Diet, Energy and Evolution

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It has now been over 10 years since the publication of the Expensive Tissue Hypothesis (ETH) (Aiello & Wheeler, 1995, *Current Anthropology* 36: 199–221), which suggested that there was an inverse relationship between the sizes and energetic costs of the brain and the digestive system. A larger brain would require a correspondingly smaller digestive system in order to maintain a BMR (basal metabolic rate) that was not excessively elevated over Kleiber expectations and a smaller digestive system would only be possible with the adoption of a higher quality diet. The original ETH posited that a relatively small gut and implied dietary change were already features of *Homo ergaster* (c.a. 1.6 mya). It also suggested that the inverse relationship between brain size and gut size was a feature not only of humans but also of the other primates. In the reply to the commentaries following the original article it was also stressed that other features, such as flight in birds, might prove to be energetically limiting in species where the size of the brain is not sufficient to represent an energetic challenge. The past decade has seen considerable research into both hominin diet and energetics. Evidence from the archaeological context, dentition, postcranial proportions and morphology, carnivore guild turnover, and hominin tapeworm genetics are consistent with the incorporation of increased amounts of animal-derived food in the diet of early members of the genus *Homo*. Research testing the broader implications of the ETH has demonstrated a robust positive correlation between dietary quality and brain size in primates but has also suggested that dietary change may not have been the sole factor that balances the energetic expense of the hominin large brain. How valid is the ETH today? In the context of this new research, the applicability of the ETH to hominin evolution is reassessed.

Paleoanthropological Research at Dikika, Ethiopia, and Comparative Morphology of the Juvenile Hominin from DIK-1

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The Dikika Research Project (DRP) had been working at Dikika, Ethiopia since 1999. Among the many paleontological discoveries is a remarkably preserved partial skeleton of a juvenile *Australopithecus afarensis* (DIK-1-1 also nicknamed "Selam") recovered at the Locality DIK-1 between 2000 and 2003. The ca. three-year-old presumed female comes from sediments ca. 3.3 Ma in age and represents the earliest and most complete juvenile fossil ever found. The find consists of the whole skull, with a natural brain endocast, the entire rib cage, hand phalanges, distal end of the right humerus, both knees, and an almost complete foot. Also included are skeletal parts that were previously little known from the early part of the hominin fossil record, including the hyoid bone and the shoulder blades. The Dikika girl documents, for the first time, the complete skull morphology of juvenile *Australopithecus afarensis*, as well as an early hominin older than 3 million years. The femora, the tibiae, and the foot preserve evidence that this ancient species walked upright even at the age of three. However the two shoulder blades share shape similarities to those of gorillas. The fingers also are long and curved, as seen in other *Australopithecus afarensis* specimens, raising some questions concerning the role of arboreality in this species. Among the rare finds is the hyoid bone. Its morphology in the Dikika girl is similar to that of African great apes and different from that of humans. The scientific significance of the new find is manifold, contributing substantially to our understanding of the morphology, body plan, behavior, movement, and developmental patterns of our early ancestors. After full cleaning and preparation of the fossil we will be able to reconstruct, for the first time, much of an entire body of a 3 year-old *Australopithecus afarensis* child.

Hominin Use of Springs and a Groundwater-Fed Wetland: The Archaeological Record from Olduvai Gorge, Tanzania (1.80-1.75 Ma)

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Paleoclimate records during the last 7 myr of hominin evolution point to general cooling and drying of global climate. Superimposed on these trends are climate oscillations (Milankovitch) which in low latitudes are dominated by the 21 kyr precession cycle. Rhythmic variability of the monsoon system in the tropics produces wet periods that last up to 5,000 yrs followed by a transition into long dry periods lasting ~5,000 yrs. Rivers shift from perennial to ephemeral, lakes from fresh to saline, but groundwater-fed resources are less affected because aquifers are shielded from surface evaporation effects. Paleoenvironmental analysis of sedimentary records from

32 excavations from Lowermost Bed II (LMB II), Olduvai Gorge, revealed that two lake cycles occurred between 1.80-1.75 Ma. High-resolution stratigraphic analysis documented a spring-fed wetland complex (~1 km^2) that flourished during low lake levels (dry period) and was drowned during high lake levels (wet period). A switch from wet to dry conditions likely altered surface and groundwater systems affecting food and potable water availability, forcing hominins to adjust their subsistence patterns. In theory, lithic artifact distributional patterns more likely result from hominin behavioral processes than random ones and should reflect the distribution and availability of critical resources in the context of their use. Analysis of behaviorally diagnostic assemblage characteristics was conducted on a sample recovered from 13 excavations representing alluvial fan, spring/wetland, and lake margin environments. Distinct and different patterns of artifact frequency, raw material diversity (Naibor Soit quartzite vs. Sadiman lava), and technological diversity are evident in both wet periods and dry periods. In one case up to a 64 % increase in artifact frequency occurred during a dry period. These data suggest that Oldowan hominins adapted their land-use patterns to exploit spring/wetland resources available during dry periods.

Allometric Scaling of Craniofacial Shape: Implications for the Liang Bua Hominins

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There has been considerable controversy concerning the taxonomy and evolutionary history of the hominin fossils recovered from the Indonesian island of Flores. One hypothesis is that these individuals were the result of insular dwarfing of *H. erectus* or a small bodied and as yet unknown hominin from the Asian mainland (e.g., Brown et al. 2004). Alternatively, some have claimed that LB 1 is a microcephalic modern human. This study will take a new approach to investigating the affinities of the Flores hominins by focusing on the three dimensional shape of the LB 1 craniofacial skeleton. To address the possibility of dwarfing in the evolutionary history of the Flores hominins, we also examined allometric scaling of craniofacial shape within the African apes and humans. As a first step, generalized Procrustes analysis was performed and principal components analysis (PCA) was used to explore the shape of the LB 1 neurocranium within a broad range of specimens representing both fossil and extant *Homo* species using geometric morphometric techniques. PCA indicated that the shape of the neurocranium was aligned most closely with *H. erectus*. A landmark set which also incorporated facial landmarks again showed similarities with *H. erectus*, particularly Asian *H. erectus*, but also with modern humans. The second set of analyses occurred in size-shape space, which, in addition to the Procrustes shape coordinates, also includes the logarithm of centroid size as an additional variable (Mitteroecker 2004). By performing a PCA in size-shape space, we were also able to explore allometric patterns within and between *Gorilla*, *Pan*, and *Homo*. While the apes, modern humans, and archaic *Homo* all have separate trajectories, their slopes are quite similar. The position of LB 1 in size-shape space is compatible with its interpretation as a scaled down version of an archaic *Homo* species.

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Dietary Reconstructions of the Middle and Late Miocene Ungulate Communities in the Siwaliks, Pakistan

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Ecomorphological analyses of fossil assemblages, involving dietary, locomotion, and size analyses of species making up paleocommunities are used as proxies to reconstruct paleohabitats. Various paleodietary techniques can capture behaviors of taxa at different phases in the life of an individual. Morphological cranial measurements can be used to discriminate between dietary adaptations of taxa on an evolutionary time scale. Mesowear (which measures the height and shape of upper molar cusps) is correlated with diet averaged over the last several months of life. Dental microwear records the pattern of microscopic pits, scratches, and gouges generated by mastication activity on the occlusal facies of teeth during the last days of life. Stable carbon isotopes sampled from tooth enamel reflect the diet of the individual during the time of enamel deposition. A species-by-species comparison of paleodietary reconstructions obtained by several methods should provide considerably more dietary resolution than single methods and also test the strengths and weaknesses of each specific method. In the Miocene Siwalik record from Pakistan, isotope evidence from paleosol carbonates indicates an expansion in C_4 grasses after 8 Ma and the local extinctions of *Sivapithecus* and other forest-dependent taxa. Dietary preferences of the ungulate communities using microwear and stable isotope data have been shown to differ between 15–7 Ma, before and after the

expansion of C_4 grasses. Mesowear analysis and mandibular measurements were recorded on a suite of common Siwalik ungulate taxa including bovids, tragulids, giraffids, and equids dated before and after 8 Ma. Results are compared to published microwear and stable carbon isotope data. Preliminary data suggest that the dietary reconstruction obtained for some taxa as well as the observation of change in diet after 8 Ma may be discordant between the four methods. This study illustrates the importance of using multiple proxies in paleodietary and paleoecological analyses.

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Preliminary Results from Paleolithic Sites on the Red Sea Coast of Eritrea

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This paper reports results of recent fieldwork in the Gulf of Zula and Buri Peninsula (Red Sea Coast) of Eritrea. Three sites were investigated, Asfet, Gelalo NW, and Misse East. Located on the southwest coast of the Gulf of Zula, Asfet is a multi-component site characterized by high diversity of raw materials and artifact types that could be attributed mainly to Earlier and Middle Stone Age industries. The Gelalo NW and Misse East sites are both located on the Buri Peninsula. Both sites revealed artifact types distinctive of the Later Stone Age tradition, namely backed blades and flakes. The research involved systematic survey, geological and topographic mapping, surface collection, and test excavations. Test excavations at Asfet, Gelalo NW, and Misse East uncovered lithic artifacts and shells in close association on the surface and in the sub-surface, suggesting human exploitation of coastal-marine resources. The chronological placement of the sites and their implications for models of Paleolithic coastal adaptations and human dispersals will be discussed.

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Qaleh Bozi: A Middle Paleolithic Industry with Bifacial Tools from Central Iran

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The majority of known Middle Paleolithic industries of southwest Asia lack bifacial tools such as foliate points. The only known assemblages with such bifacial tools are those reported from eastern Arabian peninsula. Because Mousterian industries rich in bifacial tools are present in some of the neighboring regions, such as southeastern Europe, northern Caucasus, and Central Asia, the relative absence of Mousterian bifacial industries in southwest Asia is rather puzzling. The recent discovery of a Middle Paleolithic bifacial industry in central Iran indicates an expansion of Mousterian bifacial tradition into the Central Plateau of Iran. Until the discovery of this new industry, the major Iranian Middle Paleolithic assemblages were known as Zagros Mousterian, an industry characterized by heavy reduction and utilization and high frequencies of heavily retouched tools. The recently discovered industry is found in a cluster of Middle Paleolithic cave and rockshelters some 25 km SSW of Isfahan. Qaleh Bozi sites were initially studied in 2004 by a team of geologists from University of Isfahan and later in 2005 by a joint ICHTO-University of Isfahan team. During the 2005 field season, we began removing and screening the disturbed deposits on the floor of the largest site, Qaleh Bozi 2. These deposits proved to be rich in well-preserved and diverse macro- and micro-vertebrate remains and more than 2,000 lithic artifacts, mostly in fresh condition. We also made a small stratigraphic cut at the site and opened a test pit in the smaller rockshelter of Qaleh Bozi 3. The industry is essentially made of good quality chert in the form of small rounded pebbles from the nearby Zayandeh-Rud River. The presence of bifacially shaped tools, especially foliate points, and some other aspects of the industry, such as relative absence of Levallois technique, sharply distinguish Qaleh Bozi from other Iranian Mousterian finds.

Fossil Fauna from the Luangwa Valley, Zambia

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The Luangwa rift valley in eastern Zambia has yielded artefacts from all major stages of the African Stone Age as well as the distinctive geometric rock art of central Africa. Unlike the northeastern extent of the East African Rift system of which the Luangwa is a part, this area of Zambia is not tectonically active. This both limits the application of radiometric dating and restricts the extent to which artefacts and fossils are exposed. In situ archaeological localities are currently being discovered and excavated throughout the region.

An extensive fossil fauna has also been recovered from the valley, but unlike the in situ artefacts, fossil bones and teeth have come primarily from point bars exposed seasonally along the banks of the rivers in the valley. Numerous specimens collected since 1999 were studied during the 2006 field season and identified to taxon to reconstruct palaeoenvironments and biochronology. Fossils mammals from a relatively wide range of taxa were identified, including *Loxodonta*, *Diceros*, *Hippopotamus*, several species of bovid, *Phacochoerus*, *Potamochoerus*, and *Equus*. A single fossil hominin talus was recovered. No extinct species were positively identified, with the exception of the femur of an extinct *Theropithecus* reported in 2003. No further extinct taxa were found, however, some modern species were recovered which are not known today from this region. This suggests a Middle Pleistocene or later date for the majority of this assemblage, and potentially that a different combination of habitats have been present in the region. Additional investigations include non-destructive x-ray fluorescence analysis of the fossils' chemical signatures to determine whether they derive from one or many primary contexts, and the relation between chemical signature and state of preservation. Hydrodynamic studies of the fossils may also shed light on their provenance, suggesting the extent of transport before their recovery.

ESR Dates for the Neanderthal Layer at La Ferrassie, France

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From 1902–1923, Peyrony and Capitan excavated at La Ferrassie, France. Among the finds were seven Neanderthal skeletons interpreted to represent a cemetery. This site has yielded the largest well preserved collection of penecontemporaneous Neanderthals from Europe. La Ferrassie is often used as the "typical" Neanderthal. The large associated lithic collection was defined by Bordes to be the type for the Ferrassie variant of the Mousterian. Attempts to match Peyrony's profile with the witness section some 16m away have proven controversial. Because the area around the skeletal material was excavated completely, and part of the pit later filled in to enable tours to visit the site, no modern dates have ever been attempted for the layers which housed the skeletons. The rock shelter at La Ferrassie contains a series of matrix- and clast-supported conglomerates deposited at the edge of a karst escarpment. When occupied, it would have been at least partially covered by a limestone overhang. Photos from the excavation show the skeletons surrounded by large amounts of éboulis pebbles. The site report listed *Rangifer*, large bovids, and cervids in the layer which housed the skeletons. Two bovid teeth discovered in the AMNH collections from 1912 must have come from within 2 m of the adult skeletons and from the layer which yielded the skeletons. These two teeth were dated using standard and isochron ESR. The teeth show less than 1 ppm U in the enamel and 3–5 ppm U in the dentine. Accumulated doses for the two teeth average 18.5±0.2 Gy and 22.1±0.5 Gy. Assuming 30–60% éboulis in the sediment around these teeth gives ages that correlate well with OIS 3.

Faunal Context of the Pliocene Dikika Locality, Hadar Formation, Ethiopia

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The Pliocene site of Dikika, Ethiopia, is yielding important new fossil hominins that contribute to our understanding of early human adaptation and evolution. The vertebrate fauna provides critical evidence of the environmental and ecological context of these Pliocene hominins. At Dikika we have conducted systematic surveys and collection of fossil specimens with a methodology designed to obtain the most valuable paleoenvironmental information from the fauna. Thus far about 250 fossil vertebrates have been collected from at least 30 different taxa. The biochronology of locality DIK-1 is consistent with radiometric estimates of ~3.3 Ma, but the fauna documents an important stage in the evolution of the Hadar Formation mammals. The DIK-1 fauna is more primitive than that from overlying levels in the co-existence of *Elephas ekorensis* and a primitive stage of *E. recki*, the smaller size of *Hipparion* specimens and of *Kolpochoerus afarensis* third molars, and by the large size of *Notochoerus* premolars. In terms of paleoenvironments, the presence of permanent water at the site is amply demonstrated by the abundance of hippopotamids and crocodiles. Wooded conditions are suggested by *Ugandax*, a bovid thought to have occupied forested environments. Impalas are the most common antelopes at Dikika, as they are in equivalent levels in the Hadar area (SH1), a fact that is consistent with the prevalence of C_3 vegetation indicated by paleosol carbonates. However, the high abundance of Alcelaphini (wildebeest relatives) and of the rhinocerotid *Ceratotherium*, in addition to the large number of elephants, suggests that open grasslands were an important part of the Dikika paleolandscape. The vertebrate fauna therefore indicates mixed but mesic habitats during the time around 3.3 Ma. Although the fossil vertebrate surveys have focused on narrow stratigraphic intervals, further work is needed to determine the extent of time averaging represented by the documented fauna.

