How Do Macroscopic Heat Alterations Relate to Lithic Artifact Size and Raw Material Type: A Controlled Heat-Fracture Experiment

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In archaeological contexts where intentional heat treatment is difficult to discern, macroscopic alterations on discarded lithic artifacts resulting from exposure to heat from fires represent an important body of evidence for understanding prehistoric fire behavior. Although the rate and character of thermal alteration vary with raw material properties, heating parameters (e.g., temperature, duration, ramp rate), and artifact size, the degree to which two major lithic factors—raw material type and artifact volume—independently or combined influence thermally induced macroscopic changes requires further evaluation in controlled settings. To address this, we conducted a series of laboratory experiments to examine how artifact volume affects heat-induced alterations within a single raw material (flint, basalt, quartz) and subsequently compared how these raw materials respond when volume is held constant (8cm^3, 64cm^3, and 216cm^3). Our results show clear differences across raw materials. Basalt did not exhibit macroscopic thermal alteration across volumes even at higher temperatures. Flint displayed consistent alteration across volumes, with larger pieces exhibiting significant shattering as temperatures increased. Quartzite showed less predictable thermal responses—larger volumes experienced more intense alteration, whereas smaller volumes remained unchanged despite increases in temperature. We then applied these experimental results to burned lithics from several archaeological sites from the Middle Paleolithic, Upper Paleolithic, and Neolithic across Eurasia regions. Comparative analyses demonstrate that larger artifacts with greater surface area exhibit more extensive thermal alteration, including a higher frequency of potlids on both surfaces. These findings underscore the importance of considering both raw material properties and artifact volume when interpreting burned lithics in archaeological assemblages. For example, basalt resistance to thermal alteration suggests that basalt-rich assemblages may underrepresent fire activities, whereas flint shows more predictable alteration offering opportunities to infer fire temperature and duration at sites. Consequently, archaeologists must exercise caution when comparing burned lithics across assemblages dominated by different raw materials, as variation in raw material types can significantly shape the visibility and interpretation of prehistoric fire behaviors.

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Early Hominid Carcass Access and Trophic Roles in the Plio-Pleistocene Turkana Depression: Integrating Bone Surface Modification and Food Web Modeling

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Reconstructing hominid ecological roles during the Plio-Pleistocene is essential for understanding the emergence of tool-assisted foraging, carcass exploitation, and the origins of predatory behaviors. This study integrates taphonomic and paleoecological evidence from the Turkana Depression from the Shungura and Koobi Fora Formations to evaluate early hominid involvement in prey acquisition and their position within local trophic networks. Bone surface modification (BSM) analysis was conducted on both experimental and archaeological assemblages, combining confocal microscopy and geometric morphometrics. This high-resolution approach reveals clear morphometric difference between mark types, with archaeological samples from Shungura Member F and Member L showing diagnostic cutmark signatures consistent with tool-assisted butchery on medium-to-large mammals. To contextualize these taphonomic patterns, a comprehensive faunal database incorporating body mass, diet, locomotion, and trophic role was used to build trophic networks for multiple stratigraphic members using size-based predation rules. Results from Member F indicate that the inclusion of a generalist hominid predator significantly increases network connectivity, generality (prey per predator), and trophic overlap among carnivores. Member F is significant for early evidence of stone tool use and butchery, making it a key context in the Turkana Depression for understanding hominid trophic behavior. The BSM evidence and food web modeling support an ecological scenario in which early hominids engaged in systematic carcass processing and participated more actively in carnivore guild dynamics. This integrative approach provides new insight into hominid feeding ecology and ecological impacts during the Plio-Pleistocene.

