the World Heritage Area of South Africa. Conditions of isotaphonomy between deposits were assessed, and taphonomically biased assemblages were removed from consideration. Environmentally sensitive taxa (Cercopithecidae, Bovidae, Equidae and Suidae) were assigned to ecological categories (diet, habitat, water dependence, seasonal movement). Assignment to ecological categories was based on isotopic, ecomorphological, and taxonomic evidence. Correspondence analysis was used to assess changes in faunal composition between assemblages. Diversity indices and chord distance measures were employed to evaluate the significance of fluctuations in relative abundance of these categories. Results indicate that there is a positive association of *A. robustus* with forest and open woodland adapted taxa, and a strong negative association with open grassland and edaphic grassland adapted taxa. There is a weak positive association with mixed feeding animals, a weak negative association with browsers and fresh grass grazers, and a strong negative association with pure grazers. Although *A. robustus* tends to be associated with open grassland habitats and grazing animals, they appear to prefer more closed environments within the habitat mosaics. Two possibilities present themselves: either the hominins were only occupying the area when conditions were more favorable, or they were being pushed into marginal environments and forced to subsist in sub-optimal conditions. Current isotopic research into hominin land-use patterns will assist in resolving this dichotomy.

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## **Early Hominid Bone Tool Technology and Utilisation in Eastern and Southern Africa**

Lucinda Backwell, *Institute for Human Evolution, School of Geosciences, University of the Witwatersrand*

Francesco d'Errico, *UMR 5199 du CNRS, Institut de Préhistoire et de Géologie du Quaternaire and Department of Anthropology, The George Washington University*

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Here we focus on the use of bone tools by early hominids between 1 and 2 million years ago, attempt to provide formal criteria for the identification of minimally modified implements, and present results of our analysis of purported bone tools from Swartkrans, Sterkfontein, Drimolen and Olduvai Gorge. Following a recent pseudo-tool interpretation for the Drimolen collection, new analytical techniques have been developed for the quantification of microscopic use-wear. Supplementary to our large non-human reference collection, a number of actualistic experiments have been conducted to increase the range of diagnostic features available. Our results show that the use of bone at Olduvai involves very large mammals, is confined to limb elements, applies to fresh pieces, adopts motions similar to those used for knapping stone, and probably facilitated large carcass processing. The South African bone tools derive from medium-size bovids, are made of weathered limb bone shaft fragments and horn cores that were occasionally shaped by grinding, and systematically used in digging activities, most likely termite extraction. The absence of knapped bone flakes in South African sites, and lack of South African-type digging implements in East Africa, suggests that two bone tool cultures existed during the same time period, either as extensions of a single species behaviour, or due to manufacture by two different hominid taxa. Based on the bone tool manufacturing techniques recorded, there appear to be no differences between the cognitive abilities of the hominid users. Evidence of intentional flaking by knapping on the Olduvai bone tools, and traces of grinding on those from South Africa, suggests that the users had a clear understanding of the properties of bone, could anticipate the end product, and conceived shaping techniques specific to this raw material in order to achieve optimal efficiency in the tasks for which they were used.

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## **Effects of Proximity to Stone Material Source on the Landscape Distribution of Oldowan Stone Artifacts in the Plio-Pleistocene Olduvai Basin, Tanzania**

Robert J. Blumenshine, *Center for Human Evolutionary Studies, Department of Anthropology, Rutgers University*

Fidelis T. Masao, *Paleo-cultural and Environmental Research*

Charles R. Peters, *Department of Anthropology and Institute of Ecology, University of Georgia*

Joanne C. Tactikos, *Center for Human Evolutionary Studies, Department of Anthropology, Rutgers University*

Rosa M. Albert, *ERAUB/SERP, Department de Prehistòria, Història Antiga i Arqueologia c/ Baldiri Reixach*

Peter Andrews, *Natural History Museum*

Marion K. Bamford, *Bernard Price Institute for Palaeontological Research, University of the Witwatersrand*

James I. Ebert, *Ebert & Associates*

Richard L. Hay, *4320 N. Alvernon Way, Tucson*

Jackson K. Njau, *Center for Human Evolutionary Studies, Department of Anthropology, Rutgers University*

Ian G. Stanistreet, *Department of Earth Sciences, University of Liverpool*

Harald Stollhofen, *Geologisches Institut RWTHAachen*

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Long-term, multidisciplinary research by the Olduvai Landscape Paleoanthropology Project has revealed tremendous variability among Oldowan stone artifact assemblages within an approximate 130 km<sup>2</sup> area of the Plio-Pleistocene Olduvai Lake Basin. Theoretically, stone artifact traces of hominin land use are determined principally by the distribution and abundance of resources associated with stone artifact use, discard, and loss, as well as contrasts among landscape facets in the degree of predation risk encountered by hominins. Proximity to stone material sources should also have an influence, but one subordinate to the ecological factors.

We provide an initial evaluation of these theoretical expectations, focusing on artifact assemblages from the lowermost Bed II eastern basin. Quartzite artifact assemblages show expected distance-from-material-source trends relative to proximity to Naibor Soit, a quartzitic inselberg. The weight density and proportionate weight of quartzite assemblages decreases with increasing distance from Naibor Soit, as does the size of quartzite flaked pieces and the proportion of these that are minimally reduced. While demonstrating behavioral patterning in landscape-scale traces of hominin land use, correlation analysis suggests that proximity to material source explains a minority of variability in most of the artifact assemblage parameters examined.

Determining the effects of ecological factors on the landscape distribution of stone artifact assemblages poses a far greater challenge, given the multiple sources of environmental variability across space and through time in the lowermost Bed II interval. These include the landscape succession induced by catastrophic volcanism, and faulting that imparted subtle topographic relief to the eastern basin. Nonetheless, emerging results suggest that the degree of exposure to predation risk has significant, theoretically expected effects on the density and functional diversity of stone artifact assemblages. Resolving these and other ecological effects on hominin land use requires temporally and spatially fine-grained environmental reconstructions that are matched by large, landscape-scale trace fossil samples.

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## **Pliocene Hominin Behavioral Adaptations: New Evidence from the Koobi Fora Formation**

Braun, D. R., *Rutgers University*

Harris, J. W. K., *Rutgers University*

McCoy, J., *Rutgers University*

Quinn, R. L., *Rutgers University*

Bamford, M., *University of Witwatersrand*

Bishop, L., *Liverpool John Moores University*

Lepre, C. J., *Rutgers University*

Kibunjia, M., *National Museums of Kenya*

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In the record of human evolution, stone tool technology is arguably one of the most significant adaptations. However, our knowledge of this critical time period is currently limited to a few sites in East Africa. Here we present new findings from excavations in the Koobi Fora Formation that contribute to our understanding of Pliocene hominin technological adaptations. The Upper Burgi Member (~2.1-1.89 Ma) of the Koobi Fora Formation is well known for the numerous hominin fossils recovered from this stratum. However, prior to our recent excavations in a northern sub-region of the Koobi Fora Formation, the archaeological record from this member was unknown. Here we present the initial findings from the first round of excavations at a recently discovered locality (FwJj 20). Numerous artifacts and hominin modified bone specimens recovered from these excavations have implications for the earliest stages of stone tool technology in the Koobi Fora Formation. The presence of large concentrations of tools at FwJj 20 lies in stark contrast to other Upper Burgi Mbr. sites found near the axis of the Turkana basin where evidence of tool use in the form of hominin-modified bones are found without associated stone artifacts. An extensive well preserved faunal assemblage associated with the archaeological horizon at FwJj 20 provides a rich paleoenvironmental context for the earliest stages of technological adaptations. Extensive analysis of fossil wood assemblages further enhances our understanding of the environment of deposition. The site of FwJj 20 will greatly enhance our understanding of the behavior of Pliocene hominins especially at this critical time period of rapid evolutionary change in the hominin lineage. The sophisticated technological organization and artifact-mediated extraction of high quality food resources found at FwJj 20 suggests that stone artifact manufacture was a significant part of the adaptive complex for the earliest members of the genus *Homo*.

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## **The Oldowan of the Nachukui Formation, West Turkana (Kenya)**

Hélène Roche, *UMR 7055 du CNRS, Maison de l'Archéologie et de l'Ethnologie, Nanterre Cedex*  
and the WTAP team

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The main objective of the West Turkana Archaeological Project (WTAP) is to address behavioral evolution of Plio-Pleistocene hominids, within a well limited and homogenous area on the western margin of Lake Turkana (Kenya). The Nachukui Formation corresponds to 730 m. of lacustrine and fluvial sediments which have accumulated through time (from c. 4 Myr to c. 0.5 Myr), between the ranges which border the basin on the West and the lake itself. In 2005, the WTAP conducted its tenth field season within the Nachukui Formation. To date, we have accumulated a total of 45 months of work in the field and in the lab at the National Museums of Kenya. Our paper has three main goals: to give an overview of what has been achieved during this period of research, to put the results we obtained into the perspective of the research project we originally designed, and to show the research perspectives of the WTAP. Additionally, and while waiting for more data concerning the Acheulean, we will show why we are able to assign specificity to most of the Nachukui Formation Oldowan site assemblages, regardless of whether we carry out an intra-Formation comparison or a comparison with other sites of the same age that are geographically distant. This applies to the Late Pliocene Oldowan sites (c. 2.3 Myr), as well as to the Early Pleistocene Oldowan sites (between c. 1.8 Myr and c. 1.65 Myr).

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## **Tooth Enamel Oxygen Isotope Analysis to Investigate Seasonality at the Late Pliocene Oldowan Site, Kanjera South, Kenya**

P.W. Ditchfield, *Research Laboratory for Archaeology, Oxford University*

J.D. Kingston, *Dept. of Anthropology, Emory University*

T. Plummer, *Dept. of Anthropology, Queens College, CUNY and NYCEP*

L.C. Bishop, *School of Biological and Earth Sciences, Liverpool John Moores University*

J. Ferraro, *Dept. of Anthropology, University of California, Los Angeles*

R. Potts, *Human Origins Program, National Museum of Natural History, Smithsonian Institution*

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Stable isotopic analysis of substituted carbonate within the hydroxyapatite matrix of herbivore teeth has been used in attempts to assess seasonal changes in archaeological/fossil sites and in palaeoclimatic studies. Such studies are beset by considerable problems of questionable preservation, analytical difficulties, and interpretational ambiguities. Of these issues, the last presents the greatest barrier to understanding these records of seasonality. There are several underlying processes affecting the isotopic composition of enamel oxygen isotopes. For example, the composition of ingested water may include variable amounts of water from precipitation, ground water (streams), standing water (ponds lakes), and plant water, all of which may respond to climatic conditions in different ways. There are also uncertainties relating to the animals' physiology, internal water balance, and response to evaporative stress. The mobility of large herbivores also potentially affects whether their teeth faithfully record climate from one location or from a variety of locations due to seasonal migration. Carbon isotopic signatures also change annually due to seasonally mediated dietary shifts or isotopic shifts in vegetation due to variable degrees of water stress.

In this study we present oxygen and carbon stable isotopic data from ungulate teeth (bovids, suids and equids) from the late Pliocene Oldowan site of Kanjera South (Kenya). We have analyzed a variety of taxa to include some which are resident as well as possible seasonal migrants in order to investigate potential systematic differences between these groups. Kanjera South was deposited relatively rapidly, which helps control for temporal climatic variation. Variability in data from taxa with potentially different migratory regimes assists in assessing spurious records of climatic variability due to differences in ranging patterns and contributes to investigations of the onset and nature of seasonality in East Africa.

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## **The Goldsmith Site, South Africa: Lithics and Fauna**

Dipopu Mokokwe, *University of Witwatersand*

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Goldsmith's is a newly discovered fossil and archaeological site 4 km southwest of the famous Sterkfontein Cave Site, in the buffer zone of the Cradle of Humankind World Heritage Site. It preserves one of the rare occurrences in South African fossil cave sites of stone artefacts with associated fossil fauna. Thirteen artefacts from two Stone Age cultures are represented within the site: the Earlier Stone Age and the Middle Stone Age. Eleven stone artefacts represent the Earlier Stone Age, dated to ca 2–1 million years within the Sterkfontein Valley sites, while two artefacts represent the MSA. The stone tools from both cultures are not embedded in breccia and may have originated from decalcified breccias, or alternatively from slope wash. Various faunal taxa were recovered including bovids, primates, carnivores, and others. Carnivores are the most highly represented, followed by bovids. Analysis of bone surface modifications indicates that the majority of the bones are slightly weathered, and some bone specimens are also abraded, suggesting that they may have accumulated through slope wash. The high frequencies of carnivore remains, including *Dinofelis* and a representation of most carnivore body parts, support a possible death trap scenario. The fauna suggests a paleoenvironment of a gallery forest with open woodland or savannah in the vicinity.

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A18  
24 April 2006

## **Acheulian Quarries in the Upper Karoo, South Africa**

C. Garth Sampson, *Department of Anthropology, Southern Methodist University*

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Locations of more than one thousand hornfels outcrops have been mapped in the Seacow River Valley and adjacent banks of the Gariep [Orange] River. Hornfels is a thermal metamorphic rock with conchoidal fracture. Small outcrops are very widespread in the central plateau of South Africa, and these are the source of uncounted thousands of surface lithic scatters throughout the region. All of the mapped outcrops have been quarried in the prehistoric past. About 300 of these are associated with Acheulian quarry debris, distinguished from the younger quarry debitage by very large cores and flakes, and by a thick, dark brown weathering rind. None of these sites has been chronometrically dated. The type locality of Smaldeel on the south bank of the Gariep River is described, and examples of cores and flakes recovered at the outcrop are illustrated. Metrical comparisons between the quarry debris and bifaces from nearby Acheulean sites show that bifacial reduction is entirely absent from the quarry. Spatial analysis of the maps reveals that the locations of quarries on the landscape tend to concentrate Acheulean sites in their vicinity, but only in areas where surface water is plentiful. There are also several cases of apparent 'forward planning' where Acheulean sites occur about midway between multiple quarries.

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## **Testing the Functional Efficiency of Acheulean Handaxes: The Influence of Utilitarian and Social Factors Upon Handaxe Form**

*Anna Machin, Department of Archaeology, School of Human and Environmental Sciences, University of Reading*

*Dr. Robert Hosfield, Department of Archaeology, School of Human and Environmental Sciences, University of Reading*

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The Acheulean handaxe has been described as the enigma of the Lower Palaeolithic and has been the source of widespread debate since it was first generally accepted as a prehistoric artefact over 150 years ago. Although it has commonly been proposed as a heavy duty butchery tool, its distinctive morphology, often exhibiting a high degree of symmetry, appears to be over-engineered for this purpose alone. Renewed interest in the handaxe over the last few years has focused upon this issue of symmetry, variously suggesting that the symmetry has a role in increasing the efficiency of the handaxe as a butchery tool, is a by-product of raw material type and source, has a role in social or sexual display, or indicates the existence of a nascent aesthetic sense in Early and Middle Pleistocene hominins.

This paper reports on a large-scale empirical test of the possible functional role of handaxe symmetry in relation to butchery. Sixty handaxes with varying degrees of plan-form symmetry were employed by a professional and a non-professional butcher to butcher 30 fallow deer. Whilst the results have indicated that the degree of handaxe symmetry is not directly related to the effectiveness of a handaxe for butchery, other morphological variables do appear to combine to produce an 'ideal' tool, which may lead to a tendency (possibly unintentional) towards symmetry.

We also suggest that the production of the handaxe is very likely to have occurred in a social context, where group structure and variable levels of skill will have influenced final artefact form, while the advantages afforded to the user of a functionally 'good' handaxe may have conferred value in terms of status upon the individual maker and/or their tools. This combination of factors implies that each artefact is the result of a complex web of both utilitarian and social factors, which combine and trade-off to produce the variable final forms of the Acheulean handaxe.

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## **Language and Empathy in *Homo erectus*: Behaviors Suggested by a Modern Spinal Cord From Dmanisi, But Not Nariokotome**

Marc R. Meyer, *University of Pennsylvania School of Medicine, Department of Cell and Developmental Biology*

David Lordkipanidze, *Georgian State Museum, Tbilisi*

Abesalom Vekua, *Georgian State Museum, Tbilisi*

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Recently, a partial spinal column attributed to *Homo erectus* was discovered at the site of Dmanisi, Georgia (Meyer 2005). Dated to 1.78 million years before present, the Dmanisi vertebrae are the oldest known for the genus, and present an important opportunity to examine the spinal anatomy and neuroanatomical potential of early *Homo*.

Comparative analyses against 2,257 human, chimpanzee and gorilla vertebrae demonstrate that the shape and size (absolute and size-corrected) of the Dmanisi spinal cord in the cervical, thoracic, and lumbar regions would have matched that of modern humans. This contrasts with the only other spinal column known for early *Homo*, the Nariokotome specimen (KNM-WT-15000), which exhibits evidence for a small and apelike spinal cord. The Nariokotome specimen suggested to some workers that early *Homo* lacked a human level of innervation to respiratory muscles involved in spoken language, and was therefore, incapable of producing spoken language. However, this study unequivocally supports suggestions that the KNM-WT-15000 vertebrae exhibit a developmental pathology known as neural stenosis, and is not representative of the taxon (Latimer & Ohman 2001; Meyer 2003). Moreover, this pathological condition may have conferred chronic health and locomotor difficulties in the Nariokotome individual, precipitating a considerable degree of assistance from conspecifics. In contrast, a quarter-million years before the birth of Nariokotome, *Homo erectus* at Dmanisi had already evolved a fully human postcranial neuroanatomical substrate associated with the control of respiratory muscles involved in spoken language. Thus, both altruism and spoken language may have been part of the behavioral repertoire of early *Homo*.

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A21  
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## Shoulder Function in *Homo floresiensis*

Susan G. Larson, *Dept. of Anatomical Sciences, Stony Brook University School of Medicine*

William L. Jungers, *Dept. of Anatomical Sciences, Stony Brook University School of Medicine*

Michael J. Morwood, *Dept. of Archaeology and Palaeoanthropology, School of Human and Environmental Studies, University of New England*

Thomas Sutikna, *Indonesian Centre for Archaeology, Jakarta*

Jatmiko, *Indonesian Centre for Archaeology, Jakarta*

E. Wahyu Saptomo, *Indonesian Centre for Archaeology, Jakarta*

Rokus Awe Due, *Indonesian Centre for Archaeology, Jakarta*

Tony Djubiantono, *Indonesian Centre for Archaeology, Jakarta*

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The unusually short stature and small brain size of the newly described *Homo floresiensis* have made this one of the most controversial fossil discoveries in recent years. No less remarkable is the reported minimal degree of torsion of a nearly complete humerus (LB 1/50) (Morwood et al. 2005). Humeral torsion is considered to be a hallmark of hominoids, including humans, related to the dorsal repositioning of the scapula onto an elliptical rib cage, and the concomitant lateral reorientation of the glenoid. Although the amount of humeral torsion varies among extant hominoids, it is most extreme in humans and African apes. Since no complete early hominin humeri exist, it is unclear whether this similarity in humeral torsion is a shared derived feature or the result of convergence, although estimates of only modest torsion among early hominins based on incomplete humeri suggest the latter may be the case. Nonetheless, the published estimate for *H. floresiensis* indicates even less humeral torsion in this new species of *Homo*. If correct, this minimal degree of torsion challenges our functional interpretations of shoulder morphology. Fortunately, additional upper limb material exists for *H. floresiensis* including a clavicle of the LB 1 skeleton, and a nearly complete scapula (LB 6/4). In most respects the scapula is similar to modern humans including possessing a large bar/glenoid angle, and the LB 1 humerus is an appropriate length for a hominin of its overall size. However, it appears that *H. floresiensis* had a short clavicle relative to humeral length, even when compared to modern African pygmies of similar body size. Interestingly, the KNM-WT 15000 *H. erectus* skeleton also had a relatively short clavicle. A short clavicle may indicate a more protracted scapular position, raising the possibility of a previously unsuspected transitional stage in the course of hominin pectoral girdle evolution.

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A22  
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## **Cross-Sectional Geometry of the Femur and Tibia in *Homo floresiensis***

William L. Jungers, *Anatomical Sciences, Stony Brook University*

Susan G. Larson, *Anatomical Sciences, Stony Brook University*

Thomas Sutikna, *Indonesian Centre for Archaeology*

Jatmiko, *Indonesian Centre for Archaeology, Jakarta*

E. Wahyu Saptomo, *Indonesian Centre for Archaeology, Jakarta*

Rokus Awe Due, *Indonesian Centre for Archaeology, Jakarta*

Tony Djubiantono, *Indonesian Centre for Archaeology, Jakarta*

Michael J. Morwood, *Dept. of Archaeology and Palaeoanthropology, School of Human and Environmental Studies, University of New England*

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The femur and tibia of *Homo floresiensis* are very short and below the observed range for modern humans, but they are also quite robust based on external circumferences. We have analyzed the cross-sectional geometrical properties of these long bones in the type specimen (LB 1/9 femur and LB 1/13 tibia) and in an even smaller adult (LB 8, tibia only). Specimens were scanned in Jakarta using a Siemens Emotion CT-scanner with slice thicknesses of 1.5 mm. We report here on femoral geometry at midshaft and just below the lesser trochanter and on tibial geometry at midshaft, including cortical area, polar moment of area (J), percent cortical area (the cortical index) and the  $I_{max}/I_{min}$  ratio.

Cortical areas at both femoral sites and at midshaft of the tibia of LB 1 can be matched at the lower end of the range in both Khoisan and Japanese modern humans, and the cortical area at midshaft of LB 8 also falls just within the published range for recent Japanese. Results are similar for J. The cortical indices are well within the range for modern humans but below that seen in other fossil hominins.  $I_{max}/I_{min}$  ratios also fit comfortably within the modern human range. Comparable data are not yet available for the smallest modern humans (e.g., African pygmies and Andamanese).

These results reinforce the earlier conclusion that the short hind-limb bones of *H. floresiensis* are indeed very robust and relatively “strong” in comparison to those of modern people. In other words, they have cortical areas and Js within the range of modern humans possessing absolutely much longer femora and tibiae. *H. floresiensis* does not exhibit the relatively narrow medullary cavities common to other fossil hominins, and in this respect more closely resembles modern humans. Despite their diminutive stature and short hind limbs, it seems likely that their body masses also overlapped with modern humans of small body size.

