A New Late Pliocene Fauna from the Mille-Logya Project Area, Afar Regional State, Ethiopia

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The Mille-Logya Project (MLP) was initiated in 2012 when a small team reconnoitered areas north of the Ledi-Geraru and northeast of the Woranso Mille research areas in Ethiopia. Subsequently, three field seasons conducted in 2014 and 2015 resulted in the recovery of over 1,200 fossil specimens representing a diverse fauna, including hominins. The faunal assemblage reflects more open environments compared to nearby sites such as Hadar and Dikika, as shown by the abundance of alcelaphin antelopes, *Theropithecus*, and equids, and the relatively low frequency of suids and tragelaphins, and the absence of arboreal monkeys. Biochronological and radioisotopic ages suggest the main fossil-bearing sediments date largely to between 3.0 and 2.4 Ma. Fossil preservation is somewhat patchy, but several dense accumulations of fossils derive from sections of tens of meters of sediments exposed largely between two sequences of basalts, with the exception of a few localities in intra-basalt sediments within the lower part of the sequence. The sedimentary strata begin with diatomite and laminated mudstones with abundant invertebrate indicators of stable lake conditions, followed by shallow lake and low-wave energy littoral deposits with periodic alluvium. In the upper part of the sequence, flows of the Afar Stratoid Series Basalts are interspersed with the sediments, and dominate after 2.4 Ma. The MLP area is particularly important for representing a time interval that is poorly known in eastern Africa outside the Omo-Turkana Basin, during which several key events in human evolution occurred, including the emergence of *Homo* and *Paranthropus*. Further fieldwork at MLP will help elucidate our understanding of pivotal anatomical and behavioral transitions from *Australopithecus afarensis* to other species, as well as document the faunal and environmental context in which these transitions occurred.

Is Neanderthal-Human Genetic Admixture in Eurasians Actually African Ancestry?

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Inference of Neanderthal-modern human genetic admixture by Green et al. (2010) is based on the analysis of two individual African genomes (Yoruba and San), one European (French), one East Asian (Han Chinese) and one southern Australasian (Papua New Guinea). The logic of their inference of admixture is based on the assumption that the genetic variants shared among Neanderthals and modern Eurasians, but not present in the Yoruba and San individuals reflects 2–4% Neanderthal-Eurasian admixture. If Yoruba and San fully represented the genomic diversity of all Africans, then a sample of two individuals would be adequate for ascertaining African sequence diversity. However, African genetic diversity is highly structured geographically, so a sample of two individuals from the continent with the deepest genetic structure is obviously inadequate. It excludes the northern and eastern half of Africa, which is unambiguously demonstrated by mtDNA to be the source area for Eurasian populations. Inference of Denisovan-Eurasian admixture (Krause et al. 2010) is also weak because northern/eastern Africans are excluded. By defining what is African DNA on the basis of only southern and western African genomes, northeast Africans are automatically identified as admixed rather than as modern representatives of the ancestors of Eurasians. For example, Wall et al. (2013) concluded that the Maasai of Kenya have 1–3% Neanderthal admixture, while the Luhya of Kenya, who have recent West African ancestry, show no admixture. If the Green et al. (2010) and Krause et al. (2010) analyses were repeated, adding northern and eastern African populations, how much of the inferred archaic admixture with Eurasians would be subtracted? Would the likely smaller number of remaining variants shared among Eurasians, Neanderthals, and Denisovans be significantly different from that expected from genetic drift? Neanderthal admixture with modern humans should be considered unproven until this analysis is repeated with more African populations.

References Cited

Green, R.E., Krause, J., Briggs, A.W., Maricic, T., Stenzel, U., Kircher, M., ... & Mullikin, J.C. 2010. A draft sequence of the Neandertal genome. *Science* 328: 710–722.
Krause, J., Fu, Q., Good, J.M., Viola, B., Shunkov, M.V., Derevianko, A.P., and Pääbo, S. 2010. The complete mitochondrial DNA genome of an unknown hominin from southern Siberia. *Nature* 464: 894–897.
Wall, J.D., Yang, M.A., Jay, F., Kim, S.K., Durand, E.Y., Stevison, L.S., ... & Slatkin, M. 2013. Higher levels of Neanderthal ancestry in East Asians than in Europeans. *Genetics* 194: 199–209.

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JA-53, a Big Fossilized Isolated Lower Incisor from Sangiran, Indonesia

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JA-53 is an isolated fossilized tooth which was found accidently by a local inhabitant somewhere around Sangiran. Therefore, its location and stratigraphical position is unclear. JA-53 preserves the crown and root and it looks like a lower first or second incisor (LI1 or LI2). Furthermore, in terms of its crown and root colors (dark grey and black), it seems that JA-53 might have come from the upper part of the Pucangan (Sangiran) Formation. In the context of faunal succession on Java, this specimen can be included as a member of the Trinil H.K (ca. 0.9 Ma) or Cisaat (ca. 1–1.2 Ma) faunas. Its crown size is the biggest when compared to the size of lower first and second incisors of *Pongo pygmaeus palaeosumatrensis*, *Pongo pygmaeus pygmaeus*, and *Pongo pygmaeus* from Vietnam. So, if JA-53 is a *Pongo* tooth and if its age is really very old, it would be important for reviewing the existence of Lower-Middle Pleistocene *Pongo* in Java (Sangiran) and the origin of *Pongo* in Southeast Asia. In this paper, I will discuss the application of rare earth element analysis to solve the stratigraphical problem of JA-53 and the importance of this specimen.

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Signal or Noise? Testing Hypotheses about Faunal Turnover with Implications for Human Evolution

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Patterns of faunal turnover (origination and extinction events) in the bovid fossil record have been used as evidence for the impact of global climate change on mammalian and human evolution. Specifically, the Turnover Pulse Hypothesis links intervals of elevated turnover to periods of climate change, with implications for the origins of *Homo*, and the extinction of *Australopithecus*. However, studies investigating turnover rates have yielded mixed results on different datasets. Furthermore, relatively little attention has been given to investigating how commonly intervals of elevated turnover are expected in noisy datasets, and thus the biological importance of the observed patterns of turnover in the fossil record remains unclear. This study uses simulations of turnover in which origination and extinction rates for each species are held constant. While the probability of species turnover does not change through time, the number of turnover events per time bin may nonetheless vary stochastically, producing statistical "noise" in the dataset of turnover rates. Several parameters are varied in the simulations: overall sample size, number of time bins, extinction rate, and the criterion for defining a turnover pulse. Results suggest that the size of the time bins and the turnover pulse criterion both have pronounced effects on how often "pulses" are detected under the null model (in which no meaningful pulses exist). Simulations with parameters derived from empirical studies of the African bovid fossil record suggest that apparent "pulses" of turnover may be quite common under some simulation conditions, indicating that constant turnover probabilities can nonetheless produce intervals of elevated turnover comparable to those observed in the fossil record. These results support recent conclusions (Bibi and Kiessling 2015) that the African bovid fossil record is best characterized by relatively continuous turnover rates.

References Cited

Bibi, F. and Kiessling, W. 2015. Continuous evolutionary change in Plio-Pleistocene mammals of eastern Africa. *Proceedings of the National Academy of Sciences USA* 112: 10623–10628.

Preliminary Findings of 3D Analyses of the Costal Remains of *Australopithecus sediba*

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The thorax of *Australopithecus sediba* is hypothesized to follow a mosaic evolutionary pattern showing a greater similarity with *Australopithecus afarensis* and great apes in the upper thorax and a greater similarity with humans at the lower thorax and waist (Berger et al. 2011; Schmid et al. 2013). This study presents first results of a comparative analysis of the *Australopithecus sediba* costal material using 3D geometric morphometrics. Twenty landmarks and semilandmarks were measured at the external outline of 3D rib reconstructions of computed tomography scans from ribcages of modern humans and extant apes and compared with costal remains and virtual reconstructions of MH1, MH2, and AL-288-1. Shape data were generated by generalized Procrustes superimposition and analyzed by Principal Components analyses. Our results point to ribs with an uncurved and un-torsioned overall shaft geometry, which is compatible with the hypothesis of a funnel shaped upper thorax in this species (Schmid et al. 2013). However, our analyses also suggest that shaft morphology alone may not be sufficient to comfortably predict overall rib cage morphology. This is because the morphology of the head-neck complex and the shaft, which are fully preserved in the first ribs of the *Australopithecus* sample, indicates a greater similarity between *Au. sediba*, AL-288-1, *Hylobates*, and humans than with great apes. These findings could indicate that hypotheses on early hominin thorax shape should consider also "emergent" morphological features when putting together elements of anatomical complexes such as ribs and vertebrae. Thus, in order to improve hypotheses on the rib cage morphology of *Au. sediba*, costal analyses should be combined with shape analyses of the vertebrae and the manubrium.

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References Cited

Berger, L.R., de Ruiter, D.J., Churchill, S.E., Schmid, P., Carlson, K.J., Dirks, P.H.G.M., and Kibii, J.M. 2010. *Australopithecus sediba*: A New Species of *Homo*-Like Australopith from South Africa. *Science* 328, 195–204.

Schmid, P., Churchill, S.E., Nalla, S., Weissen, E., Carlson, K.J., de Ruiter, D.J., and Berger, L.R. 2013. Mosaic Morphology in the Thorax of *Australopithecus sediba*. *Science* 340.

SIMS Reveals Diagenesis and Seasonal Paleoprecipitation: A New Method for Reconstructing Past Environments

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One goal of paleoanthropolgical inquiry is to reconstruct past environments. This presentation will highlight a new method to identify paleoprecipitation records from the stable oxygen isotope values (δ^{18}Oen) recorded in tooth enamel. Seasonal rainfall patterns are reconstructed using a secondary ion mass spectrometer (SIMS) to generate high-resolution serial spot analyses (13µm spots) of δ18Oen. Additionally, this presentation will address the specific issue of identifying diagenesis (post-depositional alteration) in tooth enamel, a material that has long been assumed to be resistant to diagenesis. Previous research identified chemical changes in the tooth enamel crystal structure using cathodoluminescence (CL). It is unclear whether changes identified by CL correspond to altered isotope ratios in the enamel. It was not until technological advancements with instrumentation, such as SIMS, that the question of diagenesis in enamel could be addressed directly because oxygen isotope values could not be measured at a high enough resolution to test this question. The aim of this research project is to identify areas of enamel diagenesis and use the data from unaltered enamel regions to reconstruct the seasonal patterns of rainfall at Allia Bay, Kenya (3.97 Ma), an early hominin site where *Australopithecus anamensis* remains have been recovered. The fossil fauna samples represent intra-annual variation with the approximate range of amplitude difference in seasonal change in oxygen isotope values being as follows: browsers=3.0‰; grazers (suidae and bovidae)=2.5‰; hippopotamidae=1.5‰. This snapshot of seasonal rainfall recorded at Allia Bay suggests a great amount of variation in the source oxygen isotope values that would have been available when *Au. anamensis* occupied the site.

Hominins in Context — Paleogeography and Ecology of the Okote Member, Koobi Fora Formation, East Turkana

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Sedimentology, stable isotopes, and trace fossils allow unusually detailed paleoenvironmental reconstruction of the Ileret Tuff Complex (ITC), an 8–9m unit within the Okote Mb, dated at 1.53–1.51 Ma. The ITC preserves abundant vertebrate fossils and trackway surfaces, with two hominin taxa represented by body fossils and at least one (probably *Homo erectus*) recorded in multiple footprint levels. Fluvial and lake margin deposits alternate with paleosols, representing multiple cycles of deposition and subaerial exposure within a time span of ~20 Ka. Vertebrates are preserved in fluvial, deltaic, and lake margin sediments. The ITC is an unusually rich source of fossil primates, bovids, suids, and other ungulates. Systematic fossil surveys indicate spatial differences in faunal composition across

small distances (~5km), with more aquatic vertebrates toward the west and more terrestrial mammals toward the east. Stable isotopes in ITC paleosol carbonates indicate dominant C_4 (grass) with some C_3 (bush, trees) vegetation. $\delta^{13}C$ analyses of tooth enamel from a range of mammalian herbivores show diets dominated by C_4 vegetation, with relatively few C_3 taxa. The combined faunal and stable isotope evidence from the ITC indicates grassland habitat with areas of woodland and bush. The preserved trackways provide evidence for numerous mammal species as well as crocodile and large birds that indicate the proximity of a large body of water. This is consistent with the sedimentology of the trackway surfaces, which formed near a relatively stable base level indicating a permanent lake. Okote Mb. deposits 50km to the south provide additional evidence for an extensive lake between ~1.6 and 1.4 Ma in the Turkana Basin. The presence of this lake and the short-term transgression and regression cycles in the ITC represent different scales of tectonic and/or climatic controls that interacted to form the Okote Mb. and preserve its rich paleontological record.

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Computed Tomography Survey of Supernumerary Molars in Extant Orangutans with Implications for Studies of the Primate Fossil Record

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Supernumerary teeth have been reported in a wide range of fossil primate taxa including Eocene adapoids, Plio-Pleistocene hominins, and other non-human hominids. In modern humans, a review of the literature shows that polydontia is less common than agenesis, more frequent in males than in females, and generally occurs at frequencies of less than 5%. Within extant non-human hominids, however, percent incidence of supernumerary teeth varies, with the overall pattern being *Pongo* > *Gorilla* > *Pan*. Within the genus *Pongo*, values reported generally range between 6 to 20%. Results from a previous visual survey of specimens held at the Cleveland Museum of Natural History, the American Museum of Natural History, and the Smithsonian National Museum of Natural History, revealed a similar pattern between genera, and a percent incidence of 7.1% in orangutans (Campbell 2013). In these types of surveys, however, unerupted molars or other dental anomalies that are not externally visible will be missed, thus potentially underestimating their occurrence. In this study we, examine 78 orangutan specimens from the Smithsonian National Museum of Natural History using computed tomography scans. Of these, 60 were represented by skulls, 11 by crania, and seven by mandibles. Results from this analysis showed a 10.3% incidence of specimens possessing supernumerary molars. Additionally, a previously unidentified supernumerary right mandibular fourth molar was found in a specimen of *Pongo pygmaeus* (USNM 142195). This specimen has been studied for over 100 years (Hrdlicka 1906) without the mandibular supernumerary being recognized. These results suggest that similar structures and anomalies may be missed in both modern and fossil specimens, including those that are well studied. Furthermore, this demonstrates the value of using modern digital imaging technology in identifying internal features and serves as an example of how readily accessible digital data can lead to new discoveries.

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References Cited

Campbell, T.L. 2013. A survey of the frequency of supernumerary teeth in non-human hominids. *American Journal of Physical Anthropology* 150(S56): 93.
Hrdlicka, A. 1906. Anatomical observations on a collection of orang skulls from Western Borneo; with a bibliography. *Proceedings of the U.S. National Museum* 31: 539–568.

ESR Dating the Fossil-Bearing Layers at the Marathousa 1 Site, Megalopolis, Greece

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In the Megalopolis Basin, the Middle Pleistocene Marathousa Member contains lacustrine clastic beds alternating with lignite seams deposited in a shallow lake or marsh. Previous geological studies suggest that clastic units correlate with colder periods, while lignite beds formed during interglacial periods. In the Marathousa Member, the Marathousa 1 site yielded stratified lithic artifacts and bones, including teeth recovered from Excavation Unit 4 between Lignite Seams II and III, deposited in a low-energy shallow swamp on a lacustrine margin. Fauna included Middle Pleistocene *Elephas* (*Palaeoloxodon*) *antiquus*, cervids, bovids, micromammals, turtles, and birds. Taphonomic data suggest that the faunal and lithic material have experienced minimal post-depositional displacement. Since ESR can directly date fossils from 0.5 Ka – 2.0 Ma, one mollusc sample and five subsamples from one cervid tooth were independently dated by standard ESR. All ESR ages were calculated using time-averaged and volumetrically averaged external dose rates by modelling the dose rates assuming typical water depths for the mollusc species and sedimentation rates and cover thicknesses estimated from geological strata. For Excavation Unit 3, the ESR age for its bivalves set its minimum age at 414±42 Ka, which correlates with Oxygen Isotope Stage (OIS) 11. For the cervid molar AT39 from below Unit 3, standard ESR analyses indicate a maximum age of 637 Ka for the artifacts and fossils in Excavation Unit 4. Isochron analysis, however, suggest that AT39 had experienced some secondary U remobilization and an U uptake parameter, p=2. AT39 was dated at 484±13 Ka assuming p=2, which correlates with OIS 13. To ascertain that its age is accurate, AT39 should be dated with coupled ESR-^{230}Th/^{234}U. These results should be confirmed by ESR dating 4–5 more teeth from Marathousa 1.