First evidence of *Paranthropus* from Afar, Ethiopia

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Documenting hominin geographic and temporal distribution via fossil discovery provides the foundation for formulating hypotheses regarding hominin habitat preference and environmental range, which in turn are key to our knowledge of the ecological parameters that control patterns of speciation, extinction, and dispersal of fossil hominins. In this regard, the Afar sedimentary basin stands out for its rich faunal and hominin record over a span of ca. 6 Myr. Remains of a dozen hominin taxa ranging from *Ardipithecus* to *Homo sapiens* have been discovered, and archeological data on some of the earliest stone tools and hominin butchery activities have been recovered from this prolific region. Despite this rich record, no remains of *Paranthropus* had been discovered to date. Here we report on the discovery in the Mille-Logya research area of the first evidence for *Paranthropus* from the Afar, dated to ca. 2.6 million years (Ma). The find is among the oldest fossils attributable to *Paranthropus* and indicates that this genus, from its earliest known appearance, had a greater geographic distribution than previously documented. The discovery of *Paranthropus* in the Afar emphasizes how little is known about hominin evolution in eastern Africa during the crucial period between 3 and 2.5 Ma, when this genus and the *Homo* lineage presumably emerged. This finding also provides significant new information about the adaptation, biogeography, temporal range, and phylogeny of the genus. *Paranthropus* was not restricted to the Omo-Turkana Basin and more southern regions of Africa, which suggests that the genus could exploit diverse habitats and regions from north Ethiopia to South Africa like *Australopithecus* and *Homo* did, highlighting its versatility.

Stylistic Diversity in the Earliest Ostrich Eggshell Bead Manufacture in East Africa

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The oldest drilled ostrich eggshell (OES) bead in East Africa is associated with Middle Stone Age artifacts in Magubike rockshelter, Tanzania, dated >50.1 thousand years (ka) (Miller and Willoughby 2014). The earliest Later Stone Age (LSA) sites in Tanzania and Kenya (Lemuta and Nasampolai industries) are older than 50 ka (Ambrose 1998; Ranhorn and Tryon 2018). OES is preserved in these LSA sites but drilled beads are absent. Bead manufacturing techniques differ significantly between the two earliest LSA OES bead sites in Kenya. Mogoti (GvJh47), in the Ntuka River Valley, dates to 48.4±1.4 cal ka. Bead preforms were shaped by snapping and/or direct percussion chipping of the perimeter, striking from the outer (convex) surface. Rotary drilling from the inner (concave) surface caused pressure-flaked spallation of the outer surface around most perforations. Biconic drilled perforations are rare. Asymmetric drill holes suggest unhafted hand-held perforators. Bead perimeters are polygonal to subrounded, not edge-ground, preserving snapped and flaked edges. The earliest beads from Enkapune Ya Muto rockshelter (GtJi12) are stratified above the Nasampolai Industry, in the Sakutiek Industry, dating to 47.4±1.1 cal ka. Shaped stone tools include thumbnail scrapers, backed microliths, and flakes and discoids with shallow invasive unifacial, bifacial, and bipolar flaking. Bead preforms were shaped by snapping and/or percussion chipping. Most drilled perforations are bidirectional, removing outer surface spallation scars. Asymmetric perforations suggest hand-held perforators. Perimeters have ground edges, some with polygonal facets, suggesting edge grinding of individual beads by hand. The Mogoti and Enkapune Ya Muto OES bead assemblages represent different styles of technique, *sensu* Leroi-Gourhan. Mogoti has a less complex, perhaps less "evolved" *chaine opératoire* than Enkapune Ya Muto. Detailed attribute analysis of more OES bead assemblages is needed to trace diachronic changes and synchronic differences in styles of technique.

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How Mesh Size Affects the Diversity of Aquatic Faunal Fossil Assemblages: Implications for Understanding Aquatic Diets

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Dietary variability is a key driver of hominin evolution, influencing physiology, behavior, and adaptability. Exploiting a wide range of food resources, including aquatic fauna, may have provided crucial nutritional flexibility. However, our understanding of early human diet is limited due to size bias in the fossil record. Large, durable remains tend to be overrepresented, while small specimens, such as fish, are often overlooked. Coarse sampling methods, like large sieve mesh, can exclude taxa from reconstructions of hominin diets and paleoenvironments; smaller mesh sizes could help mitigate this bias. To test the utility of a small mesh size, we collected aquatic faunal

fossils using a 1mm sieve from the Ileret subregion of the Koobi Fora Formation in East Turkana, Kenya. We collected 780 fish specimens from surface scrapes in Areas 6 and 4 from the Chari member and compiled them into a database with measurements and taxonomic identification. Three hundred and ninety-two specimens were taxonomically identified and separated into >3mm, <3mm (what would usually be overlooked during collection), and total combined. Statistical analyses (i.e., chi-squared, Fisher's Exact tests) showed a significant difference ($p<0.001$) in taxonomic composition between the three assemblages. Diversity analyses revealed higher alpha diversity in the combined assemblage as opposed to the >3mm assemblage (Shannon diversity: 1.42 vs 1.23). The Jaccard Index showed low similarity between the >3mm and combined assemblages (34.2%). These results highlight that the <3mm specimens accounted for a significant proportion of the element diversity and taxonomic composition. Although many identifiable specimens are >3mm, there are a few taxonomic (Characiformes and Alestidae) and element (mostly teeth) groups that would be severely underrepresented without collecting <3mm specimens. By testing the effect of mesh size, our study emphasizes the importance of acknowledging size bias in the fossil record when reconstructing early hominin diets.