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A23  
24 April 2006

## The Origin of Human Speech

Robert C. McCarthy, *Department of Anthropology, Florida Atlantic University*

David S. Strait, *Department of Anthropology, University at Albany*

Franklin Yates, *Department of Anthropology, Harvard University*

Philip Lieberman, *Department of Cognitive and Linguistic Sciences, Brown University*

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Modern humans have a unique pharyngeal configuration in which the larynx lies well below a short, retracted oral cavity, creating a supralaryngeal vocal tract (SVT) with horizontal and vertical components of approximately equal length. This “two tube” SVT dynamically filters sounds produced by the passage of air through the vocal folds in much the same way that a wind instrument filters air after it has been blown through a reed. When the lengths of the horizontal and vertical components of the SVT are in a one-to-one (1:1) ratio, vowels have highly distinctive and stable spectral peaks that place lesser demands on articulatory precision because their formant patterns remain stable over a range of tongue positions. By melding the formant pattern of individual phonemes into syllables transmitted at a slower rate, such “quantal” vowels reduce perceptual errors by allowing a data transmission rate exceeding the frequency of the human auditory system.

Quantal speech is habitually produced only by humans, and thus it is of great interest when a 1:1 SVT evolved. However, comparative anatomical studies yield conflicting SVT predictions for extinct humans including Neanderthals. Here we take a different approach, assessing the viability of differently-proportioned reconstructions relative to limits imposed on SVT morphology by swallowing and breathing. Results indicate that a 1:1 SVT appears first in the skulls of Upper Paleolithic *Homo sapiens*, well after the species originated 150-200,000 years ago. Although Middle Paleolithic humans (including both Neanderthals and *Skhul V*) possessed subequal SVTs, reconstructed spectral and formant characteristics of the vowel [i] (“eee”) suggest that they were capable of producing quantal speech, albeit with less room for error than Upper Paleolithic and modern *H. sapiens*. This suggests that fully quantal speech capabilities arose relatively recently, and may have played a role in the Upper Paleolithic revolution.

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## On the Taxonomic Validity of *Homo heidelbergensis*

Melanie Lee Chang, *Department of Psychiatry, University of California at San Francisco*

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Although historically relegated to the grade taxon “archaic *Homo sapiens*,” fossils from the African and European Middle Pleistocene are today commonly referred to the species taxon *H. heidelbergensis*. Current phylogenetic hypotheses identify *H. heidelbergensis* as either a stem species ancestral to both Neandertals and modern humans, or an ancestor exclusive to Neandertals that did not play a part in modern human origins. The assumption these opposing viewpoints share is that *H. heidelbergensis* represents a valid species taxon.

A series of phylogenetic analyses was performed for a fossil sample including European and African Middle Pleistocene specimens, Neandertals, and modern humans. Parsimony analyses were conducted with PAUP\* v. 4.0.0b10 and MacClade v. 4.05, using discrete and continuous morphological characters, many of which are considered to have taxonomic significance. “Exemplars” (individual specimens or site samples) were used as terminal taxa to avoid making assumptions about the taxonomic affinities of fossils or samples. The resulting clades were assessed for congruence with current systematic hypotheses regarding Middle Pleistocene *Homo*.

The results of this study do not support the interpretation of *H. heidelbergensis* as a single, valid species taxon. Specimens assigned to *H. heidelbergensis* never form a clade, but are always either paraphyletic with respect to Neandertals, or polyphyletic, in the results of analyses. The proposal that *H. heidelbergensis* is a stem species ancestral to both Neandertals and modern humans also cannot be supported by the results of this study. Because at least some *H. heidelbergensis* specimens are invariably more derived than *H. sapiens*, and because these specimens are invariably the immediate outgroups to a Neandertal clade, the results of these analyses are consistent with the hypothesis that some European specimens may have been ancestral to Neandertals but not modern humans. These results are consistent with the interpretation of *H. heidelbergensis* as a grade taxon.

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A25  
25 April 2006

## Jan Jelínek's Contributions to Paleoanthropology

David W. Frayer, *Department of Anthropology, University of Kansas*

Jean Auel, *author*

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Jan Jelínek was a major contributor to European prehistory and to the paleoanthropological traditions of integrating biological and cultural information in prehistoric studies. His integrative approach is well-represented in his *Great Pictorial Atlas of Prehistoric Man* (1972) where he documented and interpreted human evolution from perspectives of archeology, human and animal paleontology, art, and climate, and used ethnological examples drawn from modern hunter-gatherers. Born in 1923 in Brno (Czech Republic) and based in the Moravian Museum, he conducted wide-ranging fieldwork and published more than 250 publications including definitive analyses of Czech Neandertal and early Upper Paleolithic fossils from Šipka, Kulna, Ochoz, Mladeč, Předmostí and Dolní Věstonice. For over 40 years he was a strong advocate for the early appearance of *Homo sapiens* and the inclusion of Neandertals with *sapiens*. The latter was especially based on the morphological variation he observed in Central European fossils and evidence for transitional features between Neandertals and the Moravian Aurignacian and Gravettian samples. Beyond this, Jelínek published on a wide range of topics from cannibalism in protohistoric Moravian times to North African and Australian rock art to issues in museology. His lasting contributions to paleoanthropology involve the focus on Central European fossils for understanding the origin and evolution of European *Homo sapiens*.

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## **A Mesoclimatic Approach in the Overlap Zone of the Neanderthal and Early Modern Europeans in Central Europe**

Rudolf Musil, *Institut of Geological Sciences, Faculty of Science, Masaryk University*

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Paleoanthropologists often treat late Glacial Europe as if it were one large macroclimatic zone with some latitudinal gradation. This broad perspective ignores the important effects of geographic relief and local (meso) climatic conditions, which greatly influenced floral and faunal distributions and are directly related to human exploitation/settlement patterns. Using data derived from many Moravian localities Bulhary and the prehistoric sites of Předmostí, Dolní Věstonice and Pavlov, the variety and faunal/floral richness of Central/Southern Moravia and Northern Austria (PF2) are compared to five surrounding prehistoric areas: PF1 Southern Poland and Northern Moravia, PF3 Southern Slovakia and the Pannonian Basin, PF4 Slovenia and Croatia, PF5 Bulgaria, and PF6 Rumania. In every individual region (PF) we can find mesoclimatic zones dissimilar to the macroclimatic environment. As a model, PF2, situated in periglacial region between the Alpine glaciation and Fennoscandian ice sheet, is reviewed. From the macroclimatic point of view, this was an inhospitable arctic steppe tundra covered by shrub vegetation with low mean annual temperatures about  $-10^{\circ}\text{C}$  and mosaic permafrost. The mesoclimate data from Southern Moravia show quite a different environment. Along the nearby River Dyje, a belt of coniferous forest with sporadic deciduous trees (*Ulmus*, *Salix*, *Fagus*, *Betula*, *Acer*, *Corylus*, *Quercus*, *Tilia*, *Alnus*) existed even at 26 ka BP and points to a less bitterly cold mesoclimate. Great mammalian species diversity also confirms a large diversity of the plant cover. It is therefore not possible to generalize about the environment of local sites on the basis of the environment of major regions and vice versa. All these factors affected settlement patterns, establishing large Paleolithic settlements, and can be directly correlated to long-term exploitation, site density, and the richness of Mousterian and early Upper Paleolithic archaeological assemblages.

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A27  
25 April 2006

## **Economic Behavior and Mental Capacity of Neanderthals**

Petr Neruda, *Anthropos Institute, Moravian Museum*

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This study presents archaeological evidence from the Middle Paleolithic stratigraphic sequence in Kůlna Cave (Czech Republic) to argue for the creative behavior of Neanderthals. The basis of this argument lies in the analysis of the operational sequence and raw material procurement.

The Middle Paleolithic stratigraphic sequence in Kůlna Cave includes both Taubachian and Micoquian traditions. Taubachian layer 11 is characterized by diverse non-Levallois discoid methods of blank production without clear preference to a particular kind of support. Single side scrapers, notches, denticulates, and archaic points dominate the assemblage and bifacial tools are rare. Raw material variability indicates a rather opportunistic model of stone procurement and animal hunting. Users of these tools took advantage of both the open hilly ecosystem of the “Drahany Plateau” and the forested areas.

Micoquian layers 7c, 7a, and 6a contrast to Taubachian layers. The Neanderthal way of life was more sedentary and there is also evidence of a logistical model of collecting strategy. There was a diversification of tool types. However, the technology of their production became more standardized; the discoid method shows fewer variants and the blade method of core reduction is comparable to the Upper Paleolithic method. The variability of raw material exhibits a similar “specialization” in specific types of stone. Unfortunately, we do not have the direct dates for the youngest layer, 6a, to assign it to the Early Upper Paleolithic occupation. From the typological and technological point of view, we assume that there was a direct development of the Szeletian from the Micoquian. Currently, we do not have enough evidence to argue that this transition is associated with the Aurignacian materials produced by modern humans.

The results indicate that mental capacity of Neanderthals allowed them to apply different behavioral strategies. Information about the operational sequence and the logistics of raw material procurement suggests that Neanderthal behavior was comparable to the behavior of anatomically modern humans.

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A28  
25 April 2006

## **A Critical Re-Evaluation of the Development and Eruption of the Dentition in Living Human Populations and Its Paleoanthropological Implications**

A. Mann, *Department of Anthropology, Princeton University*

J. Monge, *Department of Anthropology, University of Pennsylvania*

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This presentation is dedicated to the memory of our friend and colleague, Dr. Jan Jelínek, whose critical and insightful approach to the study of human origins has been a constant inspiration to us.

Patterns of dental calcification and eruption in modern humans have been employed as standards for comparisons with earlier members of the human lineage. The goals of these studies have been to interpret life history variables in the past as well as in the construction of phylogenetic relationships.

Recent research in dental maturation in both chimpanzees and modern humans suggests that a critical re-evaluation of the standards in current use may be necessary. Zihlman and colleagues (2004) have shown that the patterns of dental development in a series of known age free ranging chimpanzees from the Gombe Stream National Park (Tanzania) are significantly different from the timing of patterns observed in samples of captive animals. Nadler (1998) has reported recent shifts in the timing of dental maturation in a sample of 150 children of European background.

In a study in progress of a large sample of panoramic X-rays of inner city and suburban youth aged 5½ to 13 years, we have found similar significant shifts from published standards from the 1960s in dental maturation.

These data, and others documenting secular trends in a variety of growth and development parameters, suggest that dental development (and growth in general) in these hominoids can be markedly influenced by currently unknown environmental factors. Moreover, these factors can apparently bring about these changes in comparatively short time frames. The implications of these recent findings for our understanding of the evolution of hominin maturation, as founded on studies of the dentition, require careful examination and possibly some re-calibration.

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A29  
25 April 2006

## **Neandertal-“Modern” Interactions in Central and Eastern Europe**

Milford H. Wolpoff, *Department of Anthropology, University of Michigan*

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When Neandertals encountered other populations, the consequences have significant import for evolutionary biology because the issue of whether they exchanged mates or blows directly addresses the question of whether Neandertals were a separate species. Jan Jelinek maintained the former throughout his life, and since he believed that Šipka and Mladeč were contemporary sites from the time when Neandertals were disappearing in Central Europe, we might hope to find consequences of their reproductive behavior in these samples. Moreover, as they are among the earliest “modern” Europeans, Mladeč and others from nearby find spots such as Peștera cu Oase can be expected to address the source or sources of populations entering Europe. According to the Eve theory (a new species of Africans entering Europe replaced the Neandertals), or some interpretations of Multiregional Evolution such as “assimilation” (modern human populations from Africa entered Europe and mixed with the Neandertals, mostly swamping them out), these populations should either be African or show evidence of African descent. If Jelinek was incorrect and the populations entering Europe did not mingle and exchange mates with the Neandertals, evidence of their African descent should be even more strongly expressed. Here, I use evidence of the earliest “modern Europeans to examine these predictions.

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## History of Excavations at Mladeč and Their Interpretation

Martin Oliva, *Anthropos Institute, Moravian Museum*

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The first group of reliably documented archaeological materials from Mladeč derives from Szombathy's second excavation season in 1882. At the center of space E ("The Dome of the Dead") in the upper sediments, 22 perforated animal teeth, a long-bone point, several fragments of points or awls, a used lower jaw of *Ursus spelaeus*, and two flint artifacts were found. These were mixed with bones of reindeer and *Bos* or *Bison*, and with human skeletal fragments. Apparently the anthropological finds discovered in previous years at points "a" and "b", were not accompanied by artifacts. In 1904, an ad hoc quarry was opened near the entrance to the cave. Two human crania (5 and 6) were found associated with two large bone points and some atypical lithics.

In 1922, amateurs dug their way to the area beneath the big debris cone behind the "Dome of Dead," some meters deeper than the Upper Pleistocene level in the main dome. Around two fireplaces, and at the same level, there were numerous crushed animal (mainly *Bos* or *Bison*) and human bones (for example, Archaic Skull IV), and perforated awls (?) of elk metacarpals. Many years later, J. Skutil discovered Aurignacian stone tools in the loess-loam of the present day entrance. The most recent discoveries by M. Oliva in 1981 concern red ochre signs on the walls of the "Dome of Dead," directly above the location of Skulls 2 and 3.

Overall the low frequency of lithics and the position of bone tools deep inside the cave in permanent darkness suggest that the locality was not permanently occupied. The fragmentary remains of the human skeletons (dated at 30–31 ky BP), that were presumably originally more numerous, and their occurrence along with split animal bones suggest that it was perhaps a ritual aggregation site.

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25 April 2006

## **Are the Suprainiac Fossae of Upper Paleolithic Europeans Homologous to Those of Neandertals?**

Rachel Caspari, *Department of Sociology, Anthropology and Social Work, Central Michigan University*

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The suprainiac fossa has been defined many ways, but can be most broadly defined as a depression above the inion whose expression is variable. It is ubiquitous in Neandertals, and has often been considered a Neandertal autapomorphy. Yet, similar depressions occur in some other hominids, including modern humans from the Upper Paleolithic. It has been argued that the suprainiac fossa of the early Upper Paleolithic Europeans is not homologous to the form in Neandertals. In this paper, the question of homology is examined. First, suprainiac fossa variation within Neandertals is established; second, variation in modern humans, including Early Upper Paleolithic specimens, is assessed and the question of the structural uniqueness of the Neandertal suprainiac fossa is addressed. Finally, two developmental models for the suprainiac fossa are proposed to account for the fossa in juveniles and adults. The adult model suggests that the suprainiac fossa is related to the formation of posterior cranial superstructures and other aspects of cranial shape. This raises questions about the meaning of homology in this and other structures whose expression is mediated by remodeling.

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## **From Procurement to Consumption: Paleolithic Cuisines and Their Implications**

Olga Soffer, *Department of Anthropology, University of Illinois*

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Jan Jelinek's extraordinarily broad scholarly interests included the subsistence practices of Pleistocene foragers, specifically what they caught and how. This paper extends and expands this interest in past diets by interrogating what happened next—namely, how the acquired resources were processed, prepared for consumption, and eaten.

Using multiple lines of evidence that include botanical and faunal remains, isotopic chemistry of hominid skeletons, as well as the features recovered from Upper Paleolithic sites, I document significant variability across Europe. This variability includes how the resources were processed for immediate or for delayed consumption, how the surpluses were stored, and the disparate cuisines employed in preparing the victuals for the Paleolithic table. We know that while some people transformed surplus meat into pemmican-like dry stores, others froze their reserves in storage pits. Different ways of preparing foods existed across Europe as well, with some chefs favoring sautéing and stewing in boiling pits located close to hearths (e.g., in Moravia), while others roasted meats on spits over open fires (e.g., on the Central Russian Plain).

These different regional cuisines carry implications not only for diversity in associated technologies but for demographic and social histories as well. For example, surpluses stored in pits tie their owners to place and such tethering carries significant socio-political consequences. Likewise, the preparation and consumption of soups or stews not only require appropriate utensils, but also permit the preparation of soft foods. This is in evidence at Dolni Vestonice II, for example, where the presence of likely weaning foods carries important demographic implications.

Finally, in shifting focus from "the kill" to "the meal," this paper foregrounds tasks traditionally performed by women in hunter-gatherer societies. In doing so it contributes to a growing body of research focusing on sex, gender and age in Paleolithic societies.

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## The Gravettian Burials in Moravia: Ritual and Taphonomy

Jiří A. Svoboda, *Institute of Archaeology, Academy of Sciences of the Czech Republic*

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This paper examines chronology, rituals, and taphonomy of Gravettian burial sites of Moravia, placing them in an Upper Paleolithic comparative framework. Here, a burial is understood as a result of intentional (ritual) human behavior and of a variety of postdepositional processes.

Upper Paleolithic burials dated to a limited time-span of 35–20 ka reveal a high level of variability. Pre-Gravettian burials (Mladeč I–II, and possibly Peștera cu Oasi in Romania) were deposited inside deep cavities and vertical karstic fissures. In contrast, all Gravettian burials are from open-air sites, the majority in the densely occupied, large settlements. At Dolní Věstonice-Pavlov, human remains are encountered in two extreme situations, either preserved more or less completely and protected by artificial structures, or fragmented and scattered through cultural layers, like faunal remains. At Předmostí, human bodies were concentrated as a dump of limited dimensions (4 x 2.5 m) with most skeletons incomplete, except Př 3–4, possibly the last ones buried at this spot). Variation in these burial types involves taphonomic issues such as geological processes—redeposition along the slope (Pavlov) or chaotic sedimentation and resedimentation at the foot of a limestone rock (Předmostí); carnivore activity, as suggested by accumulations of fox remains at Předmostí; and post-burial human activities during reoccupation of the settlements (Dolní Věstonice-Pavlov), or through adding more corpses at the same burial place (Předmostí).

Most Moravian burials have few grave goods, other than a few perforated animal teeth or ivory beads. An exception is the male burial Brno 2 (ivory figurine, limestone discs, numerous items of body decoration). Whereas all other Gravettian burials are Early Gravettian (27–25 ka), the Brno 2 burial was dated to Upper Gravettian (23.7 ka). Possibly Gravettian rituals changed through time, given the richly equipped later burials from Italy.

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## **Ontogenetic Stress and Kinship Hypotheses of the Upper Palaeolithic Fossil Sample from Predmosti (Czech Republic): Reflections on the Basis of Cranial Discrete Traits**

Velemínský, P., *Department of Anthropology, National Museum, Praha*

Bruzek, J., *UMR 5199 de CNRS - PACEA - Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux I and Department of Anthropology, Faculty of Humanities, University of West Bohemia*

Katina, S., *Department of Probability and Mathematical Statistics, Faculty of Mathematics, Physics and CS, Comenius University, Bratislava*

Velemínská, J., *Department of Anthropology and Human Genetics, Faculty of Natural Sciences, Charles University, Praha*

Sefčáková, A., *Department of Anthropology, Slovak National Museum, Bratislava*

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The recent discovery of an extensive set of glass negatives of early humans from Predmosti (Velemínska et al. 2003) provides the opportunity to test hypotheses about this rich Gravettian skeletal collection. Here, we: (1) establish the range of morphological variability based on discrete trait frequencies; (2) discuss recent hypotheses on the possible kinship of individuals; and, (3) evaluate the applicability of the hypostotic scores (Manzi et al. 2000) for assessing ontogenetic stress.

The Predmosti fossil assemblage was discovered in 1894-1895 and first described by Matiegka in 1934 and 1938. Because the original skeletal material was almost completely destroyed during World War II, these monographs until now have provided the bulk of the information for the site. Matiegka and more recently Zilhao and Trinkaus (2003) argued for a possible familial relationship among the 29 individuals, based on the occurrence of several, rare anatomical features.

In this study, approximately fifty non-metric traits for the Predmosti sample were scored from the photographs of eight subadult/adult skulls (P I, P III, P IV, P V, P IX, P X, P XIV, P XVIII). Traits included sutural and ossicle variation, the frequency of vessel and nerve-related foramina, joint facet variation, disorders of ossification, non-junction of the ossification centres or their developmental hypoplasia and appearance of hyperostotic activity (osseous tori, tubercles, spines or bridges).

Our results on discrete trait frequencies confirm the morphological affinity of the Predmosti fossils, and make it likely, but not certain, that the mass grave represents a familial graveyard. However, kinship of individuals cannot be affirmed with certainty on the basis of non-metric traits. We also find evidence which supports Manzi et al. (2000) hypostotic scores and the conclusion about the reduction of ontogenetic stress from Middle to Upper Palaeolithic.

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Continued from A34: **Ontogenetic Stress and Kinship Hypotheses of the Upper Palaeolithic Fossil Sample from Predmosti (Czech Republic): Reflections on the Basis of Cranial Discrete Traits**

Zilhao and Trinkaus (eds.) 2002. *Portrait of the Artist as a Child: The Gravettian Human Skeleton from Abrigo do Lagar Velho and its Archaeological Context*. Trabalhos de Arqueologia 22. Lisbon: Instituto Português de Arqueologia, Lisboa.

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## The Last Neandertals in Spain and Their Cultures

María Dolores Garralda, *U. D. de Antropología Física, Facultad de Ciencias Biológicas, Universidad Complutense de Madrid*

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Several sites in Spain document the complex period of the Middle-Upper Palaeolithic transition, demonstrating the contemporaneity of the classic Mousterian with the “transitional industries,” probably more varied than previously considered. Three well dated sites with human remains are reviewed here. El Castillo Cave (Santander), where level 18b is assigned to “Transitional Aurignacian” and dated ~40Ky, recently produced three deciduous teeth that very likely correspond to Neandertal children. Leztxiki Cave (Basque Country) has two interesting levels (III and IV) considered “Transitional Mousterian” that yielded two permanent teeth representing two Neandertal individuals. The third site, called “El Salt,” is situated in the Levant region in the interior mountains of Alicante. It consists of a wide rock-shelter presenting exclusively Mousterian throughout the entire stratigraphic sequence, and where level V/VI, dated ~37Ky, produced six teeth corresponding to an adult Neandertal.