Oldowan Behavior and Paleoecology: Analysis and Excavations from FwJj20, Il Dura, Kenya

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The archaeological record of Pliocene hominins is derived from a small number of localities in Africa. Evidence of behavior from stone artifacts and fossil bones that have been modified by hominins are rarely found in situ in late Pliocene deposits. Here we present data and findings from our most recent excavations and analyses of FwJj 20 in the Upper Burgi Member (1.9–2.0 Ma) of the Koobi Fora Formation, northern Kenya. New excavations have recovered an assemblage that is among the largest stone artifact and zooarchaeological assemblages from the Pliocene. Stone artifact analysis is combined with geological and geochemical provenience data to provide information on hominin transport and discard behaviors at FwJj 20. Patterns of artifact use and discard of specific raw materials points to selection behaviors that have been shown at other Pliocene archaeological sites. Technological analyses suggest that hominins at FwJj 20 are not following patterns of core reduction reported from other Pliocene Oldowan localities. Zooarchaeological analyses suggest variability in patterns of Oldowan hominin large mammal acquisition during the late Pliocene. We make comparisons with other Pliocene localities with evidence of hominin butchery. A range of taxa from various size classes show evidence of modification by hominins. Paleoecological data from paleontological and isotopic analyses provides a rich context for the behaviors at the site. Continued investigations into the geological context of the site provide a higher resolution understanding of the landscape dynamics in the Il Dura region. Continuing investigations at FwJj 20 underscores the variability that characterizes the Oldowan archaeological record. Various paleoecological and paleogeographic studies associated with the archaeological analyses at FwJj20 underscores the importance of contextual factors for understanding the behaviors of Pliocene hominins.

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After the Acheulean: Stratigraphy, Dating, and Archeology of Two New Formations in the Olorgesailie Basin, Southern Kenya Rift

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Since the 1940s the Olorgesailie basin in the southern Kenya Rift Valley has been explored and excavated for its rich assemblages of Acheulean artifacts, associated fossilized remains of mid-Pleistocene faunas, including a hominin similar to *Homo erectus*, and its finely calibrated depositional history of environmental change. This record characterizes the Olorgesailie Formation, which spans the interval from ca. 1.20 to 0.49 Ma. Recent work by the authors since 2001 has uncovered evidence of two later formations—the Olkesiteti (OK) and the Oltepesi (OT)—which together span the period from ca. 490 to 64 ka. These two formations represent multiple cycles of valley cutting and filling with fluvial, volcaniclastic, and lacustrine sediments. The superimposed deposits of these valley fills preserve a succession of archeological sites, with interstratified volcaniclastic units providing absolute age control. The OK Formation sites document the transition from the Acheulean to the Middle Stone Age, and the OK and OT materials together illustrate the development of new adaptive strategies within the Middle Stone Age itself, calling into question again the validity of this catch-all designation. This paper will describe the new formations, their depositional regimes, the innovative dating program used to calibrate them, and initial results from a series of ten excavated archeological sites, most of which are in the earlier part of the sequence. These results document a strong contrast with the Acheulean in the increasing use of Levallois technologies and exotic raw materials through time, suggesting more complex social and technological adaptations.

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Ungulate Mortality Patterns at FLK Zinj and Their Behavioral Implications

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Taphonomic analyses of skeletal profiles and butchery patterns in the FLK Zinj (FLKZ) archaeofauna reveal an abundance of the very skeletal elements (meaty upper limb bones and mandibles) that large carnivores consume or remove quickly and an abundance

of defleshing cut marks on those same meaty bones. From a behavioral perspective, a chronic disagreement lingers regarding reconstructions of how hominins procured carcasses and what portions they ate. Possible alternatives include hunting, power scavenging, passive scavenging from abandoned carnivore kills, and passive scavenging from attritional deaths (other than predation). How might mortality data on ungulates butchered at FLKZ contribute to an understanding of the foraging capabilities of early *Homo*? Mortality data from FLKZ are presented and compared to other Oldowan sites and to modern carnivore field studies by Schaller and Kruuk in the Serengeti. Although the FLKZ bone assemblage is large relative to other Oldowan samples, the diverse mammalian minimum number of individuals (MNI) of 48 is small for purposes of mortality pattern recognition. Bovidae in four size groups and nine species comprise an MNI of 29. Tooth eruption and occlusal wear criteria were recorded using a four-age system (neonate, subadult, prime adult, and old adult). Results are presented according to that format and, by combining the juvenile classes, according to the three-age system of Stiner. Pooling the FLKZ data combines taxa and size groups but maximizes sample size, revealing an abundance of prime adults and defining FLKZ as a living structure (or catastrophic) pattern, not a U-shaped (or attritional) pattern. Ambush predation produced FLKZ with *Homo* as hunter or power scavenger. Cursorial predation is contradicted, with *Homo* as either the endurance running hunter or a scavenger of such kills. Analyzing subsets of FLKZ by taxon or size group reveals some prime-dominated patterns and may indicate selective hunting by *Homo*.

Spatial and Temporal Patterns of *Australopithecus afarensis* Habitats at Hadar, Ethiopia

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Australopithecus afarensis has long been suggested to have existed in a mosaic of habitats. While a broad reconstruction of the Hadar paleolandscape may be described as a woodland mosaic, such a generalization masks important differences in the distribution of habitats through time and across space. Analyses of the Hadar faunal assemblages using multiple methodologies indicate that a range of habitats were available to *A. afarensis* including open and closed woodlands, gallery forests, edaphic grasslands, and shrublands. Some of the variation observed in these faunal communities can be explained by the spatial distribution of fauna across the landscape, as well as by the depositional environments with which they are associated. Although there is no clear directional trend observed in habitats through time, the faunal assemblages indicate slightly more xeric conditions beginning around 3.2 Ma. This is followed by a distinct faunal turnover that denotes a greater ecological change at 3.0 Ma with evidence of an influx of more arid adapted taxa. This shift may be related to a change in seasonal patterns, particularly an increase in the number of dry season months. Tests of association between *A. afarensis* and other taxa, as well as the spatial distribution of *A. afarensis* across the paleolandscape, provide little evidence to suggest a habitat preference for the early hominin. Despite its relatively low overall abundance compared with other taxa, *A. afarensis* is persistent throughout the half million years of environmental and climatic shifts recorded at Hadar. This implies a eurytopic adaptation for this hominin, but other evidence suggests it was not necessarily eurytrophic. Unfortunately, attempting to identify causes of the extinction for *A. afarensis* at Hadar, as well as its true LAD in the region, is complicated by the lack of strata preserved between roughly 2.7–2.9 Ma as represented by a regional disconformity.

Assessing Adult Age at Death in Neandertal Dental Remains: Preliminary Applications of a New Approach Using Three Dimensional Micro-Computed Tomography

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Changes in the age structure of populations across the Middle/Upper Paleolithic transition have important implications for understanding the origin and success of modern humans. Previous work using large dental samples has suggested increases in older adult survivorship associated with this transition, but the details of these changes (how old individuals live to be) are unclear because of the low resolution of dental age estimates for older adults. The Gustafson dental criteria, frequently used for age estimation of human teeth in forensic and archeological contexts, are considered among the most reliable methods for ageing older adults. These criteria include attrition, secondary dentin deposition, root resorption, gingival regression, root transparency, and cementum apposition. However, the most accurate of these are destructive and/or difficult to measure in archeological material and have not been applied to fossils. Our preliminary research indicates that some of these criteria can be observed and measured using micro computed tomography (mCT), and may provide a new, more accurate and non-destructive approach for assessing age in fossil hominids. In this paper, we present some results of our preliminary work on mCT ageing using an anatomical sample of modern teeth and the Krapina Neandertal fossils for which ages at death have been previously estimated by different workers using variants of the Miles method. The Krapina teeth were scanned in Zagreb on a Digisens mCT system, and the modern sample in Ann Arbor on a GE Healthcare Biosciences mCT system. In this analysis of upper and lower canines, the methodology used to quantify secondary dentin deposition and attrition is developed and the relationships between these variables and their relationship to age is assessed. In both samples the variables are highly correlated and associated with independent estimates of ages at death.

Drill Core Records of Early Late Pleistocene Megadrought in Tropical Africa: Ecological Consequences and Implications for Early Modern Human Demography

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Recently collected drill core records from Lake Malawi (African rift valley) provide a new, high resolution, continuous record of climate and environmental change for East Africa covering the past ~1.5 million years. Data from lacustrine fossils, sedimentology, sedimentary geochemistry, and watershed-derived plant materials, coupled with reflection seismic data collected prior to drilling, are yielding a coherent picture of periods of extraordinary lake level fluctuations and aridity, far exceeding what has been inferred from the Last Glacial Maximum in the region. At its extreme low stands, Lake Malawi appears to have been converted into a highly saline lake, over 550m shallower than today, and its surrounding watershed experienced desert conditions. Excellent age control demonstrates that these conditions persisted for tens of thousands of years, and occurred multiple times in the lake basin's history. The timing of these low lake stands have profound implications for interpretations of the history of anatomically modern human population bottlenecks, out-of-Africa hypotheses, and our general understanding of environmental history of East Africa during the Pleistocene.

Acknowledgements: NSF and ICDP SEACORE and DOSECC Limnological Research Center, and National Lake COre Repository.

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The Nalzet Khater 2 Paleopathologies: Correlation with Mining Activities During the Early Upper Paleolithic in Egypt

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The Nazlet Khater 2 (NK 2) skeleton, discovered in 1980 in Egypt by the Belgian Middle Egypt Prehistoric Project, is the oldest complete Early Upper Paleolithic modern human from north Africa. Its association with the mining site of Nazlet Khater 4 provides a unique opportunity to understand the osteoarthritis and enthesopathy lesions of this individual within a well-defined archeological context. After we discarded the most frequent enthesopathy and osteoarthritis etiologies, it appears that the multiple lesions of NK 2 express a coercive life style during which this individual was submitted to heavy mechanical stresses. It is possible to discuss the relationship between these bone remodelings and the mining activities on the basis of the archeological context of Nazlet Khater 4 and previous work on mining population samples.

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Hominin Paleoecology and Cervid Ecomorphology

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As the pressures of natural selection stem from the environment, accurate reconstructions of paleoecological conditions are essential for testing hypotheses concerning hominin evolution. At many hominin fossil sites, mammalian remains are among the best preserved paleoecological proxies. Ecomorphological analysis uses these mammalian remains by quantifying functional morphological characteristics and correlating variations in those characteristics to adaptations for specific habitats. Several ecomorphological studies have been conducted on the family Bovidae, but studies utilizing Cervidae ecomorphology are lacking. Furthermore, most studies to date have used linear-based techniques to quantify variation in morphology. This study quantifies aspects of rear-limb ecomorphology of the family Cervidae, often the dominant taxon in Eurasian assemblages, using three-dimensional Geometric Morphometrics (GM). GM allows for improved analysis of functional morphology in that it evaluates a shape as a configuration of 3D coordinates (instead of separate linear or angular measures), and thus information about shape differences as a whole is maintained. This study includes a 3D landmark-based GM analysis of the calcaneus and outline-based GM (elliptical Fourier analysis) of several joint surface margins. Additionally, published (linear) measurements designed for bovid ecomorphology will be presented for cervids, allowing for comparisons between Eurasian and (published) African hominin sites. Further, methods for quantifying muscle scars (which have been previously investigated qualitatively) using standard metrological analyses and area-scale fractal complexity will be introduced. The combined results from these analyses are hypothesized to allow for precise reconstructions of cervid ecomorphology and it is likely that these methods can be extended to bovid ecomorphology. Thus, the methodologies presented here can be used in the reconstruction of paleohabitats from most hominin fossil sites.

A New Investigation of the Taphonomy and Zooarchaeology of Bed II Olduvai Gorge, Tanzania

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This study provides a renewed investigation of the taphonomy and zooarchaeology of the Bed II assemblages from SHK, HWK Levels 3-5, MNK (Main), and BK. Although selectively excavated, SHK appears to have been accumulated by carnivores. HWK also reflects carnivore behavior, with hyenas the likely culprit. Previous interpretations (Monahan 1996) implicated hominids as a major agent of accumulation at MNK (Main). However, this analysis finds that MNK (Main) shows one of the strongest hyena signals of any Olduvai site and, further, that hominids played little or no role in the accumulation. Monahan's (1996) interpretation of BK as a primarily hominid accumulation is partially supported, although a slightly more complicated taphonomic history is suggested here. Overall, this analysis indicates that hyenas were more active in riparian woodlands during Bed II times relative to today (cf. Monahan 1996). This calls into question the riparian woodlands scavenging model (Blumenschine 1986), which is predicated in part on the inference that hyenas would preferentially avoid these habitats. Zooarchaeological data also indicate that Bed II assemblages in general show much stronger hyena signals than many Bed I assemblages, where felid signals are prominent. This probably reflects diachronic changes in trophic dynamics in the Olduvai Basin. An interesting pattern at all but one of the Bed II sites analyzed here arises—stone tools occurring with faunal assemblages that lack hominid-induced surface modifications. This same pattern is documented at many Bed I sites as well. This invites the alternative interpretation that many lithic assemblages from Beds I and II at Olduvai Gorge reflect battering activities not associated with carcass butchery.

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Long Distance Carcass Transport at Olduvai Gorge?

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The relative abundances of skeletal elements in Plio-Pleistocene archaeological sites have long been interpreted to represent selective transport of large prey, perhaps over long distances. Models from optimal foraging theory suggest that the degree of carcass transport selectivity can provide important insight into transport constraints, particularly transport distance. In this study we apply a quantitative method for examining skeletal element abundances to five bone assemblages from Bed I, Olduvai Gorge. Results indicate that within the subset of elements most likely to resist attritional processes, there is no evidence for preferential transport at any of the five study sites. These results are most consistent with site formation models favoring short-distance carcass transport. The patterning in Bed I contrasts strongly with later Middle Stone Age/Middle Paleolithic assemblages which provide clear evidence for highly selective transport, suggesting much longer transport distances.

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Integrated Stratigraphic Approaches: Evolving Perspectives on Time, Facies, and Paleoenvironmental Systems in the Plio-Pleistocene of the Turkana Basin, East Africa

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From the time of Charles Darwin, geological perspectives have played a major role in our understanding of evolutionary patterns and processes, and of their context. New tools and techniques in the geological sciences have augmented basic stratigraphic approaches, and allow for critical elaboration of details in geologic time and space, as well as for testing of relationships, correlations, and models. We report here an example of integrated stratigraphic analysis near the Plio-Pleistocene boundary, and its implications for age constraints on hominin fossils, depositional environments, and paleogeographic reconstructions in the Turkana Basin of East Africa. In the Turkana Basin, the Plio-Pleistocene Boundary (1.806 Ma) falls within a high-resolution stratigraphic interval spanning ca. 1.95–

1.60 Ma, resulting primarily from tectonic and sedimentary interplay. This interval is of considerable interest, with important fossil specimens and significant developments in global climate. Extensive mapping, stratigraphic description, and facies analysis allow a detailed understanding of landscape evolution through this period. Isotopic age constraints establish a solid framework for temporal control. New research, including the application of magnetostratigraphic mapping, architectural analysis, and cyclostratigraphy now present opportunities to go beyond the limits of the established chronostratigraphy. Isotopic studies, biofacies analysis, and pedofacies approaches are developing a clearer picture of habitat character and variability through this interval. Several key observations emerge from the recent work. Tectonic setting, sediment supply, and climatic oscillations are all dynamic components of this interval. Up to 15m of depositional topography can be seen in deltaic settings, comparable to erosional surfaces seen in second- and third-order incision events. Refined facies analysis provides details of depositional subenvironments, and key insights into processes of landscape evolution, habitat succession, and burial events. Recent suggestions of younger ages for Koobi Fora hominins in this interval are precluded by documented stratigraphic relationships.

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Environmental and Methodological Influences on Daily Energy Expenditure in Early Modern *Homo sapiens*

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Estimating daily energy expenditure (DEE) in early modern *Homo sapiens* is important to evaluating their ability to compete for resources with contemporaneous archaic species (e.g., Neanderthals). The factorial method, calculating activity costs as proportional to basal metabolic rate (BMR), is the most common way to estimate DEE in fossil populations, and relies heavily on the accuracy of BMR estimates. Standard BMR equations (FAO/WHO/UNU 1985) may, however, be inappropriate for use with the factorial method, since they do not account for the well-known influence of climate on human BMR. This is important when considering early modern humans moving into an increasingly broad range of habitats. This study estimates BMR and DEE in African and European early modern humans using: (1) the standard method, (2) similar equations based on tropical subjects (Henry and Rees, 1991), and, (3) a new equation including mean-annual-temperature as a BMR predictor. The latter method is considered here to be the most accurate. BMR estimates (kcal/d) for Africa are: (1) 1433, (2) 1346, and (3) 1512; and, for Europe, (1) 1644, (2) 1522, and (3) 1838. Subsequent DEE estimates range from 2288–2570 kcal/d in Africa and 2587–3124 kcal/d in Europe. The magnitude of these discrepancies is important, considering, for example, that gestation and lactation require ~200–500 kcal/d per child. Also, method (3) indicates a larger shift in caloric needs (~550 kcal/d) occurred with colonization of higher latitudes than do the other methods. Finally, the highest DEE estimates (method 3) indicate that early moderns in Europe "saved" ~200–300 kcal/d, even compared to the lowest aggregate estimate of Neanderthal DEE (with greater "savings" accompanying higher proposed Neanderthal DEE). This may support the idea that early moderns had an energetic advantage over Neanderthals, or, alternatively, that the same methods should be used to estimate DEE in both taxa.