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An Error Study for Segmentation of Micro-CT Scanned Tooth Roots in Hominids

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Tooth roots remain understudied relative to crowns, despite their importance for understanding developmental gradients, spatial constraints, and functional loading within the masticatory system. Accurate and reproducible segmentation of roots from micro-CT scans is essential for evolutionary analyses of mandibular tooth root morphology in extant hominids and fossil hominins, as all linear and geometric morphometric measurements depend on this step. Previous studies have been limited by the difficulty and time required to isolate multiple tooth roots from micro-CT scans, resulting in extremely small sample sizes and species comparisons. This study evaluates segmentation error across observers to determine whether pooled datasets are comparable, potentially enabling larger samples. Extant hominid mandibles from four genera (*Pongo*, *Gorilla*, *Pan*, *Homo*) were micro-CT scanned at voxel sizes of 0.20–0.45mm. Two observers (ANB and CM), trained with a standardized protocol, independently segmented the roots of I1–M3 using ProSurgical 3D (Stratovan Corporation). To ensure discrepancies reflect segmentation rather than measurement technique, a single observer (ANB) extracted all linear, area, and volume metrics. Error was quantified for each tooth across all measurements via pairwise comparisons using defined thresholds (<2% excellent; >5% acceptable; >10% problematic). Pairwise comparisons found that across all tooth positions and measurement categories, absolute percent error was ≤10%, with most metrics falling within the excellent range. This indicates consistent recovery of 3D root geometry between segmentations produced by two observers. Minor discrepancies in linear metrics largely reflect sensitivity to landmark placement rather than true segmentation differences. These findings show that ProSurgical3D provides reliable segmentations for complex, manually intensive structures. By demonstrating low error, this study supports pooling segmented datasets generated by multiple observers, enabling larger sample sizes and more comprehensive coverage of primate tooth root morphology than previously possible.

Later Pleistocene Faunal Assemblage with Unusual Hominin Cranial Remains from Amboseli National Park, Kenya

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The Amboseli region in southern Kenya is widely recognized for research on ecosystem dynamics, baboon and elephant ecology, and modern taphonomy. Fossil deposits also occur in the central basin, and insights from Amboseli's later Pleistocene fauna contribute to understanding long-term changes in biodiversity and human impact. Investigations in the northern lake basin by A.K. Behrensmeyer and D. Boaz in 1975 resulted in initial fossil collections and documentation of the geology of fossiliferous deposits. Vertebrate fossils, mainly mammals >15kg, occur *in situ* in the Ol Tukai Beds and eroded onto the modern lakebed surface. Most are fragmentary but well-preserved and identifiable to group or, in some cases, genus and species. Preliminary analysis identified 18 mammal taxa plus remains of reptile, bird, and fish. The fauna is similar overall to Amboseli's modern mammal community, but three species, southern reedbuck (*Redunca arundinum*), Grevy's zebra (*Equus grevyi*), and white rhinoceros (*Ceratotherium simum*), no longer occur in this region, and subsequent study also documented an extinct bovid (*Damaliscus hypsodon*). Abundant waterbuck (*Kobus ellipsiprymnus*) and hippopotamus (*Hippopotamus amphibius*) suggest more permanently wet conditions than the present ephemeral lakebed. A. Hill discovered two hominin parietal fragments (KNM-AB-14420B and KNM-AB-14420C) in 1975. D. Gifford-Gonzalez recovered an additional fragment (KNM-AB-14420A) at the same site in 1980 and also identified associated flaked stone artifacts as Middle Stone Age technology. The

hominin parietals are unusually thick, overlapping in size with Middle Pleistocene human fossils. Dating of the deposits is yet to be finalized but suggests an age between ~165/195 ka (K-Ar with correlation to associated trachybasaltic tephra) and ~37ka (^{14}C on gastropods from the Ol Tukai beds). Additional work by Behrensmeyer and her team (1976–2024) have added to the fossil collection, and a new phase of faunal analysis with comparisons to the modern mammal community is underway.