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Correlation of Widespread Late Pleistocene Volcanic Ash Layers From Six Basins across Kenya and Their Relevance to Middle Stone Age Chronology

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Volcanic ashes (tephra) provide stratigraphic and chronological equivalence among paleoanthropological sites over much of East Africa. Robust tephrostratigraphic frameworks exist for Pliocene and Early Pleistocene sites, but comparatively few widespread correlations are known from the Late Pleistocene, an interval when the increased pace of technological change requires a refined chronology. We report two extensive ash layers from the Late Pleistocene of Kenya: 1) the Wakondo Tuff, and 2) the Menengai Tuff. The Wakondo Tuff is correlated >2000km^2 from the Baringo Basin (central Kenyan Rift) to Songhor, Rusinga Island, and Karungu in the eastern Lake Victoria Basin (eLVB) of western Kenya. Uranium/thorium and optically stimulated luminescence dates bracket this tuff to between 68 and 111 Ka. The Menengai Tuff is currently correlated over >115,000km^2 between the Baringo, Chalbi, Elmenteita, Nakuru, Turkana, and Victoria basins, as well as to the source, Menengai crater (Central Kenyan Rift). Radiocarbon dates in the eLVB and Lake Nakuru constrain the age of the Menengai Tuff to ~35 Ka. The Wakondo Tuff provides a minimum age for the Middle Stone Age sites of Songhor and Keraswanin (Kapthurin Formation) in the Baringo basin. Bifacial points, Levallois points, and Levallois cores recently found around and directly above the Menengai Tuff in the eLVB demonstrate the persistence of MSA technology in East Africa <35 Ka. Menengai Tuff correlations further provide a ~35 Ka isochronous layer in sediments of Turkana, the Chalbi, and eastern Baringo Basin where MSA archaeological sites are known but for which the stratigraphic and chronologic context remains underdeveloped. The Wakondo and Menengai Tuffs refine the chronology of sites in Kenya and lay the foundations for a Late Pleistocene tephrostratigraphic framework for East Africa.

Continued Research on Group Locomotion in the Laetoli Trackway: An Intriguing Case of Direct Register

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This presentation provides comparison of direct register walking of early hominins to humans and other primates by examining a five-meter section of the Laetoli trackway from Tanzania, Africa (Leakey and Harris 1987). The intent was to determine possible explanations for the high degree of direct register walking, defined as the act of walking in another individual’s footsteps, seen in the trackway, assumed to be made by a species of *Australopithecus*. The central question of the overall research is: Why do members of a species intentionally engage in direct register walking? More specifically, to what extent do non-human species, such as chimpanzees, exhibit this behavior, and can the reasons for the behavior be determined? Measurements from the Laetoli trackway map provided a standard to define a high degree of direct register (100 percent between three individuals) using maximum track misalignment in longitudinal and

lateral axes (Boyd 2012). Video analysis of group movement of Anatomically Modern Human (AMH) hikers at Mt. St. Helens (Boyd 2014), and chimpanzees in Guinea Bossou (Hockings 2011; Yamamoto 2011) each produced direct register values that were compared to that of the Laetoli group. Results suggest that the AMH hikers and chimps did not engage in direct register walking as frequently as the Laetoli group, and that any resulting moderately high percentages of direct register walking that did occur were unintentional. The results also suggest that proximity, individual stature, and relationship may have an effect on direct register percentage between individuals, indicating that the Laetoli example of 100 percent direct register appears to be intentional. In light of this analysis, future research could be directed toward how much cognitive ability is needed in a species with a chimpanzee-size brain to exhibit such a behavior, and how that may have contributed to the process of becoming human.

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References Cited:

Boyd, Jon R. 2012. Analysis of the Laetoli Trackway: New Interpretations. Poster presentation to the Paleoanthropology Society, 17 April, 2012, Memphis, Tennessee.
Boyd, Jon R. 2014. Laetoli Research Update No. 2: Generating New Research Questions. Talk presented at Southern Arizona Social Sciences Symposium, 3 May, 2014, Tucson, Arizona.
Hockings, Kimberly J. 2011. Guinea Bossou chimpanzee road crossing videos. Oxford Brookes University, Oxford.
Leakey, Mary D. and Harris, John M. 1987. *Laetoli, a Pliocene site in Northern Tanzania*. Oxford University Press, Oxford.
Yamamoto, Shinya. 2011. Guinea Bossou Chimpanzee road crossing videos selected for initial study. Kumamoto Sanctuary, Kyoto University, Kyoto.

Chimpanzee Tool Use Involves an Understanding of Mechanical Properties of Stones: A Comparison with the Oldowan Archaeological Record

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A consistent feature of early Pleistocene artifact manufacture is the systematic selection of certain lithologies. Until recently there have been few systematic investigations of the mechanical properties that governed hominin raw material selection. There is little understanding of the mechanisms underlying these selection patterns. Unlike Pleistocene hominin behavior, chimpanzee behavior can be observed. Here we present data on observed stone selection by wild chimpanzees at Bossou, Guinea Conakry. This stone tool-using population has been studied for 40 years with 25 years of data on nut-cracking behavior collected in a natural experimental setting, in the core range of this community. Stone weight and size have been observed to affect tool selection. Little is known about how chimpanzees may discriminate between different lithologies. At the outdoor laboratory, at Bossou, we investigated tool selection among a group of wild chimpanzees. We provided the Bossou chimpanzees with rock types preferred by hominins to make stone artifacts at the site of Kanjera South, Kenya (ca. 2 Ma). These rock types are not available in the Bossou habitat. We investigated chimpanzee selectivity by calculating indices of selection based on the use of different rock types relative to rock type availability. Engineering tests of rock properties allow us to link selection patterns to specific material properties. Tool selection by chimpanzees correlates with rock mechanical properties even though these mechanical properties are not visibly distinct. This discrimination is evident from active selection of specific rock types. Chimpanzee selection differs depending on tool functionality (hammer vs. anvil). This pattern is enhanced amongst adult individuals with greater efficiency and skill in nut cracking. We compare patterns of selection between chimpanzees and the hominins at Kanjera South. The ability to consistently recognize and act on the mechanical properties may be a feature that is common to hominin and panin tool use.

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Identifying Diagnostic Criteria of Cut Marks on Experimentally Butchered Bones: A Methodological Comparison

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Cut mark analysis is an important part of interpreting hominin involvement with faunal assemblages. Distinguishing cut marks from other types of bone surface modifications relies on diagnostic features, but morphological variation between marks may lead to misclassification. The purpose of this study is to assess the presence of commonly used defining criteria in the morphology of known cut marks. These criteria include being V-shaped in cross section, straight in trajectory, elongate, presence of a barb, exhibiting shoulder effects, and displaying shoulder flaking. We scored these six criteria for 84 cut marks on juvenile domestic pig bones modified by an experienced and inexperienced butcher and calculated inter-analyst correspondence rates across two trials. Trial 1 consisted of scoring

43 cut marks as novice cut marks identifiers, while Trial 2 was performed as expert identifiers for 41 cut marks. Although most marks are V-shaped in cross section, straight in trajectory, and elongate, a majority of cut marks did not exhibit one or more of the diagnostic criteria. Complete correspondence of the state of all six features improved from 33% in Trial 1 to 61% in Trial 2. It is likely that the structural traits of juvenile bone had a strong effect on cut mark morphology and criteria scores. There was a noticeable difference in correspondence on mark diagnosis depending on experience of the butcher. This study reveals that more experimental work is necessary to establish the proper combinations of criteria that should be used to diagnose cut marks and that perhaps even different sets of criteria can be created and applied to different cases.

Skill, Not Kinship, Impacts Social Learning in Wild Chimpanzee Stone Tool Use: Implications for the Pleistocene Archaeological Record

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Little is known about the influence of social learning on technological decisions in the Pleistocene. Largely this is the result of difficulties in identifying social learning in the archaeological record. Socially learned tool use may show increases in efficiency and possibly lower levels of variation at the individual level relative to individually learned behaviors. These patterns may be reflected in archaeological signatures of social learning in Early Pleistocene contexts. It is often difficult to assess the effect of transmission biases on archaeological materials. Current research on strategic modelling focuses on the technology-related behaviors of our closest living relatives, chimpanzees, to investigate variables that may have played a role in hominin social learning. Young chimpanzees learn to use stone tools from observing older conspecifics, while older individuals prefer to observe similarly aged conspecifics, and kinship plays a role in this process of observation (Biro et al. 2003, 2006). We have expanded this work and investigated the individual processes of observation during nut-cracking in wild chimpanzees, at an outdoor laboratory, in Guinea Conakry. We focused on the available active individuals as targets of tool use observations, to understand factors affecting the selection by an 'apprentice,' when targeting a 'master' to observe. Results show that: 1) overall, more skilled individuals are chosen as a preferential target of observation; and, 2) regardless of relatedness, younger individuals prefer to observe more skilled individuals. This indicates that among our closest living relatives socially learned tool use is affected by transmission biases. This study highlights the possibility that horizontal transmission, specifically related to skill, is a major factor in the social transmission process in chimpanzee tool use. Skill may be an essential criterion underlying aspects of cultural transmission in percussive technology. We explore the impacts of these results on the identification of social learning in the Early Pleistocene.

References Cited

Biro, D., Inoue-Nakamura, N., Tonooka, R., Yamakoshi, G., Sousa, C., and Matsuzawa, T. 2003. Cultural innovation and transmission of tool use in wild chimpanzees: evidence from field experiments. *Animal Cognition* 6(4): 213–223.

Biro, D., Sousa, C., and Matsuzawa, T. 2006. Ontogeny and cultural propagation of tool use by wild chimpanzees at Bossou, Guinea: case studies in nut cracking and leaf folding. In: Matsuzawa, T., Tomonaga, M., and Tanaka, M. (eds.), *Cognitive Development in Chimpanzees*. New York: Springer, pp. 476–508.

Upper and Epipaleolithic Faunal Remains from New Excavations at Sefunim Cave (Mt. Carmel, Israel): Preliminary Results

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Renewed excavations at Sefunim Cave (Mount Carmel, Israel) have yielded rich deposits from the early Epipaleolithic (EP, 20–24 Ka cal BP) and the Upper Paleolithic (UP), primarily represented by the Levantine Aurignacian (29–35 Ka cal BP). The faunal assemblage is large and well-preserved. Analysis is ongoing; we report here on the teeth and associated cranial/mandibular fragments (NISP: 1,330). Overall, a diverse range of species was identified, including gazelle, fallow deer, roe deer, wild boar, hartebeest, goat, hyena, and hyrax. Within the Mediterranean region, Stiner and colleagues have documented marked shifts in human subsistence spanning from the late Middle Paleolithic through the late EP (Munro 2009; Speth and Clark 2006; Stiner 2005). Evidence for subsistence intensification can be found in the increased exploitation of smaller ungulates and small/quick prey such as birds and hare. A growing focus on juvenile gazelle has also been argued to reflect increased hunting pressure. The dental sample from Sefunim can be used to explore the relative frequency of small vs. large ungulates and to reconstruct gazelle age profiles. Large ungulates (aurochs, red deer, and equid) are present but rare throughout. Gazelle predominates (NISP: 718); however, the Levantine Aurignacian contains a more even representation of gazelle and fallow deer than the EP, where gazelle accounts for >75% of NISP. Using the ageing criteria outlined in Munro et al. (2009), we calculated the relative frequency of juvenile gazelle (<18 months) to range from ~25–33%. Thus far, the results from Sefunim are consistent with data from other late UP/early EP contexts in the region. Of note, initial sorting indicates that small game, with the ex-

ception of tortoise, are rare at Sefunim—this, too, is consistent with data from other Southern Levantine sites, where the shift to small/fast prey seems to occur after the Kebaran (Munro 2009; Stiner 2005).

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References Cited

Munro, N.D. 2009. Integrating inter- & intra-site analyses of Epipalaeolithic faunal assemblages from Israel. *Before Farming* 1(4), 1–18.

Munro, N.D., Bar-Oz, G., and Stutz, A.J. 2009. Aging mountain gazelle (*Gazella gazella*): refining methods of tooth eruption and wear and bone fusion. *Journal of Archaeological Science* 36, 752–763.

Speth, J.D. and Clark, J.L. 2006. Hunting and overhunting in the Levantine late Middle Paleolithic. *Before Farming* 3(1), 1–42.

Stiner, M.C. 2005. *The Faunas of Hayonim Cave, Israel: A 200,000-Year Record of Paleolithic Diet, Demography, and Society*. Peabody Museum Press, Harvard University, Cambridge, MA.

The Empirical Case against the "Demographic Turn" in Paleolithic Archaeology

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Recently it has become commonplace to interpret instances of change and periods of stability in the Paleolithic archaeological record in terms of population size. Increases in cultural complexity are claimed to result from increases in population size; decreases in cultural complexity are suggested to be due to decreases in population size; and, periods of no change are attributed to low numbers or frequent extirpation. In this paper we argue that these claims are not justified. We show that the available evidence does not support the idea that cultural complexity in hunter-gatherers is driven by population size. Instead, the evidence suggests that hunter-gatherer cultural complexity is influenced by environmental factors. Because all hominins were hunter-gatherers until the Holocene, this means that using population size to interpret patterns in the Paleolithic archaeological record is not defensible. A different approach is needed. Specifically, the population size hypothesis should be viewed as one of several competing hypotheses for episodes of change or stability, and its predictions formally tested alongside those of its competitors.

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New Ecomorphological Proxies for Paleohabitat Reconstructions: Geometric Morphometric Analyses of Cervid Joint Surface Morphology

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Ecomophological methods using artiodactyl post-cranial elements have become increasingly popular as a means to reconstruct past environments. Variations in habitat vegetational density, substrate viscosity, and topographic relief require artiodactyls to locomote in diverse ways. Joint morphology reflects the type and range of motion possible and is correlated with artiodactyl locomotor behavior. Thus, fossil joint surface morphology can be used as a proxy for the aforementioned qualities of past habitats. In this study we conducted three-dimensional geometric morphometric analyses of the femoral head and lateral tibial condyle of a sample of extant cervids (deer) with known locomotor behaviors and habitat parameters. As hypothesized by Kappelman (1988) for bovids, the main difference in femoral head shape relates to the lateral extension of the joint surface. Cervids from closed habitats have nearly spherical femoral heads, which allow for increased mobility at the hip. In contrast, cervids from open habitats have laterally expanded femoral heads, which restrict movement to the parasagittal plane and decrease the likelihood of hip dislocation. Similarly, variation in tibial plateau morphology is related to the trade-off between joint mobility and stability. Cervids moving in closed habitats have wide but flat lateral tibial condyles, while those in open habitats have narrow but deep lateral tibial condyles. These differences in joint surface morphology and their association with locomotor behaviors in different habitat types can be used as comparative references (training sets) for estimating habitat preference of fossil specimens from paleoanthropological sites.

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References Cited

Kappelman, J. 1988. Morphology and Locomotor Adaptations of the Bovid Femur in Relation to Habitat. *Journal of Morphology* 198, 119–130.

A Developmental Perspective on the Postcanine Dental Proportions of *Homo naledi*

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Relative molar size is an important feature used to distinguish *Australopithecus* from *Homo*. The mandibular molars of the recently discovered *Homo naledi* are primitive in their proportions (m1<m2<m3) but are absolutely smaller in size than those of most australopiths. Despite the primitive craniodental anatomy of *Homo naledi*, researchers have suggested that the overall anatomy ties it to the genus *Homo*. Control of relative molar proportions has been attributed to an inhibitory cascade mechanism, where a previously-initiated tooth influences a subsequently-developing tooth through the balance of activators and inhibitors produced during dental development. Low levels of inhibition produce the m1<m2<m3 gradient. Expanding on this, Evans and colleagues found that hominin primary postcanine tooth proportions (i.e., deciduous premolars and permanent molars) fit the predictions of the inhibitory cascade and that these proportions are linked to absolute m1 size. Furthermore, species of *Homo* differ from australopiths (e.g., *Ardipithecus*, *Australopithecus*, and *Paranthropus*) in this scaling pattern. We applied Evans and colleagues' model to published mean molar areas of *H. naledi* in order to test whether the developmental processes underlying the molar proportions of *H. naledi* are more similar to those of australopiths or those of *Homo*. Despite *H. naledi* possessing absolutely smaller teeth than most australopiths, the species mean values fall within the model's expected prediction intervals for australopiths, but are poorly predicted using the equation for *Homo*. These results indicate that *H. naledi* is more similar to australopiths in both scaling pattern and tooth proportions and agree with the assessment that dental proportions of *H. naledi* are primitive. Furthermore, these results suggest the dental developmental processes underlying these primitive dental proportions differ from that found in *Homo* and are more similar to those of the australopiths.