Pelvic Rotation and Walking Speed in *Homo* and *Australopithecus*

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Rak (1991) suggested that the exaggerated pelvic and biacetabular breadth seen in *Australopithecus afarensis* was an adaptation to increase stride length without increasing vertical oscillations in a bipedal hominin that had maintained short lower limbs. Pelvic width clearly has the potential to contribute to stride length through rotation of the pelvis, but the extent to which it does so is unclear. To determine this, we undertook a kinematic assessment of pelvic rotation during walking in 27 modern human subjects with a wide range of pelvic breadths and limb lengths. High-speed digital cameras and Motion Analysis gait-analysis software were used to create 3D virtual models of subjects as they walked at their preferred speeds and their fastest walking speeds. The results show that increased stride length and increased velocity are both associated with increased pelvic rotation, and that this relationship is most pronounced in individuals with shorter limbs. These data support Rak's hypothesis. They suggest that a wide pelvis was important in allowing short-legged early hominins to achieve greater stride lengths and higher walking speeds.

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Virtual Restoration of the Fossil Arago 21-47 and Phyletic Position

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A fragment of human skull (Arago 21) was discovered in 1971 in the Arago cave, Tautavel, France, in an archeostratigraphic layer dating from around 450,000 years ago. It corresponds mainly to a face that was fractured and distorded postmortem. A right parietal

bone (Arago 47) and some small fragments of parietal and occipital bones were discovered afterwards. A previous reconstruction of the face and the biparietal vault was carried out in 1981 using mouldings. The missing bones, i.e., the temporal and occipital bones, were replaced by some casts of other hominid fossils. The authors have used three-dimensional virtual reconstruction techniques on the X-ray CT scans of this fossil: i) to propose a brand new virtual restoration of it; and, ii) to study the phyletic position of Arago 21-47 by means of a three-dimensional morphometric analysis. The different fragments of the skull were isolated. Distortions were analysed and compensated. The parts that were missing, like the left parietal bone, or that were too distorted, were obtained by mirroring. All fragments were articulated virtually to reshape the skull. The shape of this Arago 21-47 reconstruction is different from the previous one, particularly the biparietal vault. A 3D modelization was made using a group of landmarks that we called the "Inter-Point Segmentary Complexes." Thanks to a 3D analysis using Procustes and PCA methods, we were able to compare this reconstruction to Middle Pleistocene hominid fossils of Europe, Asia, and Africa. The virtual reconstruction of the Arago 21-47 fossil and its 3D morphometric analysis give information about the phyletic relations between the Middle Pleistocene hominids and the Neandertals in Europe.

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The Mille-Chifra-Kasagita Triangle: A New Hominid-Bearing Early Pliocene Site in the Central Afar Region of Ethiopia

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The Afar Region of Ethiopia is known for its paleontological sites ranging in age from the Holocene to the late Miocene. Some of the sites in this region known for their hominid fossil yield include Hadar, Gona, Middle Awash, and Busidima-Dikika. However, there are still numerous exposures that have not been explored yet for their paleontological potential. The Woranso-Mille project has been conducting paleontological survey and exploration in previously unexplored areas of the Afar region of Ethiopia and has been able to locate new paleontological sites, particularly in the central part of the Afar Rift. The Mille-Chifra-Kasagita Triangle is located in the Zone 1 and Zone 4 administrative areas of the Afar Regional State. The Woranso-Mille Project has concentrated its paleontological survey and exploration efforts in this area since 2004. Fourteen vertebrate paleontological localities of early Pliocene age have been designated and 1,000 vertebrate fossil specimens, representing 25 mammalian taxa, have been collected thus far. The fossil specimens include 24 hominid specimens composed of isolated teeth, partial jaws, postcranial elements, and a partial skeleton found in 2005. The faunal assemblage was biochronologically estimated to between 3.8 and 4 million years. Preliminary radiometric dates have now confirmed a minimum age of 3.8 million years for the hominids and the associated vertebrate taxa. Therefore, this new paleontological area has opened up new venues to acquire new data related to vertebrate evolution in general, and human origins and evolution in particular, by sampling a time frame previously known poorly in the African fossil record. Taxonomic affinity of the hominids from the Woranso-Mille area remains to be determined after a detailed study is conducted. However, given their age, and the number of body elements represented in the partial skeleton, new data is more likely to be generated to understand what early hominids from ca. 3.6–4 million years ago looked like in terms of their overall morphology, body proportions, stature, etc. Moreover, this new hominid collection, once fully curated and studied, is ideal to address questions related to early hominid diversity and to test the proposed hypothesis of anagenetic evolution from *Australopithecus anamensis* to *Australopithecus afarensis*.

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Not by Meat Alone: The Potential Role of Underground Storage Organs in Neandertal Diet

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Neandertals are increasingly being viewed as top carnivores who derived the vast majority of their diet from meat. Much of the support for this hypothesis comes from stable isotope analysis of bone collagen, a technique which tracks the protein portion of the diet only. Diets high in lean meat largely fulfill micronutrient needs but can pose a problem at the macronutrient level. Lean meat can compose no more than 35% of the energy in the diet before a protein ceiling is reached. Diets that exceed this amount of protein can have detrimental physiological effects on the individual. Neandertals would have needed energy from alternative sources, particularly in late fall and winter when fat reserves in animals are depleted and lean meat intake is proportionately high. Underground storage organs (USOs) of plants offer one such alternative energy source, concentrating carbohydrates and providing fiber which would be otherwise lacking in the Neandertal diet. USOs could also provide an important seasonal energy source since they are at their maximum energy storage in late fall/winter. Although Paleolithic sites are increasingly yielding plant remains, their presence is rare and they are often given only passing mention in Neandertal dietary reconstructions. The complexity and number of potential wild plant foods, however, defies easy discussion. A review of native European wild edible plants to determine the potential Neandertal plant menu demonstrates that

high energy starchy USOs would have been potentially available throughout the Neandertal range, even during the coldest periods of the Middle Paleolithic. Important potential food species include *Typha latifolia* (cattail), *Polygonum bistorta* (mountain bistort), *Arctium lappa* (greater burdock), *Sagittaria sagittifolia* (arrowhead), and *Pastinaca sativa* (wild parsnip), among others. This paper details the macronutrient constraints of diet and presents data on the nutritional content of wild USOs and their potential distribution across the Neandertal range.

Hominin Occupation of the Bala Paleoanthropological Research Area, Southern Ethiopia

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In July 2006, exploratory field study was undertaken in the Male Basin west of the Bala River in southern Ethiopia. The area, designated the Bala Paleoanthropological Research Area (BPRA), was targeted for survey because it had not been formally reported and was geographically situated between several important hominin localities. The BPRA is in the Chew Bahir Rift, which is located between the Konso-Gardula Paleoanthropological Area and the Omo River Valley, and northeast of the Turkana Basin. These adjacent areas contain fossil remains of *Homo*, *Paranthropus*, and *Australopithecus*, as well as faunal and stratigraphic data that inform hypotheses about human evolution and the role of the environment. During the initial field season, only a small part of the permit area was explored. Nevertheless, four localities containing high densities of Middle Stone Age to Late Stone Age (Middle and early Upper Pleistocene) artifacts and low to moderate densities of fossil fauna were identified. A potentially earlier locality containing numerous Acheulean tools and some faunal remains was also identified. In large part, these archaeological occurrences and the associated faunal material have not been previously documented. Owing to the presence of multiple, temporally successive stone tool traditions, we conclude that the BPRA contains deposits that are at least as old as the Middle Pleistocene. Further, the area was most likely occupied by multiple species of *Homo*. A volcanic tuff exposed in two project area locales is undergoing geochemical analysis, which may allow for correlation with tuffs from the Turkana Basin, Omo area, and/or Konso-Gardula. These results, as well as the significance of the artifactual and faunal remains will be discussed.

The Partial Cranium from Cioclovina, Romania: Morphological Affinities of an Early Modern European

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The current modern human origins debate centers on the possibility and degree of admixture between indigenous archaic humans and modern human populations migrating out of Africa into Europe and Asia in the Late Pleistocene. Evidence for such admixture must be sought in the earliest fossil record of modern humans outside Africa, as it is those populations that would have encountered, and possibly interbred with, archaic hominins. In the case of Europe, the recent application of direct dating techniques has eliminated several specimens from the Upper Paleolithic fossil record, while confirming early ages for others. Among these earliest reliably dated specimens is the Cioclovina calvaria from Romania. Although this individual is of greatest importance for the understanding of modern human origins in Europe, a detailed morphological study and comparative analysis of this specimen has not been undertaken since its initial description. Nonetheless, the specimen has been implicated in recent discussions on admixture between Neanderthals and the earliest modern Europeans. We conducted a 3D geometric morphometric analysis of the Cioclovina specimen using a large geographic sample of recent humans, Neanderthals, and Late Pleistocene modern humans, in order to establish its phenetic affinities and to evaluate its morphology for evidence of admixture between Neanderthals and early modern Europeans. Our results show Cioclovina to be entirely modern in its overall cranial shape, as well as in details of its morphology, such as the supraorbital and the nuchal regions. Our findings do not support the hypothesis of admixture. They highlight the morphological cohesion of Eurasian early modern humans and their distinctiveness from recent human groups.

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What Were They Doing in the Oldowan: An Ethnoarchaeological Perspective from Australia

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There are diametrically opposed opinions on the cultural capacities of the hominins that produced Oldowan assemblages. At one extreme, these early hominins are considered incapable of hunting, language, foresight, or maintaining home bases. Oldowan technology

is considered a rudimentary reduction sequence used only for the production of flakes. At the other extreme, the authors of Oldowan assemblages are considered to possess substantial capabilities in all these areas. Ethnographic information from Australia, together with Oldowan archaeological data, provides a useful perspective in the debate over early hominin abilities. I argue that the view of Oldowan reduction sequences as being adopted only for the production of flakes is too limited. I suggest that a more comprehensive toolkit probably existed, consisting of throwing sticks, digging sticks, spears, chopping implements, stone balls, and flake tools. Given such a toolkit, home bases should also be an expectable part of Oldowan social organization. This expectation seems to be borne out at some Oldowan sites.

Reconstructing Human Diet from Plant Microfossils Preserved in Dental Calculus: A Case Study from Tell al-Raqa'i, Syria

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Research into the diet of historic and prehistoric groups has relied heavily on a number of markers that focus on the meat portion of diet (e.g., faunal remains, isotope data, tool typologies, and hunting patterns). Reconstruction of the plant portion of diet has relied on either stable carbon isotopes or macrobotanical remains, which are often poorly preserved or entirely absent from some sites. The study of plant microfossils such as starches and phytoliths has given researchers methods to reconstruct human use of plants from a number of different archaeological contexts. These microfossils can be recovered from soils and stone tools, and are identifiable to plant family, genus, and even species. The work presented here shows that plant microfossils are also recoverable from dental calculus, and can thus be a direct marker of an individual's plant diet, with low likelihood of contamination and high use for paleoanthropological studies. The five human teeth used in this research are from Tell al-Raqa'i in Syria, a small rural site known for large-scale grain storage and processing, dating to between roughly 5000 yBP uncalibrated and 1500–1000 yBP. Following an experimental protocol worked out over the past year, initially on 10,000-year-old goat teeth, very small amounts of calculus, generally less than 2mm^2, were removed from each tooth, but up to 80 microfossils were recovered from each sample. SEM images taken before and after sampling verify that this method does not scratch the enamel and can leave other calculus for future research. The starches were identified using a reference collection as consistent with barley, wheat, and other Near Eastern staple foods. This work has potential to be applied to any fossil teeth for which dental calculus is available. Work currently in progress applies this method to older fossils, including Neanderthals and early modern humans.

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Abrigo do Alecrim, a New Upper Paleolithic Site in the Lapedo Valley (Portugal)

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The Lapedo Valley, in central Portugal, is best known for the Lagar Velho site which has yielded evidence of multiple Upper Paleolithic occupations, as well as a Gravettian-age (ca. 24,500 BP) burial of a child said to exhibit characters indicative of mixed Neandertal-modern human ancestry. Here we report on another rock shelter site at Lapedo, the Abrigo do Alecrim, located 300m NNE of Lagar Velho, is on the talus at the base of the limestone cliff delimiting the northern side of the Lapedo gorge. Excavations in the vicinity of Alecrim were undertaken in 2002; excavation of the rock shelter itself began in 2003, and continued in 2004 and 2005. Preliminary test pits showed the presence of a thick slope-waste succession containing archaeological layers and features. To date, while excavating within only four square meters, we have catalogued 411 lithic artifacts, hundreds of pieces of faunal bone, and significant debitage associated with at least one Paleolithic hearth. A bone fragment associated with this feature was AMS radiocarbon dated to 20,510+150 BP (uncalibrated; Beta 203513), suggesting a Solutrean age. As was the case for Lagar Velho, however, the lithic artifacts recovered from Alecrim are not particularly Upper Paleolithic in character—the majority (343, or 83%) of the lithic artifacts are made on flakes; only 11 artifacts, or 3%, of the lithic artifacts can be classified as blades or bladelets. This may be due in part to the raw material used; curiously, the majority (245, or 60%) of the recovered lithic artifacts are made on quartz. Quartzite and flint artifacts make up just 28% and 12% of the lithic assemblage, respectively. Multiple refittings of some of these artifacts, as well as of fire-cracked cobbles associated with the hearth, suggest that the integrity of the cultural layers at Alecrim is intact.

A Re-Assessment of the Jebel Irhoud (Morocco) Mousterian Adult Cranial Remains

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The site of Jebel Irhoud has yielded the largest series of human remains associated with MSA/Middle Paleolithic assemblages in Northern Africa. Biostratigraphic arguments as well as radiometric dates suggest a late middle or early upper Pleistocene age for the deposits. The MPI-EVA (Leipzig), in collaboration with the INSAP (Rabat), has recently undertaken a re-excavation at the site. In parallel, a detailed study of the fossil human remains has also been conducted, including high resolution CT-scanning of the whole series. Although it has been suggested that these specimens exhibit Neanderthal affinities, they prove to be quite different in many aspects. Specifically, they lack the derived conditions typical of the Western Eurasian clade but rather share some primitive retentions with it, such as a general robusticity. Additionally, the weak convexity of the parietal, the elongated temporal, and the low shape of the occipital squama can be related to a certain degree of platycephaly. In many aspects the Irhoud specimens are reminiscent of the early modern humans from the Near East and East Africa. The face is large, but low and flat. The frontal bone is convex and upright. Irhoud 2 displays a supraorbital morphology which is close to the modern condition. A 3D geometric morphometrics comparative analysis of the Irhoud specimens was also conducted to assess their morphological affinities. Mahalanobis D2 and Procustes distances, calculated from landmark and semilandmark data of the neurocranium and the face, confirm their close relationships with upper Pleistocene and more recent modern *Homo sapiens*. The Jebel Irhoud evidence highlights the complexity of the processes of emergence of modern humans. Although genetic data suggest a small effective population size (ca. 15,000) ancestral to all extant humans, a nearly modern phenotype might have been spread throughout the entire African continent at the end of the Middle Pleistocene

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Morphological Evolution of the Bony Palate of Hominid Fossils

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The bony palate is the sole anatomical structure—used for producing articulated language—that is often preserved during fossilization. Our purpose was to study the morphological variation of this anatomical structure during human evolution. Material and method: The sample was composed of skulls and casts of great apes, fossil hominids, and modern humans. Twelve non-metric traits were studied. For the metric measurements, the palates were moulded with silicone. Several specific landmarks were defined and localized with a 3D digitizer. A morphometric 3D analysis was done using Procustes and PCA methods. Results: Some nonmetric traits show a diachronic evolution. The morphometric study showed a clear gap between apes and australopithecinae on one side and *Homo* on the other side. The bony palate of *Homo* has a growing complexity. A morphologically modern bony palate seems to be present by the time of *Homo heidelbergensis* in Europe. However, many anatomical and physiological functions contributing to the production of language are absent on fossil remains. Therefore, it is not possible to know, solely on the basis of the morphology of the bony palate, if these hominids had an articulated language, or, if they had language, the level of its complexity.