At present these fossils are the only ones assigned to Neandertals with a well documented archaeological context and dated between ~40/37Ky. This is not the case for another site, Zafarraya in Southern Spain, where several remains are known, but have difficult chrono-stratigraphical problems.

The cultural variability reflected in the three sites indicates not only the persistence of the Mousterian, but also the complexity of the so-called “Transitional” cultures and leads to the numerous, open questions about the possible interaction of Neandertals and modern humans.

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## **The Triple Burial of Dolní Věstonice: An Intriguing Example of Gravettian Funerary Practices**

Vincenzo Formicola, *Dipartimento di Etologia, Ecologia ed Evoluzione, Università di Pisa*

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Soon after the discovery of the triple burial of Dolní Věstonice, Jan Jelínek suggested that the social structure of Moravian Gravettian populations differed greatly from that typical of the hunter-gatherer bands and proposed sacrifice as potential explanation for this peculiar burial.

The skeletons of the three individuals, however, do not show signs of peri-mortem trauma and, more importantly, human sacrifices are a practice characterizing large, stratified societies. Yet, analysis of Gravettian skeletal material from over all Europe reveals that multiple burials occur in at least six sites and an increasing body of evidence points to the complexity of Gravettian societies. Clearly, the most conservative explanation for a multiple burial is a natural event like an accident or a disease. Interestingly, multiple burials frequently include young individuals of different sex. This suggests selective practices based on age and sex rather than chance events. A multiple burial may be unrelated to simultaneous deaths so that sex and age of the deceased could have affected the decision for changing a single into a multiple burial. If this is the case, we would expect that re-opening of the grave for another interment would result in perturbation of anatomical connections of the individual buried first. Absence of bone displacements indicates that the interments, if not simultaneous, were not separated long in time. Further evidence for a simultaneous interment is provided by position and analysis of grave goods, as in the case of the double burial of the Sungir children, probably the most intriguing Gravettian funerary example. Moreover, this burial, as well as the triple burial from Dolní Věstonice, includes a pathological individual. The anomalous condition of these individuals, and their peculiar burial pattern, emphasizes issues of social perception of “diversity” and suggests relationships between abnormality and extraordinary funerary behavior.

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## **Symbolism Before the Symbolism: Evidence for the Origins in the Cantabrian Middle Paleolithic**

Federico Benaldo De Quiros, *Área de Prehistoria, Universidad de León*

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During the 2001 excavations of Mousterian Unit 21 at El Castillo we uncovered a decorated stone of fine-grained grey quartzite. The stone, approximately 5,7 cm in length, is marked with a straight row of four evenly spaced, incised points which are positioned above a fifth incised dot situated directly in the middle of the upper row. The cultural behavior represented by this decorated stone develops and continues without a gap, through El Castillo's earliest and later Aurignacian levels, where possible evidence for figurative representation is found. Red ochre has been found in various places in both the Mousterian and Aurignacian levels, though its use as a functional or decorative medium is impossible to determine. Here we simply wish to stress the increasing and robust evidence for local roots of symbolic behaviour in the local Middle Paleolithic of Cantabria, and to note that the cave of El Castillo illustrates the development without any gaps from the Mousterian through to its Upper Paleolithic levels. If, as many researchers have proposed, such symbolic behavior is linked, at least in part, to greater desires for inter- and intra-group communication, spurred by demographic pressure or by shifts in social morphology, then this small pebble from Level 21a provides elegant evidence of the elaboration of such social expression by Neanderthals in the Cantabrian Middle Paleolithic. This development of social expression must also be reflected in the settlement dynamics of the Cantabrian Middle Paleolithic.

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## **Why We Need an Ontology of Paleoanthropology: A Case Study of the Mladeč Remains**

Mathias Brochhausen, *Institute for Formal Ontology and Medical Information Science, Saarland University*

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The specimens Mladeč 5 and Mladeč 6, both early modern human crania, are often said to bear traits similar to those found in Neandertal anatomy. However, this observation raises the question what exactly traits are. This in turn raises further questions: what do the terms ‘Neandertal’ and ‘Early Modern Human’ designate, or, in other words, what are the species concepts which should be used in paleoanthropology? The controversies of recent years prove that these questions are far from being answered satisfactorily in the paleoanthropological literature.

A new level of sophistication in dealing with the ontological structures underlying paleoanthropology is needed if we are to make progress in research regarding the phylogeny of humans.

First of all, concepts of species founded on samples of specimens have to be differentiated from the biological species concept. This distinction is of crucial significance, too, for the integration of the results of aDNA analysis into the picture of human antiquity. The still lingering debate as to the phylogenetic role of the Neandertals reflects the ontological lack of clarity in much paleoanthropological theorizing.

One question which has to be answered is: how can traits be used to separate one species from another? The Mladeč example shows clearly enough that which traits really do prove a genetic Neandertal contribution and which do not are still controversial. However, this can only be accomplished successfully by an ontological foundation of anatomy, for example, the Foundational Model of Anatomy. Furthermore, answers have to be given to questions concerning the relations between the entities on type level mentioned above. A framework has to be given for how genes relate to traits, traits relate to species, and genes to species. This will lead to the integration of species, traits, and genes into one system of ontological foundation for phylogenetic work.

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## **Paleoenvironments and Archaeological Traces in the Early Middle Pleistocene of the Kapthurin Formation, Kenya**

Cara A. Roure, *Department of Anthropology, University of Connecticut*

Sally McBrearty, *Department of Anthropology, University of Connecticut*

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During the Middle Pleistocene in Africa, *Homo erectus* was replaced by *Homo sapiens*, and Acheulian artifacts were replaced by those of the Middle Stone Age. But there is little agreement concerning the taxonomic identity of African Middle Pleistocene hominins, and their behavioral adaptations are poorly understood. The few known African Middle Pleistocene hominin postcranial fossils exhibit a high degree of variability, from the extremely robust Berg Aukas femoral fragment to the very gracile Bodo distal humerus and Kapthurin Formation ulna, KNM-BK 66. The trend towards a more gracile postcranial skeleton may reflect a shift to greater reliance on technology for the manipulation the environment and with it more complex behavioral adaptations. A landscape approach was employed to explore the target interval from which the Kapthurin hominin fossils were recovered in order to identify their environmental context and to examine how behavioral traces vary across microhabitat. The target interval lies within the Lacustrine Facies of the Middle Silts and Gravels Member of the Kapthurin Formation and spans the time period between  $543 \pm 4$  ka to  $509 \pm 9$  Ka. Varied microenvironments within this interval include a saline-alkaline lake, a fresh-water spring, and a system of ephemeral braided rivers and streams which delivered water to the lake flats. These habitats supported a diverse fauna that included chimpanzee (*Pan*). Stone artifacts occur at densities ranging from individual finds to small occurrences containing a few hundred specimens. Artifacts are most consistent with a simple flake and core technology, though examples of blade production occur at site GnJh- 42. The age of these blades exceeds that of blades previously found in the Kapthurin Formation by more than 200,000 years.

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25 April 2006

## **Middle Pleistocene Fossil and Stone Tool-Bearing Deposits at Groot Kloof, Near Ulco, Northern Cape Province, South Africa**

Andy Herries, *Palaeoanthropology Research Group, School of Medical Sciences, University of New South Wales*

Darren Curnoe, *Palaeoanthropology Research Group, School of Medical Sciences and Dept. of Anatomy, School of Medical Sciences, University of New South Wales*

James Brink, *Florisbad Quaternary Research, National Museum, Bloemfontein*

Phil Hopley, *Dept. Geographical Sciences, University of Bristol*

Zoe Henderson, *Dept. Archaeology, National Museum, Bloemfontein*

Karen van Reyneveld, *Dept. Archaeology, McGregor Museum, Kimberley*

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We report the discovery of a major archaeological and fossil bearing complex of karstic deposits (Groot Kloof, A, B, C and D) in the escarpment of the Ghaap Plateau, northern boundary of the Vaal River valley, Northern Cape Province. This region contains open fluvial sites sampling Lower and Middle Pleistocene tool types and the long running, but broken sequence of deposits at Wonderwerk Cave. In particular, the Final Acheulian/Early Middle Stone Age or Fauresmith assemblage, associated by some researchers with earliest *Homo sapiens*, occurs in this region. Preliminary studies of lithics suggest they sample an early MSA/late ESA type industry, with small pockets of LSA bearing breccia also occurring. Together with the suggested presence of fossils of the Florisian Land Mammal Age, a Middle Pleistocene age is inferred for these deposits. This is confirmed by a U-Th date of associated fossil-bearing tufa at  $248 \pm 22$  ka and a normal magnetic polarity. This makes the site contemporaneous with the Florisbad cranium ( $259 \pm 35$  ka) and the Oxland Tufa at Taung ( $256 \pm 21$  ka). The close association of these dates with geomorphic features suggesting a wetter climate suggests that a wet phase occurred at the transition from OIS 8 to 7 around 250 kya. Older and younger tufa also occurs at the site, inferred from radiocarbon dates and geomorphic and comparative evidence with Taung. Also associated with the deposits is a series of rock-shelters with rock art and evidence of Iron Age and LSA occupation. Their discovery, along with a further 13 archaeological localities covering the Middle Pleistocene to Holocene represents a major sequence of archaeological and fossil bearing deposits.

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## **South African Middle Stone Age Chronology: New Excavations at Diepkloof Rock Shelter; Preliminary Results**

Jean-Philippe Rigaud, *IPGQ, University of Bordeaux I*

Pierre-Jean Texier, *CNRS, UMR 6130-CEPAM, Valbonne*

John Parkington, *Department of Archaeology, University of Cape Town*

Cedric Poggenpoel, *Department of Archaeology, University of Cape Town*

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In the southern African MSA, Howiesons Poort and Stillbay facies play a crucial role because they show a set of precocious indicators of modern character. The relative chronology of these techno-complexes, however, remains imprecise because of the rarity and occasional discordance of radiometric dates and the absence of a pertinent archaeological sequence. The reopening of excavations at Diepkloof has, then, among other objectives, a goal of establishing the chronology of the MSA and characterizing the stone tool assemblages.

Although the deposits consist of more than 50 excavated stratigraphic units, from the top to the bottom, the following archaeological sequence has been observed:

- Complex 1: LSA assemblage dating to the last 1800 years;
- Complex 2: MSA assemblages characterized by retouched unifacial points and convergent scrapers, Post-Howiesons Poort;
- Complex 3: MSA assemblages of Howiesons Poort type with numerous curved backed blades (segments), side-scrapers, notches and denticulates, end-scrapers and numerous fragments of ostrich eggshell bearing marks of parallel incisions and cross hatchings;
- Complex 4: MSA Howiesons Poort type assemblages such as that above, but in which the ostrich eggshell fragments, while still numerous, are not incised;
- Complex 5: MSA assemblage characterized by foliate bifacial points, attributed to the Stillbay facies; and,
- Complex 6: MSA assemblages not yet characterized at this stage.
- Bedrock has not been reached.

From the earlier work, one set of  $^{14}\text{C}$  dates older than 40 ky and luminescence methods ages of approximately 70 ky were obtained. New dates from our excavations are: Complex 2 has an AMS  $^{14}\text{C}$  age of more than 55 ky and Complex 4, a set of TL dates in the range of 55 to 65 ky.

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## **The Same Only Smaller: Crystal Quartz Backed Tools from the Howiesons Poort Levels at Sibudu Cave (Kwazulu-Natal, South Africa)**

Anne Delagnes, *CNRS-PACEA, Université Bordeaux I*

Lyn Wadley, *University of the Witwatersrand*

Paola Villa, *University of Colorado at Boulder*

Marlize Lombard, *Natal Museum, Pietermaritzburg*

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Sibudu Cave (currently excavated by L. Wadley) contains a series of Middle Stone Age (MSA) occupations attributed to Howiesons Poort (HP), the late MSA and the final MSA. Radiometric (OSL) dates range between 66 kyr for the earliest HP layer documented, up to 33 kyr for the final MSA. The HP assemblages are characterized by the production of blades with soft hammer, either used as such or transformed into backed tools. Such technical practices, which are common to a whole set of sub-contemporaneous assemblages in South Africa, were being applied to different types of raw material at Sibudu, from the finest (hornfels) to the coarsest grained (dolerite) and also to quartz, a material particularly difficult to control when knapping.

Of particular interest is the presence of crystal quartz backed tools, mostly in Grey Sand, a layer situated in the middle of the HP sequence. This series contrasts with the rest of the tools in terms of size; it is significantly smaller (from 10 to 20 mm in length), but it exhibits the same diversity of backed tool types (from partially backed pieces to true segments). It cannot be assigned to a microlithic production, as recorded in LSA industries from other sites, because the small size of the tools does not result from a technical choice but from a natural constraint in the size of the available raw material. Beyond the difficulties for manufacturing and using such items, which likely imply the making of complex hafting systems, the knappers probably were attracted by the hard and sharp qualities of the raw material and also perhaps by its aesthetic qualities. Crystal quartz tools are recorded in a few other HP assemblages from South Africa, and their presence could be specific to the HP.

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## **Surf and Turf: Near Coastal Adaptations During the Middle and Later Stone Age of the Western Cape, South Africa**

Andrew William Kandel, *Department of Prehistory and Quaternary Ecology, University of Tübingen*

Nicholas John Conard, *Department of Prehistory and Quaternary Ecology, University of Tübingen*

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This analysis of 23 open-air localities in the Geelbek Dunes and at Anyskop compares the settlement patterns and subsistence economics of the people who inhabited the West Coast of South Africa during the Late Pleistocene and Holocene. The stratigraphy of alternating dune horizons and calcrete layers that underlies modern dunes affords the opportunity to date the archaeological and paleontological materials found on these surfaces. Despite the mobility of the dunes, experimental work demonstrates that the assemblages of stone artifacts, faunal remains, cultural materials and stone features stay together as discrete packages.

Middle Stone Age inhabitants left scattered stone artifacts on the land surface, suggesting a sparse population with a high degree of mobility. Despite the presence of diagnostic pieces, such as Howiesons Poort segments and Still Bay points, most of the associated mineralized fauna does not appear to have been modified by humans, and can thus be interpreted primarily as paleontological. Perforations in ostrich eggshell appear to result from predation by hyenas, not human activities. The predominance of large terrestrial fauna indicates an environment that was more humid than today. This trend is similar to other nearby sites, such as Elandsfontein and Duinefontein, where humans existed as one of many elements that made use of the landscape.

In contrast, Later Stone Age people exploited a wide variety of terrestrial and marine resources, which speaks of an increasing population with high mobility who employed a diversified economic approach. Diagnostic stone artifacts document episodes of flint knapping to produce tools for hunting and scraping organic materials. These LSA people exploited small game and shellfish, manufactured ostrich eggshell beads, made scrapers out of white mussels, hunted with bone implements and used grinding tools. They left behind burned stone features representing hearths around which social activities, such as cooking whale and elephant meat, occurred.

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25 April 2006

## **Initial Results of a Paleoanthropological Survey of the Weyto Basin Area, Southern Ethiopia**

David DeGusta, *Department of Anthropological Sciences, Stanford University*

Ludovic Slimak, *UMR 6636 CNRS/Université de Provence*

Asfawossen Arat, *UMR 6636 CNRS/Université de Provence*

Jason Lewis, *Department of Anthropological Sciences, Stanford University*

Stephanie Melillo, *Department of Anthropological Sciences, Stanford University*

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The Rift Extension Zone in southern Ethiopia contains several sites of known paleoanthropological importance (e.g., Konso, Fejej, and Omo). This project was designed to investigate the paleoanthropological potential of a lesser-studied area in this zone—the Weyto Basin Area. Previous broad-scale geological work documented the presence of quaternary sediments in the area. Short visits in 1990 and 1997 documented a limited fossiliferous deposit in the area and the presence of Middle Stone Age lithics. We present here the results of our 2005 field season in the Weyto Basin Area. Deposits yielding abundant lithics along with some fauna were located. Preliminary indications are that several distinct artifact-bearing and fossiliferous layers are present. A portion of the lithics appears to sample the Acheulian to Middle Stone Age transition, while those from other layer(s) are classic Middle Stone Age. Fauna identified from these deposits include bovids, primates, and suids, among other taxa. These deposits are provisionally and broadly referred to the upper half of the Pleistocene based on preliminary biostratigraphic indications. Current fieldwork is targeting sediments believed to be older, and results from this in-progress work will be presented as well.

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## **Stone Tool Production, Hafting and Use: Complex Technologies in the Sangoan on Sai Island, Sudan**

Veerle Rots, *Prehistoric Archaeology Unit, Katholieke Universiteit Leuven*

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The results of a wear analysis of Sangoan stone tools from the Site 8-B-11 at Sai Island, North Sudan are presented. Site 8-B-11 is a site where the Early to Middle Stone Age transition is represented by interstratified Late Acheulean and early Middle Stone Age occupations contained within the late Middle Pleistocene infilling of an ancient depression. Preliminary OSL-age estimates place the transitional sequence between roughly 220 and 180 ka ago. The presence of core-axes is a prominent typological feature of the early MSA levels at 8-B-11 and allows their attribution to the Sangoan Industrial Complex.

The majority of the tools are manufactured out of quartz. Based on the wear evidence, several tools could be identified as having been used in perforating, cutting and scraping motions on various materials. It is argued that the core-axes were used while hafted for the subsurface exploitation of either lithic raw material, plant foods, or perhaps iron oxides. It is demonstrated that the middle Sangoan occupation level at 8-B-11 served as a locale where specialized activities were performed, including core-axe manufacture and hafting. New quartz core-axes served as replacements for exhausted items, that were mostly fabricated out of raw materials other than quartz, which were carried back to the site in their hafts.

The hafted core-axes appear as highly mobile, curated tools, being transported across a large territory. A significant degree of planning and functional anticipation can be inferred in their manufacture. Along with other traits attested in the early Middle Stone Age assemblages of Site 8-B-11, the core-axe *chaîne opératoire* indicates that the Sangoan is the archaeological reflection of a complex behavioral system involving economic specialization, which appears in this part of Africa around 200 ka ago.

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25 April 2006

## **Between East and South: First Middle Stone Age Site in Northern Mozambique**

Julio Mercader, *Dept of Archaeology, University of Calgary*

Arianna Fogelman, *8116 Aedan Ct., San Diego, CA*

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Nankambe is the first Middle Stone Age site discovered in Northern Mozambique, a geographical corridor linking three major African regions. This presentation details the results of fieldwork carried out between April and July 2005 in a limestone cave with more than 8 meters of sedimentation and in which speleothems, lithics, and bones are abundant. The distance from the mouth to the end of the cave is about 50 m, and the modern ceiling ranges from 2-5 m. Excavation is in three areas of the cave: the talus, mouth, and inner chambers. Data analysis is on-going and will shed light on the origins of modern human behavior as reflected through technology, diet, paleoenvironment, and climate change. We present a description of the cave layout, four excavation pits, and a preliminary account of stone technology, faunal analysis, and, if available at the time of presentation, U-series and ESR dates for the site.

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## **Why Did Modern Humans Disperse From Africa ca. 60,000 Years Ago?**

Paul Mellars, *Department of Archaeology, University of Cambridge*

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The most recent genetic evidence suggests that anatomically and genetically modern populations dispersed from Africa at least 50,000 years ago, and perhaps closer to 65,000 BP according to some recent DNA estimates. Since this is around 100,000 years later than the age of the Most Recent Common Ancestor of modern populations, this raises the central question of why it took these populations 100,000 years to disperse from Africa to Asia and Europe.

It is suggested here that the answer to this question may lie in the results of recent mtDNA studies of present day African populations, combined with the spate of recent archaeological discoveries in southern and eastern Africa. Analyses of both the mitochondrial "mismatch" patterns by Harpending and others, and the recent "lineage analysis" studies of Forster, Kivisild and others, point convergently to a major episode of expansion of African populations, centered initially in one small region of Africa, and subsequently dispersing to other regions in the form of the L2 and L3 mitochondrial lineages—broadly within the time range from 80,000 to 60,000 BP.

This age range coincides closely with the age of the Still Bay and Howiesons Poort technologies as represented at the Blombos Cave, Klasies River, Diepkloof, Mumba and elsewhere, which show a number of striking behavioral innovations in the form of more complex patterns of multi-component hafting technology, new forms of bone technology, the appearance of perforated shell ornaments, and the earliest unambiguous "art" forms incised on ochre and (apparently) ostrich egg shell. Other developments in the scale of exchange networks, marine exploitation, and possibly the deliberate fire-management of plant food resources have also been suggested for this period.

It is argued here that these developments—possibly stimulated by increased environmental pressures around the transition from oxygen-isotope stages 5 to 4—may have led to the inferred population explosion" around 80,000-60,000 BP, with a subsequent expansion and dispersal of these populations, via East Africa, into Asia and Europe. The possible implications of these developments for the evolution of cognitive patterns in early modern populations will also be discussed.

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## **Was *Homo heidelbergensis* in South Asia? A Test Using the Narmada Fossil from Central India**

Sheela Athreya, *Department of Anthropology, Texas A&M University*

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The geographic distribution of *H. heidelbergensis* is debated, with dispute over whether Asian specimens from the Middle Pleistocene can be assigned to this species. This study explores the taxonomic status of the South Asian Narmada hominin from Central India. Two methods of allocation and classification are applied to a sample of Early, Middle and Late Pleistocene fossils (n=95) and a series of terminal Pleistocene, early Holocene and recent modern humans from South Asia (n=178) in order to evaluate similarities across geographic regions and trends through time within the subcontinent. The data consist of published craniometric measurements. First, multinomial logistic regression is used to examine the regional, temporal and taxonomic affinities of Narmada by obtaining posterior probabilities of its membership to a priori defined groups. Second, a separate-groups discriminant function analysis is used to derive typicality probabilities of the Narmada hominin's affinities based on its distances from group centroids. The results indicate that a) the Narmada fossil's regional affinities align it with the African specimens from the entire Pleistocene; b) Narmada is most similar to other specimens dated to the same temporal period, the Middle Pleistocene, and c) with respect to taxonomic groups, the Narmada hominin is equally likely to belong to *H. erectus (sensu lato)* and *H. heidelbergensis*. The results of the Wald post-estimation test suggest that *H. heidelbergensis* is marginally indistinct from the Neandertal sample but is significantly different from all other taxonomic groups. These findings carry contradictory implications. They offer support for the notion that *H. heidelbergensis* is a statistically distinct group. However, given its equidistance from the *H. heidelbergensis* and *H. erectus* group centroids, the status of the Narmada hominin is equivocal. This, along with the patterning of misclassifications of several Middle Pleistocene fossils from all regions indicate the transitional morphology of these hominins and may call into question their status as a biologically distinct evolutionary lineage.