Augmenting Paleoanthropological Field Research: A High Resolution Imaging System and Citizen Science

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In 2015, the Fragmented Heritage Project brought online the Fossilfinder.org website enabling the public to engage directly with paleoanthropological research. Citizen science is an expanding area of academic/public interaction that engages new audiences through the use of internet based discovery and documentation tasks. It has been used to document new planets, decipher texts, and digitize museum objects. Here, we report on research near the new Turkana Basin Institute research station at Ileret (East Lake Turkana) in northern Kenya. The region is well-known for fossil-bearing deposits dating to multiple periods of interest in human evolution (up to 4 million years old). We upload processed images for the public (citizen scientists) to study and enter data resulting from their observations. In the first two seasons of research, one million images of the ground surface were captured at a resolution of 30 pixels per cm (on the ground). This resolution was selected to correspond with normal visual acuity for a standing or partially crouched position. This previously unprecedented resolution for aerial-based imaging systems was a technological challenge and was only achieved by using the very latest (2015) imaging technology on the market. Images were collected using two survey approaches: 1) rectangular grids in predefined locations; and, 2) transects cutting across varying geological exposures. Citizen scientists are shown images and presented questions aimed to produce data pertinent to the local geology, fossils, and artifacts they observe. This paper presents results from the first five months of data collected, an assessment of the costs and benefits of such a system and how well it contributes to the problem of getting "more eyes on the ground," and some of the analytic approaches being used with some preliminary results.

New Insights into the Paleoenvironments of *Australopithecus anamensis*: A Multiproxy Analysis of the Bovids of Allia Bay, Kenya

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Australopithecus anamensis, the earliest undisputed hominin and obligate biped, lived in eastern Africa around 4 million years ago, but fossil remains of this species are only found at a handful of sites. This project presents new data on bovid remains from one of these sites, Allia Bay, Kenya (n=513). What was the paleoenvironment of *A. anamensis* at Allia Bay? How does it compare to other sites of the same period in the Omo-Turkana Basin, Kanapoi (n=213) and Mursi (n=15)? This project combines data from bovid taxonomy, ecomorphology, mesowear, taphonomy, and stable isotopes (Drapeau et al. 2014; Levin 2008). The bovid tribe composition at Allia Bay is significantly different ($p<0.01$) from that of Kanapoi and Mursi. When classified into diet categories and compared across sites, browsers are most common at Mursi and grazers are most common at Kanapoi. Both bovid types show intermediate abundances for Allia Bay. Similarly, carbon isotopic ratios are generally more depleted at Mursi, intermediate at Allia Bay, and less depleted at Kanapoi. When evaluated against seven taphonomic agents, Allia Bay shares distinctive similarities to both sites. Allia Bay mesowear scores are also indicative of a mosaic habitat: both an attrition dominated diet and a mixed diet are common in the assemblage. However, the ecomorphological analysis of the astragali suggests a more forested habitat. Overall, the analyses of the bovid remains of Allia Bay reveal a mosaic environment that is intermediate between the more open site of Kanapoi and the more forested site of Mursi. Interestingly, most fossils attributed to *A. anamensis* have been found at Kanapoi (~75%), some have been discovered at Allia Bay (~25%) (Ward et al. 2013), and no hominin remains have been found at Mursi. Analysis of the complete fauna will provide further insights into the possible relationship between habitat and hominin abundance.

References Cited

Drapeau, M.S., Bobe, R., Wynn, J.G., Campisano, C.J., Dumouchel, L., Geraads, D. 2014. The Omo Mursi Formation: A window into the East African Pliocene. *Journal of Human Evolution* 75: 64–79.

Levin, N.E. 2008. I*sotopic Records of Plio-Pleistocene Climate and Environments in Eastern Africa*. Ph.D. dissertation, The University of Utah.

Ward, C., Manthi, F., and Plavcan, J. 2013. New fossils of *Australopithecus anamensis* from Kanapoi, West Turkana, Kenya (2003–2008). *Journal of Human Evolution* 65(5): 501–524.

Geochemical and Physical Characterization of Potential Lithic Raw Material Sources in the Olduvai Basin, Tanzania

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The study of raw materials has traditionally been deeply embedded in analyses of the Early Stone Age (ESA) and the impact of source rock characteristics on early hominin ranging behavior and technological variation is now widely acknowledged. Northern Tanzania's Olduvai Basin contains dozens of ESA archaeological localities and a great diversity of potential lithic raw material sources. While the lithology and mineralogy of these sources have been well described, quantitative data on inter- and intra-source geochemical and physical characteristics are still rare, which makes it difficult to systematically test models of hominin home ranges and raw material selectivity. In 2014 and 2015, we collected over 200 rock samples from eight potential lithic raw material sources to document quantitative variation in raw material characteristics. We found statistically significant differences in both rebound hardness (as a proxy for flakeability) and geochemical signatures across several of these sources, which will aid in interpretations of hominin lithic procurement and use in the Olduvai Basin during the early Pleistocene.

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Evolution of Hominin Tooth Size Explained Through Development-Based Models

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Tooth and jaw function are frequently relied upon to explain the variation in molar proportions among humans, the great apes, and our closest extinct relatives (the hominins), laying the foundations for our interpretations of human evolution. Beginning almost a century ago, some researchers have interpreted the systematic pattern of size variation along the tooth row in mammals as the result of a 'morphogenetic gradient,' but the specific developmental mechanism(s) underlying tooth size have remained elusive, with hypotheses ranging from morphogenetic fields to the clone theory. In this study we test whether the inhibitory cascade, an activator-inhibitor mechanism that affects relative tooth size in mammals, produces the default pattern of tooth sizes for all lower primary postcanine teeth (deciduous premolars and permanent molars) in hominins. In other words, are there developmental rules constraining how hominin tooth size evolves? If the primary postcanine dentition follows the patterning predicted by the inhibitory cascade, then a potential developmental mechanism underlying the morphogenetic gradient exists. Using maximum occlusal areas of the primary postcanine dentition, we found that the hominins follow the linear pattern predicted by the inhibitory cascade. Furthermore, in species of *Homo*, including modern humans, there is a tight link between tooth proportions and absolute m1 size such that a single developmental parameter can explain both the relative and absolute sizes of primary postcanine teeth. This contrasts with the australopiths (including *Ardipithecus*, *Australopithecus*, and *Paranthropus*), where pattern of tooth size remains constant with absolute m1 size. As a result of the relationship between size and inhibitory cascade patterning, we can use the size at one tooth position to predict the mean sizes of the remaining four primary postcanine teeth in the row for hominins. This study provides a development-based expectation for predicting the evolution of tooth proportions in the hominin lineage.

A Comprehensive Morphological Investigation of the Qesem Cave Lower Second Deciduous Molar dm_2-QC2

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The hominin material from the Middle Pleistocene Qesem Cave (QC) site in Israel, includes a well preserved lower second deciduous molar (dm_2-QC2) previously described by Hershkovitz et al. (2011). The taxonomic nature and morphological variability of QC *Homo*, along with the population history of the Levantine Middle Pleistocene are yet to be understood. This contribution applied multiple approaches to provide a morphological characterization of dm_2-QC2. We used μCT images and performed a descriptive investigation of the inner morphology, analysis of the dental tissues, and 3D geometric morphometric analysis based on various dental crown features. The comparative sample included 44 dm2s from Holocene and Pleistocene modern humans, Neanderthals, and *Homo erectus*. Our results are in general agreement with those of Hershkovitz et al. (2011) with regard to the presence of mixed morphology. Dm_2-QC2 showed a Neanderthal-like squared cervical outline, but was intermediate between modern humans and Neanderthals for the shape of the crown outline (showing mild distal expansion). Dm_2-QC2 falls within Neanderthal variability for its relatively high dentine horns with inwardly bent tips. A pronounced mesio-distal elongation of the occlusal marginal ridge at the enamel-dentine junction distinguished dm_2-QC2 from the rest of the sample. The analysis of the dental tissues provided contrasting affiliation when measured on the mesial section (intermediate but close to modern humans) or for the entire crown (close to Neanderthal distribution). Dm_2-QC2 is among the largest specimens in our sample. In summary, dm_2-QC2 presents a mixed morphology, with a prevalence of features characteristic or frequent in Neanderthals. This indicates that Neanderthal features were already present in the Levant during the Middle Pleistocene. Given the scarce evidence available on human evolution in the Levantine Middle Pleistocene, a taxonomic classification of the QC humans based on our results for dm_2-QC2 is currently not possible.

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References Cited

Hershkovitz, I., Smith, P., Sarig, R., Quam, R., Rodríguez, L., García, R., Arsuaga, J.L., Barkai, R., and Gopher, A. 2011. Middle Pleistocene dental remains from Qesem Cave (Israel). *American Journal of Physical Anthropology* 144, 575–592.

The Number of Lumbar Vertebrae in Hominin Evolution and the Problem of Missing Segments

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A lumbar lordosis with wedge-shaped vertebrae is a key adaptation to upright bipedal locomotion that brings the center of gravity close to the hip joints and helps dampening thrusts during walking and running. Various scenarios have been proposed to explain the evolution of the unique human vertebral formula with 12 thoracic and 5 lumbar vertebrae that contrasts to the 13 thoracic and 4 lumbar vertebrae in extant African great apes. Unfortunately, vertebrae rarely survive in the hominin fossil record. There are only three preserved early hominin lumbar columns: two of *Australopithecus africanus* (Sts 14 and Stw 431), and one of *Homo erectus* (KNM-WT 15000). In all of them, the number of vertebrae and the segmentation pattern are debated. Moreover, different reconstructions of the Stw 431 and KNM-WT 15000 spinal columns differ in the association between vertebral body and vertebral arch fragments or in the postulation of missing elements. Here, we examine which linear measurements perform best in predicting the correct sequence of vertebrae. We measured minimum and maximum width of the inferior and superior articular facets and vertebral body size variables in a sample of modern human and chimpanzee T10 – L2 vertebral series. Using a resampling approach, we found a high probability that a reconstruction of Stw 431 and KNM-WT 15000 with six lumbar vertebrae can be rejected. However, our analysis confirms that all early hominin fossils show a more cranially located transition between ventrally/coronally and dorsally/sagittally oriented facet joints than the majority of modern humans.

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3D Assessment of Rib Curvatures in KNM-WT 15000

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KNM-WT 15000 (Walker and Leakey 1993) is a juvenile specimen of African *H. erectus* from West Turkana (Kenya) dated around 1.47 Ma (McDougall et al. 2012). It preserves one of the most complete ribcages in the hominin fossil record and is crucial for understanding the evolution of the hominin thorax and body shape. KNM-WT 15000 has been described as the earliest evidence for a tall, narrow modern human body shape (Jellema et al. 1993; Ruff 1991). However, based on its pelvis and long bone morphology, a heavy and wide body configuration, similar to Lower and Mid-Pleistocene *Homo*, has been proposed (Arsuaga et al. 1999; Gómez-Olivencia et al. 2009, 2010; Graves et al. 2010; Holliday 2012; Ruff 2010). Here we re-assess the evidence provided by the ribs of KNM-WT 15000 using 3D geometric morphometrics. Using 17 (semi)landmarks, we quantified the shape of eight ribs of KNM-WT 15000 (CT-based 3D reconstructions of AG, AY&AZ, AQ, CB, AP, AL, AM, AO) and of two ribs of Mid-Pleistocene hominins from Gran Dolina TD-6 (high quality casts of ATD6-39, ATD6-89+206). We used principal components analyses to compare these fossils with mean rib shapes of adults and sub-adults of *P. troglodytes* and modern humans from Europe and Africa (N=408). A plot of PC2 against PC1 shows variation related to serial rib position and ontogeny. PC3 reflects species-related variation with chimpanzees showing negative scores and modern humans more positive scores. Fossil *Homo* ribs fall close to modern humans at the upper-central thorax level but strongly differ from humans and chimpanzees at the lower thorax with highly positive scores representing greater axial rib curvature. Although thorax shape results from rib and vertebral morphology (Bastir et al. 2014), greater axial rib curvatures are compatible with increased lower thorax width. Because these features are similar in Lower and Mid-Pleistocene *Homo*, a wider lower thorax could be the primitive condition in *Homo*.

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References Cited

Arsuaga, J.-L., Lorenzo, C., Carretero, J.-M., Gracia, A., Martínez, I., García, N., de Castro, J.-MB., and Carbonell, E. 1999. A complete human pelvis from the Middle Pleistocene of Spain. *Nature* 399(6733): 255–258.

Bastir, M., Higuero, A., Ríos, L., and García Martínez, D. 2014. Three-dimensional analysis of sexual dimorphism in human thoracic vertebrae: Implications for the respiratory system and spine morphology. *American Journal of Physical Anthropology* 155(4): 513–521.

Gómez-Olivencia, A., Eaves-Johnson, K.L., Franciscus, R.G., Carretero, J.M., and Arsuaga, J.L. 2009. Kebara 2: new insights regarding the most complete Neandertal thorax. *Journal of Human Evolution* 57(1): 75–90.

Gómez-Olivencia, A., Carretero, J.M., Lorenzo, C., Arsuaga, J.L., Bermúdez de Castro, J.M., and Carbonell, E. 2010. The costal skeleton of *Homo antecessor*: preliminary results. *Journal of Human Evolution* 59: 620–640.

Graves, R.R., Lupo, A.C., McCarthy, R.C., Wescott, D.J., and Cunningham, D.L. 2010. Just how strapping was KNM-WT 15000? *Journal of Human Evolution* 59(5): 542–554.

Haeusler, M., Schiess, R., and Boeni, T. 2011. New vertebral and rib material point to modern bauplan of the Nariokotome *Homo erectus* skeleton. *Journal of Human Evolution* 61(5): 575–582.

Holliday, T.W. 2012. Body size, body shape, and the circumscription of the genus *Homo*. *Current Anthropology* 53(S6): S330–S345.

McDougall, I., Brown, F.H., Vasconcelos, P.M., Cohen, B.E., Thiede, D.S., and Buchanan, M.J. 2012. New single crystal $^{40}Ar/^{39}Ar$ ages improve time scale for deposition of the

Omo Group, Omo–Turkana Basin, East Africa. *Journal of the Geological Society* 169(2): 213–226.
Walker, A. and Leakey, R.E. 1993. *The Nariokotome Homo erectus skeleton*. Cambridge, MA: Harvard University Press.

Hominin-Carnivore Competition at Pleistocene Springs

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By 2.0 Ma, it is clear that hominins had begun eating archaeologically-visible quantities of meat. The persistent acquisition of meat placed hominins in competition with carnivores. In the extant African large carnivore guild, dominant species exert pressure on subordinate species to offset their activity times so as to avoid intraguild predation and kelptoparasitism (Hayward and Slowtow 2009). This temporal niche construction is constrained by the great degree of overlap in preferred prey types. As recent interlopers into the carnivore guild, hominins likely occupied a subordinate position within the carnivore hierarchy. As omnivores, however, they were not constrained by diet in the same way as their carnivore contemporaries. Did hominins minimize intraguild competition by utilizing key habitats during seasons of reduced carnivore presence? Here I present the first use of dental microwear texture analysis (DMTA) to explore hominin meat-foraging seasonality in Bed I of Olduvai Gorge, Tanzania. Pilot research has demonstrated that DMTA is capable of distinguishing between assemblages of impala (*Aepyceros melampus*) hunted by Hadza hunter-gatherers in the wet and dry seasons. Using impala microwear as an analog, I compare the microwear signatures of bovid prey species *Antidorcas recki* and *Parmularius altidens* at anthropogenic FLK *Zinj* and carnivore-generated FLK North to determine the predominant season of death for each taxon at each site. Both sites accumulated around freshwater springs during comparably xeric periods, contain the same bovid prey species, and provide strong stratigraphic and taphonomic evidence for confined phases of carcass deposition. Preliminary results indicate the preferred seasons of operation for both hominins and carnivores at watering holes in the paleo-savanna, and characterize the nature of competition between these taxa.