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Revisiting Behavioral Signatures of Early Oldowan Activity at FxJj50: A Geospatial Approach

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Reconstructing the spatial structure of Oldowan sites requires analytical approaches that can effectively detect patterning within artifact and faunal distributions. This project applies a geospatial workflow to publicly available coordinate data from the Pleistocene locality FxJj50 in the Koobi Fora Formation. Excavations demonstrate that FxJj50 preserves an archaeological horizon of lithics and faunal remains within floodplain silts of the Okote Tuff, with exceptional refitting continuity, and clear clustering of material. This makes FxJj50 ideal for evaluating how spatial structure emerges from repeated knapping events and carcass-processing behaviors (Bunn et al., 1980). Digitizing artifact placements, density maps, and refit sets, we reconstruct artifact and bone distributions across the ~200m² exposure. Kernel-density surfaces and nearest-neighbor analyses are used to identify localized knapping episodes, debitage accumulation, and bone fragmentation intensity. Additionally, we resample artifact coordinates through Monte Carlo randomization to test whether observed artifact-bone associations deviate from patterns expected under spatial randomness. Refitted sets indicate that matching fragments remain spatially close, supporting the inference that post-depositional movement was limited and that the primary clustering of artifacts likely preserves meaningful behavioral structure (Bunn et al. 1980). The spatial relationships between lithic clusters and bone concentrations are used to describe the internal structure of FxJj50 at a higher resolution. These spatial patterns allow us to evaluate lithic and faunal accumulation and whether certain areas of the site were utilized at greater behavioral intensities. Initial geospatial modeling suggested that the repeated use of a stable floodplain surface produced recurrent, spatially discrete episodes of flake production and marrow extraction (Bunn et al. 1980). Emphasizing methods that quantify spatial structure using published coordinates, we demonstrate the utility of geospatial analytical frameworks for reassessing Early Stone Age sites. Such an approach provides a replicable pathway for comparing behavioral organization and activity structuring across Oldowan assemblages using legacy datasets.

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A New Multi-Proxy, Non-Destructive Approach to Sourcing Silcrete in South Africa

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Silcrete, a commonly used raw material in South African Middle Stone Age assemblages, is a sedimentary rock that is often heat-treated to improve its quality. Silcrete's complex formation processes produce both inter-source and intra-source variation that complicates our ability to identify differences between silcrete sources. Past attempts to source silcrete relied on destructive geochemical methods, limiting archaeological sampling. To overcome this, we introduce a non-destructive protocol for sourcing silcrete that combines CIE L*a*b* colorimetry, portable X-ray fluorescence (pXRF), and silcrete grain petrology within a random-forest machine-learning model. For this study, we sampled 15 different silcrete sources in the Cape Floral Region, producing 254 flakes for analysis. The first methodological approach is CIE L*a*b* colorimetry, which provides a three-dimensional measure of lightness (L*), red-green values (a*), and yellow-blue values (b*). Our second approach uses pXRF to identify major and trace elements of each flake. Lastly, we took DinoLite grain images of each flake to track differences in petrological types (Summerfield 1983), and to analyze grain size measurements between sources. These three methodologies train and validate the random-forest machine-learning model to identify silcrete sources with a known origin. This model will further be used to identify sources for Late Pleistocene silcrete tools from Pinnacle Point, South Africa, which shows some of the highest frequencies of silcrete use in the Cape Region. By using this model on archaeological material, we can quantify with large samples (due to the non-destructive methods) where early humans obtained silcrete, addressing questions regarding mobility patterns, social networks, and foraging ranges.

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Selection and Use of Iron-Oxide Rich Coloring Materials in the French Pyrenees Region: Case Study at Isturitz, Gatzarria, and Brassempouy