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## **An Investigation of Robusticity in Modern Human Crania: Implications for *Homo erectus***

K.L. Baab, S.E. Freidline and S.L. Wang, *The Graduate School and University Center of the City University of New York and the New York Consortium in Evolutionary Primatology*

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*Homo erectus* is frequently differentiated from other taxa on the basis of cranial size, shape and the robusticity of cranial superstructures. However, the influence of size, and especially shape, on the expression of robusticity is not well understood.

We collected data from 140 recent human crania representing seven regional populations with varying levels of 'robusticity.' For each cranium, craniofacial shape was quantified by several three-dimensional (3-D) landmarks, and robusticity was assessed using the non-metric characters of Lahr (1996). Canonical correlation analysis of the Procrustes-aligned landmark shape data with the discrete robusticity traits demonstrates that (1) size is not the most important correlate of robusticity; (2) high robusticity scores for varying subsets of traits are correlated with different cranial shapes; (3) cranial shape influences the relative robusticity of many structures simultaneously; and, (4) two groups can be differentiated within each regional sample—one more robust and one more gracile. In contrast to prior studies, we find that size differences alone do not account for most variation in cranial robusticity. Rather, regional samples exhibit unique patterns of robusticity, suggesting that the idea of 'robusticity,' if it is to be useful, must be assessed in more detail than is usual. This detailed characterization is complicated by the lack of independence among robusticity traits as indicated by the correlation of multiple discrete robusticity measures with each canonical variable. The robust and gracile subdivisions within populations correspond to our independent sex assessment, confirming the utility of these traits in sex determination at the population level. However, overlap between groups argues against using these traits to identify sex in isolated specimens without knowledge of intrapopulation variation. These data on the sex-related expression of robusticity could be used to independently assess sex for fossil populations with multiple individuals, like the *H. erectus* fossils from Dmanisi or Ngandong.

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## **GIS at Plovers Lake: Database for Spatial Analysis and Reconstruction of a Middle Stone Age Site in South Africa**

Nancy L. Barrickman, *Department of Biological Anthropology and Anatomy, Duke University*

Patrick Lewis, *Department of Biology, Pfeiffer University*

Lee R. Berger, *Bernard Price Institute for Palaeontology, University of the Witwatersrand*

Steven E. Churchill, *Department of Biological Anthropology and Anatomy, Duke University*

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South African breccia caves often have complex depositional histories, and determining the site formation processes can be difficult. Disentangling the spatial associations between the geological features, fossil remains, and artifacts is imperative to correctly dating the site, deciphering cave taphonomy, inferring hominin activity, and reconstructing the paleoenvironment. One such breccia cave—Plovers Lake—is crucial to understanding human occupation of the Witwatersrand during the Middle Stone Age. Here we report on the use of Geographic Information Systems (GIS) to store, retrieve, analyze, and display excavation and geologic data as an aid to interpreting site formation processes.

The MSA levels of Plovers Lake have produced thousands of faunal remains, hundreds of lithics, and several hominin fossils. Within the deposits, there are extensive calcium carbonate flowstone layers that sealed and protected the deposits from subsequent disturbance by biotic and physical agents. The flowstones provide the opportunity to excavate the site in terms of datable, flowstone-bounded units. However, the flowstone layers are not continuous throughout the cave and are not always oriented horizontally. Instead, they have a patchy distribution and lay at various pitches on sloping talus cone deposits. Thus, reconstructing the location of the fossils and artifacts relative to the flowstone-bounded units is complex. A detailed reconstruction of the spatial associations is necessary to properly interpret the context of the recovered faunal, lithic and human remains.

We used ArcView GIS software to construct a virtual model of the cave. The software allows us to create maps of the cave for display purposes and to query the spatial associations between the hominin remains, the faunal remains, the artifacts, and the flowstones. GIS is being used to reconstruct the positions of flowstone layers and flowstone bounded units, and may also allow us to distinguish humanly-generated depositions from those resulting from carnivore activity.

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A52  
25 April 2006

## **Characterizing Archaeological Ochre at Nelson Bay Cave, South Africa**

Jocelyn Bernatchez, *Arizona State University*

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A considerable ochre record exists for both the Middle Stone Age and Later Stone Age of southern Africa, and this material plays a critical role in debates surrounding the origins of modern behavior. Despite this, little work has been done on these assemblages and ochre source exploitation patterns are not well understood for either time period. Ochre, due to its heterogeneous nature, has often been thought not suitable for sourcing analysis. However, much success has been achieved sourcing Australian ochre using a variety of techniques. Similar analysis has rarely been carried out on South African ochre deposits and assemblages. This study examines the utility of ochre sourcing using a Middle to Later Stone Age ochre assemblage from Nelson Bay Cave on the Robberg Peninsula, South Africa. Archaeological ochre samples were subjected to both powder X-Ray Diffraction (XRD) and Particle Induced X-Ray Emission (PIXE) in order to achieve chemical and mineralogical characterization. Using these techniques, several probable source groups were identified within the assemblage. This study suggests that it may be possible to match archaeological ochre fragments to geological deposits on the landscape. Such work will help to develop an understanding of ochre exploitation in the Middle to Later Stone Age and may ultimately contribute to discussions on ochre use.

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A53  
25 April 2006

## **Reconstructing Habitat Preferences Using Ecomorphic Analysis of Antelope Postcrania**

Laura C. Bishop, *School of Biological and Earth Sciences, Liverpool John Moores University*

Thomas W. Plummer, *Department of Anthropology, Queens College, CUNY & NYCEP*

Fritz Hertel, *Department of Biology, California State University at Northridge*

Lauren Halenar, *Anthropology and NYCEP, City University Graduate Center*

Frances Forrest, *Department of Anthropology, Queens College, CUNY*

Linh An, *Department of Anthropology, UCLA*

Jennifer Manfro, *Department of Anthropology, Queens College, CUNY*

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Ecomorphic analysis examines anatomical characteristics that are related to an organism's ecology. Zooarchaeologists increasingly use this relationship and methods from ecology to examine skeletal morphology of extinct organisms and infer habitat preference. In the distant past, this serves the purpose of decoupling paleoecological reconstructions from inferences based on taxonomic relationships between extinct and extant taxa. Antelope limb bones are commonly preserved at palaeontological and archaeological sites. They can present evidence of hominin collection and foraging behavior in the form of cutmarks and percussion damage. Antelope bones from hominin sites are thus both directly and, through spatial association, indirectly related to the palaeoecology of sympatric and synchronic hominins.

Here we concentrate on some of the most commonly found and well-preserved skeletal elements: the astragalus, metapodials, phalanges (I, II and III) and the distal humerus. We present discriminant function models using linear measurements, indices and facet perimeters and areas to categorize antelopes to one of four habitat types—open, light cover, heavy cover and forest. All models correctly classify modern bones with an accuracy of between 80 and 90 percent. Models are designed to focus on the bones and bone portions most frequently recovered from archaeological sites so as to maximize the usefulness of this technique for the reconstruction of hominin palaeoecology.

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## **The Roles of Synchronicity, Correlation, and Causation in Hypotheses Linking Climate Change and Hominin Evolution**

Christopher J. Campisano, *Department of Anthropology, Rutgers University, and Human Origins Program, Smithsonian Institution*

Anna K. Behrensmeyer, *Department of Paleobiology, Smithsonian Institution*

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The last three decades have produced a multitude of publications focusing on the role of paleoenvironmental context in shaping major patterns and events in hominin evolution. Such research proposes cause-effect relationships between environmental change and evolutionary events, with global climate often invoked as “the” primary force behind environmental change. For almost every major event in hominin evolution during the late Cenozoic there is at least one climatic forcing hypothesis. These hypotheses typically attempt to correlate global-scale climate shifts recorded in marine deposits to changes in the continent-based hominid fossil and archaeological record. While climate-evolution ideas often are provocative and become headline news in both the scientific and popular press, establishing truly robust cause and effect relationships is an exceptionally challenging task.

While the methods and data needed to move beyond general correlation to a convincing case for actual causation are complex, they are grounded in relatively simple criteria, including: 1) a highly resolved temporal scale to define “synchronous” events; 2) a causal mechanism that ties a climatic event to the purported biological result; 3) input from multiple lines of proxy evidence that consistently support the timing and/or direction of an expected response; and, 4) the ability to confidently rule out other potential environmental or non-environmental forces of change.

Here, we take a Devil’s Advocate approach and review several hypotheses that have correlated climate change with events in hominin evolution: the origins of bipedalism, the genus *Homo*, and stone-tools, and the origin and dispersal of *H. erectus*. Our counter-hypothesis is that there is no demonstrable climatic cause-effect relationship between these phenomena. We evaluate hypotheses using the criteria enumerated above, particularly emphasizing the issue of synchronicity. Additionally, we examine how the paleoanthropological community’s understanding of these issues has affected trends and ideas regarding late Cenozoic climate change and the course of hominin evolution.

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A55  
25 April 2006

## **Morphological Revision and Genetic Typing of a Neanderthal Fossil from Riparo Mezzena (Verona, Italy)**

D. Caramelli, *Dipartimento di Biologia Animale e Genetica, University of Florence*

P. Giunti, *Museo di Storia Naturale di Verona*

S. Ricci, *Dipartimento di Scienze Ambientali, Università of Siena*

S. Condemi, *CNRS UMR 6578, Unité d'Anthropologie, Faculté de Médecine-Université de Marseille*

L. Longo, *Museo di Storia Naturale di Verona and Dipartimento di Scienze Ambientali, Università of Siena*

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Mitochondrial DNA (mtDNA) has been retrieved for the first time from a Neanderthal specimen of Italian origin (NRM), excavated at Riparo di Mezzena (Verona, Northern Italy) and dated to around 50,000 years BP. The excavation at Riparo Mezzena (Verona, Italy) was carried out by the Natural History Museum of Verona in 1957. About 5,042 flint artefacts, faunal remains, and 13 fragments of the calvarium and a fragmented mandible were recovered from the three stratigraphic layers. The Middle Paleolithic lithic assemblage indicated a cultural attribution of the site to the Charentian (La Ferrassie type). Results of the Neanderthal fossil genetic typing, human specimens morphological revision, and study of the lithic assemblages will be presented.

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## **Does Epigenetic Variation Confound Attempts to Identify Hominid Fossil Species? An Assessment Using Extant Old World Monkey Craniodental Data**

Mark Collard, *Biological Anthropology Research Group, Department of Anthropology and Sociology, University of British Columbia*

Stephen J. Lycett, *Leverhulme Centre for Human Evolutionary Studies, University of Cambridge*

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Establishing a robust species-level taxonomy for the fossil hominids is a crucial task for palaeoanthropology. Recently, Wood & Lieberman (AJPA [2001] 116: 13-25) proposed that high levels of intra-specific epigenetic variability may be a major confounding factor in attributing hominid fossils to species. They suggested that characters subject to masticatory strain may be particularly problematic in this regard. Here, we test these hypotheses with 60 craniodental measurements recorded on representatives of eight Old World monkey species. First, we used ANOVA to investigate whether masticatory strain is a significant cause of epigenetic variability. Our analyses indicated that cranial regions associated with high masticatory strains ( $\geq 1000\mu\epsilon$ ) generally exhibit significantly higher levels of variability compared with low-to-moderately strained characters and dental characters, which do not remodel in response to strain. Subsequently, we tested the hypothesis that heightened levels of variability are a confounding factor when identifying species. High-strain, low-to-moderate strain and dental character groups were separately subjected to Discriminant Function Analysis. The prediction tested was that high-strain characters should be markedly worse in discriminating between species than low-to-moderately strained and dental characters. For comparative purposes, a further analysis was undertaken in which all 60 characters were included. The results show that high-strain characters are the poorest at discriminating species (94.9% correctly classified), compared with the low-to-moderate strain (97.5 %) and dental characters (97.4%). When all characters were included, 100% of specimens were correctly classified. While the hypothesis that high-strain characters should be least good at discriminating species was supported, the difference between the three characters groups in terms of discriminatory power was less than 3%. Moreover, the best discrimination was achieved when all characters were employed. We conclude that epigenetic variation plays only a minor confounding role in hominid taxonomy, and that wherever possible total available morphometric information should be employed.

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A57  
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## Updating Pre-Neanderthal Remains in the Southern Alps: The Site of Quinzano (Verona, Italy)

Condemi, S., *CNRS UMR 6578, Unité d'Anthropologie, Faculté de Médecine-Université de Marseille*

Govoni, L., *Dipartimento di Risorse Naturali e Culturali, University of Ferrara*

Giunti, P., *Museo di Storia Naturale di Verona*

Sala, B., *Dipartimento di Risorse Naturali e Culturali, University of Ferrara*

Longo, L., *Museo di Storia Naturale di Verona and Dipartimento di Dipartimento di Scienze Ambientali, University of Siena*

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In 1938, during a clay quarry exploitation in the site of Quinzano (Verona, Veneto, Northern Italy), a highly mineralized incomplete occipital bone was unearthed together with a lithic assemblage and faunal remains (e.g., *Mammuthus trogontheri*, *Bos primigenius*). The fragment of human skull has been considered as coming from the lowest layers (V-VII) of the sediment sequence of the “Cava Vecchia” and attributed to the Riss-Wurm interglacial (Leonardi 1942; Zorzi and Pasa 1944–45). The morphological study of the human remain was carried out by R. Battaglia (1943) who, since then, has underlined the presence of archaic characters such as a strong development of the occipital *squama* compared to the nuchal one, a high thickness of the bone in the *lambda* and *inion* area, and a very biasteric length, not related to Neanderthals. The morphological revision of the fossil, given its comparison with the great number of European pre-Wurmian occipital bones, allowed the present authors to consider that the Quinzano *squama* belongs to this early European group prior to the Neanderthal differentiation. This new attribution of the human fossil of Quinzano is compatible with the revision of the site and, in particular, with the fauna assemblage. The preliminary data of the revision of the entire assemblage will be presented.

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## The Phylogenetic Position of *Victoriapithecus*

Siobhán B. Cooke, *New York Consortium in Anthropology, The City University of New York Graduate Center*

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The taxonomic placement of the Victoriapithecidae, a family of Miocene African cercopithecoids, has been much argued in recent years. The family currently comprises two genera and four species: *Victoriapithecus macinnesi*, *Prohylobates tandyi*, *Prohylobates simonsi*, and *Prohylobates kipsaramanensis*. *Victoriapithecus* is by far the best known of these taxa, largely due to the extensive collection from Maboko Island, Kenya, mainly recovered by B. Benefit and colleagues. The Maboko specimens show several conservative features including incomplete bilophodont dentition and a small cranial capacity. *Victoriapithecus* most often been placed as the sister group to the Cercopithecidae, especially by Benefit and colleagues, and it has been hypothesized that colobine and cercopithecine monkeys evolved from this victoriapithecoid stock. However, the victoriapithecids share several cranio-dental characters with the cercopithecines to the exclusion of the colobines, so an alternative interpretation is that the "victoriapithecids" may be stem cercopithecines. This study evaluates that hypothesis.

Over fifty quantitative and qualitative cranio-dental characters of extant and fossil cercopithecines, colobines, and early catarrhines were considered. Quantitative data were taken using calipers. Results indicate close phylogenetic affinity between *Victoriapithecus* and the cercopithecines, separate from the colobines. In light of this finding, it is suggested that *Victoriapithecus* and relatives can no longer be accepted without question as a separate family within the Cercopithecoidea. A more detailed reanalysis of all known data is required to adequately choose between the two well-supported alternative hypotheses of relationship.

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## **Inferring dietary behaviour for Miocene hominoids using a high-resolution morphometric approach to incisal crown curvature**

Andrew S. Deane, *Department of Pathology and Anatomical Sciences, University of Missouri School of Medicine*

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Traditional methods used to infer diet from hominoid incisors successfully group taxa into broad dietary categories (i.e., folivore, frugivore) but often fail to represent the level of dietary complexity known for living apes. This oversimplification is a consequence of poor resolution, but is also a reflection of similar keystone adaptations in related taxa with dissimilar diets. Additional dietary resolution can be achieved with a detailed morphometric approach to incisal curvature (Deane et al. 2005). This makes it possible to identify subtle morphological differences between closely related taxa with similar keystone adaptations but dissimilar diets (i.e., *G.g. beringei* vs. *G.g. gorilla*). Given the key role of incisors in food processing it is reasonable to propose that incisor morphology is responsive to selective pressures imposed by mechanical demands specific to differing dietary regimes.

In this study I seek to re-examine and refine existing dietary hypotheses for Miocene hominoids using comparative models of dental correlation with feeding behaviours derived from a sample including all extant hominoids (n=304) and selected ceboids and cercopithecoids with specialized diets (n=47). One hundred eighty-one incisors representing 23 fossil taxa were analysed and results indicate that morphological diversity within the fossil sample exceeds the extant sample. Incisors from early Miocene taxa are typically less curved than extant hominoid incisors, but the degree of incisal curvature for middle and late Miocene taxa is similar to or exceeds extant curvatures. This may indicate a general pattern of increasing mesio-distal and labial curvature through time consistent with Van Valen's Red Queen Hypothesis (1973) and Kay and Ungar's (1997) observation that shifting molar shearing crest morphologies resulted from "adaptation just to maintain the same level of adaptedness." The approach used here can be applied to the Plio-Pleistocene hominin fossil record, which approaches late Miocene hominid diversity and can contribute to current debate on hominin dietary diversity.

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A60  
25 April 2006

## Size, Allometry and Robusticity: An Intrageneric Comparison

Sara K. Doyle, *Biological Anthropology and Anatomy, Duke University*

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Neandertals had stronger bones relative to their body mass than modern humans, contrary to expectations of interspecific studies in which larger species have relatively weaker bones. Explanations proposed to account for differences in bone strength within the genus *Homo* center on differences in tool use technology between the Pleistocene *Homo* and modern *Homo sapiens*. Modern humans, using more advanced tools for resource capture, have a lower amount of external loading on their skeletons, and therefore more gracile bones than Neandertals. However, some data from intraspecific comparisons of bone strength in mammals suggests that within a species or genus, the larger individuals are more robust than the smaller individuals. If this pattern holds true across most mammal species, then it would mean that Neandertals are not stronger than would be expected for their body size. In order to explore this idea further, this study tests the effect of body mass on measures of skeletal strength on two non-primate mammalian genera, *Canis* and *Ursus*. Bone strength was calculated as strength in torsion (J) based on measurements of cross-sectional geometry of long bones taken from biplanar radiographs of limb elements. Regressions of J on body mass indicate that bone strength increases allometrically with body mass within both of these genera. This means that, at least in some cases, larger individuals have stronger bones than smaller individuals within the same genus. The results of this study can be used to re-examine claims of significant gracilization among modern humans compared with Neandertals and other Pleistocene *Homo*. Modern humans may have weaker skeletons at least in part because they are smaller in body size.

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A61  
25 April 2006

## **New Findings of the Aliakmon Paleolithic Survey, Greece, 2004–2005**

Harvati, K., *Max Planck Institute for Evolutionary Anthropology*

Panagopoulou, E., *Ephoreia of Paleoanthropology/Speleology, Athens*

Karkanias, P., *Ephoreia of Paleoanthropology/Speleology, Athens*

Frost, S.R., *University of Oregon*

Athanassiou, A., *Ephoreia of Paleoanthropology/Speleology, Athens*

Elefanti, P., *University of London*

Schrein, C., *Arizona State University*

Baab, K., *City University of New York*

Henderson, E., *University of Oregon*

Tourloukis, E., *University of Leiden*

Garefalakis, C., *University of Southampton*

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The timing and routes of dispersal of the earliest European populations are central questions in European paleoanthropology. Greece lies on the hypothesized migration route of archaic hominids from Africa through the Near East into Europe and is the gateway into the continent through which migrant populations have repeatedly passed. The region's fossil human and Paleolithic records are therefore critical in addressing these questions. Nonetheless, Greek Paleolithic archeology and paleoanthropology remain largely unexplored.

We present preliminary results of the 3-year Aliakmon Paleolithic survey, conducted along the Aliakmon River, North-Central Greece. It is the first systematic survey for this time period in the region and focuses on the terraces of the Aliakmon. These preserve Upper Pliocene - Pleistocene fluvial sediments and a rich Plio-Pleistocene fauna. The area has also previously yielded Paleolithic artifacts, including one of the two Lower Paleolithic bifaces known from the country.

The 2004-2005 seasons confirmed the existence of the terrace systems at previously proposed levels, but indicated that their dating is much more complex than originally proposed, as most terraces are erosional rather than depositional in nature. Isolated patches of Pleistocene fossiliferous depositional terraces were found within the main erosional system, and several fossiliferous localities of Lower-Middle Pleistocene age were located. Faunal specimens collected include equids (*E. stenorhinus* and possibly *antiquus*), bovids, cervids, suids, rodents, canids (possibly *Canis etruscus*), proboscideans (cf. *Elephas antiquus*) and cf. *Hippopotamus*. Several lithic artifacts were also collected and two possible Lower Paleolithic sites were located, although no uniquely characteristic Lower Paleolithic artifacts (e.g., handaxes) were found. Given the scarcity of such sites in Greece, these findings could be pivotal in documenting early human presence in the area.