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References Cited

Bunn, H.T. and Kroll, E.M. 1986. Systematic Butchery by Plio/Pleistocene Hominids at Olduvai Gorge, Tanzania. *Current Anthropology* 27(5): 431–452.
Ferraro, J.V., Plummer, T.W., Pobiner, B.L., Oliver, J.S., Bishop, L.C., Braun, D.R., Ditchfield, P.W., Seaman, S.I., Binetti, K.M., Seaman Jr., J.W., Hertel, F., and Potts, R. 2013. Earliest Archaeological Evidence of Persistent Hominin Carnivory. *PLoS One* 8(4): 1–10.
Hayward, M.W. and Slotow, R. 2009. Temporal Partitioning of Activity in Large African Carnivores: Tests of Multiple Hypotheses. *South African Journal of Wildlife Research* 39(2): 109–125.

Fossil Hominins from Woranso-Mille (Central Afar, Ethiopia) and the Middle Pliocene Hominin Diversity Conundrum

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Fossil hominin discoveries from Ethiopia, Kenya, and Chad during the last couple of decades indicate that *Australopithecus afarensis* was not the only hominin species during the middle Pliocene. However, fierce debates continue to arise around the validity of most of the newly named middle Pliocene hominins, largely based on poor preservation of holotype specimens (*Kenyanthropus platyops*), small sample size (*Australopithecus bahrelghazali*), or the lack of evidence for ecological diversity. The hominins recovered from the middle Pliocene deposits of the Woranso-Mille (central Afar, Ethiopia) incontrovertibly demonstrate that at least the well-known *Australopithecus afarensis* and one other hominin species (*Australopithecus deyiremeda*) were contemporaneously living in the region sometime between 3.3 and 3.5 million years ago. These two species are clearly distinguishable from each other by a suit of dentognathic morphological features. Moreover, the enigmatic Burtele foot, also from Woranso-Mille, belongs to neither *Australopithecus afarensis*, based on its inferred locomotor adaptation, nor assigned to *Australopithecus deyiremeda*, pending further fossil discoveries, raising the possibility for the presence of yet another contemporaneous species in the region. While there is no doubt that the presence of multiple species during the middle Pliocene will continue to be debated, it opens new windows into our evolutionary past albeit further complicating our understanding of early hominin taxonomy and phylogenetic relationships.

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An Objective Bayesian-Based Model for Identifying Bone Surface Modification and Application to the ~2.8 Ma Ledi-Geraru Assemblage

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Bone surface modification (BSM) has long been recognized as a powerful inferential tool in identifying the differential involvement of actors responsible for altering assemblages of bone recovered from both archaeological and paleontological contexts. Since its initial use, there have been numerous advances in BSM studies, including blind test validation (Blumenschine et al. 1996), standardized multivariate analytical protocols grounded in experimentally generated collections (Domínguez-Rodrigo et al. 2009), and numerous novel descriptive morphometric approaches. In spite of such advances, major debates in BSM studies persist. The crux of these debates is the accurate identification of individual BSM with high inter-analyst correspondence. Here we argue that when fossil assemblages possess contentious BSM, such as those regionally predating stone tools or exhibiting exceptionally high inter-analyst disagreement, the solution is a complete separation from analytical models grounded in so-called 'expert knowledge.' We propose a probabilistic approach that quantifies the level of certainty associated with an assignment of an agent to a fossil BSM. We have constructed a multivariate Bayesian model that assigns agency to individual fossil BSMs. The posterior probability statements reflect the likelihood that a particular agent is responsible for each fossil BSM. As the experimental sample size increases and additional agents are incorporated, the predictive power of the model grows. Our model is trained using a large collection of experimentally generated BSMs including both quantitative and qualitative variables associated with marks produced by crocodile feeding, large ungulate trampling, and from human unmodified rock butchery. We apply our model to a sample of fossils recovered from the Gurumaha fault block, in association with the LD 350-1 mandible attributed to early *Homo* (Villmoare et al. 2015).

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References Cited

Blumenschine, R.J., Marean, C.W., and Capaldo, S.D. 1996. Blind Tests of Inter-analyst Correspondence and Accuracy in the Identification of Cut Marks, Percussion Marks, and Carnivore Tooth Marks on Bone Surfaces. *Journal of Archaeological Science* 23, 493–507.
Domínguez-Rodrigo, M., de Juana, S., Galán, A.B., and Rodríguez, M. 2009. A new protocol to differentiate trampling marks from butchery cut marks. *Journal of Archaeological Science* 36, 2643–2654.
Villmoare, B., Kimbel, W.H., Seyoum, C., Campisano, C.J., DiMaggio, E.N., Rowan, J., Braun, D.R., Arrowsmith, J.R., and Reed, K.E. 2015. Early *Homo* at 2.8 Ma from Ledi-Geraru, Afar, Ethiopia. *Science* 347, 1352–1355.

New Middle Pleistocene Elephant Butchering Site from Greece

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'Marathousa 1' is a Lower Paleolithic open-air site in the lignite mines of Megalopolis, Greece. It was discovered in 2013 and subsequently excavated in 2014 and 2015 by a joint team from the Ephoreia of Paleoanthropology and Speleology, Ministry of Culture, and the Paleoanthropology section, University of Tübingen (Panagopoulou et al. 2015). Lithic artifacts were found in stratigraphic association with elephant and other faunal remains (carnivores, bovids, cervids, micromammals, turtles, birds). The find-bearing layers occur between two lignite seams and are composed of silty sands. The site's context likely represents a low-energy depositional environment, such as a shallow-water swamp close to the shore of a lake. Fast burial in a very fine-grained matrix ensured extraordinary preservation conditions for the faunal and lithic material, but also for paleobotanical micro- and macro-remains. An elephant cranium and several postcranial elements were found in close anatomical association and are attributed to a single individual of the species *Elephas* (*Palaeoloxodon*) *antiquus*. Cut-marks and percussion marks on bones indicate hominin exploitation of the elephant carcass and other animals. The lithic assemblage is composed of small-sized flakes and flake fragments, cores, and retouched tools. Technological characteristics point to a simple operational sequence aiming at the production of flake blanks and the preliminary analysis suggests an *in situ* knapping episode. 'Marathousa 1' is the first Middle Pleistocene archaeological site ever to be excavated in mainland Greece and the first Greek open-air Lower Paleolithic site with both lithic and faunal remains to be examined by systematic excavation. A first dating analysis by ESR places it in middle Middle Pleistocene, making it the oldest currently known dated archaeological site in Greece.

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References Cited

Panagopoulou E., Tourloukis V., Thompson N., Athanassiou A., Tsartsidou G., Konidaris G.E., Giusti D., Karkanas P., and Harvati K. 2015. Marathousa 1 – A new Middle Pleistocene archaeological site from Greece. *Antiquity Project Gallery* 89 (343).

Evaluation of Fire Evidence in the Early Pleistocene at FxJj20 AB, Koobi Fora, Northern Kenya

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The presence of fire at Early Pleistocene sites is both highly contested and important to understanding the changes between australopiths and early *Homo* when compared with later *Homo*. Site FxJj20 AB, dated to 1.5 Ma, is in close proximity to FxJj20 East and FxJj20 Main, sites with potential fire evidence discovered in the 1970s. New excavations at FxJj20 AB, including a 100% collection strategy, extensive geomorphological sampling, Fourier Transform Infrared Spectrometry (FTIR) analysis of sediment and recovered artifactual materials, and high-resolution spatial analysis indicate that fire may be present at the site, and that it may be positively associated with the hominin occupation. Micromorphological analysis of collected sediments indicates that the site was deposited on a rapidly aggrading surface in a low-energy environment on a floodplain. The presence of micro-artifacts (<20mm in maximum dimension) further supports this hypothesis. Preliminary results of the FTIR analysis coupled with spatial analysis indicates that burned bone is concentrated within one portion of the site. This strengthens the argument that fire was used by hominins in the Early Pleistocene, suggesting that fire may have played a role in the physical changes which occurred between australopiths and early *Homo* and later *Homo erectus*, particularly a reduction in dental morphology and gut size, with a concurrent increase in body size. The work at FxJj20 AB represents a new way of investigating Early Pleistocene sites and has the potential to inform researchers not only about fire and hominin association, but also other behaviors that may be captured in the record.

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Phylogenetic Systematics of Oldowan (Mode 1) Assemblages

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Phylogenetics are useful for modeling cultural evolutionary relationships between taxa and can be used to reveal patterns of change reflected in the archaeological record. Lithic technology represents an ideal subject for phylogenetic analyses of culture because of ubiquitous use in hunter-gatherer and early hominin populations, its ecological and memetic malleability, and the vast literature regarding the roughly 3.3 million-year-old lithic archaeological record. The Lower Paleolithic (~3.3–0.3 Ma) archaeological record provides important insight into early hominin evolution and behavior regarding landscape use, migration, and cognitive complexity. Although Lower Paleolithic stone tools are less morphologically diverse than subsequent technologies, a considerable amount of measurable variation can be found within and between Lower Paleolithic assemblages. There have been relatively few attempts to phylogenetically model Lower Paleolithic technologies, and in the case of Oldowan (Mode 1) core-tools there have been no issued attempts. The core-tool component of the Oldowan Technological Complex represents one of the best targets for measuring behavioral variation in stone tool production and cultural evolutionary relationships over the 800,000 year period (2.6–1.8 Ma) of the Lower Pleistocene before the advent of the Acheulean Technological Complex. This poster presents the results of a phylogenetic analysis which models data from fifteen (15) Mode 1 stone tool assemblages from Africa and Eurasia. These results illustrate a low level of homoplasy and show that Oldowan core-tools from discrete assemblages can act as meaningful taxa in phylogenetic analyses. This poster also highlights several issues with phylogenetically modeling Lower Paleolithic technology and suggests future ways to improve upon this by including the use of more complex Lower Paleolithic typological systems and the creation of a comprehensive, organized and universally available Lower Paleolithic information database.

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Characterizing the Micromorphology of Cut Marks Inflicted by Oldowan and Acheulean Stone Technologies Using High-Resolution 3D Scanning

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Cut marks on animal bones suggest that the simple core and flake technology used by hominins was effective and important for butchering large mammal carcasses. However, by 1.7 Ma, Acheulean technology, characterized by large bifacially flaked handaxes, appears on the landscape and it is unclear whether these new tools were used for a similar purpose or developed for different tasks. One of the best ways to link specific tool types to butchery by hominins is through the traces they leave behind on fossils. Past attempts to identify tool-induced variations in the micromorphological characteristics of cut marks have been unsuccessful due to a lack of control over variables such as carcass size and the angle at which the tool was held. Here we offer a new approach for characterizing the unique signatures of cut marks inflicted by stone flakes and stone bifaces. Experimental cut marks were produced with stone flakes, unifacial scrapers, and bifacial handaxes controlling for bone size, type, and portion, and raw material of the lithics. 3D reconstructions of each experimentally created mark were produced using a Nanovea white-light confocal profilometer. Quantitative measurements that were recorded from the 3D models of the cut marks included volume, surface area, maximum depth, maximum width, and length. Additional measurements collected from the 2D cross-sectional profiles were cross-sectional area, width, depth, and roughness. Statistical tests are applied to these measurements to identify those that vary with tool type. When applied to the fossil record these quantitative measurements may allow cut marks to be linked to specific tool types and provide a better understanding of the technological innovations of the Early Stone Age.

Does Handaxe Shape Strongly Influence Cutting Performance? A Large-Scale Quantitative Experiment

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Handaxes represent one of the most temporally enduring and geographically widespread of Paleolithic artifacts and thus comprised a key technological strategy of many hominin populations. Archaeologically observable variation in the shape of handaxes has been frequently noted. It is logical to ask whether some of this variability may have had functional implications. Certainly, functional explanations for handaxe form variation represent one of the few hypotheses that may be directly tested, and, in turn, aid our understanding of the factors that may have been most relevant in shaping contrasting patterns of shape diversity within the Acheulean technocomplex. Here, we report the results of a large-scale (n=500 handaxes) experiment designed to examine the influence of variation in handaxe shape on cutting efficiency rates during laboratory tasks. We used a comprehensive dataset of morphometric (size-adjusted) variables and statistical methods (including multivariate methods) to address this issue. Our analyses indicate that considerable variation in handaxe shape may occur independently of any strong effect on cutting efficiency. These results have several implications for understanding handaxe shape variation in the archaeological record. Most importantly, at a general level, our results indicate that observable shape variability within and between handaxe assemblages may have been related to factors other than functional considerations with respect to cutting performance.

Individual Differences in Stone Tool-Making Aptitude and Executive Function: Implications for Cognitive Evolution

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Individual variation provides the raw material for natural selection. Yet, despite over 100 years of speculation that stone tool-making drove human cognitive evolution, the relationship between individual cognitive variation and stone knapping aptitude remains unknown. One major obstacle to progress on this question has been the difficulty of conducting the long-term, controlled experimental studies of skill acquisition needed to dissect the interaction of practice and aptitude. A second obstacle has been a lack of methods to objectively assess and compare individual knapping skill. Here we present initial results from an ongoing study that addresses these challenges by training naïve volunteers in handaxe technology. Each subject receives 100 hours of training accompanied by regular assessments (psychometric, behavioral, and MRI). To quantify skill, knapping performance on periodic tests is first observed and rated on a 10 point scale using a systematic rubric. We then fit a multivariate model of actual artifact metrics to these ratings to derive an objective "quality" score. To accommodate erratic trial-by-trial performance across learning (Eren et al. 2011) we regress quality scores on hours of practice for each individual and use the slopes and predicted values from these individualized "learning curves" as metrics of aptitude. Psychometric results from the first training cohort show that these individual differences correlate with pre-training perfor-

mance on the Tower of London, a classic planning task, but not with Canonical (response set-shifting) or Stroop (inhibition) versions of the Wisconsin Card Sort. This is consistent with recent fMRI evidence of knapping task effects in dorsolateral prefrontal cortex (Stout et al. 2015), and identifies "executive" functions of information monitoring and manipulation as a likely target of selection acting on knapping aptitude. Ongoing work will use structural MRI to test for neuroanatomical correlates of these individual differences.

References Cited
Eren, M.I., Bradley, B.A., and Sampson, C.G. 2011. Middle Paleolithic skill level and the individual knapper: an experiment. *American Antiquity* 76(2): 229–251.
Stout, D., Hecht, E., Khreisheh, N., Bradley, B., and Chaminade, T. 2015. Cognitive demands of Lower Paleolithic toolmaking. *PLoS ONE* 10(4): e0121804.

Taxonomic and Taphonomic Analysis of Faunal Remains from a Recently Identified Fossil Deposit at Gondolin, South Africa

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The Plio-Pleistocene cave site of Gondolin is located in the north-western corner of the Cradle of Humankind, South Africa. The site has been subject to only 4-month long excavations since its discovery in 1977. The first excavations in 1979 focussed on *in situ* calcified breccia that yielded 27 faunal taxa that were deposited through the action of a leopard-like felid. The second excavation in 1997 was on an *ex situ* mine dump, and yielded a *Paranthropus* individual comparable in size to *P. boisei* from East Africa, and a probable *Homo*. The excavations in 2003 on an *in situ* decalcified breccia recovered highly fragmentary diaphyseal fragments and isolated teeth that were accumulated through water action. The latest excavations in June 2015 identified a new decalcified fossil deposit close to that investigated in 1979. This deposit yielded abundant and well-preserved faunal remains including the first felid from the site cf. *Panthera pardus*, *Hystrix makapanensis*, *Metridiochoerus andrewsi*, *Redunca arundinum*, cf. *Hipparion herpestes*, *Procavia transvaalensis*, and *Hystrix africaeaustralis*. Taphonomic analysis reveals at least three agents contribute to the formation of the fossils assemblage: porcupine, other small rodents, and carnivores.

