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Determining early hominid habitats in the Middle Awash Valley, Ethiopia, using paleosol stable isotopes

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The rich hominid fossil record in the Middle Awash region of the Afar Rift of Ethiopia spans the Late Miocene to Pleistocene. Associated fossils and sediments can be used to investigate fundamental questions about the environmental contexts of early hominids. Paleosol (fossil soil) carbonate and organic matter carbon isotope ratios provide direct, quantitative evidence for floral microhabitat composition, specifically the proportions of trees to grasses. Pedogenic carbonate oxygen isotope ratios are influenced by several factors, including temperature, humidity, evapotranspiration, elevation, proximity to oceans, and global ice volume (Cerling 1984). Paleosol carbonates were analyzed from twelve localities associated with early hominid fossil horizons along the western margin and rift floor of the Middle Awash. Samples from Late Miocene sites (5.8-5.2 Myr) associated with *Ardipithecus ramidus kadabba* (Haile-Selassie 2001) have the lowest $\delta^{13}C$ and $\delta^{18}O$ values, reflecting grassy woodland to closed woodland habitats (WoldeGabriel *et al.* 2001). Woodland habitats persisted until at least 3.8 Myr. Samples from Late Pliocene sites (2.5 Myr) associated with *Australopithecus garhi* (de Heinzelin *et al.* 1999) have intermediate values, reflecting a mosaic of grassy woodland and wooded grassland microhabitats. Early Pleistocene sites associated with *Homo erectus* (1.0 Myr) (Asfaw *et al.* 2002), and late Pleistocene sites associated with an advanced Acheulean industry (0.3 Myr) (Schick and Clark 2000) have the highest carbon and oxygen isotope ratios, reflecting predominantly lightly wooded to open dry grasslands.

Oxygen isotope ratios increase by approximately 18‰ from the Late Miocene to the Pleistocene, reflecting local increases in temperature, decreases in humidity and increased global ice volumes. The high magnitude of this shift suggests decreased elevation, caused by subsidence of the Afar Rift Valley, contributed to the high rate of increase in $\delta^{18}O$ values through time.

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An assessment of patterns of geographic variation in the frontal bone morphology of Middle Pleistocene *Homo*

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This study examines the predictions embodied in competing models of the evolutionary history of Middle Pleistocene *Homo* through a detailed analysis of geographical variation in frontal bone morphology. Evidence that geographically proximate populations are morphologically more similar and those further apart are more dissimilar would lend support to a clinal model of variation. A significant correlation between lower morphological and geographic distance classes but not among higher ones would suggest that isolation-by-distance and multiple dispersals are likely sources of craniofacial variation among these populations. A final alternative hypothesis sees variation as the product of cladogenesis and thus significant at the species level, whereby no geographic patterning in the distribution of morphological features would be observed.

Six sagittal, parasagittal and coronal outlines of the frontal bone were collected on forty-five Early, Middle and Late Pleistocene fossils. These outlines were quantified using Elliptical Fourier Analysis. The amplitude measurements were reduced using principal components analysis and a Euclidean distance matrix was calculated. A geographic distance matrix was then constructed using pairwise sets of fossils. These matrices were compared using Mantel's test to determine if morphological distance was significantly correlated with geographic distance. A second analysis on the original principal components scores, using Moran's spatially autocorrelated *I* statistic, was used to determine if these variables at various geographic locations were significantly different, and what the pattern of those differences was. This analysis indicates that there is no significant correlation between the degree of morphological differentiation and the geographic distance of these fossils, thus failing to support a model of clinal patterning in the observed variability. However, morphological differences are consistently smaller between specimens within the same or neighboring regions. Thus, an explanation proposing a high degree of cladogenesis among these fossils is also not a supported. These results suggest that isolation-by-distance is a likely source of craniofacial variation among Middle Pleistocene *Homo*. This would be consistent with a scenario proposing low population densities and multidirectional dispersal patterns among the groups of this time period