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A62  
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## **Neandertals at the Beach: Late Pleistocene Coastal Settlement of Central Portugal**

Jonathan Haws, *Dept. of Anthropology, University of Louisville*

Bryan Hockett, *United States Bureau of Land Management, Elko, NV*

Caroline Funk, *Division of Social and Behavioral Sciences, The Richard Stockton College*

J. Michael Daniels, *Dept. of Geography, University of Wyoming*

Michael Benedetti, *Dept. of Earth Sciences, University of North Carolina at Wilmington*

Nuno F. Bicho, *FCHS, Campus de Gambelas, Universidade do Algarve*

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In the 2005 field season, we began a systematic survey to locate coastal Paleolithic sites in central Portugal near the town of Nazaré. This location was chosen because a deep submarine canyon forms immediately offshore. The steep bathymetric situation means that the glacial shorelines in the Nazaré area would not have extended more than 2–5 km than present and coastal sites should exist on land. Here we report the preliminary results of the survey.

The project team has mapped the location of 85 archaeological sites and/or caves and rockshelters of potential interest. Of these, about 50 are open-air lithic scatters on exposed or deflated Pleistocene surfaces along the coast. One site in particular, Mira Nascente, was found on a raised beach about 10 km north of Nazaré. This site yielded a collection of flint flakes, cores and chipping debris in a discrete stratigraphic level immediately above a layer of smoothed quartz and quartzite beach pebbles. The context of these artifacts and the extraordinary condition of the flake edges suggests a very well preserved occupation where spatially organized activities took place. The presence of Levallois flakes indicated a Middle Paleolithic occupation. An AMS radiocarbon date of 36,030±710 BP on charcoal appears to confirm the cultural attribution.

The initial survey results are significant because they confirm the main hypothesis guiding the project. Namely, that Paleolithic people occupied the region in order to exploit a rich diversity of coastal resources created by an intensive upwelling system during the Last Glacial.

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## **Experimental Analysis of Stable Oxygen Isotopes ( $\delta^{18}\text{O}$ ) in Mammalian Enamel Carbonate, Phosphate, and Protein: Implications for Palaeoenvironmental Reconstruction**

Karola Kirsanow, *Department of Anthropology, Harvard University*

Noreen Tuross, *Department of Anthropology, Harvard University*

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The relationship between environmental and evolutionary change has long been a subject of palaeoanthropological inquiry. Climatic shifts in the late Pliocene are reflected in the growth and spread of the African savannas and accompanying changes in the edible landscape of sub-Saharan Africa, events that have significant implications for hominid evolution.

Palaeoenvironmental reconstruction that utilizes the isotopic composition of marine sediments and ice cores has done much to elucidate the global nature of Pliocene environmental change. Analysis of oxygen stable isotopes in terrestrial vertebrate calcified tissue is a promising avenue of palaeoenvironmental research because of its direct applicability to material of palaeoanthropological concern—fossil bones and teeth. Realizing the full potential of this more direct source of information has been difficult due to ambiguities in the source of the oxygen in different substrates and the differential diagenesis that affects apatitic oxygen. The potential for an additional direct oxygen isotopic record to compare with soil carbonates could greatly add to the fine scale and local understanding of climate change.

Three sources of  $\delta^{18}\text{O}$  exist in mammalian tooth enamel: carbonate and phosphate oxygen from the mineral phase, and amelogenin and other protein remnant-derived oxygen from the protein phase. A comparison of the  $\delta^{18}\text{O}$  values of these three sources will improve our understanding of both the relationship of the tissue isotopic value to water/temperature and the diagenetic susceptibilities of each source, with the goal of providing an additional reliable terrestrial palaeoenvironmental indicator. Here we present  $\delta^{18}\text{O}$  data from phosphate, carbonate in apatite, and protein (collagen and enamel) of modern pigs raised on a controlled diet, and examine the relationship between the isotopic values of the three oxygen sources in tooth enamel and their potential and limitations for palaeoenvironmental reconstruction.

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## **A New Method for the Morphometric Analysis of Paleolithic Artifacts: The Crossbeam Co-ordinate Caliper**

Stephen J. Lycett, *Leverhulme Centre for Human Evolutionary Studies, University of Cambridge*

Noreen von Cramon-Taubadel, *Leverhulme Centre for Human Evolutionary Studies, University of Cambridge*

Robert A. Foley, *Leverhulme Centre for Human Evolutionary Studies, University of Cambridge*

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It may be argued that techniques for the morphometric analysis of Paleolithic stone tools have not kept pace with dramatic developments in the shape analysis of fossil and skeletal data. Here, we present and describe a new instrument—the Crossbeam Co-ordinate Caliper—that geometrically locates homologous landmarks upon lithic nuclei and measures Euclidean distances between them via a single protocol. We also present example analyses of Pleistocene lithic nuclei (i.e., ‘cores’ *sensu lato*), and introduce to lithic studies several techniques previously used in biological applications of shape analysis. Our first analysis applies the multivariate statistical technique of Discriminant Function Analysis (DFA) to 55 discrete (scale-adjusted) metric variables in order to quantitatively explore which, if any, shape differences are significant between different groups of lithic artefacts. The second analysis employs co-ordinate landmark configurations and 3D geometric morphometric techniques (Generalized Procrustes Analysis) to further explore quantitative aspects of shape variation in these lithic nuclei. Both analyses demonstrate that specific shape properties of stone artifacts, hitherto not quantitatively analyzed by traditional techniques, are amenable to analysis via the Crossbeam Co-ordinate Caliper. Moreover, these variables are important in categorizing shape differences between the groups of lithic artifacts. We conclude that use of an instrument such as the Crossbeam Co-ordinate Caliper may provide a useful adjunct to traditional techniques of lithic analysis, particularly in developing a quantitative morphometric approach to the shape variation of Paleolithic artifacts. Moreover, analyses of this type may yield important insights into the variability seen in Paleolithic technologies, be they due to cultural differences, cognitive differences between hominin species, raw material variability, or reduction intensity.

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## Sexual Dimorphism in Hominin Supraorbital Morphology

K.P. McNulty, *Department of Anthropology, Baylor University*

K.L. Baab, *Department of Anthropology, CUNY and New York Consortium in Evolutionary Primatology*

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The supraorbital region is a frequently used indicator of sex in fossil hominin specimens. Known to be useful in distinguishing sex within modern humans and perhaps apes, morphology thought to be “robust” is usually designated as male, while more “gracile” forms are thought to be female. Less attention has been paid to metric variation between sexes beyond differences in absolute size. In assessing the sex of fossil humans, however, criteria of robusticity and size assume either actual (when multiple specimens are thought to be conspecific) or potential (when only a single specimen is known) vectors of sexual dimorphism. This can be especially problematic in hominins which are characterized by reduced canines, a good independent corroboration of sex in most other primates.

In order to examine the usefulness of supraorbital morphology in distinguishing between sexes, this study examined patterns of dimorphism in the supraorbital region of multiple hominin and hominoid species. Landmark-based morphometric methods were used to test a null hypothesis of monomorphism in gorillas, chimpanzees, bonobos, and modern humans. Patterns of shape differences between the sexes were then examined for each species. These analyses found significant differences between mean configurations of males and females in all species, albeit with substantial range overlap. The amount of total variability accounted for by sex is small, however, ranging from 6.6% in modern humans to 2.7% in *Pan troglodytes*. Moreover, patterns of shape differences between the sexes were distinct amongst the various species. These results recommend caution in the use of supraorbital morphology to diagnose sex among fossil specimens, especially without knowledge of sexual variation within species, as is often the case with fossil hominins.

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## **Elucidating the Relationship Between Edge Retouch and Blank Morphology in Stone Tools: An Experimental Approach**

Gilliane F. Monnier, *Department of Anthropology, University of Minnesota*

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During the last two decades, most Paleolithic stone tool studies have shifted from a typological approach to a technological one. While the technological approach has revealed important new data concerning blank production, it has largely ignored retouched tool production. Specifically, the relationship between blank form, edge retouch, and resulting tool type remains largely understudied. One of the few studies to address this issue recently is Bisson (2001), which proposes two “rules of Middle Paleolithic scraper production”: 1) the striking platform and adjacent blunt edges are left intact to facilitate prehension; and, 2) the longest edge with the most acute edge angle is retouched first. Bisson derives these rules from observations of novice flintknapper behavior, and concludes that they are the product of deliberate choices made during scraper manufacture. It is hypothesized here that these rules in fact reflect the physical properties of blanks rather than flintknappers’ choices. In other words, the striking platform and adjacent blunt edges of scrapers are unretouched because it is exceedingly difficult to retouch an edge with a 90° platform. Similarly, acute edges will exhibit greater amounts of retouch for the opposite reason. These hypotheses were tested by replicating Bisson’s experiment minus the human element; 125 experimental blanks were retouched by machine. Subsequently, images of the resulting “tools” were digitized in two dimensions, which enabled retouch to be precisely quantified. The results of the analysis and an exploration of the relationships between edge retouch and blank morphology (size, shape, edge angle) are presented in this poster.

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Bisson, M. S. 2001. Interview with a Neanderthal: An Experimental Approach for Reconstruction Scraper Production Rules, and Their Implications for Imposed form in Middle Palaeolithic Tools. *Cambridge Archaeological Journal* 11(2): 165–184.

## Late Pleistocene Human Metacarpal Cross-Sectional Geometry

W. Niewoehner, *Department of Anthropology, California State University at San Bernardino*

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Biplanar x-rays of Neandertal, Upper Paleolithic, Qafzeh 8 and 9, and recent human metacarpals (MC) 1 through 5 were used to calculate J, total area (TA), cortical area (CA) and percent CA at 50% of diaphyseal length using the eccentric elliptical model (Ohman 1993) followed by corrections to the calculated TA and CA using regression equations for elliptical models (Lazenby 1998). The sample sizes are: Neandertal MC1=5; MC2=6; MC3=6; MC4=4; MC5=5; Upper Paleolithic MC1=3; MC2=6; MC3=4; MC4=5; MC5=2; Qafzeh MC1=1; MC2=1; MC3=2; MC4=1; MC5=1; recent human MC1=69; MC2=77; MC3=74; MC4=73; MC5=68. The cross-sectional parameters were analyzed using bivariate plots of log J on log MC articular length, log CA on log MC length, and log CA on log TA. The recent human regression lines were calculated as RMA regressions and the residuals from the recent human regression line were tested for significant between-sample differences.

The Late Pleistocene fossil sample means generally fall above the recent human regression line for CA and percent CA and have mean values for J that are close to the recent human line, but there are no statistically significant differences in between-sample measures of J, CA, or percent CA. Qafzeh 8 and 9 have significantly elevated MC3 CA values relative only to the recent human sample. The Neandertal sample has significantly elevated values for MC4 CA and MC5 CA relative only to the recent human sample.

These results must be tempered by the fact that sample sizes are small and that the MC1 diaphyseal shape departs significantly from the tubular model assumed for calculating cross-sectional properties.

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Lazenby, R.A. 1998. Second Metacarpal Cross-Sectional Geometry: Rehabilitating a Circular Argument. *American Journal of Human Biology* 10: 747–756.

Ohman, J.C. 1993. Computer Software for Estimating Cross-Sectional Geometric Properties of Long Bones with Concentric and Eccentric Elliptical Models. *Journal of Human Evolution* 25: 217–227.

This research was funded by grants from the NSF, the Leakey Foundation, and the University of New Mexico. X-rays of Late Pleistocene metacarpals were generously supplied by E. Trinkaus.

## **Electromyography of the Brachial Muscles During Hard-Hammer Percussion Production of Oldowan Tools**

Caley M. Orr, *School of Human Evolution and Social Change and Institute of Human Origins, Arizona State University and NSF IGERT Program in Neural and Musculoskeletal Adaptation in Form and Function*

Lisa M. Raleigh, *NSF IGERT Program in Neural and Musculoskeletal Adaptation in Form and Function, and Harrington Department of Bioengineering, Arizona State University*

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The physiological and anatomical correlates of tool-making and tool-use have been of interest to anthropologists. Some workers have contributed data on the kinematics and electromyography (EMG) of the hand during such activity, but there are no data on the role of the brachial muscles during flintknapping. We present preliminary EMG data from the hammerstone arm of four subjects and examine the role of the triceps during Oldowan tool production to see how it interacts with the biceps to provide power or to stabilize the elbow joint during hard-hammer percussion. Although there is some intersubject variability in the recruitment patterns of these two muscles, the triceps is generally most active at the highest elbow flexion angles (~100–130°) during the initiation of the arm-swing. The biceps is active throughout the motion and may act to dynamically stabilize the elbow. Humans are distinct from other large-bodied hominoid primates in having an elbow configuration that results in a maximum moment arm of the triceps muscle that occurs at ~90° of joint flexion. It has been hypothesized that this configuration is adapted for a common posture during manipulative tasks. The results of this study suggest that triceps activation during hard-hammer percussion does not co-occur with the elbow position of maximum mechanical advantage. However, the abilities to produce speed and torque are inversely related in a lever system. The velocity of the hammerstone at impact may be more important in producing flakes than the overall torque produced at the elbow, and the triceps might exploit a shorter moment arm to produce rapid movement of the forearm. Comparable data during hard-hammer percussion by nonhuman primates would be necessary to determine if humans have a specialized pattern of muscle recruitment for this activity.

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## Partitioning of Dental Variation Within and Among Chimpanzee, Gorilla and Baboon Taxa: Implications for Taxonomy and Hominin Models

Varsha C Pilbrow, *Department of Anthropology, University of Illinois at Urbana-Champaign*

Eric Delson, *Department of Anthropology, Lehman College/CUNY, and American Museum of Natural History, and NYCEP*

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In order to better comprehend the taxonomic diversity of early hominins, it is important to utilize models based on extant taxa whose variation can be well understood. The question is always whether to use close relatives such as chimpanzees and gorillas, which are known today only as spatially restricted populations, or to examine more distantly related forms such as baboons, which are widespread in environments comparable to those inhabited by early humans. In this study, dental variation in baboon taxa is compared with that in chimpanzees and gorillas to see how baboon models could contribute to understanding hominin taxonomy.

Wright's (1969)  $F_{st}$  is used to study the partitioning of variance within and among six baboon varieties (guinea, anubis, yellow, kindia, hamadryas and chacma). Length and breadth dimensions of molars from 221 individuals were used in the analysis. This was compared with 235 individuals of the genus *Pan*, from four taxa (*P. t. verus*, *P. t. troglodytes*, *P. t. schweinfurthi*, and *P. paniscus*) and 204 gorilla individuals from three subspecies (*Gorilla gorilla gorilla*, *G. g. graueri*, and *G. g. beringei*).

An assumption of equal population sizes and a heritability estimate of 0.5 leads to an  $F_{st}$  of 0.19 for baboons, indicating that 81% of variance occurs within baboon taxa. By comparison, the  $F_{st}$  for the subspecies of *P. troglodytes* and *G. gorilla* was 0.10 and 0.12, respectively. When *P. paniscus* was added to the *P. troglodytes* sample, the  $F_{st}$  rose to 0.20.

Baboon taxa are considered to be biological subspecies but phylogenetic species. Within-group variance in baboons is lower than in chimpanzee or gorilla subspecies, but it is comparable to the species of *Pan*. While the designation of subspecies fits with the observation that baboon taxa interbreed at the edges of their distribution, they are nonetheless distinct from each other, comparable to allopatric species of *Pan*. Given the greater diversity of baboon taxa compared to the African apes, they can serve as valuable models for hominin taxonomy.

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Wright S. 1969. *Evolution and the Genetics of Populations. Vol. 2. The Theory of Gene Frequencies*. Chicago: University of Chicago Press.

## **Inter- and Intra- Tooth Isotopic Variation in Mammalian Fossil Tooth Enamel from Western Israel: Implications for Paleoenvironmental and Paleoclimate Change Over the Past ~400 ka**

J. Rowland, *Department of Geosciences, University of Arizona*

M. Stiner, *Department of Anthropology, University of Arizona*

J. Quade, *Department of Geosciences, University of Arizona*

D. Dettman, *Department of Geosciences, University of Arizona*

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The extent to which climate-driven environmental changes may account for observed variation in human subsistence behavior and prey selection is uncertain, especially in the Levant, a key geographic region for biotic dispersals between Africa and Eurasia. In this study, stable isotope values ( $^{13}\text{C}$ ,  $^{18}\text{O}$ ) of large herbivore bioapatite are used to examine paleoenvironmental and paleoclimate change in this region. We draw upon archaeological faunal records from Qesem Cave, Hayonim Cave and Meged Rockshelter (Israel) that span the past ~400 ka. *Dama* remains dominate the Lower Paleolithic sequences, while *Gazella* become more prevalent through the Middle and Upper Paleolithic.

$\delta^{13}\text{C}$  values of fossil molar enamel from all time periods fall between -13.9 and -7.3‰, indicating that large herbivore (*Dama*, *Gazella*, *Bos*, and *Capra*) diet was dominated by  $\text{C}_3$  plants. The younger samples tend to have higher  $\delta^{13}\text{C}_{\text{PDB}}$  values, due to increasing aridity and/or minor consumption of  $\text{C}_4$  plants. Enamel  $\delta^{18}\text{O}_{\text{SMOW}}$  values from the same time series have a range of +26.2 to +34.2‰. The modern  $\delta^{18}\text{O}_{\text{SMOW}}$  weighted average of meteoric water in this region is -5‰, and glacial  $\delta^{18}\text{O}_{\text{SMOW}}$  is likely around 1-2‰, suggesting that tooth enamel is enriched ( $\epsilon_{\text{bioapatite-water}}$ ) on the order of 30-38‰ with respect to drinking water. *Gazella* exhibits the greatest  $\epsilon_{\text{bioapatite-water}}$ , much larger than that predicted by recent physiologic models of  $\delta^{18}\text{O}$  values. This points toward significant, species-specific enrichment of  $\delta^{18}\text{O}_{\text{SMOW}}$  values. Isotopic differences in glacial versus interglacial samples are currently being examined for signs of paleoenvironmental variation, through the application of intra-tooth (seasonal) microsampling. The seasonal amplitudes of both  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  are variable through time, with intra-tooth isotopic ranges of 0.5-3.9‰ for  $\delta^{13}\text{C}_{\text{PDB}}$  values and 0.9-5.4‰ for  $\delta^{18}\text{O}_{\text{SMOW}}$  values. The average amplitude of  $\delta^{18}\text{O}_{\text{SMOW}}$  values is about half that of modern meteoric water in the region.

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## **Subchondral Bone Thickness in the Distal Radius: Implications for Interpreting Positional Behaviors of Fossil Hominins**

Mathew L. Sisk, *Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University*

Biren A. Patel, *Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University*

Kristian J. Carlson, *Anthropologisches Institut und Museum, Universität Zürich*

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Locomotor behaviors of early hominins and fossil apes frequently have been inferred from the external anatomy of the distal radius. While external joint morphology can describe range of motion between articular surfaces, it is internal structure that provides information on habitual joint loading. Extant primates that habitually load their forelimbs in compression (i.e., quadrupeds) exhibit greater apparent density in the subchondral plate of the distal radius compared to those that do not (i.e., suspensory / bipedal primates). Unfortunately, density differences are difficult to assess within fossils because mineral content is sensitive to site-specific geologic conditions. Therefore, another means of evaluating habitual loading of the primate wrist is needed. In this study, we compared subchondral thickness of the distal radial articular surface across a sample of primates. We evaluated quadrupedal (monkeys and African apes), suspensory (Asian apes), and bipedal (humans) groups, representing three different means of habitual forelimb loading (i.e., compression, tension, or non-weight-bearing, respectively). Serial CT scans were obtained in sagittal planes and thickness of the subchondral cortical plate was measured at standard intervals from medial to lateral across the articular surface (e.g., 25, 50, and 75%). At each interval, cortical plate thickness was assessed at three positions from dorsal to volar (e.g., 25, 50 and 75%). Mean thickness was derived for each subchondral cortical plate. Bipedal and suspensory hominoids have a thinner subchondral cortical plate in the distal radius compared to quadrupedal monkeys and African apes. These results complement previous studies of apparent density patterns suggesting that primates habitually supporting body mass in compression have thicker and more expansive areas of relatively high density in the subchondral cortical plate of their distal radius. Subchondral thickness may provide a useful signal of habitual forelimb use, and thus a means of inferring locomotor behaviors in early hominins and their Miocene ancestors.

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## **What Do Birds Indicate About the Taphonomy and Paleoenvironment of Plio-Pleistocene Hominin Localities in South Africa?**

Thomas Stidham, *Department of Biology, Texas A&M University*

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Bird bones are the second most common taxonomic component (after mammals) at most hominin localities in the Sterkfontein Valley. Despite this abundance, few studies have examined them, and none have documented an entire avifauna. The study of the bird record from hominin localities adds new data, and refines previous hypotheses about cave deposit taphonomy and past environments. Examination of avifaunas from sites in the World Heritage Area, including Gladysvale Cave, Kromdraai, and some of the “Bolt’s Farm” localities, reveals a taxonomically and ecologically diverse fauna. The bird bones were examined for ontogenetic age, bone surface modifications, and skeletal element representation. In the case of the Peabody Chamber of Gladysvale Cave, a subequal representation of forelimb and hindlimb elements and other factors suggest accumulation by non-predatory taxa or abiotic factors. This contrasts with Kromdraai where bird bone assemblages are composed of over 72% forelimb material, indicative of predator accumulation. Bird bones appear to have been accumulated by a variety of agents. They are subject to different taphonomic biases than mammals, and are thus likely to sample different ecological circumstances relative to mammalian faunas from the same localities. The habitat specificity of some bird taxa can refine paleoenvironmental reconstruction in the Sterkfontein Valley. For example, bishops and widows from Gladysvale Cave indicate the past presence of reed-beds, buttonquail fossils indicate a variety of wet patchy and also dense grasslands below 40 cm in height, and the grass owl points to grasses over 50 cm tall. Previously, the mammalian fauna has not suggested such a detailed reconstruction of the past environment. In combination with mammalian data, the avifaunas of the Sterkfontein Valley can provide a great deal of illumination of the hominin habitats, as well as further insight into the taphonomy of the cave deposits where their fossils have been found.