Evolutionary History of Javanese *Homo erectus*: An Examination Based on Revised and New Cranial Measurements

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This study aims at accurately describing cranial morphological changes of *H. erectus* in Java, using refined measurements carefully taken from 15 adult and four subadult crania from the Sangiran (the Bapang Formation above the Grenzbank zone [Bapang-AG] levels), Sambungmacan, and Ngandong. The identification of some obscure landmarks was aided by using micro-CT imaging, and the measurements obtained were compared with previously published estimates to further reduce possible errors. While recent studies tend to emphasize evolutionary conservatism in Javanese *H. erectus*, our results reinforce the idea that the chronologically later groups experienced distinct morphological changes in a number of cranial traits. Some of these changes, particularly those related to brain size expansion, can be compared to the general evolutionary trend of *Homo* worldwide, whereas others are apparently unique specializations restricted to Javanese *H. erectus*. Such morphological specializations in Java include previously undescribed anteroposterior lengthening of the midcranial base and the anterior shift of the posterior temporal muscle that might have influenced the morphology of the angular torus and supramastoid sulcus. Analyses of morphological variation indicate the presence of various

intermediate forms between the chronologically earlier and later morphotypes of Javanese *H. erectus*, particularly in the crania from Sambungmacan. This strongly suggests the continuous, gradual morphological evolution of Javanese *H. erectus* from the Bapang-AG to Ngandong periods. In addition, we tested the dual ancestry model of Aboriginal Australians by examining whether the variation structure within Pleistocene Australians can be reasonably explained by hybridization of the model's supposed two ancestors: Javanese *H. erectus* and migrating groups of *H. sapiens* arriving from Africa. Our results contradict the model's expectations and support the hypothesis that the Javanese lineage of *H. erectus* went extinct without making significant contributions to the ancestry of modern humans.

Digastric Origin Morphology and Non-Masticatory Tooth Use in the Native Point Saldermuit: Implications for a Possible Neanderthal Autapomorphy

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The inferior projection of the occipitomastoid crest in many specimens of Neanderthals is often considered to be an autapomorphy of that specific population. This study explores the possibility that this feature is not an autapomorphy, but is the result of the hyperdevelopment of the adjacent origin for the digastric muscle. Wear patterns on the incisors of several Neanderthals suggest that they engaged in non-masticatory tooth use. Such activities would encourage the hyperdevelopment of the digastric muscles, which would stabilize the mandible when objects were held between the teeth. Similar patterns of non-masticatory tooth use have been documented in Arctic populations in North America. Occipitomastoid crest projection and mastoid length were measured in a sample of 29 crania from the Native Point Saldermuit. The crania also were examined qualitatively for incisor wear, antemortem tooth loss, presence of mandibular tori, and gross morphology of the digastric origin. Crania from several non-Inuit sites in northern North America were analyzed for comparison. The qualitative data support that the Native Point sample represents individuals who habitually engaged in non-masticatory tooth use, showing different patterns in the Saldermuit and non-Saldermuit groups. A between group comparison for mastoid length was not significant (p=.644). The comparison for occipitomastoid crest projection was borderline significant (p=.0967), suggesting that the two samples differ in this feature. This study suggests that the hyperdevelopment of the occipitomastoid crest may not be an autapomorphy, but instead may be the result of non-masticatory tooth use.

Hominid Species Number at Sangiran: A Randomization Test of the Dental Evidence

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Recent work by Kaifu and colleagues (2005a, 2005b) has reinvigorated the debate concerning the number of hominid species represented at Sangiran, Central Java, Indonesia. Their analyses of the dento-gnathic evidence from this Early Pleistocene site demonstrated significant differences between the earlier and later hominid fossils derived from the Sangiran and Bapang Formations, respectively. The authors conclude that the possibility of multiple species at Sangiran remains an open question. To further investigate this issue, we analyze the available mandibular, post-canine, dental data from Sangiran. This primary sample is derived from 21 individuals and includes 38 separate teeth (6 P3, 5 P4, 10 M1, 11 M2, and 6 M3). We compare M-D length and B-L breadth measurements from Sangiran to comparative samples of mixed-sex, modern, large-bodied hominoids (*Pan* n=32, *Gorilla* n=29 and *Homo* n=60). In addition, comparisons are made with a sample of teeth from *Australopithecus afarensis* (from Hadar, Laetoli, and Maka), which is used as an accepted hominid paleospecies that incorporates approximately the same amount of geological time as found in the Sangiran sample. Pair-wise comparisons and exact randomization are used to test the null hypothesis that the Sangiran sample does not significantly differ in magnitude or pattern from the single-species comparators.

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The Energetic Consequences of Walking on Gradients and Carrying Burdens

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The effectiveness of people walking while carrying burdens and/or on gradients has been of interest to anthropologists for some time. No empirical equation exists, however, to assess the energetic expenditure of individuals traveling up and downhill with burdens. To begin to rectify this lacuna, gait parameters, physiological variables, and the energetic expenditure of 11 adults were assessed as they walked with burdens of 5 and 10 kg on a treadmill at gradients of 0, +/- 8, and 16%. These data were then compared to predictive equations and data available from the literature. Using velocity, body mass, gradient, and burden mass as independent covariates, these new data were used to create predictive equations, which explained >80% of the variation in energetic expenditure. These new

equations are appropriate for predicting energetic expenditure in people carrying burdens of <25% of total body mass and walking up and downhill at gradients of <20%.

Presence of the Maxillary Sinus in the Fossil Colobine *Cercopithecoides williamsi* from South Africa: An Assessment Using Computed Tomography

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Extant cercopithecoid monkeys, with the exception of macaques, are distinguished among primates by their lack of paranasal sinuses. Since the presence of at least a maxillary sinus is widespread among eutherian mammals, it is hypothesized that the loss of this structure occurred in the last common ancestor of cercopithecoids; thus, its presence in extant macaques is not homologous to that in other primates. Previous character state reconstructions including the Miocene (ca. 15 Ma) Old World monkey *Victoriapithecus macinnesi* support this view; CT examination of the complete cranium KNM-MB 29100 revealed the lack of the maxillary sinus in this stem cercopithecoid. In this context, we report on CT examination of two crania of the South African Pleistocene colobine *Cercopithecoides williamsi* (3.0–1.5 Ma). Both have been described previously—BF 42a is a relatively intact cranium from Bolts Farm and MP113 is an intact facial skeleton including the anterior cranial vault from the Makapansgat Limeworks. They were scanned using a Phillips Brilliance CT system at 1.0mm slice thickness. Both demonstrate well-developed maxillary sinuses, which are unknown in extant colobines and unexpected in cercopithecoid monkeys in general. Colobine monkey fossils are widespread in South and East Africa and Asia, but none have been reported to possess paranasal pneumatization. Thus, the presence of a maxillary sinus in these South African specimens suggests that other fossil colobines should be examined for this feature using CT. We discuss the phylogenetic and evolutionary issues raised by the presence of this sinus in *C. williamsi*, as well as the implications for achieving a better understanding of its evolution and function.

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Comparing Landscape Use by Australopith Species Using High Resolution Strontium Isotope Ratio Tracking in Tooth Enamel

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The diets of *Australopithecus africanus* and *Paranthropus robustus* are indistinguishable from $^{13}C/^{12}C$ determinations although molar occlusal microwear points to subtle differences in wear patterns, raising questions about the nature of the distinction in dietary ecology, if at all. Marked $^{87}Sr/^{86}Sr$ variability across the Sterkfontein Valley landscape and its environs due to strong geological zonation, shown from a previous study that included soils, plants, and Swartkrans fossils, permits us to assess possible differences in the foraging ranges of these two australopiths. Given the unusually high $^{87}Sr/^{86}Sr$ differences, we tested application of laser ablation ICP-MS methods, which gives lower analytical but higher sampling precision and little visible damage, to obtain short time series for $^{87}Sr/^{86}Sr$ in modern bovids living in the valley. The time window approximates the period of molar (or premolar) tooth mineralization, about one to two years. Sequential analysis of molar crown enamel of four *P. robustus* and four *A. africanus* individuals shows that movement of these two australopiths across the regional landscape differed both in average terms and in the detailed series. The results suggest that *P. robustus* ranged more widely beyond the valley, in contrast to *A. africanus*. Comparison of the $^{87}Sr/^{86}Sr$ and existing $^{13}C/^{12}C$ series tracks for the same *Paranthropus* individuals suggests that higher incidence of C_4 consumption at certain times cannot reliably be linked to any particular landscape sectors such as valley versus granite hills.

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Paleomagnetic Stratigraphy and Astronomic-Age Divisions for the Olduvai Subchron in the Northern Turkana Basin (Kenya)

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Current hominin studies from Africa focus on time and climate issues, ranging from the impacts of global climate events on speciation to the seasonal climate constraints of behavioral ecology. Sedimentary sequences of the Turkana Basin provide a window into Plio-Pleistocene hominin evolution and the Quaternary environments for East Africa. We studied these sequences using paleomagnetic stratigraphy and report on the timing of global and local paleoclimate changes in relation to the hominin-bearing deposits at West

Turkana archaeological and Koobi Fora fossil localities. Examined deposits were cyclically bedded lake-margin mudstones, with depositional origins from Milankovitch climate forcing. We conducted field-based and laboratory paleomagnetic stratigraphy studies to precisely correlate these hominin-bearing deposits with periodic climate-change events dating from the Olduvai Subchron (1.96–1.78 Ma). Paleomagnetic stratigraphy data was generated by ~90 sets of thermal and alternating field demagnetization experiments on collected samples of lake-margin deposits. Results allowed for confident identification of the Olduvai Subchron within the previously established stratigraphic frameworks. At Koobi Fora, the recognition of the top of the Olduvai Subchron facilitated a direct correlation between the hominin-bearing deposits and the global solar-radiation budget minimum associated with insolation cycle 174 at 1.778 Ma. Normal polarity samples from lower in the section are interpreted to derive from the time range of insolation cycles 178 (1.829 Ma), 180 (1.851 Ma), and 182 (1.872 Ma). Samples from Naiyena Engol, West Turkana, have normal polarities aligned with insolation cycle 174, or possibly insolation cycles 178 and 180. Stratigraphic correlations from the lake-margin deposits to the Geomagnetic Polarity Timescale and insolation cycles allow for the reconstruction of paleoenvironmental conditions lasting years to tens of thousands of years. These findings can be used to assess global paleoclimate parameters of Plio-Pleistocene environmental change in the Turkana Basin and to predict seasonal/annual rainfall intensities for hominin habitats of the basin.

Temporalis Configuration and Morphological Integration in Middle Pleistocene Hominids

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While the masticatory configuration of early hominids and Neanderthals has been studied extensively, less is known about other archaic *Homo*, particularly from the Middle Pleistocene. Kabwe (a Middle Pleistocene hominid from Zambia) in particular has a unique temporalis configuration. Rather than the smooth "fan"-shape characteristic of modern humans, Kabwe's temporal line is bifurcated at the coronal suture, with the posterior portion of the temporalis extending further postero-superiorly onto the cranium. Because the temporalis muscle spans the braincase and face, it is possible that morphological integration with different functional units in the craniofacial complex affects its size and shape. In order to test this hypothesis, we collected 65 3D landmarks from the neurocranium, basicranium, and face of 30 specimens of *Homo erectus*, *H. heidelbergensis/rhodesiensis*, *H. neanderthalensis*, and Late Pleistocene *H. sapiens*, in addition to comparative samples of gorillas, chimpanzees, and extant humans. We used thin-plate spline and principal components analysis of both landmark and sliding semilandmark data to assess size and shape variation in the craniofacial complex, and regression and partial least squares analyses to assess integration between different portions of the temporalis and the cranium. Results indicate that, in hominids, the anterior and posterior portions of the temporalis covary with facial and neurocranial size and shape respectively. These results support the hypothesis that the temporalis muscle and craniofacial complex are morphologically integrated, and suggest that the combination of a large, archaic braincase and projecting face in Kabwe and other Middle Pleistocene hominids affects temporalis configuration. Additionally, this unique configuration may alter the orientation and position of the temporalis muscle resultant, necessitating a change in the triangle of support (see Spencer 1999) that affects the biomechanics of chewing. This interplay between morphological integration and biomechanics has important implications for our understanding of diversity in the genus *Homo*.

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Is the Soanian a Middle Paleolithic Industry? A Morphometric Assessment

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The Soanian is traditionally seen as one of the major (non-Acheulean) Paleolithic techno-complexes of the Indian subcontinent. Over several decades, comparisons of Soanian assemblages have been made with the non-bifacial industries of East Asia and north-west Europe. The chronological status and typo-technological relationship(s) of the Soanian to other Paleolithic industries has been the subject of much debate. When first named and described, the Soanian was considered to contain evidence of Mode 3 Levallois-style core reduction. However, in recent years, the potential Mode 3 component of the Soanian has largely been ignored, and the techno-complex is described under various guises as a core/flake or "Mode 1" techno-complex. Here a comparative morphometric assessment of Soanian cores and other Paleolithic nuclei (n=577) is undertaken, to test the hypothesis that this industry contains a definite Mode 3 Levallois element. Discriminant Function Analyses (DFA) of morphometric variables (n=60 variables) provide strong evidence that at least some of the so-called Mode 1 Soanian techno-complex actually contains Mode 3 Levallois cores. The analyses provide strong corroboration that the Soanian techno-complex should be considered a Middle Paleolithic industry, with attendant implications for the behavioral strategies of hominins exploiting the Siwalik frontal range during the Middle to Late Pleistocene.

The Mandible and Lower Dentition of *Morotopithecus bishopi*

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The Moroto II locality from northeast Uganda is radiometrically dated to >20.6 Ma. The type specimen of *Morotopithecus bishopi* is from this locality, and consists of the face and maxilla of a single individual. Other published hominoid dental remains from Moroto II include three isolated upper teeth (two canines and one molar) and a fragmentary, edentulous mandible. All dental specimens but one isolated canine have been interpreted to be male. Here we report on a new partial mandible and the first hominoid lower tooth crowns from Moroto II. The central incisor crown is broken off, but the lateral incisor is labiolingually long and narrow, as in *Proconsul* and *Afropithecus*. The canine has a distinct distal heel with radiating striations lateral to the junction of the distal ridge and lingual cingulum. The canine also has a flat mesiolingual face, rather than the rounded outline seen in male and female *Proconsul*, and male *Afropithecus*. In terms of the size of the base, the canine falls within the distribution of those of female *P. major* or *P. nyanzae*, but the tip is missing. The crowns of the premolars are absent but judging from the roots, P4 was as long as P3, which distinguishes the specimen from both *Proconsul* and *Afropithecus* because the latter have relatively shorter P4s. The molars are narrow and long, and relatively large compared to canine size. Overall, the new mandible can be distinguished from both *P. major* and *A. turkanensis* and confirms the presence of a morph with much smaller canines than that represented by the type specimen or the edentulous mandible. If all the large and small specimens are from a single species, the degree of dimorphism is high, but it remains possible that more than one hominoid taxon is present at Moroto II.

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Absolute AMS ^{14}C Dates from the Mousterian Occupation of Les Pradelles (Marillac-le-Franc, Charente, France)

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Les Pradelles is a karstic depression that was initially excavated by Bernard Vandermeersch between 1967 and 1980 and by the present team since 2001. These excavations, almost all of which have taken place in the eastern portion of the site, have resulted in the discovery of many Neandertal remains in addition to faunal remains and Mousterian of La Quina type lithics. A faunal bone from the uppermost depositional layer (facies 7/8) of the eastern profile produced an AMS ^{14}C date of 32,440±440 BP (Beta-191800). Two other bones from underlying deposits produced results indicative of a date beyond the technique's range. The Neandertal remains, as well as the Mousterian artifacts, have been excavated from facies 2 to 4, which underlie the layers from which the dated bones were found. These results suggest that the top of the cave infilling was deposited before the end of the second third of OIS 3 and that a published date of about 40,000 BP for the base of the stratigraphy underestimates the age of the Neandertals. In order to understand the depositional history of the whole site, recent excavations exposed several profiles in its western portion. Archaeological remains from facies 7/8 from the western side of the site are found at an altitude similar to that of facies 2 (above the substratum) of the eastern profile. AMS ^{14}C dates on bones from facies 2 of the eastern profile, however, produced results of 40,600±530 BP (Beta-219943) and >42,000 BP (Beta-219945), and 41,770±1440 BP (Beta-219942) and 39,860±490 BP (Beta-219944). The dates from similar altitudes from the eastern and western ends of the site thus differ markedly. They allow us to hypothesize a different geological and archaeological evolution of the site, with a western part much more recent than its eastern half.