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In Europe, the Proto-Aurignacian, so far attributed to *Homo sapiens* (Benazzi et al. 2015), is considered by some to be the predecessor of the Early Aurignacian (Anderson 2019; Anderson et al. 2015; Banks et al. 2013; Teyssandier 2007), or by others to be contemporaneous to the Early Aurignacian, representing regional variability (Hublin 2015; Mellars 2006). The Early Aurignacian, the first pan-European industry, marks the consequent disappearance of Neanderthals from these areas and is characterized by technological changes, such as frequent coloring material (ochre *sensu lato*) use. My research seeks to use coloring materials as a lens through which to assess the shift from the Proto-Aurignacian to the Early Aurignacian, and to explore the regional variability within the Early Aurignacian. Focusing on three key archaeological sites—Isturitz and Gatzarria, which contain both Proto- and Early Aurignacian layers, and Brassempouy, which preserves a well-stratified Early Aurignacian assemblage—this project seeks to identify culturally specific patterns of raw material preference and of use. A preliminary study using macroscopic, mesoscopic, and microscopic scales of observation on the different raw materials from each site and on samples from preliminary geological surveys reveals precise collection methods, as well as selection of similar types of raw materials between the three sites, indicating possible connections between the groups that inhabited these three sites. This study will provide an account of coloring material selection, revealing how early European populations constructed meaning through material culture.

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Geographic Distribution of Dental Traits in Archaic *Homo*

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Dental non-metric traits (NMTs) exhibit broad geographic variation within modern *Homo sapiens* and are widely used to infer population affinity. Similar approaches have been applied to archaic *Homo* to evaluate species designations and to assess both intra- and interspecific variation, for example, the high frequency of the mid-trigonid crest in Neanderthal lower molars (Bailey 2002). The functional significance of many NMT remains uncertain, and ongoing debate centers on the extent to which observed morphological variation reflects neutral evolutionary processes such as genetic drift versus potential adaptive responses. This study tests the hypothesis that specific dental traits exhibit regionally patterned distributions and that documenting this patterning will clarify the evolutionary processes driving morphological differentiation. The dataset includes specimens dated to MIS 5 through MIS 3 (~130,000–29,000 BP) from Europe, Central and Southwestern Asia, and the Levant. Site information was compiled using the ROCEEH Out of Africa Database (Kandel et al. 2023). Only individuals with complete or near-complete first incisors and first molars were included. Trait frequencies were analyzed using hierarchical clustering and principal coordinates analysis (PCoA) to assess spatial structure, and permutational multivariate analysis of variance (PERMANOVA) was used to test for statistically significant regional differences. All analyses were conducted in R. By clarifying regional variation in first-incisor and first-molar morphology in *Homo* during the Late Pleistocene, this study aims to improve our understanding of population structure and to explore whether observed morphological patterns may relate to climatic or geographic factors.

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Homo erectus, Hunting, and Humanness at FLK Zinj: Comparative Evidence From Older and Younger Sites

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The use of meat of large prey animals affected Early Pleistocene hominin biological and behavioral evolution through significant influences on diet quality, foraging strategies, and socioecological behavior. Three classes of evidence—skeletal profiles, abundant butchery modifications, and prey mortality profiles—collectively indicate capable ambush hunting as the most likely, predominant cause of the faunal assemblage from the FLK Zinj site excavated by Mary Leakey at Olduvai Gorge, Tanzania. At 1.84 Ma, FLK Zinj provides the oldest sustainable evidence of capable ambush hunting at a time when early *Homo erectus* was the most "humanlike" of several coeval hominin taxa living in the East African landscape, arguably indicating *Homo erectus* as the most likely toolmaker and hunter at FLK Zinj. In principle, some form of scavenging from large felids, or persistence hunting via endurance running, might offer plausible alternatives to ambush hunting. The mortality pattern of butchered large bovids from FLK Zinj contradicts scavenging from lions and persistence hunting but aligns well with ambush hunting observed ethnographically and reconstructed by other scholars from younger archaeological evidence. This presentation provides a first detailed comparison of faunal evidence of hunting between FLK Zinj, Kanjera South (an older site claimed to document hunting at 2.0 Ma), and Gesher Benot Ya'aqov and Qesem Cave (both younger sites in Israel with varied evidence of hunting and humanness spanning the Middle Pleistocene). A paucity of evidence of hunting by hominins or of repeated carcass transport to foraging base sites (aka strategic centralized locations, home bases) for food sharing characterizes sites older than FLK Zinj. In contrast, FLK Zinj and these younger sites share strong similarities in evidence of capable hunting, group coordination in some foraging activities, food sharing, and an Early to Middle Pleistocene evolution of other ingredients of a recognizably human foraging strategy.