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## **Large Mammal Community Turnover in the Levant 400-10 kya and its Relation to the Hominid Cultural Chronology**

Mary C. Stiner, *Department of Anthropology, University of Arizona*

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Variation in Dorothea Bate's gazelle-fallow deer index is widely believed to signal important changes in environmental conditions in the Mediterranean coastal hill region of the Levant during the Middle and Late Pleistocene, an area that includes many important Paleolithic cave sites in the Carmel Ridge, Samarran Hills, and lower Galilee. The reasoning behind the use of the index rests on the remarkable and shifting mixture of Eurasian and Afro-Arabian mammal communities across the biogeographic suture zones in this region. Two ungulate species—mountain gazelle and Mesopotamian fallow deer—may be especially diagnostic of ecological changes. However, interpreting trends in their relative frequencies is complicated by the fact that a decline in one almost always means an increase in the other. Analysis of the de-trended relations between these and other taxa (e.g., tortoises and aurochs) reveals the nearly singular importance of gazelle abundance. There is a dramatic burst in gazelle abundance with the earliest Mousterian, and their proportion continues to rise through the Holocene. In the Acheulo-Yabrudian, by contrast, one sees a singularly Holarctic mammalian community in which fallow deer are very common and gazelles absent. Increases in gazelle numbers with time may well signal expansion of open land habitats, fragmentation of Mediterranean forests, and perhaps intensified cycles of fire disruption. However, the abundance of gazelles in Pleistocene environments is weakly connected to that of tortoises, another animal that responds to changes in aridity, albeit in distinct ways. Another view of this phenomenon is provided by stable carbon and oxygen isotope analyses of the key ungulate taxa (Rowland et al.: see page A70). Species representation in the early part of the faunal series in Israel suggests a climate-driven incursion of Afro-Arabian taxa into the area around the Acheulo-Yabrudian (Qesem Cave) to early Middle Paleolithic (Hayonim Cave) transition some 200–250 kya.

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A74  
25 April 2006

## **The Depth of Early Human Technological Behaviour: A 3-D Approach to the Examination of Cognitive and Behavioural Aspects of Core Reduction**

Alexandra Sumner, *Department of Anthropology, University of Toronto*

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The study of refitted lithic material presents a unique opportunity for examining the nature of stone tool manufacture from a number of perspectives. Perhaps the most compelling are those which address issues of prehistoric cognition. The introduction of computer imaging programs not generally applied to archaeological analysis permits a more controlled testing of questions regarding the cognitive aspects of lithic reduction. By using 3-D imaging, computer morphometrics and statistical analysis the reduction stages of a sample of late MSA refitted cores from the site of Taramsa Hill, Upper Egypt, is schematically illustrated and analysed for specific concepts of short-term memory (working memory) and visio-spatial elements employed by prehistoric knappers during tool manufacture. Framed within theories of brain organization and function this paper presents the results of my analysis, a review of methodological procedures, and its future applications. It also broadly addresses the current debate surrounding early human cognitive and behavioural complexity in Africa prior to that which characterizes the European Upper Palaeolithic.

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## **Carnivore Ravaging of Boiled Bone Assemblages: Zooarchaeological Implications for Middle and Upper Paleolithic Sites**

J.C. Thompson, *School of Human Evolution and Social Change, Arizona State University*

Yolanda Lee-Gorishti, *Department of Anthropology, University of Connecticut*

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Bones contain two forms of nutritive value: bone marrow and bone grease. Bone marrow is located within the shaft of long bones and grease is located mainly in the ends of long bones and in the spongy portions of other elements. When humans have first or primary access to a carcass they break the long bone shafts and remove the marrow for consumption. Experimental work has shown that with the marrow removed, the relative nutritive value of long bone ends increases, and carnivores regularly consume these portions and ignore the empty shafts. However, it is unknown how carnivore bone portion choice would change if the grease was removed from spongy portions through extractive processes such as bone boiling.

It is widely believed that Upper Paleolithic hunter-gatherers used bone boiling technology, but it is unclear if Middle Paleolithic Neandertals in the same environments did. The ethnographic literature indicates that for modern humans, bone grease extraction is a critical survival tool in harsh, seasonal climates. If spongy portions of boiled long bones are not as attractive to carnivores, then the effects of their ravaging may be reduced in these assemblages. If Middle Paleolithic Neandertals did not have bone boiling technology, it could mean that these assemblages are not directly comparable to those from the Upper Paleolithic. Furthermore, it is possible that the results of most actualistic studies regarding bone portion choice and surface modification are not directly applicable to zooarchaeological assemblages created by human groups with bone boiling technology. This poster presents the results of experiments in which marrow was removed through hammerstone percussion, bone grease was extracted through boiling, and wild spotted hyenas (*Crocuta crocuta*) ravaged the assemblages. Carnivore bone portion choice and surface modification on boiled bone assemblage are discussed in the context of Middle and Upper Paleolithic zooarchaeology.

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## **Mobility Strategies and Core Technologies in the Levantine Middle Paleolithic**

Ian J. Wallace, *Department of Anthropology, University of Minnesota*

John J. Shea, *Department of Anthropology, Stony Brook University*

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Mobility has often been proposed as a significant source of Middle Paleolithic archaeological variability in the Levant. In 1968, Sally Binford first hypothesized a chronological and geographic shift in mobility patterns where the Early Middle Paleolithic sites on the Levantine coast were occupied ephemerally, while during the later Middle Paleolithic occupations became more residentially-stable and focused on cave/rockshelters. In the 1990s, Lieberman and Shea proposed that variation in mobility patterns may be related to divergent subsistence strategies practiced between early modern humans and Neandertals. Recently, Hovers, Meignen, and others, have revived Binford's original hypothesis of a diachronic shift in mobility strategies during the Middle Paleolithic Period in the Levant, albeit with more sophisticated lines of evidence.

Models of Levantine Middle Paleolithic mobility have been based on rare and taphonomically sensitive faunal evidence from a limited number of sites. Because lithic artifacts are the most ubiquitous archaeological remains available to the prehistorian, relationships between stone tool technology and mobility strategies can improve tests of hypotheses about prehistoric mobility patterns. This study examines variation in Levantine Middle Paleolithic land-use strategies from the perspective of core technology. A model which links expedient core reduction techniques and decreased mobility is adapted from one developed for late prehistoric contexts in the New World. By incorporating core data from numerous Levantine Middle Paleolithic assemblages, this study tests hypotheses about diachronic change, synchronic geographic variation, and possible hominin behavioral differences in mobility strategies.

The findings are congruent with an inferred decrease in residential mobility between the earliest and later phases of the Middle Paleolithic in the Levant. The core data also support the hypothesis of structural differences in coastal vs. interior land-use strategies. Finally, our findings are consistent with hypothetical differences between early modern human and Neandertal mobility strategies.

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A77  
25 April 2006

## **Magnetostratigraphy at the Makapansgat Limeworks Australopithecine Site**

Ginette L. Warr, *Department of Archaeology, University of Liverpool*

Andy I. R. Herries, *Palaeoanthropology Research Group, University of New South Wales*

Alf G. Latham, *Department of Archaeology, University of Liverpool*

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The Makapansgat Limeworks site is purported to be one of the oldest hominid sites in South Africa. Located north of the 'Cradle of Humankind' in Limpopo Province, the cave contains several phases of deposits conventionally arranged as Members. Fossil bearing deposits are located within a varied stratigraphic sequence of silts, breccias and speleothem horizons potentially covering a period in the order of a million years or more.

Palaeomagnetic dating in the 1970s suggested ages for the main fossil deposits of about 3 Ma. However, these studies did not directly sample the bone-dense grey breccia known as Member 3 of the Classic Section from which many of the hominin fossils have been recovered. A second series of palaeomagnetic studies in the Western repository, beginning in 1999, is based on denser sampling and a re-appraisal of the stratigraphy that has uncovered several additional reversals, including a reversal above the grey breccia (Member 3). Sampling has now included Member X, a recently recognized subunit near the base of the sequence, and has been extended to include the pink breccia (Member 4) from which the in-situ Australopithecine cranial fragments, MLD 37/38, were found.

We report on this new work, discussing the problems of, and possible solutions for, dealing with the magnetostratigraphy of deposits having different deposition rates, and discuss the implications for the age of the Australopithecine bearing units.

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A78  
25 April 2006

## **Cerebellar Evolution Provides Infrastructure for Modern Human Cognition**

Anne H. Weaver, *Santa Fe Community College*

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An increase in relative cerebellar volume may account in part for the decrease in brain volume relative to body mass observed in recent humans compared to Late Pleistocene humans. The cerebellum is extensively connected with many regions of the cerebral cortex, and is involved in a broad continuum of sensory-motor and cognitive operations, from lexical retrieval and phoneme production to visuo-spatial computations, enhancement of motor routines, and procedural memory. In addition, cerebellar architecture appears to be ideally designed to support the recursive algorithms necessary for generativity, epitomized by language but manifest in many other cognitive behaviors as well. Extension of pre-existing cerebellar-cortical neural loops and cerebellar algorithms to cognitive operations would have enabled recent humans to manipulate an increasingly complex universe of objects, symbols and symbol sets through neural reorganization rather than encephalization. By automating and optimizing cognitive operations, the cerebellum may have provided a cost-effective way to improve the cognitive efficiency of recent humans, permitting us to generate and manage the accelerating cultural complexity that has emerged over the last 30 thousand years. Changes in relative cerebellar volume are likely to reflect the interaction of genetic and ontogenetic sensitivity to cultural input.

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## **Osteological Approaches to the Evolution of Projectile Weaponry**

Steven E. Churchill, *Biological Anthropology & Anatomy, Duke University*

Jill A. Rhodes, *Biological Anthropology & Anatomy, Duke University*

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When in evolutionary history did long-range projectile weapons become an important component of hunting tool kits? The origins of projectile weaponry can be addressed, in part, through analyses of the skeletal remains of the prehistoric humans who made and used them. Habitual behavior patterns—including those related to the production and use of technology—can be imprinted on the skeleton through both genetic and epigenetic pathways. Recent studies in the field of sports medicine indicate that individuals who engage in habitual throwing have increased humeral torsion angles in their throwing arms and a greater degree of bilateral asymmetry in torsion angles than do non-throwers. Other skeletal evidence may be found in the forearm and shoulder. Bilaterally asymmetric hypertrophy of the ulnar supinator crest has been associated with throwing behavior in Prehistoric hunter-gatherer societies of South Asia. Additionally, the morphology of the scapular glenoid fossa may indicate adaptation stresses associated with movement patterns. A reduced glenoid index, such as that identified in Middle Paleolithic samples, suggests a shoulder joint poorly-adapted to withstand dorsally- and ventrally-directed forces at the shoulder that occur during throwing. This contribution examines the magnitude of and asymmetry in humeral torsion angles, supinator crest morphology and glenoid fossa breadth in Middle and Upper Paleolithic fossil hominins and comparative samples of North American recent humans relative to the question of the origin of projectile weaponry. Although the results are not clear-cut, the overall pattern of osteological indicators is consistent with the claim that projectile weapons arose in the African later MSA and moved into Europe in the hands of modern humans.

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## **Opening the Stone: A Multivariate Reassessment of the Neandertal Status of the Teshik Tash Child**

Terrence Ritzman, *School of Human Evolution and Social Change, Arizona State University*

Michelle Glantz, *Department of Anthropology, Colorado State University*

Sheela Athreya, *Department of Anthropology, Texas A&M University*

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Since its discovery in southeastern Uzbekistan in 1938, most paleoanthropologists have considered the Teshik-Tash child as a Neandertal sub-adult. The child's taxonomic status is important to interpretations of the Central Asia Middle Paleolithic as well as studies of Upper Pleistocene hominin growth and development. In an examination of the original Russian monograph, it is evident that problems associated with the reconstruction of the Teshik-Tash cranium and the noted incompleteness of key morphologies associated with the cranial base and face make its Neandertal attribution less certain than previously assumed. Moreover, Weidenreich (1945), Coquengnot et al. (1996), and others have presented analyses that call into question the taxonomic affinity of this specimen. The present study reassesses the Neandertal status of the Teshik-Tash child by comparing it to similarly aged subadults from two recent modern human samples and a fossil sample comprised of sub-adult Neandertals, Upper Paleolithic modern humans, and Middle Paleolithic modern humans. Examinations of two separate anatomical regions, the mandible and the facial skeleton, are conducted using discriminate function analysis. Our study also determines the success with which statistical procedures correctly classify individuals in each analysis. This procedure facilitates the evaluation of the validity of Teshik-Tash's classification and, by proxy, the distinctiveness of the groups as described by the variables measured. Results of the facial analysis indicate that Teshik-Tash groups with Neandertals with relatively high posterior probability, while results of the mandible analysis indicate that the specimen groups with recent modern humans with lower posterior probability. In general, the facial analysis was more successful at correctly classifying individuals. Other interesting patterns in the results of the classification procedures, however, suggest that the Neandertal status of the Teshik-Tash child is equivocal. This research indicates that current characterizations of the Central Asian Middle Paleolithic may be overly simplistic and that significant geographically patterned morphological variation existed during the Upper Pleistocene.

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A81  
26 April 2006

## Settling the Age Dispute for the Late Middle Paleolithic at the Obi-Rakhmat Hominid Site, Uzbekistan

B.A.B. Blackwell, *Dept. of Chemistry, Williams College and RFK Science Research Institute*

A. Mian, *RFK Science Research Institute*

S.M. Baboumian, *RFK Science Research Institute*

J.I.B. Blickstein, *Dept. of Chemistry, Williams College and RFK Science Research Institute*

A.R. Skinner, *Dept. of Chemistry, Williams College and RFK Science Research Institute*

P.J. Wrinn, *Dept. of Anthropology, University of Arizona*

A.I. Krivoshapkin, *Institute of Archaeology & Ethnography, Russian Academy of Sciences, Novosibirsk*

A.P. Derevi'anko, *Institute of Archaeology & Ethnography, Russian Academy of Sciences, Novosibirsk*

J.D.M. Wagner, *Dept. of Geosciences, University of Arizona*

P.J. Patchett, *Dept. of Geosciences, University of Arizona*

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In the Tien Shan Mt., northeastern Uzbekistan, the Obi-Rakhmat rockshelter has yielded newly discovered hominid teeth and cranial fragments from at least two individuals showing both modern and archaic traits. Metric comparisons for the hominids from Obi-Rakhmat suggest a resemblance to those from Peștera cu Oase, Romania, identified as anatomically modern *Homo sapiens*. These hominids occurred associated with an abundant, blade-based industry having both Middle and Upper Paleolithic characteristics and a rich faunal assemblage in typical cave fill sediment. Because ESR (electron spin resonance) can absolutely date enamel from 5 ka to 5 Ma, eight bovid teeth were dated by standard and isochron ESR to resolve the 60 ky discrepancy between the  $^{14}\text{C}$  and  $^{230}\text{Th}/^{234}\text{U}$  ages for Obi-Rakhmat:  $^{230}\text{Th}/^{234}\text{U}$  ages corrected for initial  $^{230}\text{Th}$  for Layers 5-12 ranged from  $84.5$  to  $96.6 \pm 1.4$ - $8.5$  ka. With external dose rates at  $800$ - $1500$   $\mu\text{Gy}/\text{y}$ , and high dentinal U concentrations producing high internal dose rates, accumulated doses of  $215$ - $305$  Gy yielded preliminary ESR ages for all subsamples. Teeth from Layer 13 averaged  $64 \pm 1$  ka assuming linear U uptake, while that from Layer 14.3 averaged  $68 \pm 2$  ka, and those from Layer 21.2 averaged  $87 \pm 3$  ka. These correlate with Oxygen Isotope Stages (OIS) 5a-4. Assuming a constant sedimentation rate, the hominid remains date to  $\sim 72$  ka. The majority of the cultural deposits predate the maximum dating limit for  $^{14}\text{C}$ .

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## **The Narmada Basin Palaeoanthropology Project (central India): Preliminary Results and Future Directions**

P.R. Chauhan, *The Stone Age Institute and Indiana University*

R. Patnaik, *CAS in Geology, Panjab University*

M.R. Rao, *Birbal Sahni Institute of Palaeobotany*

V. Sathe, *Department of Archaeology, Deccan College Postgraduate & Research Institute*

B. Blackwell, *Department of Chemistry, Williams College*

A. Skinner, *Department of Chemistry, Williams College*

S. Athreya, *Department of Anthropology, Texas A&M University*

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The Narmada Basin Palaeoanthropology Project is a multi-disciplinary endeavour involving scientists from India and the United States. The study area includes specific zones of future submergence through large-dam construction along the entire Narmada River, including the fossil-hominid site of Hathnora. Our primary goal is to understand early hominin adaptive strategies in direct relation to the depositional history of the river since the Lower Pleistocene. Key palaeoanthropological research questions are currently being addressed through systematic geoarchaeological excavations at artefact- and fossil-yielding locations, application of specific radiometric dating techniques, palaeoenvironmental reconstructions using pollen and vertebrate faunal assemblages and geomorphological observations. Preliminary results of three seasons of fieldwork, from 2003 to 2006, at Hathnora and nearby type-sections in Madhya Pradesh, are discussed.

At Hathnora, we have recovered pollen samples, additional vertebrate fossils, shells, Palaeolithic artefacts, and an ostrich eggshell fragment—all in *in situ* contexts from different strata. Preliminary radiocarbon dates associated with younger strata at the site are discussed, having indirect implications on the chronology of the *presumably* older hominin fossils. At Pilikarar, we have also recovered possibly the oldest-known Acheulian assemblage in the Narmada region (comprising quartzite handaxes, cleavers, picks and cores in fresh condition) from and above a boulder-bed overlying laterite deposits belonging to the Pilikarar Formation (presumably Lower Pleistocene). Additional archaeological occurrences include stratified Late Acheulian and Upper Palaeolithic artifacts and Mesolithic surface scatters closer to the river. Vertebrate fossils from surface and *in situ* contexts demonstrate variable taphonomic bias, suggesting that the currently-accepted biostratigraphic correlations are in need of major revision. The presence of pollen/spores from the Dhansi section indicate a warm and humid climate during the Mid-Pleistocene and pollen/spores from the Baneta Formation are indicative of a cool and dry climatic regime corresponding to the Last Glacial Maximum (LGM) episode. When combined with the palaeoenvironmental and geochronological data, the archaeological evidence reflects dynamic hominin adaptive strategies over time in the Narmada basin.

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26 April 2006

## **Kaletepe Deresi 3 and the Early Human Presence in Anatolia**

Ludovic Slimak, *Economies Sociétés et Environnements Préhistoriques, UMR 6636*

Steven L. Kuhn (corresponding author), *Dept. Of Anthropology, University of Arizona*

Nur Balkan-Atlı, *Prehistory Section, Faculty of Letters, Istanbul University*

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The Kaletepe Deresi 3 (KD3) locality is located in central Turkey, within the Central Anatolian Volcanic Province. The site is situated on the edge of the extensive Kömürcü obsidian flows and was discovered during investigations of the Neolithic workshops there. The stratigraphic sequence at KD3 is roughly 4.5 meters in depth and consists of reworked and in situ tephros, rhyolite and obsidian. Air-fall tephros in the upper part of the sequence and the underlying rhyolithic bedrock bracket most of the sequence between 160 KYA and ca. 1.3 Mya. At least eight distinct Lower and Middle Paleolithic archaeological horizons have been identified at KD3. Lithic assemblages illustrate a wide range of technological behaviors and document significant changes over time in raw material exploitation and artifact manufacture. The uppermost levels (I, I' and II) contain typical Middle Paleolithic with Levallois technology produced on obsidian. Levels II' and III yield early Middle Paleolithic or late Lower Paleolithic assemblages, again made predominantly on obsidian. In contrast, assemblages from the earlier levels show a preference for course-grained rocks, such as andesite and rhyolite, and only restricted use of obsidian. The industry from level VI can be characterized as Mode I: it was oriented around the production of large flakes from minimally-prepared cores. The earliest levels (V, and VI-XII) have yielded the first in situ Acheulean assemblages documented in Turkey, including handaxes and cleavers produced from both obsidian and andesite. Pending more precise chronostratigraphic information, the KD3 sequence has direct implications for our understanding of the ages and geographic distributions of different types of early Paleolithic assemblage in southern Eurasia and for the hypothesis of a late dispersal of the Acheulean, as well as for the timing and routes of hominin dispersals into Eurasia.

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## **New Data for the Paleolithic Site of Ain Hummal (Syria)**

Thomas Hauck, *Institute of Prehistory and Archaeological Science (IPNA), University of Basel*

Jean-Marie Le Tensorer, *Institute of Prehistory and Archaeological Science (IPNA), University of Basel*

Dorota Wojtczak, *Institute of Prehistory and Archaeological Science (IPNA), University of Basel*

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The site of Hummal is one of the typical well-sites in the arid region of Central Syria. First mentioned in 1966 by M. und G. Buccellati, the well was more closely examined in 1980 by J. Cauvin, F. Hours and L. Copeland, thereby detecting the Hummalian blade industry for the first time. Since 1999, regular excavations directed by J.-M. Le Tensorer have been carried out.

The most remarkable feature of Hummal is a long stratigraphy covering more than 20 geological layers and a multitude of archaeological horizons. At a depth of 13 m, a pebble industry with Oldowan resemblance represents the oldest human materials. Here, choppers and chopping tools are associated with irregular flakes. On top of these, Lower Paleolithic fire traces connected with a flake industry (Tayacien) can be found in carbonatic sediments.

The Older Middle Paleolithic is represented by a typical Near Eastern flake industry with heavy scrapers, the Yabrudian. Suddenly a radical change in human technology appears with the Hummalien blade industry. This culture, of which Hummal is the type-site, shows perfect points and scrapers on regular elongated blades together with Levallois elements. The Hummalian is followed by a huge Middle Paleolithic complex containing several archaeological layers. A detailed study of the ~ 4m long Levallois-Mousterian sequence is underway. The focus is on the internal technological variability. The Upper Paleolithic is represented only by insignificant remnants, a few beautiful scrapers on blades being an exception to the lack of data.

The geological situation appears to be extremely complicated because of the collapses of one or maybe several dolina(s). Detailed geomorphological studies are still lacking as well as radiometric dates for the most significant archaeological horizons (analysis in preparation). Generally speaking, the site of Hummal is one of the most important Paleolithic sites for human cultural development in the arid region of Syria.