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Two Middle Pleistocene Human Hyoid Bones from the Sima de los Huesos Site (Sierra de Atapuerca, Spain)

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The hyoid bone is among the least represented skeletal element in the human fossil record, and the recent discovery of an *Australopithecus afarensis* hyoid bone, reported as being chimpanzee-like (Alemseged et al. 2006), has generated renewed interest in the evolutionary significance of this bone in the human lineage. Prior to this, only one other hyoid specimen was known, from the Kebara 2 Neandertal (Arensburg et al., 1988). This paucity in the fossil record, with only two specimens separated by nearly three million years, has meant that it has not been possible to address questions of the biological, temporal, or geographic variation which may influence phylogenetic interpretations based on this bone. The present study describes and compares two hyoid bones from the Middle Pleistocene site of the Sima de los Huesos (SH) in the Sierra de Atapuerca (Spain). These specimens considerably extend the known fossil record for the genus *Homo* to deep in the Middle Pleistocene. The Atapuerca SH hyoids are clearly human-like in both their morphology and dimensions, and, based on modern human developmental criteria, both specimens can be attributed to adult individuals. Their comparison with the Kebara 2 Neandertal specimen makes it possible to begin to approach the question of temporal variation and sexual dimorphism in this bone within the Neandertal evolutionary lineage. The present results show that the degree of metric and anatomical variation in this lineage was of the same kind and magnitude as that seen in living humans. The modern hyoid morphology, then, was present in the fossil record by at least 530 kya (Bischoff et al. 2006) and appears to represent a shared derived feature seen in both the modern human and Neandertal evolutionary lineages, one which was inherited from their last common ancestor.

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Examining the Emergence of the Still Bay and Howiesons Poort Industries in South Africa Using Behavioral Ecological Models

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Changes in the organization of lithic technological systems during the later Middle Stone Age (MSA) of South Africa are examined using lithic data presented by Singer and Wymer (1982) and Henshilwood et al. (2001) for two important South African MSA sites, Blombos Cave and Klasies River Mouth. Multivariate pattern-recognition statistics are used to describe the transition to (1) the biface-dominated Still Bay industry at Blombos Cave, and, (2) the microlithic Howiesons Poort industry at Klasies River Mouth. Based on the results of these analyses, this study proposes a synthetic model of the emergence of the Still Bay and Howiesons Poort industries from earlier MSA industries. Using a few central principles of tool design and behavioral ecological models derived from the study of modern foragers, it is suggested that the Still Bay came about as the result of deteriorating environmental conditions at the beginning of Oxygen Isotope Stage 4, which caused resources to become scarce and more widely distributed. It is proposed that the bifacial points of the Still Bay industry were functionally similar to earlier MSA points, but represented a significant change in terms of the management of lithic raw material using an elaborate bifacial reduction strategy. Furthermore, this strategy for raw material management corresponded with increased mobility and further movement away from lithic raw material sources. The Howiesons Poort industry, on the other hand, involved the manufacture of less functionally flexible composite tools requiring more labor and longer downtime for maintenance and repair. This technological strategy is argued to emerge as the result of the more specific targeting of certain resources with planned logistical trips, resulting from improved strategies for information sharing, such as those apparent with the decorated objects from Blombos Cave.

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The Taxonomic Status of Early *Homo sapiens* from Herto, Ethiopia

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In 2003, White and colleagues erected a new subspecies, *H. sapiens idaltu*, to accommodate ~160,000-year-old skeletal remains from Herto, Ethiopia. However, the most complete specimen, BOU-VP-16/1, combines a globular cranium with a face retracted beneath the frontal lobes of the brain, two hallmarks of anatomical "modernity" that characterize *H. sapiens sapiens*. Furthermore, the supposed intermediate morphological status of the Herto remains is used to support a single, unbroken line of African ancestry stretching from *H. erectus* to *H. sapiens sapiens*. Because this taxonomic decision affects our understanding of the phylogenetic relationships among Pleistocene *Homo*, it is necessary to critically re-examine whether Herto should be placed in its own subspecies. To re-examine the taxonomic position of BOU-VP-16/1, we assembled Howells' data from the neurocranium and face for specimens of African and Asian *H. erectus*, archaic *Homo* including Neanderthals, and early anatomically modern, Late Pleistocene, and recent *H. sapiens*. We used univariate analyses, principal components (PCA), and discriminant function analyses (DFA) to assess population affinities of this cranium. Although BOU-VP-16/1 is large, univariate analyses of Howells' data indicate that most measurements fall within the range of variation of early modern and Late Pleistocene *H. sapiens*. PCAs of size-adjusted neurocranial and facial variables place BOU-VP-16/1 within the 95% confidence intervals for anatomically modern and Late Pleistocene *H. sapiens*. In no PCA does BOU-VP-16/1 appear intermediate between archaic and modern humans. Finally, DFA assigns BOU-VP-16/1 to the early anatomically modern human group with a 95% posterior probability. In sum, critical re-evaluation and re-analysis of the available evidence fails to support the placement of BOU-VP-16/1 into its own subspecies. Instead, the early modern human remains from Herto, Ethiopia, should be considered part of a larger Pleistocene *H. sapiens* population that also includes remains from Irhoud, Skhul, Qafzeh, and Omo.

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Bovid Ecomorphology: A Cautionary Tale from the Omo

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The analysis of bovid postcranial morphology to infer habitat preference, commonly termed "bovid ecomorphology," is an increasingly popular method of reconstructing paleoenvironments. This approach typically uses discriminant functions developed on modern samples to generate habitat predictions for individual fossil specimens. Most analyses have been limited to one anatomical element, and the primary focus has been on generating the habitat predictions. Here we examine the methodological challenges faced in going from habitat predictions for individual specimens to actual paleoenvironmental reconstructions. Our study is based on measurements of 1,687 astragali, proximal phalanges, and intermediate phalanges from the Shungura Formation, Omo, Ethiopia. Detailed analysis of these data highlights several issues in using such predictions to reconstruct paleoenvironments, and suggests various analytical methods that should be employed in doing so. Sample size and composition issues are potentially serious, especially when integrating results from multiple elements. Taphonomic biases between samples can be evaluated by examination of size class distributions, and possibly ameliorated by use of morphogroups that include fragmentary specimens. Spatial and temporal ecological variation must also be accounted for, particularly since most modern biomes contain bovids with varying habitat preferences. While "ecomorphology" is often claimed to be a "taxon-free" approach, the results can be sensitive to the taxonomic composition of the modern sample used. Questions arise over how to (or whether to) integrate information on the taxonomic composition of fossil samples with ecomorphological analysis. In sum, the analysis of the Omo bovid assemblage demonstrates that more work is needed to develop methods for generating robust paleoenvironmental reconstructions from ecomorphological habitat predictions.

A New Angle on Middle Stone Age Hunting Technology in South Africa

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Archaeologists have always been interested in hunting strategies of people living in the Stone Age. Early interpretations of weaponry were speculative but in the last ten years technological studies have transformed lithic interpretations in Europe and America. This paper presents preliminary results of a comparative technological study of Middle Stone Age (MSA) points and segments from two sites in KwaZulu-Natal, South Africa—Sibudu Cave and Umhlatuzana Rock Shelter—and Later Stone Age (LSA) segments from Jubilee Shelter in the Magaliesberg, South Africa. The MSA points have ages between about 75 to 33 ka and the MSA segments mostly come from layers with ages of >60 ka. The LSA segments have ages between 6,000 and 3,000 years ago. The study examines changing hunting strategies through time in the MSA because both tool types have been considered parts of hunting weaponry—points as spears, segments as arrows. Segments may have replaced points as hunting weapons (possibly as arrows) during the Howiesons Poort Industry where points are very rare in archaeological assemblages. The possibility that segments had the same function in the MSA

and the LSA is also examined.

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Ungulate Species Abundance and Human Population Densities During the Middle to Upper Paleolithic Transition in Western Europe: The Population Bottleneck Model

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For several authors, the Middle to Upper Paleolithic transition corresponds to the demic expansion of modern humans out of Africa and the replacement of archaic sapiens in Eurasia and Australia. However, the fact that recent re-analyses of Aurignacian assemblages (Bon 2002; Tsanova and Bordes 1983; Teyssandier 2004) stress the heterogeneous nature of this industry is hard to reconcile with this interpretation. In addition, data from Saint-Césaire (France) show indications of cultural continuity in subsistence strategies and in bone utilization as fuel during this time period, in spite of climatically-induced changes in taxonomic composition. In order to explain this continuity, a population bottleneck model is proposed as an alternative to demic expansion scenarios. The population bottleneck model suggests that the climatic reduction of ungulate taxa from four (red deer, horse, bison, and reindeer) to two main prey species (horse and reindeer) during the French early Upper Paleolithic significantly increased seasonal and annual fluctuations in prey abundance. These increased fluctuations, mostly resulting from an increasing reliance on the highly cyclical reindeer, would have reduced, over a relatively short timescale, local human population densities through small-scale bottlenecks and group extinctions. These conditions would have promoted genetic drift, a factor that may explain the loss during the early Upper Paleolithic of some of the genetic traits closely associated with archaic populations. In the long term, these populations would have adapted to these increased fluctuations in prey abundance by expanding their social networks. It is suggested that in situ models that focus on changes in local human population densities, prey abundance, and the effects of genetic drift provide more satisfactory explanations for the Middle to Upper Paleolithic transition than replacement scenarios.

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The Early Upper Palaeolithic Occupation of Vogelherd Cave (Germany): Human Subsistence and Cultural Innovation During the Aurignacian

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Recent results from the zooarchaeological analysis of faunal remains from Vogelherd Cave provide new insight on the subsistence behavior of early modern human groups during the Aurignacian. The Aurignacian deposits at Vogelherd yielded a great deal of cultural material, likely reflecting several episodes of human occupations; radiocarbon assays place these primarily between 31–32 ka BP. A variety of Pleistocene mammals are represented, although reindeer and horse were the primary prey of humans. Hunting of both taxa took place during the fall, coinciding with reindeer migrations and local abundance of horses. Complete or nearly complete prey carcasses were then transported from the kill locations to the cave for processing. The zooarchaeological study shows that Vogelherd was a preferred locale of Aurignacian groups for a broad range of activities, including the time- and labor-intensive exploitation of ungulate prey for meat, marrow, and fat resources, as well as the production and maintenance of artifacts such as figurative artwork, personal ornaments, bone and ivory armatures, and lithic tools. Considering its rich faunal and artifact assemblages, the Aurignacian deposits at Vogelherd provide a wealth of information on human behavior during this critical period of the Early Upper Palaeolithic, when cultural innovations were flourishing.

Crocodilian Predation Risk for Plio-Pleistocene Hominins at Olduvai Gorge, Tanzania

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We report traces of crocodilian feeding on *Homo habilis* fossil bone specimens from Bed I, Olduvai Gorge. The left foot bones of OH 8 from FLKNN level 3 and the OH 35 left tibia and fibula from FLK level 22 (*Zinjanthropus* Floor) bear carnivore bone damage including bisected tooth pits and punctures, which are diagnostic traces of crocodile feeding (Njau and Blumenschine 2006). The size of the tooth marks and the anatomical location of crocodile damage to the OH 8 talus and calcaneum conform precisely to damage on the distal epiphyses of the OH 35 tibia and fibula. These taphonomic observations confirm Susman and Stern's (1982) inference based on articulation that OH 8 and OH 35 derive from the same individual, despite having been found at sites lying ca. 200m apart and apparently from slightly different stratigraphic levels. These hominin skeletal parts and associated rich Oldowan stone artifact and butchered bone assemblages have been inferred by the Leakeys (1959, 1960, 1971) to have accumulated on hominin "living sites." Yet the evidence of crocodiles feeding and possibly preying on the probable stone tool makers seems incongruent with the "living site" interpretation. Together, large mammalian carnivores and crocodiles may have posed a complex landscape mosaic of predation risk that can only be resolved by placing the activity traces of hominins and carnivores in a detailed and broad-scale paleolandscape context.

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Bone Surface Modification Studies: Taphonomic Perspectives from Middle-Late Pleistocene Xujiayao, China

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At what point in time Plio-Pleistocene hominins became dominant members of the carnivore guild is a question critical for addressing many hypotheses related to human evolutionary studies. Much of this research has been conducted in the Western Old World. The nature of hominin-carnivore interactions over large game resources in Plio-Pleistocene East Asia is only beginning to be understood. We present the first of a series of taphonomic studies from the Middle-Late Pleistocene open-air Xujiayao site in the western Nihewan Basin, northern China. The Xujiayao faunal assemblage is dominated by *Equus przewalskii* remains. Except for some adhering matrix, the cortical bone surfaces of the collection are in pristine condition; thus facilitating investigation of the bone surface modifications. Bone surface modification analysis of the limb bones (femur, tibia, humerus, radio-ulna, metapodials) indicates that a high percentage of cut marks and percussion marks are present, suggestive of efficient hominin predation. A relatively low percentage of tooth marked bones, particularly on the midshafts, indicates that carnivore influence in the formation of the faunal assemblage may have been minimal. Because the age of the Xujiayao assemblage is questionable (age range between 500–60 ka), it is uncertain whether this can be considered the earliest evidence of hominin primary access to large game in northern China (if the earlier dates are correct) or whether Xujiayao can be considered a slightly earlier precursor to other evidence in East Asia of early access to concentrated protein and fat resources (e.g., Zhoukoudian Upper Cave). The results of an OSL analysis will be presented which should clarify the age of Xujiayao and the related hominin behavioral implications.

Molar Tissue Volumes and Enamel Thickness in South African Fossil Hominins

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Enamel thickness is among the most widely cited diagnostic indicators of hominin fossils. Despite the importance of this character in hominin taxonomy, only a small number of fossil molars have been studied. In the present study, we employed microfocal computed-tomographic imaging to non-destructively measure enamel thickness in molars of *Australopithecus africanus*, *Paranthropus robustus*, and a comparative sample of modern humans. Using virtual models of a subset of unworn fossil molars from our sample, we created standard two-dimensional sections for comparison with previous studies, as well as whole-crown three-dimensional measurements

of tissue volumes. Average enamel thickness (AET) is the mean straight-line distance between the enamel-dentine junction and outer enamel surface; relative enamel thickness is AET scaled by the quantity of dentine, eliminating the effects of tooth size differences. Two- and three-dimensional data reveal that *P. robustus* has relatively thicker enamel than the other taxa (with an overlapping range), in accord with previous studies. Unlike previous analyses, *A. africanus* has relatively thinner enamel than humans (but with an overlapping range). This discrepancy in enamel thickness is particularly wide when three-dimensional data are considered, suggesting that the pattern of enamel thickness on molar crowns is important to consider in inter-specific comparisons (e.g., variation in enamel thickness along the mesio-distal axis of the tooth). AET in each of the taxa is overlapping, with *A. africanus* near the human mean, and *P. robustus* within the high end of the human range. The proportion of molar crown volume that is dentine in each taxon is *A. africanus*, 57%; *P. robustus*, 46%; *H. sapiens*, 50%. Relative tissue proportions should be considered in combination with enamel thickness, appear to be effective at distinguishing fossil taxa, and may be useful for the taxonomic diagnosis of mixed fossil assemblages.