An Archaeological Signature for Early Tool Use: Modeling Site Formation in Nonhuman Primates

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There is now a near-consensus that the use of unmodified stone tools, like those presently used by some nonhuman primates, preceded the development of hominin stone knapping (Luncz et al. 2022; Panger et al. 2002; Proffitt et al. 2025). Our ability to identify and interpret an archaeological record of such tools is limited by constraints on recognizing individual artifacts that have not been intentionally manufactured. In light of these limitations, site-level signatures of tool use provide a possible avenue for understanding technological evolution before the Oldowan or Lomekwian. However, such site-level signatures present their own uncertainties in terms of site formation, which analogies from living primate tool users may help to clarify. Stone tool use by white-faced capuchin monkeys produces accumulations of artifacts and debris that vary greatly in size, and therefore in potential archaeological visibility. This study seeks to clarify how landscape and taphonomic factors affect where large, conspicuous anvil sites are likely to form. This analysis is based on empirical data from capuchin anvil sites surveyed between 2021 and 2024 in Coiba National Park, Panama. Here, we present a spatially explicit model for the occurrence of large midden sites with respect to various environment types and the proximity of resources within the capuchin home range. Our results point to the importance of environment type in enabling large, visible, and long-lasting archaeological sites. They also establish the low overall likelihood of large accumulations resulting from percussion tool use.

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Reconstructing Population Interaction Among Sicily's Earliest Inhabitants

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Ethnographic research shows that social networks are central to the survival of foraging groups, who maintain extensive, long-distance ties across generations. This complexity suggests that without considering social interaction in the Paleolithic, we miss a crucial dimension of human evolution. Sicily, the first Mediterranean island to be occupied around 16.7 thousand years ago during a period of environmental upheaval, offers an ideal "island laboratory" for exploring how social networks shaped early human landscape use, adaptation, and survival. Genetic and dietary isotopic evidence suggest that Sicily's earliest inhabitants formed a small population

divided into isolated groups in different regions of the island. However, our recent technological analysis of stone tool assemblages from three Late Pleistocene sites tells a more connected story—the distribution of quartzite tools suggests either wider mobility than the biomolecular data imply or the exchange of raw materials across considerable distances. Both possibilities point to more intergroup interaction than previously recognized. This poster integrates our technological findings with published data from sites across the island to reassess the structure and role of social networks in shaping human adaptation and survival in Late Pleistocene Sicily.

The Middle Paleolithic at Sefunim Cave (Mt. Carmel, Israel): New Insights From Zooarchaeological and Isotopic Analyses

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Zooarchaeological data have been influential to our thinking about variation in human behavior across the Middle to Upper Paleolithic (MP-UP) transition (~75–30 ka). Stiner and colleagues proposed an expansion of diet breadth in the UP, marked by a shift in the exploitation of small game (from slow/sessile taxa like tortoise to agile taxa like birds; Stiner 2005) and an intensified focus on gazelle vs. larger ungulates like fallow deer (Clark et al. 2024 and references therein). However, distinguishing variation in human hunting behavior from climate-driven resource shifts is often challenging. Furthermore, sites with sporadic human occupation often show increased hyena activity, with hyena preferentially targeting fallow deer (Orbach and Yeshurun 2021), underscoring the need to track all accumulating agents when tracing change across the MP-UP transition. With deposits spanning ~71–21 ka, Sefunim can provide important insight into these dynamics (Shimelmitz et al. 2018). Previous analyses of the UP faunal assemblage (~40–30 ka; NISP=3348) identified humans as the primary accumulating agent, with gazelle as the most identified taxon; however, the small game is dominated by tortoise, with few birds or small mammals. Here, we focus on zooarchaeological and isotopic data from the MP deposits (~71 ka; NISP=630), aimed at reconstructing the formation history of the assemblage. Following from recent analyses characterizing fallow deer assemblages from natural, anthropogenic, and carnivore deposits (Orbach et al. 2025), we pay particular attention to that taxon. Not only is fallow deer the most identified species (n=246), but strontium and oxygen isotope data also allow for an assessment of where these animals were hunted. Although we find clear evidence of human agency, our results indicate a stronger hyena contribution in the MP than in later deposits, complicating attempts to directly compare the behavior of the MP and UP inhabitants of the site.