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New Hominin Fossil Humeri from Koobi Fora Reflect the Diversity of Lower Pleistocene Hominins

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Previous studies have demonstrated the utility of distal humeral diaphyseal morphology for taxonomic assignment of Lower Pleistocene fossil hominins. To date, three humeral morphs have been identified among 2-1 Ma fossils in eastern Africa (i.e., *Paranthropus boisei*, *Homo habilis*, *Homo erectus*). Although *Homo rudolfensis* is also known from this time period, few of the previously analyzed humeral fossils derive from the spatiotemporal context currently known for this taxon. In this study, we use diaphyseal morphology to diagnose three recently discovered hominin fossil humeri from Koobi Fora (c. 2.0-1.5 Ma), including two isolated specimens (KNM-ER 64034, 64037) and one associated with a 2.02-2.03 Ma partial skeleton (KNM-ER 64061) thought to represent early *Homo*. Cross-sectional shape at a consistent location of the diaphysis was quantified by placing coordinate landmarks on humeral surface scans of a variety of extant hominids and fossil hominins. In addition to an expanded sample of African/Georgian *H. erectus*, our fossil sample was augmented by inclusion of the humeral fragment associated with KNM-ER 1500, a 1.9 Ma partial skeleton thought to represent either *P. boisei* or *H. rudolfensis*. Principal components analysis (of Procrustes superimposed shapes) was used to summarize morphometric affinities among specimens. Shape dissimilarity of individual specimens to fossil group means was quantified using Procrustes distance and assessed in the context of intraspecific variation in modern hominid species. KNM-ER 64034 (Okote Mb.) and KNM-ER 64037 (Upper Burgi Mb.) have clear affinities with '*H. erectus*' and '*P. boisei*', respectively. The humeri of ER 1500 and ER 64061 are extremely similar to one another and share unique shape differences from other fossil humeri, suggesting that the two skeletons are conspecific and belong to a hominin species (c. 2.0-1.9 Ma) heretofore unsampled in humeral diaphyseal analyses (i.e., *H. rudolfensis*).

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Intraspecific Variability in Postcanine Occlusal Wear in Early Hominins and the Occlusal Wear Gradient Model: Preliminary Results

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Dental attrition is intrinsically related to processes that occur during food processing. Thus, patterns of tooth wear may provide important insights into the diet and tooth use behaviors of extinct species. Recent studies on extant primates have proven that examining intra-species and inter-tooth variability, rather than making direct comparisons of gross wear between species, are of great use to this end. For example, comparisons of intra-specific occlusal wear have revealed significant differences between hard- and soft-object feeders, and between primates living in open savannahs and those dwelling in more closed habitats. Here, we propose a theoretical model that may be used as a conceptual framework for the interpretation of these types of studies: the Occlusal Wear Gradient model. Under this model, we examine intra-specific occlusal wear variability by calculating the percentage of dentine exposure (PDE) for each postcanine tooth in the lower dentition of four species of early hominins (*Australopithecus afarensis*, *A. africanus*, *Paranthropus boisei*, and *P. robustus*) and three apes (*Pan troglodytes*, *Gorilla gorilla*, and *Pongo pygmaeus*) with documented dietary differences. We compare the PDE of each tooth against the PDE of M1 using regression analysis. Our results indicate substantial differences between species. For instance, *A. afarensis* and *Po. pygmaeus* have significantly lower values of PDE in the M2 than *P. boisei* and *G. gorilla*. This suggests *P. boisei* may have included a high amount of tough foods, like grasses, in its diet while *A. afarensis* had a broader diet that included a variable amount of tough and soft foods, like fruits. In addition, *P. boisei* and *P. robustus* show higher values of PDE in the premolars, indicating an intensive use of these teeth. Though these results are preliminary, they revive the potential of studies of gross dental wear as a proxy to infer feeding behaviors in extinct taxa.

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Human Biogeography in the Lesser Sunda Islands: Implications of Recently Uncovered Pleistocene Skeletal Material from Alor, Indonesia

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The movement of modern humans through island Southeast Asia and into Australia is the last leg of a migration event that began in Africa thousands of years before. The timing and direction of this movement remains poorly resolved, particularly for the Lesser Sunda Islands located east of Java. Most of these were never connected to continental Southeast Asia, and the pattern of overwater dispersal of *Homo sapiens* among them, as suggested by currently available data, is counterintuitive if taken at face value. Here we report on human skeletal material and cultural remains recovered from two excavations on the island of Alor, east of Flores. These excavations provide the first archaeological data for this island. The first skeleton is ca. 13 Ka on the basis of direct U-Th dating and associated charcoal and shell radiocarbon dates, and is underlain by archaeological deposits extending to the Last Glacial Maximum (LGM). The second is dated to ca. 20 Ka on the basis of optically stimulated luminescence analysis of sediment recovered from inside the cranium. Both skeletons are anatomically modern. The archaeology associated with these skeletons indicates a reliance on marine resources, in particular fish. These data are compatible with the record of pelagic fishing, and thus presumably modern humans, on Timor from 42 Ka, but stand in marked contrast to the archaeological record of Flores, where the earliest evidence of modern humans currently dates to ca. 10 Ka. While the glacial island Alor-Pantar was never connected to either Timor or Flores, today both are visible from Alor and Pantar, and would have posed little difficulty to access for sea-faring modern humans. Our data suggest that *H. sapiens* were widespread in the Lesser Sunda Islands from at least the LGM and that the apparent late arrival of *H. sapiens* on Flores is highly anomalous.

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Pathologies of Skeleton MH2 (*Australopithecus sediba*)

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Musculoskeletal disorders are a growing contributor to health costs. They comprise low back pain and other problems of the spine,

knee and hip osteoarthritis, and shoulder impingement syndrome. In contrast to the high prevalence of musculoskeletal disorders in modern humans, they are surprisingly uncommon among non-human primates. This can only partly be explained by the increased lifespan of modern humans. These disorders might therefore be evolutionary trade-offs of bipedalism. Here, we analyze the skeleton of MH2 (*Australopithecus sediba*). This early hominin species shows key adaptations of the musculoskeletal system to bipedalism, including a reorganization of the shoulder and pelvic girdles, knee joint and foot and a well-developed lumbar lordosis. On the other hand, MH2 is a relatively old individual based on advanced dental attrition. We discuss the pathological alterations of this skeleton in the context of an evolutionary theory explaining the pathogenesis of musculoskeletal disorders.

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Sutural Variability in the Hominoid Anterior Cranial Fossa

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In anthropoids, the orbital plates of frontal bone meet at a "retro-ethmoid" frontal suture in the midline anterior cranial fossa (ACF), separating the presphenoid and mesethmoid bones. Previous research indicates that this configuration appears variably in chimpanzees and gorillas and infrequently in modern humans, with speculation that its incidence is related to differential growth of the brain and orbits, size of the brow ridges or face, or upper facial prognathism. We collected qualitative and quantitative data from 164 previously-opened cranial specimens from 15 hominoid species in addition to qualitative observations on non-hominoid and hominin specimens in order to: 1) document sutural variability in the primate ACF; 2) rethink the evolutionary trajectory of frontal bone contribution to the midline ACF; and, 3) create a database of ACF observations and measurements which can be used to test hypotheses about structural relationships in the hominoid ACF. In adults, we catalogued presphenoid/mesethmoid contact in the midline ACF in 100% of orangutans, 91.3% of modern humans, 57.1% of chimpanzees, 42.9% of gorillas, and 21.1% of hylobatids. Presphenoid/mesethmoid contact is variable in archaic *Homo*, including *Homo neanderthalensis*, but seems to be the rule in *Australopithecus*. Frontal involvement in the midline ACF is more common in chimpanzee and gorilla males than females, providing ancillary support for the idea that frontal contribution to the midline ACF is related to some aspect of facial scaling, such as brow ridge size or upper facial prognathism. In each species, a greater percentage of adult compared to juvenile specimens exhibits midline frontal involvement, providing some indication that the frontal bone invades the midline ACF during ontogeny. Intra- and interspecific scaling analyses are necessary to further test competing hypotheses about the structural role, if any, of frontal bone involvement in the midline ACF.

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Acheulian Assemblages between the Limpopo and Zambezi: The Origins of Prepared Core Technology at Maunganidze (Manicaland, Zimbabwe)

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A growing effort in the study of the African Acheulean focuses on the utilization of prepared core technologies that enabled hominins to detach flake blanks for a variety of tools in a standardized manner (Kuman 2014; Tryon and Potts 2011), as Acheulean prepared cores are partly comparable to those that typify the Middle Stone Age techniques subsumed under the umbrella of 'Mode 3' (Foley and Lahr 1997). Whether the morphological similarities between Acheulean and Middle Stone Age (MSA) prepared cores confer the earlier examples a precursor role (Kuman 2001) or just convergence (Lycett 2009), the main obstacle to exploring the origins of this technical approach is the dearth of information from stratified sites. Different types of Acheulean prepared cores have been documented in multiple, contrasting ecosystems within both temperate and tropical domains and across the wet, seasonal, and arid domains. The overwhelming majority of the data, however, comes from the temperate zone of South Africa (Walker et al. 2014) where there is a consistent use of prepared core technology during the Acheulean within a well-defined industry known as 'Victoria West.' This paper presents the results of archaeological research in the proximities of the montane, moist wooded rim that links central, eastern, and southern Africa, in the Zambezian zone. The site of Maunganidze is located in Manicaland (eastern Zimbabwe) where 20m2 were dug to assess site preservation, integrity, stratigraphy, and to obtain a large assemblage that would be amenable to techno-typological characterization. The industry unearthed (n=349) was primarily made in quartzite, basalt, and rhyolite. Flakes and fragments constitute ~60% of the recovered materials, with cores representing ~30% of the entire assemblage. Prepared core technology accounts for more than half of the reduction including medium and large format cores. Within the large ones, the core was utilized to obtain side-struck preferential flakes, mostly in quartzite. Their shapes are pointed ovates that display an asymmetrical cross section and generated a main flake from the shallower side, perpendicular to the longest axis of the piece. In some cases, the distal end becomes curved in profile so that it gives the core an uncinated form. Large Cutting Tools (~1/6 of the excavated collection) include handaxes, cleavers, picks, biface rough-outs,

and unifacials. Retouched pieces are present but do not abound.

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References Cited

Foley, R. and Lahr, M.M. 1997. Mode 3 Technologies and the evolution of modern humans. *Cambridge Archaeological Journal* 7: 1, 3–36.
Kuman, K. 2001. An Acheulean factory site with prepared core technology near Taung, South Africa. *South African Archaeological Bulletin* 55, 107–122.
Kuman, K. 2014. The Acheulean industrial complex. In: Smith, C. (ed.), *Encyclopedia of Global Archaeology*. New York: Springer, pp. 7–18.
Lycett, J.S. 2009. Are Victoria West cores "proto-Levallois"? A phylogenetic assessment. *Journal of Human Evolution* 56, 175–191.
Tryon, C.A. and Potts, R. 2011. The epistemologies of different approaches to lithic analysis approaches for understanding flake production in the African Acheulian. *Paleoanthropology* 2011, 376–389.
Walker, S.J.H. et. al. 2014. Kathu Townlands: A high density Earlier Stone Age locality in the interior of South Africa. *PLoS ONE* 9 (7): e103436.

New Vertebral Fossils from the KSD-VP-1/1 *Australopithecus afarensis* Skeleton

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A series of six partial cervical vertebrae were recovered in association with the KSD-VP-1/1 *Australopithecus afarensis* postcranial remains dated to 3.6 million years before present (Meyer 2015). The series preserves elements from the C2 axis to the C7 vertebral level and represents the oldest adult cervical column known in the hominin fossil record. As other cervical remains have been isolated or in a less complete articular series, this study offers the first assessment of hominin functional neck anatomy across consecutive vertebral levels. In addition, these fossils offer an opportunity to examine other previously unknown aspects of australopith anatomy including head carriage in *A. afarensis*. The fossil vertebrae were compared to those of *Homo sapiens* (59 individuals), *Pan* (N=26) *Gorilla* (N=21), *A. afarensis* (N=2), *Paranthropus robustus* (N=1), *H. erectus* (N=2), *H. heidelbergensis* (N=3), and *H. neanderthalensis* (N=2). Analyses demonstrate that nearly all vertebral features in KSD-VP-1/1 are human-like, and display a shift from the stiff-necked ventral axial loading profile of non-human primate vertebrae to the more mobile neck and dorsal axial loading profile of later orthograde bipeds. Although some of the most cranial levels of the KSD-VP-1/1 cervical spine exhibit more ape-like characters in some respects than those of *H. sapiens*, rather than having functional implications, the observed differences are likely developmental reciprocates of australopith cranial morphogenesis. Other analyses also present a biomechanical and enthesopathological signature identical to the dynamic vertical loading regime of genus *Homo* consistent with habitual upright posture and bipedalism. Despite their antiquity, the KSD-VP-1/1 vertebrae produce a surprisingly human-like kinematic signal, inferring a highly mobile neck and human-like mode of load transfer and head carriage in *A. afarensis*.

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References Cited

Meyer, M.R. 2015. The cervical vertebrae of KSD-VP-1/1. In: Haile-Selassie, Y. and Su, D. (eds.), *The Postcranial Anatomy of Australopithecus afarensis: New Insights from KSD-VP-1/1*. New York: Springer.

An Experimental Link between Stone Tool Technology and Cognitive Complexity

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Stone tool-making, observed archaeologically from 3.3 Ma, involves complex goal-orientated problem solving and forethought. The decision making involved in stone tool manufacture is used here to model behavioral complexity throughout hominin evolution. Knapping experiments were used to explore the degree of behavioral complexity involved in five different kinds of stone tool manufacture (bipolar, discoidal, bifacial, Levallois, and blade) that broadly represent the evolution of lithic core technology from the Oldowan to the Upper Paleolithic. Determining the level of behavioral complexity involved in each of these reduction sequences using problem-solution distance modelling offers a means of detecting significant transitions in the evolution of human cognitive complexity. Experiments were filmed and the duration of different stages in the sequence was annotated. Hierarchical diagrams were produced showing the organization of the different actions involved in stone tool knapping. The results show a pattern of increasingly complex behavior through the sequence of bipolar, discoidal, bifacial, blade, and Levallois knapping, with the latter strategy requiring the most hierarchical and recursive complexity. As hierarchical and recursive organization is thought to be a common component of tool production and syntactic language, this study has implications for the emergence of complex language. We present evidence that some of the cognitive abilities required to produce hierarchical and recursive language were in place by the beginning of the Middle Paleolithic (MP) or Middle Stone Age (MSA).

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Quantifying Taxonomic Distinctions in Tooth Mark Morphology with High-Resolution 3D Scanning

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Reconstructing the ecology of Early Stone Age archaeological sites is critical to understanding the conditions and behaviors that led to these accumulations, particularly as hominins encroached upon the larger carnivore guild by regularly consuming flesh and marrow from mammal carcasses. However, little is known about the specific carnivore taxa with which hominins were competing and interacting due to the paucity of both hominin and carnivore fossils in the paleontological record. The abundance of tooth marked bone at these early archaeological sites highlights the potential of these traces to help refine our knowledge of past hominin and carnivore interactions. Attempts to link tooth mark morphology to specific carnivore taxa have mostly been unsuccessful due to the two-dimensional techniques employed in these analyses, which consist of measuring the length and width of tooth pits from digital photographs. These two-dimensional measurements do show a weak correlation between carnivore size and tooth mark size, demonstrating the potential for improved results with more sophisticated techniques of data collection and analysis. This project uses high-resolution 3D scanning to produce accurate and precise characterizations of tooth mark morphology. Samples of tooth marks from modern mammalian carnivores and crocodilians were collected and scanned using a Nanovea white-light confocal profilometer to produce high-resolution 3D models of the marks. Measurements collected from the models include volume of the tooth mark (bone displaced), depth (maximum, average), as well as roughness profiles of the interior of the tooth mark. Statistical comparisons between these and other variables help identify taxonomic distinctions in the morphology of individual tooth marks. Quantifying tooth mark morphology with a replicable and data-rich methodology has the potential to greatly enhance our paleoecological reconstructions of Early Stone Age archaeological sites and shed new light on hominin and carnivore feeding interactions.