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New Analyses of Hominin- and Carnivore-Induced Damages in the FLK-Zinj Faunal Assemblage: Concordance, Conflicts and Remaining Interpretative Differences

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Analyses of FLK-Zinj limb assemblage damage patterns (Bunn and Kroll 1986; Oliver 1994; Blumenschine 1995; Dominguez-Rodrigo 2006) have—due to differences in observed damage frequencies and the perceived efficacy of experimental models as explanatory devices—yielded different interpretations of the hominin behaviours represented. The question remains: Did hominins acquire mainly marrow from carnivore-ravaged carcasses or did they acquire substantial meat from largely intact carcasses? Here, new analyses of cut, percussion, and tooth marks in the FLK-Zinj assemblage address inter-observer variation in damage frequencies and the utility of existing experimental models. This study makes four points: 1) cut mark and percussion mark frequencies observed by various researchers are (contra Lupo and O'Connell 2002) similar; 2) widely varied tooth mark frequencies (Oliver 1994; Blumenschine 1995; Dominguez-Rodrigo 2006) are likely due to difficulties in assigning agent to inconspicuous marks where biotic and abiotic processes may mimic carnivore damage; 3) cut marks are preferentially located on shafts, a location experimental (Nilssen 2000) and ethnoarchaeological butchery studies (Bunn 2001; Lupo and O'Connell 2002) indicate is referable to defleshing; and, 4) tooth marks on fracture and medullary surfaces of hammerstone-broken shafts indicate that carnivores scavenged hominin food-refuse. This scavenging likely resulted in tooth-marking of the assemblage in ways not observed experimentally and suggests that current experimental models (Blumenschine 1988; Selvaggio 1994; Capaldo 1997) may not capture the range of past carnivore activity. Three conclusions are offered: 1) estimating access sequence using tooth mark frequencies alone is inadvisable due to inter-observer error in identification and limited behavioral variability captured by experimental studies; 2) most carcass parts were brought to FLK-Zinj with considerable meat attached; and, 3) food transport to central places suggests that, like many carnivores living in predator-rich, semi-open habitats and who bear altricial young, hominins employed a dual-unit foraging strategy (Oliver 1994).

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Middle Paleolithic Settlement in the Egyptian High Desert: Preliminary Results

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Two seasons of systematic survey in the high desert near Abydos, Middle Egypt, have revealed a significant presence of Middle Paleolithic activities across this landscape. Because it lies along one of the possible routes out-of-Africa, it holds great potential for understanding early modern human behaviors, particularly from about 140,000 to 70,000 bp, before the Sahara Desert became hyperarid. We have designed methodologies to consistently sample the landscape, as well as record information about the lithic artifacts encountered. We collect data from samples every 100 meters, in addition to high density locales conventionally known as "sites." To date, we have surveyed 240 hectares and recorded 998 samples, as well as 133 high density areas. Our investigations include areas of the high desert both close to the Nile Valley corridor (approximately 4 km), at greater distance (about 12 km), and even farther (approximately 25 km). We have found evidence of Middle Paleolithic activities nearly everywhere we have thus far looked. Of the diagnostic samples and high density patches, 87% are Middle Paleolithic and contain Nubian Levallois and/or centripetal Levallois technology. One of our goals is to build a comprehensive database of the distribution of Middle Paleolithic activity locales in the high desert in order to examine the Nubian Complex settlement model proposed by Van Peer (2001). Van Peer's model incorporates five sites separated geographically by as much as 600 km, and hypothesizes that the Nubian Complex is a radiating system with base camps in the Nile Valley corridor. Our data thus far suggest that his model does not accurately predict or explain Nubian Complex settlement patterning, likely because his sample is so widely separated geographically that it does not represent settlement patterning attributable to one group. We address Middle Paleolithic settlement patterning as it can be reconstructed from our high desert data.

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Multivariate Analysis of the Postcranium of Markina Gora (Kostenki XIV), A 30,000-Year-Old Skeleton from Russia

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The Markina Gora skeleton was excavated in 1954. Debets (1955, *Sovetskaia Etnografiia* 1: 43–53) described it as "negroid" based on its marked alveolar prognathism and high brachial and crural indices. The skeleton has received little subsequent attention, but recent AMS dates of 30,000 BP for its stratum make it one of the earliest modern humans in Europe. To evaluate the morphological affinities of Markina Gora, we performed a discriminant analysis to clarify its similarity to Gravettian, Skhul-Qafzeh, and four other fossil populations in addition to ten samples of recent humans who differ in climatic adaptations and subsistence practices (n=327 skeletons). Only males (the fossil's sex) were included in the comparisons. Data on Markina Gora's long bone lengths and mid-shaft and articular dimensions were taken from Debets (1955). We also examined the crural, brachial, pilastric, and cnemic indices, and femoral head diameter divided by maximum femoral length. The Mahalanobis distances from the discriminant analysis place Markina Gora closer to Gravettian males and to Skhul IV than to any other sample. Mesolithic, Gravettian, Epigravettian, and Zulu males have the smallest D^2 distances to Markina Gora. It is similar in some respects to warm adapted populations, but differs dramatically in others. It has a high brachial index (80.7), most like Skhul IV and Zulu males, but a less distinctive crural index (80.8), which would be remarkable only in Artic populations. The pilastric index (112.5) is unremarkable, but the specimen has a low cnemic index (61.1), similar to Gravettian and other presumably mobile populations. Markina Gora has an elevated index of femoral head diameter to maximum length, resembling Mesolithic Europeans, Inuit, and Saami males, likely indicating a high body mass for stature. Despite earlier descriptions of Markina Gora as morphologically distinct, these results underscore its broad resemblance to other early modern human samples.

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Expanding the Taxonomic Range of Omnivores and Carnivores in Feeding Experiments and the Application of Actualistic Tooth Mark Data to Zooarcheological Analysis

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Archaeologists use experimentally-derived tooth mark frequencies, locations, and size data to infer the extent of carnivore involvement in the formation and modification of faunal assemblages, determine whether hominids accessed fleshy or defleshed carcasses, and to identify the size classes of predators marking a bone assemblage. These inferences are often debated because: 1) frequency counts can vary widely between observers; and, 2) the carnivore taxa for which tooth pit dimensional data are available are limited. Here we present data from feeding experiments undertaken with sixteen different omnivore and carnivore species ranging in size from coatis to tigers. After presenting subjects with defleshed goat and/or cow limb bones, the retrieved fragments were analyzed for surface and fracture damage. Marks were scored by degree of expression and counted. "Conspicuous" tooth pits were molded using dental impression material and major and minor axes measured off the mold using digital calipers. This study provides a range of tooth mark frequencies based on mark identifiability and expands the taxonomic and size range of carnivores providing tooth pit data. The results: 1) suggest that inter-observer variability in tooth mark frequencies is likely due to variation in mark expression; and, 2) demonstrate considerable overlap in tooth pit dimensions between different size-class carnivores.

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Interpreting an MSA-ESA Open-Air Stratified Site at Kudu Koppie, Limpopo Province, South Africa

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Kudu Koppie is an LSA/MSA/ESA site located near the confluence of the Shashe and Limpopo rivers, along South Africa's northernmost borders with Botswana and Zimbabwe. It is an open-air site that has been subjected to long-term deflation at least twice during the Pleistocene. However, three lines of evidence indicate that stratigraphic integrity has been preserved. First, sedimentology reveals a discontinuity between the two Pleistocene lag deposits. Secondly, refitting and nodule matching show that there is no vertical displacement of related artifacts across the contact zone between the sedimentological bodies. Thirdly, the conclusion that the site represents two distinct archaeological entities is supported by typological and technological characteristics. The upper lag deposit contains bifacially retouched points, characteristic of MSA industries. The underlying deposit includes large tools such as core-axes, picks, and core-scrapers and has been attributed to a local variant the Sangoan Industrial Complex. Kudu Koppie has the potential to shed light on the critical period of the final ESA in this region, immediately prior to the appearance of fully developed Middle Stone Age.

Chimpanzee (*Pan troglodytes verus*) Behavioral Responses to Stresses Associated with Living in a Savanna-Mosaic Environment: Implications for Hominin Adaptations to Open Habitats

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Chimpanzees in the newly-habituated Fongoli community in southeastern Senegal show a unique suite of behavioral adaptations to stresses associated with their savanna environment. These include using caves as shelters during the dry season, soaking in pools of water during the early rainy season, and moving and foraging at night during maximum phases of the moon. Eleven adult males of this 35-member community serve as focal subjects in a long-term study of the ecology and behavior of chimpanzees in a savanna-mosaic environment. The Fongoli chimpanzee home range is predominantly woodland and grassland with small patches of gallery forest. While chimpanzees at Fongoli are species-typical in certain regards, such as including ripe fruit in the diet during all months of the year, they also adjust their behavior to the particular stresses of this dry, hot, and open environment. For example, their large home range (>63km^2) is sometimes used cyclically, with the community traveling as one large party, in contrast to the typical chimpanzee fission-fusion pattern. Here, we report on Fongoli chimpanzee activity budgets and ranging behavior during dry versus wet seasons based on over 2,500 hours of observational data collected from March 2005-August 2006. Combined with data on temperature in the

various habitats within the savanna mosaic, results show that Fongoli chimpanzees minimize energy expenditure during the hottest months and at the hottest time of day by resting more and traveling less, in addition to selectively using small patches of closed-canopy habitats, such as gallery forest. Details of how chimpanzees alter their ranging behavior on a larger scale at these times also will be examined. The stresses associated with a savanna-mosaic environment and chimpanzees' behavioral adjustments to them have important implications for our understanding of early hominin behavior in similar environments.

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New Auditory Ossicles from Southwest Asian Mousterian Sites

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The present study analyzes new Neandertal and early modern human auditory ossicles from the sites of Amud and Qafzeh in Southwest Asia. All the specimens derive from Mousterian contexts and they more than double the previously known sample from this region. A complete incus was recovered from the left temporal bone in the Amud 7 Neandertal infant, and is one of only four known Neandertal specimens. In most metric dimensions, the Amud 7 incus falls within the modern human range of variation. However, the more closed angle between the short and long crurae falls below the lower limit of the modern human distribution. Morphologically, all the Neandertal incudi described to date show a very straight long process. While this anatomy is also infrequently found in modern humans (including Qafzeh 11), its presence in all three known Neandertals suggests fixation of this anatomical variant within this Pleistocene population. The combination of a very straight long process and a more closed angle between the crurae may indicate a slightly different relative positioning of the stapes within the tympanic cavity. In addition, the right malleus and incus were removed from the adhering matrix within the temporal bones of both Qafzeh 12 and Qafzeh 15. These specimens are similar to the previously described Qafzeh ossicles. Metrically, the new specimens are small, extend the range of variation in some metric variables within this sample, and fall outside the modern human range of variation in a few variables. However, morphologically, the new specimens do not differ in any meaningful way from living humans. The new specimens shed important light on a little known anatomical region in the fossil record, and, in the case of Amud 7, allow us to confirm what appears to be a consistent difference in Neandertal incudi.

Variability in East African Hominin Environments: Isotopic Evidence from Lacustrine Ostracods in the Koobi Fora and Galana Boi Formations, Turkana Basin, Northern Kenya

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Linking human evolutionary change to variability in terrestrial ecosystems requires high-resolution environmental proxies through deep time. Floral compositions reconstructed by isotopic analyses of paleosol carbonates reflect critical portions of East African hominin habitats, yet are discontinuous temporally and spatially. Here we complement paleosol records from the Turkana Basin in northern Kenya and proxy environmental variability with oxygen isotopic (delta^{18}O) values of lacustrine ostracods. Ostracods are benthic/epibenthic meiofaunal crustaceans abundant in modern Lake Turkana. Preserved ostracod carapaces are found in lacustrine exposures of the Holocene Galana Boi and Plio-Pleistocene Koobi Fora Formations. Ostracods record lake conditions by incorporating delta^{18}O values of lake water into their carapaces during growth (i.e., less than one year). Lake water delta^{18}O values vary with changes in temperature and evaporation in the basin and variations in rainfall to the catchment area of the Omo River. Monsoon intensity and resultant lake level fluctuations via the Omo River have been shown as responsive to global climate. We compared delta^{18}O values of modern waters to those of several species of ostracods living in the lake today in order to gauge differential isotopic offset and potential vital effects. We analyzed ostracods from the Galana Boi and Koobi Fora Formations spanning approximately the last 4 million years. We assessed diagenetic alteration of carapaces by calculating isotopic differences across species and comparing results to modern offsets. Additionally, we employed cathodoluminescence to detect secondary mineral formation. Our results corroborate sedimentological interpretations and correspond to the tectonic changes of the basin and climatic conditions in the source region of the Omo River. Most of the lacustrine ostracods show delta^{18}O values similar to those at present; however, significant deviations from modern values suggest major reorganization of the basin (e.g., open vs. closed lake system) and extremes in monsoon intensity.

New Middle Palaeolithic Human Remains from Las Pelenos (Monsempron-Libos, France)

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The Las Pelenos site is located at the Monsempron-Libos commune, about 25 km north-east of Villeneuve-sur-Lot, Lot-et-Garonne, France. The site corresponds to a dense human occupation at the basement of a limestone cliff facing south-southeast, not far from the confluence between the Lemance and Lot rivers. This archaeological site was first mentioned in a geological report published in 1864 by J.L. Combes. However, the single season of excavations was carried out in the early 1950's by L. Coulonges, with the fill containing artifacts and numerous bones (including human bones) from different Palaeolithic human occupations. In the report published in 1952, 10 cranial remains and two isolated teeth that originated from the Mousterian layer were described in detail by H.-V. Vallois. They represent, according to Vallois, at least four distinct Neanderthal individuals. After a sounding, one of us (A.Q.) started a new research program at Las Pelenos that enabled us to gain new insights into the site formation processes, the detailed stratigraphy, and the Palaeolithic occupations. In addition, a few new human remains were uncovered from the Mousterian of La Quina type archaeological context that are the main subject of this contribution. The new skeletal hominin pieces include two isolated permanent teeth (one upper left molar and one right lower canine), a small cranial fragment, and an almost complete right parietal bone. These human remains, due to their preservation, reinforce our knowledge of Neanderthal variability from southwestern Europe and permit further perspectives.

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Taphonomy and Local Paleoecology of the Juvenile Hominin from DIK-1, Ethiopia

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The juvenile *A. afarensis* fossil (nicknamed "Selam") from the DIK-1 locality in the Dikika Research Project (DRP) area of northeastern Ethiopia represents one of the most significant paleoanthropological discoveries in recent history. The skull and upper torso of the specimen were discovered embedded in a sandstone block near the top of a steeply eroding hillside. Sieving and close surface inspection up to 120m from the skull uncovered appendicular parts of the skeleton as far as 30m downslope. This presentation reviews the fossil's recovery, examines the distribution of fossil elements associated with the DIK-1 juvenile hominin and discusses the site taphonomy, local stratigraphy, and paleoecology. Detailed stratigraphic analysis of the site reveals three candidate sandstone layers at or above the point of discovery that could have given rise to the fossil. We evaluate the likelihood of each layer using data from the microstatigraphy, adhering matrix, and pattern of bone distribution. GIS and 3D rendering are used to visualize the site and the distribution of fossil elements to evaluate possible taphonomic scenarios. Evidence from the sediments that yielded the child, and from the preservation of the bones, indicates that the individual was probably buried in a flood event soon after death. It is also possible that the same flood could have caused her demise. Locally distributed fossil fauna such as fish and rodents from DIK-1 support the reconstruction of a wooded, deltaic environment with a high degree of local habitat heterogeneity. A combined evidence approach is used to reconstruct the immediate environment where Salem died and was buried.

Hominin Niche Construction and the Middle-Upper Paleolithic Transition in Italy

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Niche construction theory is a comparatively recent development in evolutionary biology. It refers to the evolutionary process whereby an organism modifies its environment in potentially advantageous ways. This broadens the scope of traditional evolutionary theory by giving organisms an active role in shaping their environments, thus creating contexts more favorable to their evolutionary success. Niche construction theory is gaining acceptance in mainstream evolutionary biology and has recently been used to clarify some debates pertaining to hominin evolution. Despite this promise, however, it has yet to be used as a conceptual framework in Paleolithic archaeology, even though the level of resolution of the Pleistocene archaeological record makes it ideal for detecting and tracking instances of hominin niche construction. This paper reports on recent research on the Middle-Upper Paleolithic transition in Italy, and it highlights how niche construction theory, in conjunction with resilience theory, can serve as an enlightening conceptual framework to understand hominin behavioral and biogeographical changes during that time interval. Focusing on the lithic technology and subsistence patterns of Late Mousterian, Uluzzian, and proto-Aurignacian assemblages, it details how the end of the Mousterian and

the beginning of the Upper Paleolithic in the Italian peninsula can be understood as a classic example of hominin niche construction. This research highlights some fundamental similarities between Early Upper Paleolithic adaptations in northern and southern Italy, but their distinct expression and respective evolutionary fate also attests to the importance of accounting for historical contingency as a means to explain particular social evolutionary trajectories.