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## **Faunal Elements from the Hummal Site (El Kowm, Syrian Arab Republic)**

Peter Schmid, *Anthropological Institute and Museum, University of Zurich*

Thomas Hauck, *IPNA, University of Basel*

Jean-Marie Le Tensorer, *Anthropological Institute & Museum, University of Zurich, and IPNA, University of Basel*

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A preliminary analysis is provided of the vertebrate faunal remains from the Hummal site located in the El Kowm basin (Syrian Arab Republic). The faunal assemblages are accompanied by a Middle Paleolithic industry. Although absolute dates are missing for the moment, it seems that the Mousterian layers at Hummal can be placed in an earlier phase of the Levantine Middle Paleolithic. Within the El Kowm area two essential resources existed: a good flint supply and adequate grazing for the herbivorous animals on which the Hummal inhabitants relied. Boreal Eurasian species such as *Dama*, *Cervus*, *Capreolus*, *Sus*, *Hippopotamus*, are all completely lacking at Hummal. Most of the cave sites with Neanderthal remains that have been excavated in the Near East lie within the Boreal Eurasian zone, with its fossil faunas. Neanderthals used the Levant during one of the cold spells of the last ice age, when the Middle East would have been warmer and wetter than the frozen lands to the north.

In contrast, the Hummal material is dominated by steppe and desert genera such as *Camelus*, *Gazella*, *Hemionus*, and *Strutio*, which form the major part of the Saharan-Indian species. The El Kowm area contributes to our currently poor knowledge of the Saharan-Indian fauna adapted to the arid conditions during the Pleistocene. Fossil records and modern distributions suggest that the environmental conditions in the El Kowm Basin during the Middle Paleolithic occupations essentially were not different from the semi-desert conditions prevailing today, suggesting that this fauna is long established and long adapted to the semi-arid conditions of this area. Thus, the Middle Paleolithic occupations seem to have occurred in dry environmental conditions from the beginning.

A special character of the Hummal assemblages is represented by a megafaunal element, a giant camel unrecognized in this region before. In addition we report for the first time hominine remains from the Mousterian layers. The association of possible neanderthaloid fossils with a Saharan-Indian fauna will be discussed.

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## **Inclined to Resharpen: Reduction and Form-Function Relationships in the French Mousterian**

Peter Hiscock, *School of Archaeology and Anthropology, Australian National University*

Chris Clarkson, *School of Archaeology and Anthropology, Australian National University*

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The history of debates over the nature of Mousterian implements and assemblage variation reveals near universal use of the archaeological principle that implement form often reflects intended function because prehistoric artisans designed specimens to be functionally specific and proficient. However it is now clear that much of Mousterian variability results from progressive alteration of the form of implement during their use-life. Since differences in the extent of reduction demonstrably alters the morphology of implements, including edge characteristics and specifically edge angles, we pose the question: “how can implements be designed for, and be efficient in, a specific use if their morphology is continuously changing?” We illustrate the interpretive difficulties arising from this question through an analysis of Mousterian retouched flakes from the classic site of Combe Grenal, and through the experimental reduction of scrapers. Our conclusion is that archaeology must move away from a naïve presumption that conventionally recognized implement types have a simple association with particular uses or that implements are designed to be efficient in a particular use.

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## **A Long Palaeolithic Sequence in Southwest France: The Karstic Sites of Coudoulous (Lot, Quercy, France)**

Jean-Philip Brugal, *UMR 6636 du CNRS, ESEP, Maison Méditerranéenne des Sciences de l'Homme*

Jacques Jaubert, *UMR 5199, PACEA, Université Bordeaux I*

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The region of the Quercy is characterized by middle elevated limestone plateau (Causses) dissected by main east-north/west-south rivers coming down from the margin of Massif Central toward the Aquitaine Basin. This region documents numerous Paleolithic and paleontological sites, mostly located in caves and rock-shelters; among them the karstic complex of Coudoulous yields the longest record. Interdisciplinary studies were conducted in 1994–2003 and allow proposing a general synthesis about the geological infilling as well as all fossils (micro- to macro-fauna, flora) and lithic artifact materials. Two main deposits/caves recorded a combined chronoclimatic sequence dated between c. 300 ka to c. 40 ka with very rich faunal assemblages and different cultural layers. The faunal diversity is high and the sequences bring important new insights about paleoenvironmental conditions during at least OIS 7 to 3, with an especially large section of OIS 5. The sites demonstrate various patterns of bone accumulations and socio-economic activities by archaic human groups. Most of the bone assemblages have a natural origin with herbivores trapped in the cave that works as a pitfall. In some levels carnivores used the place for hibernating or reproductive purposes (ursid, felid). Predators, including humans, seem to act upon the death assemblage (thanatocoenosis) in order to recover a portion of ungulate carrions. This marginal strategy is discussed in relation with regular occurrence of herbivorous trapping for different Pleistocene phases in the context of natural karstic pitfalls, always abundant in this limestone landscape (methodic scavenging). Moreover, a very impressive layer dated around c. 160 ka, documents an abundant Middle Paleolithic industry made on local quartz and a few flints associated with remains of steppe bison (c. 98% of NISP), estimated to be 232 individuals. Taphonomic, isotopic, sex, and age analysis, eco-ethologic, typo-technology, and raw material studies suggest several seasonal hunting occupations by Preneanderthal groups, involving a recurrent focused exploitation on a single game resource. The long Paleolithic sequences of Coudoulous constitute significant land-marks for our knowledge about settlement and socioeconomic dynamics of prehistoric groups.

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## **Teeth as Tools? A Comparison of Neanderthal and Early Modern Human Incisor Microwear**

Amanda G. Henry, *Center for Advanced Study of Hominid Paleobiology, Dept. of Anthropology, The George Washington University*

Kathleen D. Gordon, *Department of Anthropology, National Museum of Natural History, Smithsonian Institution*

Erik Trinkaus, *Department of Anthropology, Washington University*

Alison S. Brooks, *Center for Advanced Study of Hominid Paleobiology, Dept. of Anthropology, The George Washington University*

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The cause of the extreme wear exhibited by many Neanderthal incisors has been much debated. Some argue that this kind of wear, especially with evidence of increased labial wear, is the result of ‘cultural’, not dietary, use of the teeth. Both gross morphological studies and analyses of microwear from scanning electron microscope images have been used to describe Neanderthal teeth and compare them to modern populations, specifically Amerindian groups for which ethnographic data on tooth-use has been documented. Some of these studies have led researchers to hypothesize that Neanderthals and penecontemporaneous early modern humans (EMH) used their teeth very differently. None of these studies, however, directly compared a sample of Neanderthal and EMH teeth. We used scanning electron microscopy to quantify and compare the microwear of Neanderthal incisors with that of early modern human incisors. We made three comparisons, one each to test for cultural (Middle Paleolithic vs. Upper Paleolithic), geographic (Near East vs. Europe) and populational (Neanderthal vs. EMH) differences. Our results indicate all comparisons show significant differences in at least some of the variables (out of 26 variables, three variables were significant in the first comparison, eight in the second and three in the third). However, the most significant differences separate European teeth from Near Eastern teeth, regardless of group (four of the variables were significant at  $p < 0.001$ ), and the pattern of differences (lower density of features, low feature linearity, fewer striations, and large, wide features) is broadly similar to that which separates Inuits from other Amerindian groups. This suggests that local climate variation may be more important than populational or cultural differences in causing dental microwear.

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## **Were Neandertal and Modern Human Cranial Differences Produced by Natural Selection or Random Genetic Drift?**

Timothy D. Weaver, *Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology*

Charles C. Roseman, *Department of Anthropology, University of Illinois at Urbana-Champaign*

Chris B. Stringer, *Department of Palaeontology, The Natural History Museum*

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For over a century, researchers have documented that Neandertal and modern human crania are morphologically distinct. Evolutionary explanations for these differences typically emphasize adaptation by natural selection. Features of the crania of Neandertals may be adaptations to the glacial climate of Pleistocene Europe or to high mechanical strains from habitually using the front teeth as tools; those of modern humans may be adaptations for articulate speech production. A minority of researchers has proposed non-adaptive explanations, stressing isolation between Neandertals and modern humans and independent, random diversification.

We present the results of a wide variety of statistical tests based on explicit, quantitative predictions from quantitative- and population-genetic theory for morphological evolution in the absence of natural selection. These tests are based on 37 standard cranial measurements from a sample of 2524 modern humans from Howells' dataset and 20 Neandertal fossils, and 377 genetic repeat loci from a sample of 1056 modern humans from the HGDP-CEPH human genome diversity cell line panel. Our analyses suggest that Neandertal and modern human cranial differences were likely produced by random genetic drift rather than by natural selection. We conclude that the most probable ultimate evolutionary explanation for many of the differences between Neandertal and modern human crania is likely to be isolation into two independent evolutionary lineages followed by random genetic drift. Neandertal and modern human crania represent two endpoints from a vast set of possible random evolutionary outcomes; the differences between them primarily reflect the time elapsed since the divergence between the Neandertal and modern human lineages in the Middle Pleistocene.

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## **A 3D Analysis of the Neanderthal Occipital Bun: Reassessment of a Proposed Derived Trait**

Gunz, Philipp, *Max Planck Institute for Evolutionary Anthropology, Dept. of Human Evolution*

Harvati, Katerina, *Max Planck Institute for Evolutionary Anthropology, Dept. of Human Evolution*

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The occipital bun is considered a derived Neanderthal trait. The presence of a weak bun in Upper Paleolithic European fossils is often cited as evidence for admixture/continuity between Neanderthals and anatomically modern humans. However, this feature is difficult to measure, and the term 'occipital bun' has been applied to various morphological patterns. We extend previous 2D geometric morphometric analyses by one of us (Harvati et al. 2002; Reddy et al. 2005) to include 3D data. We quantitatively evaluate the presence and degree of expression of this trait in Neanderthals, Upper Paleolithic Europeans, Middle-Late Pleistocene African and European fossils, and recent humans (335 crania, representing 12 geographic populations, covering a wide range of modern human shape variability).

3D coordinates of landmarks (lambda, inion, asterion) and curves (midsagittal outline of the occipital bun and lambdoid suture) were measured using a Microscribe digitizer. The curves were resampled to yield the same number of points for every specimen. These points (semilandmarks) gain geometric homology within the sample through sliding along the curvature, so as to minimize the thin-plate-spline bending energy between each specimen and the Procrustes average. The resulting coordinates were superimposed using Procrustes registration. The shape coordinates were then analyzed using principal components analysis.

We used two different subsets of landmarks and semilandmarks: (1) the midsagittal outline and (2) this midsagittal outline and the lambdoid suture curve. When the first subset is analyzed we find almost complete overlap of Neanderthal and AMHS shape variability. When the data are augmented by lateral information using the second coordinate subset, Neanderthals fall outside the range of modern variation. Upper Paleolithic Homo sapiens cannot be distinguished from recent humans. Petralona and Atapuerca SH 5 cluster with Neanderthals, as does Kabwe. Results warrant re-evaluation of the polarity and status of this trait.

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## Who Made the Early Upper Paleolithic? The Wisdom of the Teeth

Shara E. Bailey, *Department of Anthropology, New York University, and Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology*

Timothy D. Weaver, *Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology*

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Human remains associated with the earliest Upper Paleolithic industries are frustratingly sparse. What is preserved often comprises teeth, which are frequently considered to be taxonomically undiagnostic without supporting cranial or postcranial information. While recent research has shown that Neandertals possess a unique dental pattern relative to anatomically modern humans, it is rare to find maxillae or mandibulae that preserve all or most of their teeth. Thus, the probability of correctly identifying the taxonomic status of individuals represented only by a few or single teeth is not known. This is an important issue, especially in the context of the recent debate over whether anatomically modern humans or Neandertals are responsible for early Upper Paleolithic industries.

We present a computer program that uses a Bayesian statistical approach to classify individuals represented exclusively by teeth as belonging to two or more possible groups. In this case, the classification is based on two groups: “known” samples of 123 Neandertals and 70 Upper Paleolithic modern humans. The program provides posterior probabilities of group membership, accounting for the sizes of the “known” samples. In a cross validation test on the “known” samples 86% of the Neandertals and 83% of the Upper Paleolithic modern humans classified correctly, with an overall correct classification rate of 85%. Satisfied that the method worked, we then applied it to an “unknown” sample of Châtelperronian- and early Aurignacian-associated human teeth. The Châtelperronian-associated teeth were assigned 93% (14/15) of the time to Neandertals, while the early Aurignacian-associated teeth were assigned 90% (28/31) of the time to Upper Paleolithic modern humans. Furthermore, our results suggest that the earliest modern Europeans and Aterian-associated Africans are not well-accommodated by either group.

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## **The Mousterian-Aurignacian Transition at the Riparo Bombrini (Liguria, Italy) Rockshelter**

Brigitte M. Holt, *Department of Anthropology, University of Massachusetts*

Fabio Negrino, *Via Lorenzo Costa 2/6A, Genova, Italy*

Vincenzo Formicola, *Dipartimento di Etologia, Ecologia ed Evoluzione, Università di Pisa*

Julien Riel-Salvatore, *School of Human Evolution and Social Change, Arizona State University*

Steve E. Churchill, *Biological Anthropology and Anatomy, Duke University*

Giuseppe Vicino, *Civico Museo del Finale, Finale Ligure Borgo (SV), Italy*

Angiolo Del Lucchese, *Soprintendenza Archeologica della Liguria, Genova, Italy*

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The debate around the Middle-Upper Paleolithic transition shows no sign of abating and the nature of this transition remains one of the most debated topics in paleoanthropology. The archaeological record of northern Italy is especially germane to this issue: unlike other areas where an initial Upper Paleolithic industry often underlies the Aurignacian, there seems to be a clear discontinuity in northern Italy between terminal Mousterian and subsequent Aurignacian.

We report here results from four seasons of excavation at the rockshelter of Riparo Bombrini (Balzi Rossi, Liguria, Italy). Three markedly separate horizons were uncovered: the deepest, Level IV, yielded abundant Mousterian lithics and faunal remains. A second, transitional, unit, represented by the topmost layer of Level IV is only a few centimeters thick and is characterized by the presence of large limestone blocks from partial collapse of the roof. The scarcity of material and presence of carnivore coprolites suggest sporadic human occupation. The third unit, Level III, following immediately above this transitional layer, contains a rich Aurignacian industry, including lamelles Dufour, bone tools, abundant ochre, numerous decorative objects (perforated shells, bone tools and pendants, among others), and widespread use of exotic raw material.

Climatic data suggest the transition took place during a warm phase or during the following, colder and more humid, phase. The Aurignacian assemblage was deposited during the succeeding cold and dry phase. While preliminary faunal analysis suggests little change in site use over time, the composition of the lithic assemblages point to marked technological discontinuity between the two time periods. New AMS dates will be presented for the Aurignacian, as well as the first absolute date for the Mousterian at Balzi Rossi. In addition, we will discuss implications of the Riparo Bombrini data in the context of the diffusion dynamics of modern humans in Western Europe.

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A93  
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## **Current Research on the Late Middle Paleolithic and Early Upper Paleolithic in Swabia**

Nicholas J. Conard, *Abteilung für Ältere Urgeschichte und Quartärökologie, Universität Tübingen*

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Recent and ongoing excavations in the Lone and Ach Valleys of the Swabian Jura continue to produce important results for our understanding of the demographic and behavioural shifts associated with the late Middle Paleolithic and early Upper Paleolithic. This paper presents a number of new results from research at sites including Hohle Fels, Geißenklösterle, and Vogelherd.

New radiocarbon dates continue to document the technical problems we face when trying to date events and behavioural patterns in the period between 30 and 50 ka bp. Results from Hohle Fels confirm earlier work at Geißenklösterle and point to major adaptive and demographic shifts between the late Middle and early Upper Paleolithic. While Neanderthals practiced low impact adaptive strategies, modern humans, who arrived in the region about 40 ka bp via the Danube Corridor, practiced higher impact subsistence strategies that led to increased population densities. After the initial appearance of modern humans, Neanderthals, if present at all, quickly left this region. Together with these changes, we observe evidence for early examples of figurative art and musical instruments that are important innovations predicted by the *Kulturpumpe* hypothesis. New examples of ornaments, artworks and musical instruments will be presented.

Finally, the paper addresses the beginnings of the Gravettian ca. 30 ka bp and the second phase of the *Kulturpumpe* model. Here we see further innovations in organic and lithic technology as well changes in iconography including a shift from the animal imagery of the Aurignacian to the sexual imagery of the Gravettian.

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## **New Excavations at the Paleolithic Site of Chez-Pinaud Jonzac (Charente-Maritime, France)**

Shannon P. McPherron, *Max Planck Institute for Evolutionary Anthropology*

Jean-Jacques Hublin, *Max Planck Institute for Evolutionary Anthropology*

Jacques Jaubert, *University of Bordeaux I, IPQG*

Marie Soressi, *Max Planck Institute for Evolutionary Anthropology*

Shara Bailey, *Max Planck Institute for Evolutionary Anthropology*

Jean-Guillaume Bordes, *University of Bordeaux I, IPQG*

Emilie Claud, *University of Bordeaux I, IPQG*

Jean-Baptiste Mallye, *University of Bordeaux I, IPQG*

Alexandre Michel, *University of Bordeaux I, IPQG*

William Rendu, *University of Bordeaux I, IPQG*

Michael Richards, *Max Planck Institute for Evolutionary Anthropology*

Daniel Richter, *Max Planck Institute for Evolutionary Anthropology*

Teresa Steele, *Max Planck Institute for Evolutionary Anthropology*

Gillian Taylor, *Max Planck Institute for Evolutionary Anthropology*

Jean-Pierre Texier, *University of Bordeaux I, IPQG*

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The Paleolithic site of Chez-Pinaud Jonzac was discovered in 1997 by a geologist in search of stratigraphic sections and subsequently excavated in 1998–99 and 2003 by a team of researchers led by J. Airvaux. The results of the 1998–99 excavation, published in 2004, show a site with a deep sequence beginning with a thick layer of Quina Mousterian associated with a well preserved, very rich fauna dominated by reindeer. The upper layers show a transition from a Levallois rich industry to a handaxe rich, non-Levallois MTA industry. Overlying this, Airvaux reported a Châtelperronian industry. However, in the same volume, one of us (MS) raised some doubts over this attribution. Finally, the last archaeological layers, showing variable preservation across the site, could be assigned to the Aurignacian. Given the importance of Middle to Upper Paleolithic transition sites and the high state of preservation in the Quina layers, a new four year project of excavation was begun in 2004 by a team from the University of Bordeaux I and the Max Planck Institute. Among the project goals are to clarify the industries at the transition, to date the entire sequence, and to better assess the geology and site formation processes. With regard to the latter, of particular interest are the cultural and natural factors leading to the deposition of the over one meter deep Quina “bone bed” layer. Here we report on the results to date and place them in the context of recent work in the late Middle Paleolithic of southwest France. These results include AMS and TL dates from the transitional layers, isotopic analysis of the fauna and of a single hominin tooth found in an MTA context, and a better understanding of the assemblages and their context.

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## No Neandertal/Early Modern Human Interstratification at the Châtelperronian Type-Site

Francesco d'Errico, *PACEA/UMR 5199 du CNRS, Institut de Préhistoire et de Géologie du Quaternaire, UFR de Géologie, Talence*

Jean-Guillaume Bordes, *PACEA/UMR 5199 du CNRS, Institut de Préhistoire et de Géologie du Quaternaire, UFR de Géologie, Talence*

Arnaud Lenoble, *PACEA/UMR 5199 du CNRS, Institut de Préhistoire et de Géologie du Quaternaire, UFR de Géologie, Talence*

João Zilhão, *Department of Archaeology and Anthropology, University of Bristol*

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The interpretation of the Châtelperronian as the acculturation of late Neandertals by anatomically modern human neighbors assumes an age of ca.39–40,000 <sup>14</sup>C BP for the earliest Aurignacian, and seeks support in a few putative instances of interstratification, interpreted as evidence for a long contemporaneity and cultural interaction. However, such an early chronology for the Aurignacian is questionable, and the reappraisal of Roc-de-Combe and Piage sequences shows these are better explained as the result of excavation error and post-depositional processes. Gravina et al. (Nature 2005) report a series of radiocarbon dates for the Châtelperron type-site interpreted as evidence for an interstratification of distinctively Châtelperronian and Aurignacian occupations, with Aurignacian level B4 dating to ca.36–39 ka <sup>14</sup>C BP; these are interpreted as the earliest secure dates for the presence of Aurignacian technology in France. We have reappraised the original documentation left by the site excavator, H. Delporte, including an unpublished manuscript and photographs, and undertook a taphonomic analysis of the fauna and a technological and typological study of the lithic assemblages. The Châtelperron faunal assemblages mostly consist of bone fragments regurgitated by hyaenas or gnawed by carnivores with rare instances of anthropogenic modification. Post-Mousterian lithic assemblages from Delporte's excavation, including B4, are almost exclusively composed of typical Châtelperronian tools, cores and debitage; diagnostic Aurignacian tools, no more than one or two per level, exist from top to bottom of the B1–B5 sequence. A variable proportion of artifacts from all levels bear edge damage and smoothing/polish suggestive of post-depositional displacement; a number are fractured or show removals produced by heavy metal tools with semi-concreted sediment adhering to recent breaks. We conclude that at least Châtelperron levels B1–B3, and in all likelihood the entire B1–B5 sequence, represent reworked sediments and archeological material, probably backdirt from the excavations conducted at the site in the nineteenth century.

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Gravina, B., P. Mellars, and C.B. Ramsey. 2005. Radiocarbon Dating of Interstratified Neanderthal and Early Modern Human Occupations at the Châtelperronian type-Site. *Nature* 433: 51–56.