Environmental context and taphonomy of the A.L. 333 Locality, Hadar, Ethiopia

The Lower Beds at Olduvai Gorge are well known for their content of early hominid fossils and Oldowan stone tools, and their ages have been established by 39Ar/40Ar method and paleomagnetic stratigraphy. Ages are generally less certain for the upper deposits at Olduvai Gorge because of the scarcity of datable tuffs. The youngest archaeologically significant site at Olduvai is the type section of the Naisiusiu beds. Excavated by the Leakeys in the 19060's and 1970's, these beds contain microlithic tools suggestive of the LSA. Previous efforts to date the site are inconclusive, with C-14 dates of 17.000-17,550 (Hay, 1976) and >42,000 BP (Manega, 1993). The tuff bed in the zone with artifacts is reworked material and therefore not datable by 39Ar/40Ar, so some other dating method was needed. In the summer of 2001, five equid teeth were collected from the type Naisiusiu site. Another tooth had been previously collected. ESR ages have been determined for four of these teeth and, assuming linear uranium uptake, cluster around 60 ± 10 ka. These dates are considerably older than previous estimates and suggest an early MSA/LSA transition in East Africa.

New Chemical Evidence of Australopithecine Diets

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Over the past decade, stable isotope studies have demonstrated that South African australopithecines ingested significant quantities of C_4 resources. As these resources are not consumed to a significant extent by *Pan*, *Gorilla*, or *Pongo*, this suggests a considerable broadening of the ancestral C_3 resource base by australopithecines. Unfortunately, however, stable carbon isotopes alone do not allow us to distinguish between the consumption of a variety of C_4 foods (tropical grasses, sedges, or animals eating these foods). Nonetheless, other lines of evidence have recently pointed to termites and sedges as possible C_4 sources. The purpose of this paper is three-fold. Firstly, we present data from new stable isotope analyses of 19 australopithecines, effectively doubling the published sample size. Secondly, we present the first Sr/Ca data for *A. africanus* and its associated fauna. Lastly, we discuss the possibility of termite- and sedge-consuming hominids in light of new data on the isotopic and elemental compositions of these foods in Kruger National Park, South Africa.

Red deer hunting by Middle and Upper Paleolithic hominids from western

Europe

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Fossil hominid morphology, archaeology, and genetics indicate that in Europe 30,000-40,000 years ago, anatomically modern humans and their Upper Paleolithic industries replaced Neandertals and their Middle Paleolithic tools. Neandertals had thrived for hundreds of thousands of years, so why were they replaced? One possibility is that modern humans were able to extract more resources from the environment. I tested this explanation by assessing variation present in ancient hunting practices and by investigating the relationship between Late Pleistocene hominids, tool industries, and hunting. I examined the hunting of one species, red deer (*Cervus elaphus*), through time and across space using prey age-at-death as an indicator of hunting strategy. Using data collected on fossil samples from France and northern Spain, I reconstructed age distributions using three methods: histograms, boxplots of median crown heights, and modified triangular plots, and two tooth combinations: dp4/p4 and dp4/m1. Two samples served as comparative baselines: a sample of *C. elaphus* killed by modern hunters in western Montana and a sample of *C. elaphus* hunted by wolves reintroduced into Yellowstone National Park, Wyoming. The mortality distributions of these two modern samples differ dramatically; the wolf-kill sample contains more juvenile and old individuals, while the hunter-kill sample has more young adults. My results show that Neandertals and modern humans did not differ significantly in their ability to hunt prime-age red deer. None of the mortality distributions from the archaeological samples resemble the distribution constructed from the wolf-kill sample. Nevertheless, the samples included in this study show a shift in prey age-at-death during the Middle Paleolithic approximately 50,000 years ago. Young adult prey are more abundant in recent assemblages than in more ancient assemblages. Over 25 archaeological samples from western Europe contribute to these conclusions, making this study the most comprehensive study of Pleistocene hunting to date.

Preliminary results on subsistence and technology of the initial Upper Paleolithic and Ahmarian at Üçağizli Cave (Hatay, Turkey)

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Üçağızlı Cave on the Hatay (Mediterranean) coast of Turkey preserves a technological and faunal sequence spanning the Initial Upper Paleolithic (>41,000 radiocarbon years BP) through Ahmarian (ca., 30,000 years BP), along with an early Epipaleolithic component (Kuhn et al. 1999; 2001). Excellent preservation at the site provides a unique perspective on foraging and technology in the Levantine early Upper Paleolithic, otherwise known almost exclusively from stone tools. Nine major cultural layers have been identified. Formal bone tools and marine shell ornaments occur throughout the sequence. The diverse contents of the cultural deposits indicate use of the site as a residential camp throughout its occupation history; there are large quantities of stone tools, ornaments, bone and antler implements,