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From Nothing to Something: The Earliest Appearance of the Archaeological Record

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Before 2.6 million years ago (Ma), no archaeological record has been securely documented, and therefore there is no evidence of hominin tool use. Then, at 2.6–2.58 Ma, there is widespread evidence for tool manufacture and use at several archaeological sites with undisputed stone tools and fossil fauna at Gona, Ethiopia (and elsewhere soon thereafter). Additionally, the evidence from the earliest archaeological sites at Gona shows that the earliest stone tool makers were skilled flintknappers and were able to select high quality stone raw materials. Here we examine the reasons behind this seeming abrupt transition from the absence of tools to the presence thereof, including different types of sampling biases, archaeological visibility, paleogeographic influences, paleoenvironmental change, and the biological record of hominin evolution. We review what is presently known of the sparse late Pliocene archaeological record in East Africa, with particular reference to the paleogeographic and paleoenvironmental context of the earliest archaeological sites. Research at Gona is highlighted here because of its early age as well as its relatively large number of early sites. We also briefly explore the reasons behind some of the diversity that has been noted among some of the late Pliocene artifact assemblages. Based on our observations at Gona, the earliest use of flaked stone tools is likely to be slightly older than 2.6 Ma. These stone tools represent a significant change in behavior that set the stage for subsequent hominin evolution, since the present evidence of the hominin fossil record suggests that stone tool manufacture and use preceded the significant brain size increase seen in early *Homo*. The paleogeographic and paleoenvironmental evidence points to the earliest use of stone tools in certain settings usually (but not always) close to raw material sources and ecotones between riparian woodlands and open grasslands.

Explaining the "Exclusively Bipedal" Characters of Australopithecines and Their Significance in Hominid Classification

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Close similarities between the recently unearthed Dikika scapula (DIK-1-1) and that of gorillas (a terrestrial quadruped), underscores the significance of terrestrial quadrupedality in early human and African ape lineages. The Wood-Jonesian notion embraced by 20th century paleoanthropologists that the human lineage descended to the ground so perfectly preadapted to bipedality that it forwent a quadrupedal terrestrial stage no longer can be supported. Comparative studies show early members of the human lineage were terrestrial, but retained some ability to climb trees. When terrestrial, these taxa, depending on circumstances, practiced both quadrupedal and bipedal behaviors. Quantification of human and great ape foramen magnum orientation (relative to either the Frankfurt or orbital plane) and position show neither is linked to bipedal behaviors or postures. Instead both seem to depend on relative brain and face size. Comparative survey of the femoral bicondylar angle in mammals shows it is common in vertical climbers, functioning as a carrying angle. A bowl-shaped pelvis and short iliac alae are also associated with vertical climbing. Their presence in *Oreopithecus*, a fossil ape predating the homind-African ape split, suggests these characters were retained in australopithecines from the common hominoid ancestor. A talar articulation perpendicular to the tibial long axis is a mammalian character distinguishing committed cursors from arboreal climbers. It is not exclusive to bipedality. Australopithecine vertebral remains show they lacked the human-like lumbar lordosis linked with habitually erect trunk postures. The Laetoli trails fail to provide evidence that their makers were exclusively bipedal. Although falsification of bipedal exclusiveness for these characters or the trails may be interpreted to mean australopithecines are not hominids, phylogeny is based on shared derived characters and not on inferred character function. Whether or not some australopithecines are hominids in the classic sense depends on their sharing derived characters with humans exclusive of other hominoids.

Zooarchaeological Distinction of Felids and Hyenids: Implications for Models of Early Hominid Carcass Foraging

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Large carnivores are ubiquitous agents in the formation of Stone Age archaeofaunas. Although some previous research has been devoted to identification of the type of carnivore responsible for accumulating and modifying bones, they are often treated as a monolithic class of taphonomic actor. Differentiating the taphonomic signal of hyenids and felids is particularly important for understanding the formation of Early Stone Age sites and how the behavior of Plio-Pleistocene hominids fits within this framework. It is known that a key difference between these two carnivores is the extent to which they tooth-mark and fragment bones. Felids, as flesh specialists with comparatively gracile dentitions, tooth-mark and fragment bones at low frequencies relative to bone-crushing hyenids. What taphonomists lack, however, is a robust quantitative method for distinguishing the relative contribution of these two groups of carnivores to site formation. In an attempt to provide such a method, this project presents an analysis of several bone assemblages created by modern captive felids (lions, tigers, leopards, and mountain lions) and wild spotted hyenas. The goal of this analysis is to demonstrate whether tooth mark frequencies and measures of bone fragmentation reveal a consistent separation between the two types of carnivores. In addition to identifying characteristics of "pure" felid- and hyenid-modified bone assemblages, plotting various attributes along simple bivariate scatterplots provides a means of assessing where along the felid-hyenid continuum an assemblage of unknown derivation lies. This method is applied to important assemblages from Swartkrans Cave, South Africa (1.8–1.0 million years ago) and Olduvai Gorge, Tanzania (1.8–1.2 million years ago).

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Genetic Influence and Integration of Dental Traits

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The dentition and jaws are the most frequently used elements in assessment of phylogenetic status of fossil primates. However, the fundamental genetic architecture underlying variation in dentognathic traits is still poorly understood. Demonstration of significant genetic influence on trait variation is a necessity before traits can be meaningfully incorporated into phylogenetic analyses. Equally important is the identification of integrated or modular trait sets in order to eliminate biases resulting from trait redundancy. To examine the genetic architecture of dentognathic traits, dental impressions were taken of 195 members, ranging in age from 16 to 69 years, of the Jirel population of eastern Nepal. Arch width and length, as well as mesiodistal lengths of available teeth, were measured from dental casts using the software program Nemocast. Heritability (h2) was estimated for all variables using a maximum-likelihood variance decomposition approach. The trait mean and mean effects of the covariates age and sex were also simultaneously estimated. Most dentognathic measures were significantly heritable ($p<0.05$). Mesiodistal dimensions were moderately to highly heritable (mean h2 = 0.52). Dental arch length measures were more frequently significantly heritable than arch width measures, with approximately 45% of the variation in length attributable to genetic factors. Genetic correlations identified trait pairs sharing significant gene effects. Over 2,600 members of the Jirel population belong to a single pedigree which has been fully genome scanned. This pedigree provides an unparalleled opportunity for investigating the fundamental aspects of the genetic architecture of the dentognathic complex in a population with minimal access to dental care. Future work will combine these findings with our genetic epidemiological work on the craniofacial complex. The net result will be a set of synergistic studies that will complement and inform each other, allowing us to explore the mechanisms responsible for the evolution of the craniofacial complex in novel ways.

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New ESR Dates for a New Bone-Bearing Layer at Pradayrol, Lot, France

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Near Caniac-du-Causse, the Pradayrol site occurs in a large abri with fill reaching 10–15m. A test trench was excavated through four stratigraphic units, two of which yielded mammalian teeth for dating. More than 1,000 artifacts were found at Pradayrol, mostly sidescrapers made from quartzite or flint and flaking debris found in Layer 2A. The small tool size suggests in situ production and raw material parsimony. This Denticulate Mousterian tool kit is similar to that at La Borde. In 1999, in Layer 2A, an upper right permanent incisor from an adult hominid was found, which is comparable in size and features with the Neanderthal teeth from La Chaise-de-Vouthon. Also found in Layer 2A were numerous extinct Middle Pleistocene fauna, including *Dicerorhinus mercki*, *Equus mosbachensis*, *Canis etruscus*, and *Ursus deningeri*, all suggesting an age >150 ka. In order to determine an absolute age, four bovid teeth from Layer 2A were dated by standard and isochron ESR. Ages from 18 independent analyses suggest an average LU age for Layer 2A of 330±5 ka, which correlates with Oxygen Isotope Stage (OIS) 9. Isochron analyses suggest that U remobilization in the teeth occurred recently. New excavations in 2005 revealed another two layers below Layer 2A. Fauna in Layer 4B include *Ursus deningeri*, porcupine, hyenae, *Canis* sp., Marmota, equids, cervids, bovids, rodents, and many bats. Several enamel fragments and two partial teeth from Layer 4B were dated using standard ESR. Accumulated doses and U concentrations for teeth from this layer resemble those from Layer 2A. The sediment, however, shows more variation in radioactivity and sedimentary dose rates. Preliminary results from 10 analyses suggest that the ages for teeth in this layer are similar to those from Layer 2A. This suggests that Layer 4B also correlates with OIS 9.

Relative Genetic Distances Among Early Human Fossils as Indicated by 3D Morphology of the Temporal Bone

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Three-dimensional morphology of the temporal bone has been shown to reflect genetic distances among modern human populations and hominoid species. In this study, this knowledge was applied to early human fossils with the purpose of assessing their relative genetic distances to each other, to a comparative sample of 13 modern human populations, and to several Neandertal specimens. Nine ectocranial temporal bone landmarks were digitized on 12 early *Homo sapiens* casts and original fossils from Africa and Europe that were found to be complete for the regions of interest. Procrustes distances were then calculated and compared. Modern human populations were found to be very similar to each other in temporal bone morphology. Early human fossils, however, were widely disparate in morphology, and had larger average distances among specimens than was found among modern humans, indicating that early fossil humans likely were more genetically variable than modern humans. However, this is not surprising as the fossil sample spans a much greater time depth. The early human fossils did not cluster as a distinct group in a multidimensional scaling plot. Instead, they were dispersed around all sides of the cluster of modern human populations. Of the fossil specimens digitized, LH18 was most similar in temporal bone morphology to modern humans, followed closely by Oberkassel1, Langwith Cave, Brunn3, and CroMagnon1. Based on the fact that temporal bone morphology appears to reflect genetic distances in humans, these specimens were concluded to be more genetically similar to modern humans than specimens that differ substantially in temporal bone morphology. Seven Neandertals were also included in the analysis, and were found to be significantly different in temporal bone morphology from all modern human populations, but not from some of the early human specimens. European Neandertals were not more similar to modern Europeans than to any other modern human population.

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An Individual-Based, Comparative Advantage Model for Examining the Potential Benefits of Economic Specialization in Neanderthal and Early Modern Human Societies

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The demise of the Neanderthals and the survival of (anatomically) modern humans has been of continued interest to anthropologists for the last 100 years or so. One possible difference of importance between the two groups may be the level of economic cooperation. Here I present a model for quantifying the benefits of economic cooperation by examining all facets of productive, economic activity critical to survival of small groups in the severe climate of Europe in the late Pleistocene. The model is based on David Ricardo's Law of Comparative Advantage. Data from the prehistoric archaeological and physical anthropological records define the main economic parameters of the model: group size, task repertoire, and skill variation. Settlement patterns for both groups are based on individual

site data, climate, and periods of occupation. Climate records, as derived from ice-cores, terrestrial cores, and climatic reconstructions, define the climatic input for the model. The data suggests that early modern humans performed a wider range of activities and tasks, congregated in larger groups, and probably had a more diverse range of skills than Neanderthals. The model suggests that each member of the group benefits when tasks are assigned to those members most proficient in the performance of that task, and when the resulting outputs are equitably distributed among the members of the group. The model indicates that benefits that might have improved chances of survival were achieved by early moderns in the range of 18–20%, and by Neanderthals in the range of 10–12%. Settlement patterns in Europe indicate that early moderns were able to survive in higher latitudes and colder zones than Neanderthals. I argue that economic cooperation advanced during this period primarily as a response to the deteriorating climate of the time, and these behaviors enabled modern humans better to survive the unpredictable climate of the late Pleistocene.

Dental Development, Enamel Thickness, and Age at Death in the Scladina Cave Belgian Neanderthal

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More than twenty five years of continuous excavation in Scladina Cave, Belgium has yielded more than half of a juvenile Neanderthal dentition dated at about 100,000 ybp. The degree of development suggests that it is younger than Le Moustier 2, and older than juveniles from Hortus, Le Fate, and Obi-Rakhmat. The mandibular dentition, which is slightly advanced relative to the maxillary dentition, includes second molars that are close to clinical emergence. However, the maxillary and mandibular permanent second premolars are deep within their respective crypts. This is problematic for age assessment; most modern standards suggest a range of 10–12 years at death. However, a number of studies of incremental dental development suggest that Neanderthals experienced a slightly shorter developmental period than modern humans. This study assessed whether dental development and age at death in this individual support the proposed 'rapid Neanderthal developmental profile.' Long-period incremental features on tooth crowns and roots were quantified, and the duration of crown formation and root development were estimated. Enamel thickness was measured from microfocal computed tomography. Age at death was estimated using a range of modern human initiation ages; these were added to crown and root formation times. The numbers of long-period lines (perikymata) are similar to values from other Neanderthals and modern humans from South Africa, and are lower than values of modern humans from Northern England. Enamel thickness is thinner than modern human mean values, and similar to other Neanderthals. The age at death of this individual was lower than modern humans at an equivalent degree of development, suggesting that Neanderthals experienced earlier molar initiation than some modern human populations. These findings imply that age at death in juvenile Neanderthals should not be assessed by comparison with standards derived from Western European children.

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Neandertal Energetics Revisited: Insights into Population Dynamics and Life History Evolution

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Paleoanthropologists are increasingly utilizing energetic models to provide insights into hominin ecology and evolution. Energy dynamics represent a key interface between an organism and its environment; how energy is extracted from limited resources and allocated to various somatic functions has consequences for survival and reproduction. Within the past few years, several teams of researchers have reconstructed Neandertal energy budgets in order to address issues such as foraging efficiency, population density and spatial utilization, cold tolerance, and the replacement of Neandertals by modern humans. In the present paper, we revisit the issue of Neandertal energetics by systematically reviewing evidence for Neandertal energy expenditure and intake, which we interpret through the lens of recent developments in human biology and nutritional sciences. We estimate Neandertal energy expenditure and dietary needs by using published sex-specific body mass estimates coupled with physiological information on contemporary high-latitude populations. Comparative data suggest that three important factors contribute to high energy requirements in Neandertals: (1) adaptation to cold stress, (2) consumption of high meat, high protein diets, and, (3) high levels of physical activity. Contemporary northern populations have systematically elevated basal metabolic rates (BMRs) compared to lower latitude groups, an apparent adaptation to chronic and severe cold stress. In addition, field and laboratory studies suggest high dietary protein is associated with substantially increased metabolic heat production. Additionally, activity patterns among contemporary northern populations and Neandertal post-cranial morphology suggest relatively high physical activity levels. Thus, multiple lines of evidence point to extremely high energy requirements and intakes among Neandertals. The high turnover of metabolic energy in Neandertals likely had important implications for key aspects of life history, such as physical growth rates, age at reproductive maturity, and lifespan. Consequently, a detailed exploration of Neandertal energetics provides insights into hominin population dynamics during the Middle to Upper Paleolithic transition.

Using 3D Modeling to Differentiate between Notches Produced by Hammerstone Percussion and Carnivore Gnawing

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For researchers concerned with reconstructing hominin diet and ecology through faunal remains, it is critical to distinguish between hominin and carnivore bone modification. Hammerstone-on-anvil percussion produces notches, impact flakes, striae, and pits, but carnivore gnawing can produce a similar suite of bone modification characteristics as well. Researchers have attempted to find quantitative differences in the frequency and morphology of carnivore tooth and hominin produced notches (percussion notches) with linear and nonlinear methods. Persistent limiting factors include difficulties of accurately characterizing complex morphology with tools such as a goniometer, defining reference points of measurement that are replicable, and variation in size and geometry of the skeletal elements involved. We present results of an experiment to determine if morphological data derived from 3D models of notches produces less inter- and intra- observer variability than conventional methods, and if new measurement techniques afforded by 3D modeling can improve our ability to interpret causes of marks. In the first aspect of the project we collected data on angle release of hyena and human created notches using a goniometer, then created 3D digital models of the same notches using laser and touch scanners and used angle measurement techniques available with Rapidform 2006 surface characterization software to determine angle release values. The second aspect of the project involved testing the validity of the new methods that assess the complex variability across the notch surface. 3D model surface analysis software provides tools for characterizing 3D shape, including volume, reference geometry, and 3D cross section analysis. Application of these tools opens new ways of conceptualizing notch morphology that will better distinguish between human and carnivore created assemblages. We discuss the relative merits of these methodologies in terms of inter-observer variability and in terms of power to discriminate amongst notch types.