## **On the Reality of a Claimed Châtelperronian-Aurignacian Interstratification at Grotte des Fées de Châtelperron (Allier, France)**

Julien Riel-Salvatore, *School of Human Evolution and Social Change, Arizona State University*

Alexandra E. Miller, *School of Human Evolution and Social Change, Arizona State University*

Geoffrey A. Clark, *School of Human Evolution and Social Change, Arizona State University*

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Recently published data derived from a reanalysis of material from the Châtelperronian type-site of Grotte des Fées de Châtelperron (Allier, France) suggest that an Aurignacian assemblage might have been found stratified between two Châtelperronian assemblages at that site. If true, this claim has profound implications about the nature of potential interactions between the hominin populations responsible for making the two industries, especially since no other claim of interstratification has held up to critical scrutiny. Here, we present a critical review of the various lines of evidence presented by Gravina et al. (2005) to support their claims for the Grotte des Fées interstratification. First, an evaluation of the new chronological data they bring to bear on the issue shows that their interpretation is undermined by some probabilistic concerns. We suggest that anciently excavated Paleolithic deposits in general are unlikely to yield the kind of fine-grained evidence needed to document industrial interstratifications over short time intervals. Additionally, a detailed review of typological data from other Châtelperronian assemblages suggests that the criteria invoked to identify an Aurignacian occupation at Grotte des Fées provide only ambiguous support for such an interpretation. Specifically, the identification of purported 'Aurignacian diagnostics' within a Châtelperronian assemblage is argued to be an inadequate way of identifying an Aurignacian occupation, both logically and statistically. Lastly, we discuss some of the limitations of the ecological scenario put forth to explain the nature and timing of the interstratification at Grotte des Fées. Our review casts serious doubts on the existence of interstratifications between Aurignacian and 'transitional' assemblages as a whole, at least as they are currently documented. We conclude by proposing one potential explanation of this pattern which contrasts with the prevalent idea of an 'Aurignacian invasion' of Eurasia by allegedly modern humans.

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Gravina, B., P. Mellars, and C.B. Ramsey. 2005. Radiocarbon Dating of Interstratified Neanderthal and Early Modern Human Occupations at the Châtelperronian type-Site. *Nature* 483: 51–56.

## **Testing the Modern Human Expansion Hypothesis Using the Saint-Césaire Fauna**

Eugène Morin, *Department of Anthropology, McGill University*

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The present analysis tests the hypothesis of a demic expansion of early modern humans into Western Europe during the Middle to Upper Paleolithic transition. This assumption is a key element of the Neandertal replacement model. Faunal remains from Saint-Césaire, a cave site in central western France, are used for this test.

The existing evidence indicates that in the late Mousterian, human populations were vulnerable to fluctuations in animal resource abundance. In France, this situation resulted in periodic exposure to food stress. If the hypothesis of a modern human incursion into Eurasia at the beginning of the Upper Paleolithic is correct, it can be inferred that this demographic pulse increased local populations beyond carrying capacity and led to resource depression. In this context, it is argued that Neandertals and early modern humans modified their subsistence strategies in order to adapt to a decrease in foraging efficiency. Specifically, five aspects of faunal assemblages, all related to the maximization of energy, are investigated. These aspects include: i) the taxa exploited; ii) the skeletal parts exploited for marrow; iii) the skeletal parts transported; iv) the practice of bone grease rendering; and, and v) the extent of scavenging. These implications are tested using eight faunal assemblages from Saint-Césaire. Other factors that may induce diet changes, such as climate, were also taken into consideration. The results suggest stability in subsistence strategies throughout the Saint-Césaire sequence. No evidence of a decrease in foraging efficiency was found. Published data from two other sites corroborate these patterns. These findings appear to invalidate the demic expansion hypothesis. Instead, a model stressing decreases in population densities, local continuity, small-scale migrations, and genetic drift, is offered as an alternative to explain the Middle to Upper Paleolithic transition in that region.

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## **Spatial Analysis of Human Remains from the Châtelperronian Layers at Arcy-sur-Cure and Saint-Césaire (France)**

Jean-Jacques Hublin, *Max Planck Institute for Evolutionary Anthropology*

Marie Soressi, *Max Planck Institute for Evolutionary Anthropology*

Shara E. Bailey, *Max Planck Institute for Evolutionary Anthropology*

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Human remains associated with the misnamed ‘transitional’ industries between Middle (MP) and Upper Paleolithic (UP) in Europe are scarce. To date, only two Châtelperronian sites have yielded significant fossils: Arcy-sur-Cure and Saint-Césaire in France. At both sites it has been suggested that some admixture of “real” Châtelperronian and Mousterian artifacts could have occurred. At Arcy-sur-Cure recent re-excavation and technological analysis of the Châtelperronian layers at the Grotte du Renne confirm their integrity and the identity of a Châtelperronian entity. This assemblage displays its own technological features and traits such as the use of body ornaments, usually considered indicative of UP or ‘modern’ behavior. We report here a morphological assessment of 29 largely unpublished teeth found in layers VIII to X together with an analysis of their spatial distribution. Like the previously reported temporal bone from one of the same layers, the series displays combinations of features which are observed with very high frequencies in Neandertals and very low frequencies in modern humans. The spatial analysis of the most diagnostic remains demonstrates that they are found throughout the three Châtelperronian layers. Furthermore, they appear to be equally distributed between the rear section of the site where Châtelperronian layers reach more than a meter of thickness and are horizontally arranged, and the front part of the site, where layers are thin and sloping.

At Saint-Césaire, a Neandertal skeleton was unearthed from the upper layers. Three-dimensional plotting of artifacts and human remains, together with a precise first-hand analysis of the lithic industry confirms the association of the human skeleton with a well-defined Châtelperronian layer. Our study confirms the attribution of the Châtelperronian assemblages at la Grotte du Renne and Saint-Césaire to late Neandertal populations. Site formation processes resulting in possible layer admixture cannot account for this association.

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A99  
26 April 2006

## **Excavations at the Peștera cu Oase: The Chronometric, Stratigraphic and Taphonomic Context of Europe's Earliest Modern Humans**

João Zilhão, *Department of Archaeology and Anthropology, University of Bristol*

Erik Trinkaus, *Department of Anthropology, Washington University*

Silviu Constantin, *Institutul de Speologie "Emil Racoviță," Bucharest*

Hélène Rougier, *Service Anthropologie et Préhistoire, Institut royal des Sciences naturelles de Belgique, Bruxelles*

Jérôme Quilès, *UMR 5608 Unité Toulousaine d'Archéologie et d'Histoire, Université Toulouse Le Mirail*

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The Peștera cu Oase yielded cranial remains of two early modern human individuals. The associated stratigraphic and chronometric evidence (direct radiocarbon dating of the human fossils and of many other faunal samples, as well as U-series dating of speleothems growing on the surface of the deposits) constrains the deposition of the Oase 1 mandible to the ca. 42–41 ka cal BP interval, whereas the age of the Oase 2 cranium is likely to fall in the same range and is securely in excess of 34 ka cal BP. Their morphology includes several archaic, cf. Neandertal traits, suggestive of admixture at the time of contact, which is consistent with the fact that, given dates for the latest Neanderthals in central and eastern Europe, the Oase fossils must represent the continent's earliest modern human populations; correlation with the Greenland climate proxy places their immigration no earlier than the beginning of GIS-11. No evidence of human activity was recorded in the Oase system, which, throughout the period of accumulation of the bone assemblages contained therein, functioned as a cave bear hibernation site, first, and then as a wolf den. The taphonomic context indicates that the human remains relate to a natural accumulation process, not to mortuary behaviour. No post-cranial material was found, and all human bone fragments recovered belong to either the Oase 1 mandible or the Oase 2 cranium; the teeth missing in both were not found either, in spite of the water-sieving of the sediments. These absences are likely to be a reflection of the limited size of the excavated area (ca. 10 m<sup>2</sup>, for a total volume of some 2.5 m<sup>3</sup>), which was constrained by the nature of the (speleodiving) access route and an overall conservationist approach to what is one of the best preserved cave bear sites known.

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A100  
26 April 2006

## **Hammer or Crescent Wrench? Stone Tool Form and Function in the Aurignacian of Southwest Germany**

Bruce L. Hardy, *Department of Anthropology, Kenyon College*

Michael Bolus, *Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Universität Tübingen*

Nicholas J. Conard, *Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Universität Tübingen*

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The early Upper Paleolithic of Europe is associated with the appearance of blade/microlith technology (e.g., Aurignacian, Mode 4). These industries include a wider range of formal tool types than seen in the Middle Paleolithic. Greater diversity in tool types is often interpreted as specialized tools created for specific tasks. This, in turn, is said to reflect dramatic behavioral shifts between Neandertals and modern humans. In order to test previous interpretations, it is necessary to have a detailed understanding of early Upper Paleolithic stone tool function. Toward this end, microscopic residue and use-wear analyses were undertaken on 110 stone tools from three Aurignacian sites in southwest Germany (Hohle Fels, Geißenklosterle, and Vogelherd). These cave sites evidenced remarkable residue preservation, with approximately 82% of the sample showing some form of functional evidence. Residues observed included hair, feathers, bone/antler, wood, plant tissue, phytoliths, starch grains, and resin. The results suggest that tool typology is not strongly linked to the processing of specific materials. For example, endscrapers from the sample show evidence of processing wood, charred wood, plants, starchy plants, birds, bone/antler, and animals (hair). Hairs are found on tools typologically classified as blades, flakes, borers, pointed blades and combination tools (nosed endscraper-borer, burin-laterally retouched blade). In the early Upper Paleolithic of southwest Germany, a wide range of tool types appear to have been used to process a diverse array of materials. These results suggest that the interpretation of behavioral patterns from stone tools must consider more than tool typology.

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## **Eco-Cultural Niche Modeling of European Human Populations during the Last Glacial Maximum**

William E. Banks, *Centre National de la Recherche Scientifique, UMR 5199, Institut de Préhistoire et de Géologie du Quaternaire, Talence*

Francesco d'Errico, *Centre National de la Recherche Scientifique, UMR 5199, Institut de Préhistoire et de Géologie du Quaternaire, Talence, and Department of Anthropology, George Washington University*

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Few attempts have been made to model the impact of the OIS2–3 millennial-scale climatic variability (Dansgaard-Oeschger oscillations and Heinrich events) on the human populations of Europe. To accomplish this we employ an approach termed Eco-Cultural Niche Modeling (ECNM), utilizing Genetic Algorithm for Rule-Set Production (GARP) software. GARP is a machine-learning genetic algorithm that uses geographic and climate data to create an ecological niche model for a species, which represents the environmental conditions in which that species could maintain a population. A niche model for a species in the past can be produced by integrating paleoclimatic interpolations and the geographic coordinates of localities where the species was observed prehistorically (e.g., archaeological sites) or by projecting an ecological niche model for one time period onto modeled climates for a second time period and testing the ability of this model to predict known occurrences for the second time period. In the case of archaeologically defined populations, ECNM predicts a baseline distribution that represents the territory in which that population could have been present. We produced ECNMs based on the geographic coordinates of all European archaeological sites dated to the Last Glacial Maximum (LGM) and on recent climatic interpolations for the LGM. More specific ECNMs were created based on combined cultural traits. In parallel, niche models for large ungulate species exploited by prehistoric hunter-gatherer populations were also created. Results indicate that the distribution of hunter-gatherers during the LGM was primarily determined by mean annual temperature. The ECNMs, however, predict for each archaeological culture a longitudinal distribution greater than is observed archaeologically and that encompasses territories occupied by other archaeological cultures. The fact that hunter-gatherer groups from the LGM act as sympatric species is tentatively attributed, based on cultural-ecological studies, to the limitations imposed on a culture in order for it to remain cohesive and viable.

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A102  
26 April 2006

## **Stratigraphy and Dating of the Early Upper Paleolithic at Kostenki (Russia)**

John F. Hoffecker, *Institute of Arctic and Alpine Research, University of Colorado, Boulder*

Vance T. Holliday, *Departments of Anthropology and Geosciences, University of Arizona*

M. V. Anikovich, *Institute of the History of Material Culture, Russian Academy of Sciences, Saint Petersburg*

A. A. Sinitsyn, *Institute of the History of Material Culture, Russian Academy of Sciences, Saint Petersburg*

G. M. Levkovskaya, *Institute of the History of Material Culture, Russian Academy of Sciences, Saint Petersburg*

G. A. Pospelova, *Institute of Earth Physics, Russian Academy of Sciences, Moscow*

Steven L. Forman, *Department of Earth and Environmental Sciences, University of Illinois at Chicago*

Paul Goldberg, *Department of Archaeology, Boston University*

Biagio Giaccio, *Istituto di Geologia Ambientale e Geoingegneria—CNR, Rome*

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The earliest known Upper Paleolithic sites in Eastern Europe are at Kostenki, which is located on the central plain approximately 500 km south of Moscow. A total of 21 open-air sites occupy terraces on the west bank of the Don River at Kostenki, and at least nine of them contain one or more occupation layers that date within the time range of Marine Isotope Stage 3. The sites containing early Upper Paleolithic (EUP) layers are found on the second terrace level (15–20 m), both in the main valley and large ravines incised into Cretaceous limestone and sand of the west bank. Springs are active in the ravines.

EUP occupations are buried in a complex sequence of loams, humic layers, carbonate lenses, and bands of rubble that overlies alluvium of the second terrace. Field and thin-section analyses of these deposits indicate that they represent brief periods of stability and soil formation, repeatedly interrupted by deposition of primary carbonate from springs and seeps, as well as by colluviation from higher slopes. The sequence is subdivided by a volcanic ash layer identified as the *Campanian Ignimbrite Y5* tephra (39 ka). Below the CI tephra at Kostenki 12, the Laschamps Excursion (42–44 ka) is tentatively identified, and a series of OSL dates yield ages of 45–52 ka.

Palynological data from sediments containing the EUP layers suggest relatively mild climates, and the layers below the CI tephra may be correlated with several DO events following Heinrich Event 5 (HE 5). EUP layers above the tephra may be correlated with younger DO events after HE 4 (ca. 40–30 ka). The Kostenki chronology indicates that a fully developed EUP industry was established on the central East European Plain as early as anywhere in Europe (ca. 45 ka), and prior to the CI eruption (39 ka), which probably had significant ecological impact.

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## **Tardiglacial Territorialism in Cantabria, Northern Spain**

Manuel R. González Morales, *Instituto Internacional de Investigaciones Prehistoricas, Universidad de Cantabria*

Lawrence Guy Straus, *Department of Anthropology, University of New Mexico and Instituto Internacional de Investigaciones Prehistoricas, Universidad de Cantabria*

Ana Belen Marín, *Instituto Internacional de Investigaciones Prehistoricas, Universidad de Cantabria*

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Rarely in Paleolithic prehistory can we identify the “territories” of particular culturally defined social entities such as regional bands. Yet estimation of the geographic extent of the core areas habitually used by Ice Age forager groups for subsistence and social interaction is a crucial factor in understanding and comparing different regional human adaptive patterns. Traditionally, the scale of late Upper Paleolithic territories in the narrow strip of land between the Cantabrian Cordillera and coast has been assumed to be small relative to those of France or Germany, based on the high relief & ecotonal character of this region, the scant migratory nature of the main ungulate prey species, and the (semi-)local sources of most lithic raw materials.

In 2004, during excavation of a rich Lower Magdalenian occupation level in Mirón Cave (Cantabria) dated by three radiocarbon assays to 15,450–15,700 BP, we uncovered a large red deer stag scapula engraved with the head and neck of a red deer hind. This extraordinary object joins four engraved scapulae found early in the 20th century in Altamira and at least 24 in Castillo, as well as others uncovered more recently in Pendo, Rascaño, Juyo, and Cierro. The Mirón example is the easternmost one, extending the core geographic distribution to still only 60 km long on the east-west axis. There is ambiguity about the <sup>14</sup>C ages of the engraved scapulae from Castillo (at most, 16,850 BP) and Altamira (14,500–15,900 BP), while the Juyo examples are from an undated layer bracketed by levels dated to 14,440 and 15,300 BP. The distinctively striated images of red deer hinds on the scapulae are very similar to images engraved on the walls of Castillo and Altamira. In turn, the parietal engravings in Altamira are overlain by polychrome bison paintings which are AMS-dated to ca. 14,800 BP, indicating an earlier age for the engravings, in line with a 15–16 kya age for the scapulae. The implication is that engravings of red deer hinds with particular stylistic canons, using the striation technique as “shading” to show body relief and musculature, constitute a stylistic marker of a local social entity during the Lower Cantabrian Magdalenian, ca. 15,500 BP.

The Mirón example is significant in its similarity to the Altamira and Castillo images and in its being in a montane site, thereby clearly defining the territory of a possible group of extensively interacting bands as including the coastal zone, the edge of the coastal hills, and the Cantabrian Cordillera. This “territory” was centered within the valleys of four short rivers that descend from the Cordillera to the Bay of Biscay. The scapulae were all discarded as “trash” within dense occupation middens, along with abundant faunal remains (dominated by ibex in the montane sites and red deer in the lowland ones), knapping debris, lithic tools and weapon elements, antler projectile points, and hearth materials. Their “function” remains as enigmatic as that of the very similar striated engravings on the cave walls, but they do seem to serve modern archeology to define a probable forager social territory during the Oldest Dryas phase of the late Last Glacial.

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## **Big and Small Game Diversity Trends in the Southern Levantine Epipaleolithic: Increasing Our Resolution of the Broad Spectrum Revolution**

Aaron Jonas Stutz, *Department of Anthropology, University of Michigan*

Natalie D. Munro, *Department of Anthropology, University of Connecticut*

Guy Bar-Oz, *Laboratory of Archaeozoology, Zinman Institute of Archaeology, University of Haifa*

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Since Flannery's presentation of the Broad Spectrum Revolution model, dynamics in diet breadth have been central to addressing interrelated changes in human population size, foraging returns, and the technology and organization of foraging activity during the late Upper Pleistocene (Stiner 2001). In this paper we analyze terminal Pleistocene taxonomic diversity trends in the southern Levant. We study a time series of eight faunal assemblages spanning the period ca. 19–12 ka, representing the Kebaran, Geometric Kebaran, Early and Late Natufian archaeological cultures. The assemblages are from the Western Galilee/Carmel, Israel, subregion. With geographic control, the study sample provides better chronological coverage of the Epipaleolithic than previously achieved. This provides a unique opportunity to examine temporal change in food resource use in the long term transition to sedentism and agriculture, as we seek to tease apart the impacts of climate change from those of population growth and social/technological dynamics.

We use the Mantel test to evaluate the significance of temporal trends in body-size-based big game diversity, as well as in diversity of small game types. Results demonstrate a highly significant decline through time in the relative abundance of medium and large big game, measured relative to small big game. This suggests that the apparent "gazelle specialization" by Late Epipaleolithic (Natufian) hunters reflects longer-term rising human foraging pressure on the largest prey types in the spectrum. Results also show that large and medium big game abundance varied inversely through time with that of both fast and slow escaping small game.

Considered in the context of associated data on climate change, these results provide substantial new support for the hypothesis that human populations expanded rapidly in size following the Last Glacial Maximum, and that with increased pressure on preferred prey types, human foragers adopted a range of intensification strategies.

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Stiner, M.C. 2001. Thirty Years on the "Broad Spectrum Revolution" and Paleolithic Demography. *Proceedings of the National Academy of Sciences* 98: 6993–6996.

A106  
26 April 2006

## **Zhoukoudian Upper Cave Revisited: A Taphonomic Perspective**

Christopher J. Norton, *Department of Anthropology, Rutgers University*

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This is the first taphonomic analysis of the Zhoukoudian Upper Cave (“ZKD UC”) fauna utilizing current theoretical and methodological taphonomic approaches, and relevant actualistic taphonomic and ethnoarchaeological models. As with many archaeofaunal collections that were excavated before the 1970s, the ZKD UC faunal assemblage suffers from culturally mediated preferential retention of particular skeletal elements. Specifically, many of the difficult-to-identify limb bone fragments appear to have disappeared over time. However, as argued here, a taphonomic study on what remains is still useful. Interpretation of the taphonomic analysis of the ZKD UC archaeofaunal collection indicate that: a) hunter-gatherers played a greater role in the formation of the faunal assemblage than what was originally proposed; b) signs for an expanded hunter-gatherer diet breadth during the Late Paleolithic are present; c) evidence for successful cervid hunting appears to be present, despite the biased nature of the archaeofaunal collection; and, d) the proposed human burials may be more complicated than originally proposed.

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A106  
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## **Excavations at Yuchnyan Cave (Hunan Province, PRC)—A Late Pleistocene Site**

Yuan, J., *Institute of Archaeology, Hunan*

Bar-Yosef, O., *Harvard University*

Boaretto, E., *Weizmann Institute of Science*

Goldberg, P., *Boston University*

Gu H., *Institute of Archaeology, Hunan*

Jiao, T., *Bishop Museum, Hawaii*

Li, S., *Beijing University*

Weiner, S., *Weizmann Institute of Science*

Wu, X., *Beijing University*

Zang, W., *Beijing University*

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Yuchanyan Cave is a karstic cavity in Dao County in southern Hunan. Its chamber is about 15 meters wide and 10–12 meters deep. The first excavations in 1993 and 1995 were conducted by J. Yuan. The stratified 1.2–1.8 m thick deposits contained stone artifacts, a rich faunal assemblage, remains of two pots, and two rice husks. The latter were identified by Zang W. as wild rice, perhaps cultivated. Phytolith analysis supported the presence of the rice family (Oryzoideae). Among the stone tools we note several adzes, without polishing, shaped by percussion as well as choppers, heavy duty scrapers, and flakes. There were also a few bone and shell tools and perforated deer and carnivore teeth that were used as elements of ornamentation. One of the two pots was reconstructed as a deep conical vessel. The fauna contained 28 species of mammals, mainly deer species, wild boar, with rare wild cattle and bear, as well as various carnivores, and numerous bird species. Edible land snails (*Viviparus* sp.) are common in the deposits together with a few aquatic shells (*Unio* sp.). Recent excavations (2004–5) confirmed the results of the original field operations. A major portion of the cave stratigraphy accumulated as lenses of ashes, with a few examples of red soil lenses brought-in from outside, probably to serve as a base for cooking. Wood charcoal and bone samples processed and dated by the Weizmann Institute and the Radiocarbon Laboratory of Beijing University, indicate that the pottery remains date to ca. 16.5–15.2 cal B.P. thus supporting previous reports from East Asia concerning the antiquity of ceramic production. The upper part of the ashy complex dates to 14.5–14.0 Ka cal B.P. and the cave was abandoned by the prehistoric foragers just before or during the onset of the Younger Dryas.

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