cobble grinding stones and anvils, food debris in the forms of broken bones and shell, hearths and ash dumps, and, in an upper Ahmarian layer, a large rock alignment. The shelter's position adjacent to the mouth of a high-walled, narrow valley would have presented considerable advantages for hunting roe deer, fallow deer, wild goat, and other ungulates. Throughout the sequence there was heavy emphasis on scraping tools, scraping and defleshing of prey, "through-bone" methods of carcass dismemberment, and extensive use of fire, possibly for smoking meat. These patterns, along with the predominance of large and medium game among the fauna, indicate a continuous focus on ungulate hunting and processing at this locality, irrespective of culture complex. Increases in dietary breadth are evidenced with time, independent of climate-induced shifts in prey species representation. The changes in diet breadth may also be associated with more increasingly prolonged occupations of the site.

Stone tools and the brain: the neural substrates of Mode I knapping skill as revealed by Positron Emission Tomography (PET)

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Attempts to understand the implications of early stone tools with respect to hominid psychological and brain evolution have long suffered from a scarcity of hard evidence regarding the actual neural substrates of stone toolmaking skill. Functional brain imaging studies using Positron Emission Tomography (PET) are now beginning to readdress this problem by providing a new avenue of experimental inquiry for human origins researchers. The research presented here follows a previously published pilot study (Stout *et al.* 2000; *JAS* 27: 1215-1223) in using PET to identify the regions of the brain that display increased activity during Mode I (Oldowan-style) flake production. Six subjects with no prior knapping experience were imaged under three different experimental conditions: (1) a control condition consisting of simple percussion without flake removal, (2) "novice" knapping, and (3) "experienced" knapping following four hours of practice. Significant knapping-related activations were observed in (1) the primary sensorimotor cortices surrounding the central sulcus, (2) the premotor cortex of the frontal lobe, (3) the polymodal association cortices of the superior parietal lobule, (4) the visual cortices of the occipital lobe, and (5) the cerebellum. These activations reveal the relatively intense visuomotor demands of stone knapping and highlight those regions of the brain that would have been the most likely targets of selection on knapping skill. The pattern of activations observed during experienced knapping is qualitatively similar to that seen in novice knapping, but of lesser intensity. This reflects the increased stability and efficiency of performance that comes with experience. Available evidence does not indicate the recruitment of prefrontal planning and problem solving regions during Mode I flaking, nor show any clear overlap between toolmaking and language processing networks. Results from this PET research have major implications for numerous hypotheses concerning the cognitive and evolutionary implications of early stone tools.

Taphonomic versus ecological factors in the rarity of fossil hominins at Laetoli, Tanzania

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Australopithecus afarensis is a remarkably rare component of the Laetoli fauna, representing less than 0.2% of the mammalian specimens collected. It is important to determine whether this rarity is a reflection of their original representation in the fauna, because this would have implications for understanding their habitat preference and niche specialization. Clues to answering this question come from a closer examination of the hominin remains themselves. The Laetoli sample, compared with that from Hadar, is much more fragmentary, and consists almost exclusively of cranio-dental specimens. A similar pattern is found in cercopithecids, in which postcranials comprise only 8% of specimens. Since the Laetoli fossils are part of a subaerially deposited attritional assemblage with evidence of carnivore activity, the rarity and composition of the hominin remains might be explained as a consequence of carnivore ravaging. To test this hypothesis, we collected data on the representation of cranio-dental and postcranial specimens assigned to seven size classes of ruminants at Laetoli. Ruminants were selected because they are the best represented taxon (53% of all mammal specimens) with a broad range of body sizes (~5-1000 kg). The results show that medium-sized bovids (~25-250 kg) have a much higher proportion of cranio-dental remains relative to postcranials than do small and large-size ruminants. This may be explained as a consequence of more intensive carnivore ravaging of medium-sized bovid carcasses. Larger ruminants, with their more robust skeletal elements, are less likely to be entirely destroyed by carnivore activity, while smaller bovids are more likely to be buried by periodic volcanic ashfalls and so avoid detection by scavenging carnivores. The inferred body size of *A. afarensis* would make it particularly susceptible to destruction by carnivores, and this may be a significant factor in accounting for their low representation in the fauna, and the rarity of their postcranials.

Intraspecific variation of enamal thickness in humans and modern apes, and its significance to the interpretation of fossil hominids

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Enamel thickness has been a feature of some importance in hominoid paleobiology and systematics. A significant amount of research on molar enamel thickness was generated from interest in