Hunting Technologies in the Middle Stone Age of South Africa: From the Stillbay to the Post-Howiesons Poort

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Between 80 and 35 ka three technocomplexes are documented in stratigraphic succession at sites such as Diepkloof and Sibudu—the Stillbay, the Howiesons Poort and the post-Howiesons Poort. All three technocomplexes have a wide distribution in South Africa, cover a relatively long span of time, from about 10 to 25 ka each, and are characterized by technological shifts between macrolithic and quasi-microlithic assemblages and discontinuities in tool production techniques. Technological analysis of materials from Blombos and Rose Cottage indicate that these changes are at least in part correlated with changes in hunting weaponry, from bifacial spear points shaped from flakes or blocks to small backed pieces made almost exclusively on blades, and to unifacial points made on flakes with a variable amount of retouch. Morphometric and impact fracture analyses suggest that the Stillbay and post-Howiesons Poort points were on the whole used for thrusting or throwing spears. The Howiesons Poort toolkit was dominated by backed blades although not all can be considered as hunting weapons. The MSA technological shifts and diachronic changes in hunting weapons combined with stability in some domestic tool models seem to prefigure the changes in weaponry and alternations in technological behaviors seen in the LSA and in European Upper Palaeolithic sequences. The hypothesis that the HP segments were arrowheads is discussed.

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Continuity and Change in Technological and Economic Strategies During the Middle and Upper Paleolithic in the Brive Basin Region of Southwestern France

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Over a century of archaeological research in the Brive Basin region of southwestern France has produced evidence of atypical Paleolithic industries probably due to a lack of abundant and high-quality local lithic raw materials. Other environmental factors made this small natural basin attractive for Paleolithic hunter-gatherers as reflected by the high density of Paleolithic sites. Lithic assemblages from eight distinct sites were analyzed in order to test a series of hypotheses regarding changes in lithic raw material procurement patterns and techno-economic strategies from the Middle Paleolithic to the end of the Upper Paleolithic. These assemblages are all located in a 10km radius and document all the industrial techno-complexes classically defining the Middle and Upper Paleolithic of Western Europe, including Chatelperronian assemblages from the site of Grotte du Loup. This study focused on typical expectations regarding shifts in lithic raw material use during the so-called Middle to Upper Paleolithic transition. One of these expectations is the increase in the use of non-local lithic raw materials during the first phases of the Upper Paleolithic. However, in the assemblages studied, it appears that, if variations in lithic raw material distribution in the different technological and typological categories are observed, these differences do not reflect a clear tendency towards the increasing use of non-local raw materials starting with the Upper Paleolithic.

In fact, alternate hypotheses focused on the relationship between raw material distance and stone tool use intensity are better able to account for differences in raw material frequencies.

Is There an Optimal Speed of Human Running?

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It is widely believed that, while there is an energetically optimal human walking speed, the cost of running a given distance (cost of transport) does not change with speed. In contrast, it is widely supposed that the cost of quadrupedal locomotion has optimal speeds within each gait based on data on the domestic horse (Hoyt and Taylor 1981). Carrier (1984) and more recently Bramble and Lieberman (2004) have argued that the lack of an optimal speed for human running may have given our ancestors an advantage in being able to select from a range of efficient speeds when using endurance running to exhaust, and then kill, quadrupedal prey. The works widely cited as establishing the speed invariance of the cost of transport in human running (Boje 1944; Margaria et al. 1963; Menier and Pugh 1968; Cavanagh et al. 1977), however, were not designed to detect small differences in the cost of running at a range of speeds. Here we report the results of a study in which we measured the rate of oxygen consumption (VO_2) and carbon dioxide production in human subjects running at a wide range of speeds (7.2–17.7 m/s). We collected gases for five minutes per speed and averaged data for the last two minutes to get the VO_2 value for that trial. We find that curvilinear models of cost with speed consistently have higher r^2 values than those for linear models of the same data. Across all subjects, the curvilinear model averaged r^2 values of 92.14, while the linear model resulted in an r^2 value of 57.15. Thus the relationship of cost and speed is curvilinear in human running, resulting in an energetically optimal speed for each individual.

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The Gravettian Infant Burials from Krems-Wachtberg, Austria

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Within the last decade the Prehistoric Commission of the Austrian Academy of Sciences focused on the investigation/re-investigation of Paleolithic sites in eastern Austria. Among the documented find-spots, the settlements of Krems, Krems-Hundssteig, and Krems-Wachtberg became a particular concern. In 2005 and 2006, two burials of infants, dated to 27,000 years, were discovered at the Gravettian open air site of Krems-Wachtberg. While Upper Paleolithic graves of adults are extensively documented, burial evidence of pre-adolescents is rare and arguments concerning the putatively different treatment of adults and infants abound. The recently discovered infant burials at Krems-Wachtberg were abundantly covered with red ochre and decorated with ornaments, implying clearly that these are deliberate burials associated with a ritual, and furthermore emphasizing that even newborns were considered full members of Gravettian hunter-gatherer communities. They substantially enrich the debate about rituals and document that infants were considered full members of hunter-gatherer communities. Furthermore, they enlarge our sample size of human fossil remains and help resolve issues of ontogeny of early modern humans. The present contribution deals with practical aspects, e.g., the conservation practices used, restorative aspects, and taphonomic issues; moreover using CT- and laser techniques, we will discuss the first morphometric investigations and results of comparative analysis.

Morphological Affinities of the Wrist of *Homo floresiensis*

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The shape of the trapezoid in *Homo sapiens* is derived in comparison to the shape in other primates. Whereas the trapezoid of nonhuman primates is shaped like a pyramidal wedge (the narrow tip is palmar while the wide base is dorsal), that of *H. sapiens* is boot-shaped, resulting from a radio-ulnar and proximo-distal widening of the palmar half of the bone. The human trapezium, scaphoid, capitate, and second metacarpal base exhibit a derived complex of features that correlates with the distinctive shape of the trapezoid. Current paleontological evidence indicates that this derived complex of features evolved as early as 800,000 years ago and is a synapomorphy of *H. sapiens* and *Homo neanderthalensis*. The *Homo floresiensis* type specimen (LB1) includes a trapezoid, scaphoid, and capitate, all well-preserved and non-pathological. These small carpals display none of the aforementioned shared, derived features of *H. sapiens* and *H. neanderthalensis*. Rather, these bones are morphologically identical to the conditions seen in all African apes and in *Australopithecus afarensis*. The trapezoid is wedge-shaped with a small, dorsally-placed facet for the capitate and a large, triangular-shaped facet for the scaphoid, while the capitate and scaphoid exhibit the morphology that is typically correlated with the primitive trapezoid condition. As might be expected, the scaphoid and os centrale of *H. floresiensis* are completely fused, which is a synapomorphy of *Gorilla*, *Pan*, and *Homo*. The primitive carpal morphology of *H. floresiensis* is not consistent with hypotheses of a congenital or developmental abnormality afflicting a modern *H. sapiens*. Rather, the evidence is more consistent with hypotheses that *H. floresiensis* is descended from a hominin ancestor that migrated out of Africa prior to the evolution of the shared, derived carpal morphology characteristic of *H. sapiens* and *H. neanderthalensis*.

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The Archaeological Potential of the Northern Kenyan Rift Valley: New Middle Stone Age Sites from the Kapedo Beds

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Large portions of the Rift Valley in Kenya remain archaeologically unexplored, despite the long research history and number of projects in this region relative to other areas in Africa. Artifacts recovered from our 2006 survey of the Kapedo Beds conclusively demonstrate the still largely untapped potential of northern portions of the Kenyan Rift Valley. They also provide an important reference point to assess the extent of regional patterning of hominin behavior among Middle Stone Age sites. The Kapedo Beds (1°04′N, 36°05′E) are geographically intermediate between the better studied Baringo and Turkana basins, and consist of Pleistocene alluvial and volcaniclastic sediments, the latter derived from the adjacent volcano, Silali. Prior $^{40}Ar/^{39}Ar$ analyses of volcanic material from Silali (Smith et al. 1995) suggest an age range of ~220,000–123,000 years ago for the deposition of the Kapedo Beds. We recovered archaeological traces from five localities in the Kapedo Beds. Excavations at two of them produced in situ lithic assemblages interstratified with tephra. The artifacts from these localities show use of Levallois, discoidal, and other methods of flake production, include a bifacially flaked pick, and preserve refitted artifact sets that consist of both surface and excavated material. All are consistent with a Middle Stone Age attribution. Our petrographic comparison of dated tephra deposits from Silali with those from excavated archaeological sites indicates a potential correlation, and thus increased chronological control. We test this tephra correlation using compositional microanalyses by electron microprobe.

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Comparative Anatomy of the Hominid Mandibles from Dmanisi, Georgia

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In recent years the site of Dmanisi, Georgia, has yielded a remarkable collection of well preserved fossil hominids from a geographically and temporally circumscribed Lower Pleistocene locality. The preservation of complete or near complete elements from multiple individuals within the locality allows for extensive comparisons of variability both within the site and with other terminal Pliocene/Lower Pleistocene fossil sites. Within the hominid sample from Dmanisi, the current sample of four mandibles provides the most striking array of variation. The sample includes one of the largest Pleistocene *Homo* mandibles (D2600), one of the smallest Lower Pleistocene mandibles (D211), a nearly complete sub-adult (D2735), and a completely edentulous specimen (D3900). This paper provides a detailed survey of the comparative anatomy of these specimens. Explanatory hypotheses for the Dmanisi variability are considered in the context of anatomical variation observed in other Plio-Pleistocene hominid samples as well as extant apes and humans. Our results suggest that despite the variability observed within the Dmanisi sample, the mandibles present several unique or rare shared features that serve to distinguish the sample from other Plio-Pleistocene samples. Additionally, the anatomical variation within the site fits the expectations, in pattern, of variation associated with age and possibly sexual dimorphism, but, in range of anatomical variation, it exceeds that found in most comparable samples.

Population Specific Tools for Sex Diagnosis of Upper Palaeolithic and Mesolithic Hominids from Europe

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Reliable sex estimation of fossil *Homo sapiens sapiens* is crucial in bioarcheological studies. The adult hip-bone (os coxae) is the best non-population-specific indicator for reliable sex determination, however this bone is often damaged or missing in prehistoric samples. The use of other bones is limited by the population specific nature of metrical methods defined on reference human skeletal samples. Previous studies have shown that the shift in sexual dimorphism pattern led to a majority of males in identification (Bruzek et al. 2004). To avoid these methodological problems an approach using primary and secondary sex diagnosis (Murail et al. 1999) was applied to 99 European specimens from the Gravettian to the Mesolithic. This approach is based first on a reliable sex diagnosis from os coxae and secondarily on population specific discriminant analyses (PSDA). These PSDA, using 14 extra-hip-bone measurements (humerus, femur, and talus), were employed on unknown sex subjects in the first instance. We determined by primary diagnosis 23 females and 27 males, with a very high accuracy. In a secondary diagnosis with PSDA, an accurate determination for 25 additional skeletons was reached. Finally we obtain a sex determination for 76% of our sample (37 females, 38 males), and previous sex attribution for eight individuals was changed. This specific tool of sexual diagnosis, with a high sex allocation rate and accuracy, can now be improved by a completion of the database with other skeletons and more non-pelvic metrical data.

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First Look at a Neandertal Birth Canal

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We present a virtual reconstruction of the female Neandertal pelvis from Tabun, Israel. For the first time it is possible to examine the dimensions of a Neandertal birth canal. Comparing our Tabun reconstruction with the nearly complete male Neandertal pelvis from Kebara, Israel, also gives insight into sexual dimorphism in Neandertals. We produced our virtual reconstruction by: (1) computed tomography (CT) scanning the original Tabun pelvic fragments, which comprise parts of the left and right ilium, ischium, and pubis; (2) virtually removing the filling material and metal rods used in the original reconstruction, the femoral head from the right acetabulum, and the heavily distorted regions; (3) fitting the right- and (mirrored) left-sided fragments together by matching overlapping anatomy using a surface alignment algorithm; (4) estimating the dimensions of the sacrum using an expectation-maximization algorithm based on landmarks collected on the preserved anatomy and a large modern human reference sample; (5) orienting the right hemi-pelvis in standard anatomical position; and, (6) mirroring the about the mid-line to produce the left side. Using a sample of 231 recent humans, the Kebara pelvis, and our Tabun reconstruction, we conducted univariate analyses of distances and angles as well as multivariate geometric morphometric analyses of three-dimensional landmarks. Our preliminary results show similarities between Tabun and Kebara, and further suggest that evolution may have produced in Neandertals and modern humans two somewhat different solutions to increased constraints on the birth canal imposed by expansion in brain size relative to body size during the last few hundred thousand years.

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Earlier and Middle Stone Age Prepared Core Reduction Strategies at Kudu Koppie, Northern South Africa

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The lowermost level of the site of Kudu Koppie in the Limpopo River Valley of South Africa yields a terminal Earlier Stone Age industry containing core-axes and described as a local variant of the Sangoan industry (Kuman et. al. 2004, 2005). A small flake-based MSA industry containing retouched points overlies the Sangoan levels. Both culture-stratigraphic units contain prepared cores. The aim of this paper is to describe the lithic reduction strategies employed in the Limpopo River Valley and relate these strategies to the variables of time and raw material. Though the prepared cores recovered from Kudu Koppie are morphologically different from "tortoise-shell" Levallois cores of Europe, it is my position that they reflect the application of the same principles inherent in the Levallois Volumetric Concept (Boëda 1995). A technological analysis of the prepared cores and end-products of Kudu Koppie suggests that both the Sangoan and MSA toolmakers employed the Levallois Volumetric Concept, but often exploited a nodule's natural convexities and form. The MSA toolmakers used a greater variety of prepared core methods and intensely exploited chert nodules, the scarcity of which may have resulted in a more "formalized" application of the Levallois Volumetric Concept. These observations are considered in light of their cognitive and economic implications, and within the context of the behavioral modernity debate.

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Geological and Tectonic Framework for the 3.8–0.6 Ma Dikika Research Project Area, and its Implications for the Study of the Paleoenvironments of Human Evolution in the Afar Depression, Ethiopia

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The Dikika Research Project (DRP) area has produced two recently reported hominin discoveries, the most remarkable of which is an exquisitely preserved early juvenile *Australopithecus afarensis*, dubbed "Selam." Sediments in this research area overlie the Dahla Series Basalts (DSB; 8–4 Ma), and are interstratified with other volcanic units that have already provided age constraints on the Hadar and Busidima Formations, both of which are exposed in their entirety in the DRP area. The oldest identified tephra correlates to a unit dated at 3.8 Ma while the youngest correlates to a unit dated at 0.6 Ma. Given these age constraints, and additional geological and sedimentological data from the DRP, we are able to reconstruct a geological and tectonic history for the region. Sedimentation begins in the Basal Member of the Hadar Formation, which is deposited on a faulted and deeply weathered surface of the DSB in a sedimentary basin which was actively extending along faults which parallel the Red Sea Rift System. Facies in the Basal Member indicate a shallow fluctuating lake with a shoreline developed on the eroded basalt surface. Later sediments in the remainder of the Hadar Formation indicate the progressive infilling of this basin and the migration of the shoreline northwards towards the basin axis, with several brief transgressions southwards. Following 2.9 Ma, the DRP area is subjected to uplift along a series of faults that parallel the Ethiopian Rift System, while the sediments are eroded along a plane of angular unconformity with the underlying Hadar Formation. Following 2.7 Ma, the basin axis shifts both in character and position and the newly developed basin is filled with sediments of the Busidima Formation. This basin is defined by the rotation of an asymmetric half-graben around an identifiable border fault, consistent with active tectonics of the Ethiopian Rift. Sediments deposited in the Busidima Half-graben thicken towards the border fault and record the migration of the paleo-Awash River across its floodplain in response to this new tectonic setting. Depositional environments of these two basins are markedly different, while other environmental variables such as the proportion of C_4 grasses recorded by paleosol carbonates reflect the changes in basin characteristics. These local environmental changes are superimposed on the global and regional records of climate change. These findings highlight the fact that only through a greater understanding of both the tectonic and climatic controls on hominin paleoenvironments will we understand the role of the environment in human evolutionary patterns.