Homo or *Pongo*? Taxonomic Discrimination of Hominoid Upper Molars Based on the Internal Surface of the Mesial Marginal Ridge

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The taxonomic status of isolated hominoid teeth from Asian Pleistocene deposits has long been controversial due to the metrical and morphological similarities between *Homo* and *Pongo* molars. Here we report a variant observed on the internal surface of the mesial marginal ridge of the upper molars that appears to be taxonomically informative. The presence of mesial marginal accessory tubercles (MMAT) has been previously reported in humans and other primates. However, until now, it has never been systematically studied across a taxonomically diverse sample of hominoids. Micro-computed tomography was used to examine the enamel-dentine junction of 373 hominoid upper molars, including *Australopithecus* (n=55), *Paranthropus* (n=42), early *Homo* (n=10), *H. neanderthalensis* (n=58), *H. sapiens* (n=95), *Pan* (n=62), *Gorilla* (n=21), and *Pongo* (n=30). We analyzed trait presence and expression per group and the reliability of our estimates was tested via bootstrapping (1,000 iterations). Results reveal that nearly 80% of individuals in our *Pongo* sample exhibit a single MMAT on the mesial slope of the protocone. In fact, no *Pongo* molar shows a smooth surface on the mesial marginal ridge. In contrast, the MMAT is nearly absent in early hominins and African great apes. While it appears in moderate frequencies among members of our own genus, this feature in *Homo* species is not necessarily associated with the protocone nor is it manifested as a single tubercle. The bootstrapping analysis (95% confidence) suggests that the occurrence of the MMAT at the mesial protocone differs significantly between *Pongo* (69.7%–83.9%) and all other hominioids (0%–31.1%). Although the sample size for early *Homo* species is relatively small, these results can provide some resolution to the taxonomic ambiguities of several Asian hominoid dental remains and contribute to the better understanding of hominoid biogeography during the Pleistocene.

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A Quantitative Reassessment of Feeding Trace Morphology and Implications for the Earliest Cut Marked Bones

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The consumption of larger mammal carcasses by early hominins marks an important adaptive shift that substantially increased the amount and quality of resources available to our ancestors. This behavior can be recognized by the presence of hominin feeding traces in the form of butchery marks on fossilized animal bones and also by the effect of hominin carcass consumption on the frequency of carnivore tooth marks in fossil assemblages. However, inferences based on these feeding traces are limited by our ability to correctly identify them on fossils. Currently, the morphological criteria used to describe these marks and distinguish them from traces left by other taphonomic processes are almost exclusively qualitative and, as a result, the reliability of researcher identifications can only be evaluated through blind-testing and degree of correspondence among independent analysts. This has led to high profile and unresolved disagreements about the origin of marks in the Dikika and FLK *Zinjanthropus* assemblages, both of which have been central to defining the carnivorous feeding behavior of our ancestors. In this paper we introduce a new quantitative method for describing stone tool cut marks and distinguishing them from both mammalian and crocodilian tooth marks. 3D data was collected from modern samples of all three mark types using a Nanovea white light confocal profilometer. Although similar techniques have been used to collect 3D data from feeding traces, the methods of data analysis employed here are unique in using not only profiles extracted from the collected data, but also the entire 3D model to measure volume of bone displaced, maximum depth, average depth, length, width, and surface roughness of the mark. Accurate and repeatable measurements of these and other variables will ensure greater reliability in the identification of surface modifications and have the potential to resolve long-standing debates about the origins of feeding traces on fossils.

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Hominin Behavioral Landscapes: Merging Stable Isotopes, Zooarchaeology and Ecometrics for Insights into Hominin Ecology at East Turkana, Northern Kenya

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An enduring goal of paleoanthropology is a well-resolved ecological framework for hominin evolution. Understanding how ecological dynamics and hominin adaptation are linked has been challenging, requiring paleoecological data at temporal and spatial scales relevant to reconstructing hominin resource use over time. This study focuses on the paleoecosystem of East Turkana in northern Kenya between 2 and 1.4 million years ago. These fossil-rich deposits, which document the evolution of hominins and other African mammals, provide a rare opportunity to examine ecological adaptation within the context of a dynamic paleoecosystem. By combining large stable isotopic (n=800), zooarchaeological (n=13 sites), and ecometric (n=323) datasets, our multiproxy analyses provide important insights into the dietary evolution of the mammalian community during this important period in hominin evolution. First, we find that certain mammalian taxa (e.g., suids) record subtle differences in localized vegetation at East Turkana. Second, our analyses suggest different patterns of dietary evolution among East Turkana mammals. While a majority of taxa show little change in dietary proxies between 2 and 1.4 million years ago (e.g., *Kolpochoerus*, *Hippopotamus*), others experience temporal dietary transitions (e.g., Antilopini, *Homo*) during the same time interval. Lastly, we find that contemporaneous East Turkana archaeological sites are dominated by grazing (i.e., carbon-enriched) taxa, which presents the possibility that consumption of these resources contributed to the previously documented isotopic enrichment of East Turkana hominin taxa during this period.

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An Experimental Butchery Study of the Influence of the Amount of Flesh and Butcher Expertise on Resulting Cut Marks

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Here we present the results of an experimental study investigating cut mark attributes on butchered ungulate limb bones. We consider how the amount of defleshing prior to butchery influences the length or angle of the resulting cut marks. Experimental butcheries were conducted on eight pig limbs, some by an experienced butcher and some by an inexperienced butcher, with some limbs having been partially defleshed and some left fully fleshed. The amount of flesh left on the bone modeled two different hominin carcass acquisition scenarios: scavenging carcasses that were already partially eaten by carnivores (partially defleshed) or accessing carcasses early after death (fully fleshed). Following a method developed by Merritt (2015), we analyzed the effect of the amount of flesh removed prior to butchery and the expertise of the butcher on the average, range, and standard deviation of length and angle of the cut marks. Kruskal-Wallis tests demonstrate that the level of defleshing has significant correlations with cut mark cluster area, angle range, and cut mark count. Spearman Rank Order Analysis also shows significant correlations between the standard deviation of length with cut mark count, length range, and cluster area, the average angle with the standard deviation of angle, and the cluster area with average length, length range, and standard deviation of length. Demonstrating which of these variables are correlated in this experimental study potentially allows us to compare our data with examples from the archaeological record and make inferences about the butchery processes inflicted on fossil bones. For instance, cluster size, angle range, and cut mark count may be indicative of the skill level of early hominin butchers and/or their timing of access to carcasses.

References Cited

Merritt, S.R. 2015. Cut mark cluster geometry and equifinality in replicated Early Stone Age butchery. *International Journal of Osteoarchaeology*. doi: 10.1002/oa.2448.

Variability in Early Acheulean technology in East Turkana, Koobi Fora, Kenya

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Hominins practiced Acheulean Large Cutting Tool technologies (LCTs) for ~1.4 Ma, and researchers have thus far tended to interpret variability in the shape of LCTs by reference to reduction intensity of the tools and/or the impact of raw material availability on their forms. However, 'early Acheulean' research (sites >~1 Ma) has tended to focus on addressing the antiquity of LCT production in general and on developing different ways of identifying the initial presence of the Acheulean in the archaeological record. Variation within early Acheulean LCT technology and the implications for hominin behavioral variability have received considerably less attention. Here we investigate variability in hominin landscape use through the first comparative analysis of early Acheulean LCT technology from spatially separated sites. While holding the well-established influence of raw material type variation between sites constant, we test three hypotheses. Namely: 1) that significant differences in LCT morphology exist between sites, and that this variation is explained by reduction intensity; 2) that there is no significant variation in LCTs between sites despite differences in site settings; and, 3) that there is significant variability between sites, but that it is related to factors other than reduction intensity. We test these hypotheses by documenting which aspects of LCT shape are associated with reduction (allometric shape). We then describe and interpret the residual variation between sites and explore the implications for hominin behavior. We examine 300 LCTs from four broadly contemporaneous early Acheulean sites dated to ~1.4 Ma, namely, FxJj65, FxJj63, FxJj37, and FxJj21. We provide a qualitative comparison of the assemblages, as well as a quantitative description of the pertinent technological attributes. We complement and integrate these conventional approaches with the analysis of LCT shape, using the shape analysis tools of 3D geometric morphometrics.

Early Hominin Auditory Capacities

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Studies of sensory capacities in past life forms have offered new insights into their adaptations and lifeways. Audition is particularly amenable to study in fossils because it is strongly related to physical properties which can be approached through their skeletal structures. We have studied the anatomy of the outer and middle ear in the early hominin taxa *Australopithecus africanus* and *Paranthropus robustus* and estimated their auditory capacities. Compared with chimpanzees, the early hominin taxa are derived towards modern humans in their slightly shorter and considerably wider external auditory canal, smaller tympanic membrane, and lower malleus/incus lever ratio, but they remain primitive in the small size of their stapes footplate. Compared with chimpanzees, both early hominin taxa show a heightened sensitivity to frequencies between 1.5–3.5 kHz and an occupied band of maximum sensitivity that is shifted toward slightly higher frequencies. The results have implications for sensory ecology and communication, and suggest that the early hominin auditory pattern may have facilitated an increased emphasis on short range vocal communication in open habitats.

The Large and Small Mammal Communities from Cooper's D and Their Significance for *Paranthropus robustus* ecology

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Paranthropus robustus is unique among the paranthropine clade in its South African geographic, temporal, and ecological contexts. Although *P. robustus* appears to share derived chewing adaptations associated with hard/tough foods with other *Paranthropus* species, it differs from its congeners in other features indicating possible diet such as isotopes and microwear. Cooper's D, Bloubank Valley, South Africa, has yielded multiple *P. robustus* specimens, and rich associated large and small mammal communities. Dated to 1.5–1.4 Ma, Cooper's D is the best constrained age for a *P. robustus* assemblage, providing a unique opportunity for habitat reconstruction that is clearly situated temporally and geographically. This study includes multivariate analyses of large and small mammal communities. Large mammals focused on newly identified Bovidae and included univariate analyses of bovid size class and element distributions. Multivariate correspondence analyses were used to compare the fossil community as a whole to extant communities in modern African habitats to retrodict affinities that would have served as ecological parameters for *P. robustus* adaptations. Analogous multivariate analyses were used to characterize modern micromammal community structures of 53 extant African sites in a range of habitats as a comparative sample for reconstructing paleohabitats of fossil micromammal assemblages of Cooper's D and allied sites. Analyses of taxonomic and ecological diversity indicate that Cooper's D fauna is similar to that of other, contemporaneous South African *Paranthropus* sites, but that it underwent unique taphonomic processes selectively preserving size class II bovids. Multivariate analyses suggest that the communities of large and small mammals are ecologically most similar to those of extant African shrublands, and that the paleohabitat was one that was fairly dry. This conclusion suggests that *P. robustus* foraged in regions with lower quality food items, and therefore had a more varied diet, than its counterparts in East Africa.

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Changes in Community Ecology from 3.4–2.0 Ma in the Lower Awash Valley: Implications for Hominin Paleobiology

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Over the past 40 years, numerous hominin fossils have been recovered in the lower Awash valley, including specimens from Hadar, Gona, Dikika, Woranso-Mille, and Ledi-Geraru. Hominin fossils recently discovered at Ledi-Geraru occur between the Hadar (3.8–2.95 Ma) and Busidima (2.7–0.7 Ma) Formations, thereby filling a pre-existing gap and providing a long sequence of both fossil hominins and the associated mammal communities that provide essential contextual data. Mammal community ecology is of great value as it provides proxy data for reconstructing rainfall and seasonality. Here we trace trait changes in mammal communities through time (3.4–2.35 Ma) in the lower Awash valley. Assemblages derived from the middle Pliocene have the highest percentages of frugivores and

browsers in the sequence, while late Pliocene (2.8–2.6 Ma) assemblages have higher percentages of mammals exhibiting terrestriality and grazing. Assemblages dated to <2.35 Ma transition back to slightly higher percentages of frugivores and browsers. While some other traits (fresh grass grazing, mixed feeding, aquatic substrate use) remain at similar percentages through time, the species exhibiting those traits change at three time periods, ~3.0 Ma, 2.82 Ma, and 2.35 Ma. These traits indicate that more specialist taxa occur early in the succession, and there is a transition to more generalist taxa in later times. Some generalist species, which appear throughout much of the sequence, however, record increased C_4 plants in their diets. Although not completely linear, estimated rainfall diminishes from earlier to later times, and dry season months increase. A trend between 3.0–2.6 Ma toward more open and arid habitats is accompanied by the disappearance of *Australopithecus afarensis* and the appearance of *Homo*, while at *H.* cf. *H. habilis* times the habitat returns to more wooded.

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Paleolithic Site Integrity and Edge Damage: Novel Methods of Digital Microscopy to Identify Post-Depositional Processes

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The paleoanthropological significance of archaeological traces is dependent on a detailed understanding of the formation of the behavioral record. The context of archaeological materials is often more important than the morphology of the material themselves. Frequently, that context is a product of the sedimentary processes contributing to site formation. Water flow is a well-known contributor to the disturbance and secondary reorganization of archaeological materials. The degree of edge rounding on stone artifacts is often used to evaluate the degree of hydrological disturbance during site formation. High frequencies of "fresh" or sharp-edged artifacts are often used to infer minimal degrees of disturbance. Edge rounding is often assessed macroscopically. However, traces of water flow may accrue at the microscopic scale long before it becomes evident macroscopically. Relatively little work has been done to document the degree of damage associated with contexts where artifacts are likely to be abraded but other measures of post-depositional modification are not evident (e.g., orientation of materials, macroscopic abrasion). Here we present novel analytical methods for documenting edge damage on stone artifacts in experimentally controlled low-energy contexts. Through the use of digital microscopy we produced 3D models of stone tool edge surfaces that were characterized by both surface ruggedness and roughness using terrain analyses aided by GIS software. The results of this analysis demonstrate that while macroscopic changes are often absent, stone artifact edges accrue substantial edge damage observable at the microscopic level. This result has implications for the application of macroscopic indicators as a gauge of site integrity. Damage patterns observed in our experimental sample are diverse, indicating the potential overlap between damage patterns considered to be traces of use-wear. The results of this study suggest that more thorough assessments of tool edges should be used to investigate the integrity of Paleolithic sites.

New Excavations in the Proto-Aurignacian Deposits at Riparo Bombrini, Italy: Results of the 2015 Field Season

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After an interruption of 10 years, in 2015, the Université de Montréal and the Università di Genova started a new joint multi-year excavation project focused on the Paleolithic deposits of Riparo Bombrini. The site is part of the Balzi Rossi site complex (Liguria, NW Italy) and has yielded some of the most recent dates for the Mousterian in Europe. Our project's aim is to expose more of the occupation area at Bombrini to establish whether patterns of technological organization and site spatial arrangements suggested by earlier excavations are validated over a much larger area. Additionally, it will allow the collection of more artifactual information to document the Middle-Upper Paleolithic at the site and to better understand this process in the region. While extensive terminal Mousterian deposits are still to be found at the site, our fieldwork also established the presence of remaining proto-Aurignacian deposits which were the focus of this first field season. We report here preliminary data on: 1) the overall structure of the project; 2) the spatial distribution of artifacts in the excavated area; 3) the recovered proto-Aurignacian lithic assemblage (especially bladelets); and, 4) the taphonomy of the highly fragmented faunal assemblage. These data, collected from an area immediately adjacent to that excavated in 2002–2005, show a fair amount of continuity in the spatial distribution of artifacts but reveal a somewhat distinct lithic management strategy. Both these lines of evidence thus provide important new information on the nature of the internal variability of the proto-Aurignacian. These data, complemented by taphonomic observations that indicate that the faunal assemblage was mainly accumulated by humans, permit a holistic understanding of the site formation processes at work at Riparo Bombrini at the very beginning of the Upper Paleolithic.

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Dietary Shifts in the Giraffid *Sivatherium* and Paleoenvironmental Differences between the Afar and Turkana Basins during the Late Pliocene

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The widely distributed giraffid *Sivatherium maurusium* was known to have undergone a dietary transition from an obligate browser to grazer ~1.8 million years ago (Ma) based on enamel stable carbon isotope ($\delta^{13}C$) data from the Turkana Basin (Cerling et al. 2015). Here we present new enamel $\delta^{13}C$ data from the Hadar Formation (3.4–2.95 Ma) and Ledi-Geraru (2.8–2.6 Ma), which show that *Sivatherium* was grazing by ~2.8 Ma in the Afar, roughly one million years earlier than in the Turkana Basin. The timing of the $\delta^{13}C$ shifts in *Sivatherium* are complemented by paleosol data from these basins, which have suggested an expansion of C_4 vegetation in the Afar between 2.9–2.7 Ma and a much later expansion of C_4 vegetation in the Turkana Basin only after 2 Ma (Levin et al. 2011). In addition, a correspondence analysis of late Pliocene mammalian faunas shows that Afar faunas suggest open and possibly more arid habitats than those of the Turkana Basin during this time. Together these independent lines of evidence suggest that late Pliocene (3–2.6 Ma) paleoenvironments differed substantially between the Afar and Turkana Basins, with more open C_4-dominated habitats in the former versus more wooded C_3-dominated habitats in the latter. These results have implications for our understanding of the potential role of environmental change in the emergence of the genus *Homo* during the late Pliocene.

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References Cited

Cerling, T.E. et al. 2015. Dietary changes of large herbivores in the Turkana Basin, Kenya from 4 to 1 Ma. *Proceedings of the National Academy of Sciences* 112(37), 11467–11472.
Levin, N. E., Brown, F.H., Behrensmeyer, A.K., Bobe, R., and Cerling, T.E. 2011. Paleosol carbonates from the Omo Group: Isotopic records of local and regional environmental change in East Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 307(1), 75–89.

Homo naledi: A New Species of Hominin from the Dinaledi Chamber, South Africa

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Homo naledi is a previously unknown species of extinct hominin discovered within the Dinaledi Chamber of the Rising Star cave system, Gauteng, South Africa. This species is characterized by body mass and stature similar to small-bodied human populations, with a small endocranial volume similar to australopiths. Cranial morphology of *H. naledi* is unique, but most similar to early *Homo* species including *H. erectus*, *H. habilis*, or *H. rudolfensis*. While primitive, the dentition is generally small and simple in occlusal morphology. *H. naledi* has humanlike manipulatory adaptations of the hand and wrist. It also exhibits a humanlike leg and foot. These humanlike aspects are contrasted in the postcrania with a more primitive or australopith-like trunk, shoulder, fingers, pelvis, and proximal femur. Nonetheless, the shared derived features that connect *H. naledi* with other members of *Homo* occupy most regions of the *H. naledi* skeleton and represent distinct functional systems, including locomotion, manipulation, and mastication. With at least 15 individuals and most skeletal elements represented by multiple specimens, this is the largest assemblage of a single species of hominins yet discovered in Africa. To date we have recovered more than 1,700 specimens, with comprehensive representation of skeletal elements across the lifespan, and from multiple individuals. Regardless of the fact that the Dinaledi Chamber is currently undated, *H. naledi* highlights gaps in our understanding of ancient *Homo* across the vast geographic span of the African continent. The tree of *Homo*-like hominins is far from complete: we have missed key transitional forms and lineages that persisted for hundreds of thousands of years.

Evidence of Stone Tools and Cut-Marked Bones from Ain Boucherit Early Pleistocene Deposits (2.2–1.95 Ma), Algeria

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The Aïn Hanech research area (Algeria) is significant for documenting the oldest currently known archaeological occurrences in North Africa, estimated to 1.8–1.7 Ma. Recent fieldwork in the nearby deposits at Aïn Boucherit has resulted in the discovery of even older stone tools and cut-marked bones, spanning from 2.2 to 1.95 Ma. The Aïn Boucherit occurrences are found in two stratigraphic units: Unit P/Q and Unit R. Unit P/Q, which is the fossil bearing stratum from which both Pomel and Arambourg collected fossil bones, is stratigraphically located 13m below the 1.8–1.7 Ma Ain Hanech and El-Kherba Oldowan bearing deposits. In addition to a diverse savanna fauna, within this same unit, we also collected *in situ* Mode I stone artifacts and cut-marked bones. Excavations in Unit R, located 7m above the Ain Boucherit fossiliferous stratum (Unit P/Q) and 6m below the Ain Hanech and El-Kherba Oldowan localities (Unit T), yielded animal fossils associated with a Mode I lithic assemblage contained in a floodplain context. The fauna preserves several cut-marked and hammerstone-percussed bones. The age of the Aïn Boucherit archaeological occurrences is constrained by means of magnetostratigraphy, mammalian biochronology, and Electron Spin Resonance (ESR) dating methods. The magnetostratigraphic study documents both normal and reversed polarities, indicating that Unit P/Q dates to the Matuyama Reverse Chron and Unit R to the onset of the Olduvai Normal Subchron. Based on biochronological evidence, the age of Aïn Boucherit is estimated to ~2.2 Ma for Unit P/Q and ~1.95 Ma for Unit R. Furthermore, ESR dating results on optically bleached quartz grains extracted from sediments are consistent with the paleomagnetic and biochronological age estimates. Thus, Aïn Boucherit preserves the oldest archaeological occurrences outside of the East African Rift, showing that ancestral hominins inhabited the Mediterranean fringe much earlier than previously thought.

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Character Displacement among *Paranthropus*, early *Homo*, and *Theropithecus*: Reconstructing Dietary Competition in the Fossil Hominin Record

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Indirect and direct dietary competition is a common selection pressure for gnathic and dental morphologies among living, overlapping populations of mammals. The fossil record of eastern Africa suggests that some fossil primates, including hominins, may have overlapped in time and space. This is particularly true for fossil remains of early *Homo*, *Paranthropus*, and *Theropithecus*. Stable carbon isotope analyses of these taxa suggest considerable overlap in their dietary niche, which could implicate competition in the evolution of masticatory morphologies in these taxa. Unfortunately, different foods can yield similar isotopic signatures and time-averaging at fossil sites makes dietary competition difficult to confirm. In this study, we adapted a character displacement analysis based in living taxa for use in Plio-Pleistocene large-bodied primates (i.e., *Homo*, *Paranthropus*, and *Theropithecus*) in order to determine the probability of dietary competition among these taxa. Our modern, comparative data drew from the dental morphologies in overlapping populations of living primates (i.e., *Cercocebus*, *Gorilla*, *Hylobates*, *Macaca*, *Pan*, *Papio*, and *Pongo*) and in isolated populations of the same taxa. The analysis was able to recover signals of indirect and direct competition in living apes and when applied to the dental morphologies of fossil primates, the results suggest that *Paranthropus boisei* directly competed for resources with both early *Homo* and *Theropithecus* in eastern Africa during the Plio-Pleistocene. However, our results did not find evidence of competition between early *Homo* and *Theropithecus*. Our study provides a new multiproxy method of synthesizing disparate data regarding fossil hominin diets, and our results suggest that the high competitive pressures faced by *P. boisei* in eastern Africa may have contributed to the extinction of *Paranthropus* in this region.

The Early Acheulian from Gona, Ethiopia: Implications for Technological and Hominin Diet Transitions

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Recent investigations have pushed the age of the earliest Acheulian to ~1.75 million years ago (Ma), with the archaeological evidence currently well-documented at Konso in Ethiopia and at Kokiselei in Kenya. The Paleolithic record at Gona, Ethiopia, is documented from semi-continuous, archaeology-rich deposits spanning the past 2.6 million years, providing an opportunity for investigating the emergence of the Acheulian. Since 2012, the Gona archaeology team has been conducting investigations in deposits estimated between 2.0–1.5 Ma in order to explore the timing and the background for the technological transition to the Acheulian. We have documented several new archaeological localities in this time range, including some with large Oldowan-type artifacts similar to Acheulian Large Cutting Tools (LCTs). Research is in progress to refine the age of these sites with radiometric and non-radiometric techniques. Preliminary results suggest that compared to the preceding Oldowan, the makers of the earliest Acheulian were engaged in a different strategy of stone raw material selectivity, based mainly on large size and heavy weight, but also targeting raw materials with good flaking quality where accessible. More significant exploitation of animal carcasses is associated with earlier Oldowan sites than with Acheulian archaeofauna. Preservation biases and a prior research focus on the earliest Oldowan may in part explain the recovery of more cut-marked bones with these sites, but the rarity of large animal fossils with bone modifications at Early Acheulian sites appears to be notable, especially in light of the long-standing assumption that handaxes were used, in part, for animal butchery. The Acheulian is different technologically from the Oldowan, but the ecological background and adaptive significance of this emergent stone technology for *H. erectus* is unclear. Further, Oldowan-type core/flake artifacts co-existed with the Acheulian, and the nature of the technological transition has yet to be fully investigated and appreciated.

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The Lithic Assemblage from Mughr el-Hamameh, Jordan (39–45 Ka cal BP)

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This paper describes the stone tools from Mughr el-Hamameh, a cave site in Northwest Jordan dated to 45–39 Ka cal BP (Stutz et al. 2015). The people who made stone tools at Mughr el-Hamameh did so using cobbles from local gravel deposits and older stone tools procured from unknown, but presumably local, sources. Prismatic blade/bladelet cores outnumber Levallois cores by about 4 to 1 (34% to 9%), but bipolar cores and other informal/non-hierarchical cores account for 48% of all cores. Evidence of Levallois core-reduction is concentrated on reworked patinated flakes. Scaled pieces are the most common retouched artifact type. Endscrapers are about evenly distributed among flakes and blades. Burins and backed/truncated pieces are rare. El Wad points are rare. Two pieces resemble Emireh points. Some artifacts preserve traces of red ochre. Aspects of the Mughr el-Hamameh operational chain are compared to those from roughly contemporaneous lithic assemblages from Üçagizli Cave, Boker Tachtit, Ksar 'Akil, and Kebara. Overall, cores, retouched tools, and flakes reflecting non-hierarchical and bipolar flake production methods dominate the Mughr el-Hamameh assemblage. We provisionally interpret this preponderance of "expedient" core technology as evidence for relatively low levels of residential mobility among the human populations who lived near Mughr el-Hamameh along the eastern shores of Lake Lisan during Marine Isotope Stage 3 (see also Parry and Kelly 1987; Wallace and Shea 2006). Notably, low levels of residential mobility have also been inferred for Final Pleistocene and Early Holocene occupations of this same region, albeit with different lithic signatures and ecological consequences (Edwards 2012; Goring-Morris and Belfer-Cohen 2011). The Mughr el-Hamameh lithic assemblage does not conform to any previously-recognized Levantine stone tool industry (Shea 2013). Rather than using this finding to enlarge the number of named stone tool industries ("NASTIES") in Levantine prehistory (Shea 2014), this paper calls for new research strategies to investigate how mobility, foraging, on-site activities, and other factors shaped Late Pleistocene lithic assemblage variability.

References Cited

Edwards, P.C. (ed.). 2012. *Wadi Hammeh 27: An early Natufian site at Pella, Jordan*. Leiden: Koninklijke Brill NV.

Goring-Morris, A.N. and A. Belfer-Cohen. 2011. Neolithization Processes in the Levant: The Outer Envelope. *Current Anthropology* 52: 195–208.

Parry, W.A. and R.L. Kelly. 1987. Expedient Core Technology and Sedentism. In: *The Organization of Core Technology*, J.K. Johnson and C.A. Morrow (eds.), pp. 285–304. Boulder, CO: Westview Press.

Shea, J.J. 2013. *Stone Tools in the Paleolithic and Neolithic of the Near East: A Guide*. New York: Cambridge University Press.

Shea, J.J. 2014. Sink the Mousterian? Named stone tool industries (NASTIES) as obstacles to investigating hominin evolutionary relationships in the Later Middle Paleolithic Levant. *Quaternary International* 350: 169–179.

Stutz, A.J., J.J. Shea, J.A. Rech, J.S. Pigati, J. Wilson, M. Belmaker, R.M. Albert, T. Arpin, D. Cabanes, J.L. Clark, G. Hartman, F. Hourani, C.E. White, and L. Nilsson Stutz. 2015. Early Upper Paleolithic chronology in the Levant: new ABOx-SC accelerator mass spectrometry results from the Mughr el-Hamamah Site, Jordan. *Journal of Human Evolution* 85: 157–173.

Wallace, I.J. and J.J. Shea. 2006. Mobility Patterns and Core Technologies in the Middle Paleolithic of the Levant. J*ournal of Archaeological Science* 33: 1293–1309.

Handaxes, Blades and Levallois Items of Obsidian: Preliminary Results of an Archaeological Survey and Subsequent Test Excavations in the Syunik Province, Armenian Highlands

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A survey and successive pilot excavations conducted during 2012–2014 by the Scientific Research Center for Historical and Cultural Heritage in Gorhayk, Syunik province, Armenia, yielded a significant assemblage of knapped obsidian artifacts. The artifacts were spread over a ca 40km^2 area on a plateau, at an elevation of 2200–2400 masl. These include handaxes varying in size and shape, Quina scrapers, and Levallois items and blades. A subsequent small scale, targeted excavation, conducted by a joint Armenian-American expedition, yielded an assemblage of similar typo-technological composition. The majority of the artifacts were found in a paleosol immediately below a very thin layer of topsoil, but some were recovered on top and within the regolith overlaying the basalt bedrock. The physical condition of the artifacts and numerous chips suggest that the items have not been moved over a long distance. The bedrock has been dated using $^{40}Ar/^{39}Ar$ geochronology to 662±6.8 Ka(2σ). Preliminary Obsidian Hydration Dating (OHD) based on several non-diagnostic flakes recovered from different strata provided two separate sets of readings, one ranging from ca. 122–134 Ka, and the other greater than 200 Ka. While OHD clearly indicates that the area has been exploited through the Middle Paleolithic, the techno-typological composition of the assemblage shows that its origin may go back as early as the late Lower Paleolithic. Moreover, the techno-typological similarity with the assemblage from Nor Geghi 1 (Adler et al. 2014), located 200km northwest of Gorhayk, allows contemplating the possibility of a locally developed Lower-Middle Paleolithic transition. Future studies incorporating a more detailed survey of the Syunik plateau and adjacent areas, together with investigation of the obsidian sources and caves noticed during the original survey, will shed more light on technological adaptations of early humans exploiting the area.

References Cited

Adler, D.S., Wilkinson, K.N., Blockley, S., Mark, D.F., Pinhasi, R., Schmidt-Magee, B.A., Nahapetyan, S., Mallol, C., Berna, F., Glauberman, P.J. Raczynski-Henk, Y., Wales, N., Frahm, E. Jöris, O. MacLeod, A. Smith, V.C., Cullen, V.L., and Gasparian, B. 2014. Early Levallois technology and the Lower to Middle Paleolithic transition in the Southern Caucasus. *Scienc*e 345, 1609–1613.

Depositional Context of the Early Upper Paleolithic Occupation (45–39 ka) at Mughr el-Hamamah, Jordan: Implications for Tracing Behavioral Change across the Middle-Upper Paleolithic Transition

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Mughr el-Hamamah (Caves of the Doves) is the only buried Early Upper Paleolithic cave or rockshelter site to have been excavated in the Jordan Valley since the work of Turville-Petre at Emireh Cave (Garrod 1951, 1955). The site preserves a single late Pleistocene archaeological layer, which accumulated over likely no more than six millennia, ca. 45–39 Ka (Stutz et al. 2015). The *in situ* Early Upper Paleolithic deposits at Mughr el-Hamamah preserve a palimpsest sequence of mobile camp traces, including stratified lenticular hearth features, unusually abundant and large charcoal fragments, a large macrofaunal assemblage, a microfaunal assemblage, phytolith preservation, and a substantial artifact assemblage. The latter incorporates diverse lithics, with technological characteristics including both Initial Upper Paleolithic and Early Ahmarian patterns (cf. Kerry and Henry 2003; Kuhn et al. 2009; Kuhn and Zwyns 2014). It also includes a small number of narrow bone points or tools. Despite its relatively short stratigraphic sequence, Mughr el-Hamamah provides a unique opportunity to understand better the eastern Jordan Valley environment during Marine Isotope Stage 3 and its influence on foraging, settlement, on-site activity, and mobility behaviors of human groups. This paper presents new results on the depositional context of the Early Upper Paleolithic lithic assemblage, along with initial results on the phytolith and macrobotanical assemblages. Consideration of these data in regional Levantine context underscores that, although behavioral changes in the Middle-Upper Paleolithic transition may have followed a more subtle, complex, and sometimes gradual course than previously thought (Kuhn 2013), multiple lines of evidence may begin to reveal shifts in foraging, provisioning, residential mobility, and onsite activity patterns in the 50–40 ka timeframe. Such resolution of behavioral change is necessary for understanding anatomical modern human-Neandertal population biological turnover, both regionally and at a broader western Eurasian scale.

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References Cited

Garrod, D.A.E. 1951. A Transitional Industry from the Base of the Upper Palæolithic in Palestine and Syria. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 81, 121–130.

Garrod, D.A.E. 1955. The Mugharet el-Emireh in Lower Galilee: type station of the Emiran Industry. *Journal of the Royal Anthropological Institute* 85, 141–162.

Kerry, K.W. and Henry, D.O. 2003. Tor Fawaz (J403): An Upper Paleolithic Occupation in the Jebel Qalkha Area, Southwest Jordan. In: Goring-Morris, A.N. and Belfer-Cohen, A. (eds.), *More Than Meets the Eye: Studies on Upper Palaeolithic Diversity in the Near East*. Oxbow, Oxford, pp. 171–184.

Kuhn, S.L. 2013. Questions of Complexity and Scale in Explanations for Cultural Transitions in the Pleistocene: A Case Study from the Early Upper Paleolithic. *Journal of Archaeological Method and Theory* 20, 194–211.

Kuhn, S.L., Stiner, M.C., Güleç, E., Özer, I., Yılmaz, H., Baykara, I., Açıkkol, A., Goldberg, P., Molina, K.M., Ünay, E., and Suata-Alpaslan, F. 2009. The early Upper Paleolithic occupations at Üçağızlı Cave (Hatay, Turkey). *Journal of Human Evolution* 56, 87–113.

Kuhn, S.L. and Zwyns, N. 2014. Rethinking the initial Upper Paleolithic. *Quaternary International* 347, 29–38.

Stutz, A.J., Shea, J.J., Rech, J.A., Pigati, J.S., Wilson, J., Belmaker, M., Albert, R.M., Arpin, T., Cabanes, D., Clark, J.L., Hartman, G., Hourani, F., White, C.E., and Nilsson Stutz, L. 2015. Early Upper Paleolithic chronology in the Levant: new ABOx-SC accelerator mass spectrometry results from the Mughr el-Hamamah Site, Jordan. *Journal of Human Evolution* 85, 157–173.

Multilevel Societies and Hominin Social Evolution: Insights from Hamadryas Baboons

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The study of human social evolution has long benefited from comparisons with nonhuman primates, especially 'savanna' baboons (*Papio* spp.) and chimpanzees (*Pan* spp.). Here we note the utility of drawing parallels with a multi-level society, that of hamadryas baboons, *Papio hamadryas*. Multilevel societies facilitate the maintenance of strong and consistent social bonds among some individuals while allowing separation among others, which may be important when social and sexual bonds carry significant and reliable benefits to individuals within social groups. We draw parallels between processes thought to characterize the evolution of hamadryas social organization and those thought to characterize late Pliocene or early Pleistocene hominins, particularly *Homo erectus*. *H. erectus* has been argued to represent a pivotal species in that its larger body and brain size and more extensive ranging patterns increased the costs of reproduction for females, potentially selecting for greater levels of sociality than in earlier hominins. The higher costs of reproduction likely faced by *H. erectus* females, exacerbated by an increased reliance on difficult to acquire, nutrient-dense foods, are thought to have been alleviated by a strengthening of male-female bonds (via male provisioning and the evolution of monogamy) or the assistance of older, post-reproductive females (via grandmothering). We suggest that both of these social arrangements could have been present in

Plio-Pleistocene hominins if they lived in multilevel societies. Crucial to our argument and supported by recent genetic data, hamadryas display a combination of the male kin bonding thought to have characterized early hominins, the male-female pair-bonding that is thought to have developed at some point during human evolution, and the female bonding that underlies the grandmother hypothesis. The evolution of a multilevel society thus provides the potential to develop the complexity that we see in modern human social organization.

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Sexual Dimorphism in the Shape of the Extant Hominid Mandibular Ramus

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Though limited, previous studies of sexual dimorphism in extant hominid mandibular shape have generally found that *Gorilla* and *Pongo* exhibit substantially greater differences between males and females than *Pan* and *Homo*. However, these analyses focused primarily on the overall shape of the mandible, mandibular corpus, and symphysis, and they did not specifically examine ramus shape dimorphism. It is therefore unclear whether the ramus shows the same pattern of shape variation as other portions of the mandible. Understanding this pattern is important due to the potential utility of the ramus for interpreting shape variation in extant hominids and fossil hominins. Here we quantify the extent and pattern of sexual dimorphism in the mandibular ramus using 2D sliding semilandmark data derived from adult *Gorilla gorilla*, *Pan troglodytes*, *Pongo pygmaeus*, and *Homo sapiens* (n=221). Differences between males and females were analyzed using principal component and thin plate spline analyses, and Procrustes distances between sexes were calculated and assessed for significance. Results show that males and females are well separated in PC plots of all species except humans. Procrustes distances between sexes for each species were significant for all taxa (including humans), with the largest distances between the sexes in African apes. However, only subtle differences were exhibited between the mean male and female ramus shapes, with males exhibiting slightly more superiorly and posteriorly oriented coronoids in all taxa. These results may indicate important functional differences between males and females in the attachment of the temporalis muscle to the coronoid process. Furthermore, these data may be relevant to interpreting variation in the mandibular remains of fossil hominin taxa, including *Australopithecus sediba*.

New Approaches to Taphonomy and Field Survey of Fossils across the Hadar Paleo-Landscape at 3.3 Ma

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Two important sources of evidence for early hominin tool use are stone tools and fossil bones bearing traces of butchery modification. However, the earliest tools may be made from perishable materials, be difficult to identify, or not commonly leave marks on bones. Where modified bones are present, they may not be easily identified using the survey methods typically employed by paleontologists. This is because of a preference for more complete skeletal parts, which are taxonomically more easily identified than fragments, but less likely to exhibit marks made during destructive taphonomic processes such as butchery. Understanding the emergence of hominin tool use requires a systematic assessment of pre-Oldowan deposits for comparison to later deposits, as well as characterization of bone modifications across the landscapes on which hominin populations were active. To address this issue, we developed new field methods that combine the principles of systematic archaeological survey and mapping with collection strategies tailored to fossil-rich deposits that contain hominin remains but no flaked stone artifacts. This survey was deployed in the Sidi Hakoma member of the Hadar Formation in the Hadar Research Area of Ethiopia. The survey included taphonomic analysis of nearly 13,000 surface-collected fossils from a stratigraphic section corresponding to a narrow temporal interval of 3.30–3.35 Ma. Within this sample, 2,198 bone surface modifications larger than 1mm in maximum dimension were recorded and subjected to detailed analysis to characterize their size, shape, and attributes. Two-thirds of all fossils had little to no subaerial weathering, and there was almost no evidence of fluvial edge rounding. Bone marks ranged in size up to 3.5cm, and showed a diversity of amorphous and elongate forms. We combine these mapped data of taphonomic modifications in pre-Oldowan deposits, and show that a diversity of bone-modifying agents were active in spatially-patterned ways across this paleo-landscape.

A Comparison of Dental Attrition and Chipping in *Homo naledi* with Other South African Hominins

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This study compares tooth wear and chipping frequency in multiple South African hominin species. Original specimens were examined macroscopically with only complete crowns evidencing occlusal wear (grade 2 and above) being included in the chipping analysis. Molar wear was scored on a scale of 1–10 following Scott (1979). Two *Homo naledi* molars show significant angled wear in which one side has almost all enamel worn away and the other has no dentine exposed. On average, the lingual half of the occlusal surface on maxilla molars are one-half of a grade higher than the buccal, with lowers trending in the opposite direction. This pattern is also observed in *Australopithecus* but not *Paranthropus*. Members of these genera have overlapping ante-mortem chipping rates across tooth groups, ranging from 5% to 15%. There is significantly more chipping in *H. naledi*, with 40% of teeth affected. Specifically, 53% of molars, 42% of premolars, and 23% of anterior teeth have at least one chip; of these, 50% have two or more. Maxillary teeth are slightly more affected than mandibular (42% and 37%, respectively), and 78% is located interproximally. Interproximal areas are more affected than buccal, and posterior teeth are more affected than anterior. This finding is suggestive of a dietary cause rather than non-masticatory. A diet containing particularly hard, resistant food, or contaminants such as sand or grit is likely. Diagnostic angled molar wear in the sample, as well as the small size of the chips, is supportive of the latter possibility. Wear data suggests the diet of *H. naledi* may have been more similar to *Australopithecus* than *Paranthropus*, with angled molar wear suggesting potential differences with both. Chipping is far higher in *H. naledi* than other fossil hominins and is also suggestive of a different diet in terms of food type and/or contaminants therein.

References Cited

Scott, Eugenie C. 1979. Dental wear scoring technique. *American Journal of Physical Anthropology* 51.2: 213–217.

Orthogrady and Foramen Magnum Orientation: Interpreting the Fossil Record

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Because the basicranium links the functions of the skull and the postcranium, paleoanthropologists have long used basiscranial morphology to infer orthogrady and bipedalism and identify fossils as early hominins (e.g., *Sahelanthropus*, *Ardipithecus*). Among the traits thought to indicate orthogrady, and thus used to classify hominins, is a more anteriorly positioned foramen magnum (FM). However, whether orthogrady results in changes to FM position has long been debated. I test this hypothesis using 3D geometric morphometrics and linear data from the crania of 6 marsupial, 6 strepsirrhine, and 3 hominoid taxa (n=280) representing bipedal, orthograde, and quadrupedal taxa. Among strepsirrhines, taxa that engage in more orthograde behaviors (*Otolemur*, *Propithecus*) have more inferiorly and less posteriorly oriented FM than other closely-related taxa. This trend holds across primates, with *Homo* representing the most extreme case, and *Pan* most similar to *Homo* in this regard. Additionally, size may play an important role in FM orientation among hominoids ($R^2=0.9415$, $p<0.001$). However, there are no significant differences in the distance of the FM to anterior landmarks of the cranial base. A similar pattern holds broadly across marsupials, but not within macropods (the family including kangaroos and their close relatives). Thus the apparent anterior displacement of the FM is actually due to the visual effects of a shift in FM angle when crania are studied in standard basal or inferior views and supports the use of 3D data for statistical analyses of FM orientation. These results further reinforce the usefulness of considering FM orientation when investigating the behavioral repertoires of fossil taxa, but indicate caution when interpreting early fossils in the *Pan-Homo* clade, especially those of small body size.

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Variation in Habitat Heterogeneity within Pliocene East Turkana, Kenya: Defining the Mosaic

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Decades of fieldwork in the Turkana Basin have resulted in extensive geological and paleoenvironmental descriptions and the recovery of thousands of fossils, including hominins. Though paleoanthropologists have long posited links between paleoenvironmental proxies and hominin evolution, clear, causal relationships between the two remain elusive. However, ecological theory connects environment to mammalian responses at landscape scales by linking mechanisms such as variation in competition, due to habitat heterogeneity, to variation in mammalian biodiversity across regions. In particular, a time period that deserves closer ecological examination is the mid-Pliocene, when hominin diversity was high and the dietary ecologies of *Australopithecus afarensis* and *Kenyanthropus platyops* capture a shift toward incorporating resources from more open habitats. This study analyzes the local to regional-scale vegetation patterns that

influence large mammal niche space within East Turkana, Kenya, using extant ecosystems in Kenya as a baseline of vegetation variation. Modern vegetation is measured within 10 parks in Kenya using a geographically-referenced, phytogeographic map of Africa created by the United States Geological Survey. Fossil vegetation data are compiled from a published database of soil carbonate stable isotope data and from new samples from East Turkana, Kenya, collected using strategic lateral sampling of contemporaneous soils from multiple sites in three regions (n=138). Heterogeneity, for both fossil and modern samples, is measured as the α diversity of plant cover for each habitat using Shannon's diversity index. Analyses show that habitat heterogeneity in East Turkana varies more between sites than within, where the greatest difference is found between the northern and southern regions. Northern sites demonstrate more open habitats with greater diversity as compared to southern sites. This suggests that a greater range of species, including hominins, may have been able to exploit the northern Turkana sites as compared to those in the south.

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Update on the Paleoanthropology of the Kibish Formation, Southwestern Ethiopia

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The Kibish Formation in southwestern Ethiopia preserves skeletal and archaeological remains that provide critical evidence on the timing, location, and context of our species' origin. The best-known early *Homo sapiens* fossils are the Omo I and II skulls from Member I. Expeditions between 1999 and 2003 greatly improved knowledge of the Kibish chronostratigraphy, including by obtaining precise dates of 196 and 104 Ka for tuffs in Members I and III, respectively. It was argued that each member was laid down relatively rapidly so that Omo I and II could be assigned to the older date. More recent analyses by Brown et al. (2012) have resulted in a date of 172 Ka for a tuff in Member II, corroborating the previous date for the Member I fossils. In 2014, we returned to the Kibish Formation to undertake the first intensive survey of Member III deposits. Several new localities were discovered preserving Middle Stone Age lithic artifacts, including large bifacial core-tools, small foliate points with dimensions consistent with projectile technology, and microlithic Levallois cores and flakes. Little fossil material was found in association with lithic artifacts. As in earlier analyses by Assefa and colleagues (2008), all identifiable fossils could be assigned to taxa that have lived in the region during historic times. However, subsequent analyses of the bovids by Rowan et al. (2015) have refined our understanding of that group within the Kibish sequence. The only human fossil recovered was a fragment of a distal femur found on the surface. The specimen preserves the lateral condyle, patellar surface, most of the popliteal surface, and the lateral portion of the intercondylar fossa. In sum, recent analyses and fieldwork have both corroborated previous results and expanded our understanding of the Kibish Formation, an important region for the origin and early evolution of our species.

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References Cited

Assefa, Z., Yirga, S., and Reed, K.E. 2008. The large-mammal fauna from the Kibish Formation. *Journal of Human Evolution* 55, 501–512.
Brown, F.H., McDougall, I., and Fleagle, J.G. 2012. Correlation of the KHS Tuff of the Kibish Formation to volcanic ash layers at other sites, and the age of early *Homo sapiens* (Omo I and Omo II). *Journal of Human Evolution* 63, 577–585.
Rowan, J., Faith, J.T., Gebru, Y., and Fleagle, J.G. 2015. Taxonomy and paleoecology of fossil Bovidae (Mammalia, Artiodactyla) from the Kibish Formation, southern Ethiopia: implications for dietary change, biogeography, and the structure of the living bovid faunas of East Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology* 420, 210–222.

Labret Use Among the Gravettian Peoples of Central Europe and the Russian Plain: Dynamic Social Identities in the Mid-Upper Paleolithic

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Anomalous buccal wear facets on human teeth from the Pavlovian sites (Brno-Žabovřesky, Dolní Věstonice, Pavlov, and Předmostí) are well-documented but the behavior(s) producing the facets remain unknown. This study reinvestigated the prevalence and patterning of buccal wear facets using macroscopic and microscopic techniques on the original fossils in addition to written descriptions and photographs of Brno III and the majority of the Předmostí fossils (which were destroyed in 1945). Results show that buccal wear is most prominent on the maxillary teeth, and the number of facetted maxillary, and eventually mandibular, teeth increases with age-at-death across the sample. Some children display facets whereas all adolescents and adults exhibit buccal facets. Furthermore, only the right or left side is affected in the majority of adolescents and young adults, whereas older adults exhibit bilateral (but asymmetric) buccal faceting. This consistent pattern of buccal wear (in terms of prevalence and morphology) and evidence from dentoalveolar remodeling suggests that a durable, "fixed" object was in uniform contact across neighboring buccal tooth surfaces. Macroscopic and microscopic examination of buccal facets in the Pavlovian is most consistent with wear caused by facial piercings, or labrets, documented in bioarchaeological and ethnographic contexts. The Pavlovian patterning by age suggests that unilateral, buccal labret piercings were a

marker of group-level identity (possibly related to initiation rituals) among children, whereas the addition of a second labret marked a life events in late adolescence or early adulthood. The stretching of piercings to incorporate larger labrets was likely a prolonged process performed by each individual. Thus, buccal facets are indicative of dynamic changes in social identity across the life-course of Pavlovian peoples. Finally, new evidence for buccal facets is described for the site of Sunghir and implications for widespread social connectivity among Gravettian peoples from Central Europe to the Russian Plain is discussed.

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