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Experimental Investigation of Combustion Features Using Microcharcoal Morphological Patterning

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Anthropogenic pyrotechnology represents an important innovation in human evolution. The ability to manipulate fire would have offered protection, light, heat, and the ability to modify the digestibility of food through cooking. Some researchers argue that fire use began in the Early Pleistocene with *Homo erectus*—the species' increased brain size and reduced gut and tooth dimensions may have required a cooked diet. The presence of microcharcoals (carbon compounds caused by incompletely combusted plant materials) in sediment is a common proxy for combustion. Previous work (Feurdean et al. 2023) analyzed the morphologies of experimental microcharcoals of forb, grass, and wood species found in the Eurasian steppe to explore variations due to fuel type and temperature of burning in microcharcoal morphology. Area/Perimeter (A/P) ratios of microcharcoal decrease with increased temperature. Fuel type can be identified using Length/Width (L/W) ratios of microcharcoal. Here we apply an experimental approach to understand the relationship between aspects of fire and the microcharcoal morphology. This method would increase the ability to extract information about fire regimes using relatively simple techniques. We aimed to create a comparative database of A/P and L/W ratios of microcharcoals through

a series of experimental burns using fuel materials comparable to those available to Early Pleistocene hominins in the Koobi Fora Formation, Kenya. Experimental fires illustrate similar trends in A/P and L/W microcharcoal ratios compared with the previous studies. Hotter fires produced microcharcoals with smaller A/P ratios. When grass is the major fuel type in a fire, the resultant microcharcoals have higher L/W ratios. This methodology is pragmatic for field analysis and can be used in East African grasslands to quickly study samples. This type of quick morphological study can be used to guide targeted surveys and sample collection while in the field.

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A Comparison of Variance-Covariance Matrices in Fossil and Extant Papionins

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Analyses of morphological evolution reliant on variance-covariance (V/CV) matrices are increasingly common; however, scarcity and taxonomic uncertainty for fossil specimens make matrix estimation for extinct species challenging. The V/CV matrix of closely related extant taxa are often substituted for those of extinct taxa when necessary, but this assumes reasonable similarity between the V/CV matrices of extinct and extant taxa. Here, we compare the structure of V/CV matrices estimated from a well-preserved fossil sample to extant taxa to test this assumption. A sample of fossil papionins assigned to the genus *Papio* (n=4) and extant taxa representing nearly all genera of papionins (n=236) were used. Interlandmark distances were extracted from both raw and GPA-adjusted landmark data and V/CV matrices were then calculated for the fossil sample, the taxon assumed to be most closely related to fossil specimens (*P. anubis*, n=62), two additional closely related extant taxa (*L. albigena*, n=58, and *T. gelada*, n=20), and pooled data from the extant papionins. Random Skewers analysis was then used to compare fossil and extant V/CV matrices. All correlations were statistically significant after Bonferroni correction. Reasonably strong correlations (R>0.6) were found between the fossil matrix and both the *P. anubis* and extant matrices in both datasets, and between the fossil matrix and that of both *L. albigena* and *T. gelada* in the raw dataset. Substituting the V/CV matrix of an extant taxon in place of that of an extinct taxon may therefore be reasonable in some situations; however, lack of very strong correlations, low sample size in our fossil dataset, and the unavoidable uncertainty of fossil taxonomy mean that such substitutions should be carefully considered before being implemented and results of any such analysis should be interpreted with caution.

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Micromorphological Analysis of Early LGM (26–22 cal kBP) Deposits at Boomplaas Cave, South Africa: Preliminary Results

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Lithic miniaturization is a global phenomenon widely considered to reflect a strategy of more efficient, maintainable, and portable toolkits better adapted to difficult environmental conditions, particularly those associated with the Last Glacial Maximum (LGM, 26–19 ka). In South Africa, miniaturized LGM assemblages are often attributed to the Robberg Technocomplex, a spatially and temporally variable technological system hypothesized to result from changing mobility, population density, and/or hunting behaviors associated with regionally specific environmental settings. However, evaluating these hypotheses is difficult without high-resolution investigations into site use strategies and occupation dynamics associated with Robberg assemblages. This study addresses this limitation through a microcontextualized analysis of the early LGM deposits (ca. 26–22 cal kBP) at Boomplaas Cave, Western Cape province, to further identify behaviors associated with Robberg stone tool use. Thin sections from seven micromorphological blocks are being analyzed with petrographic microscopy and micro-X-Ray fluorescence to assess site formation processes, the presence and extent of post-depositional alteration, and the frequency and sequencing of different types of anthropogenic contributions to the sedimentary sequence. We have observed laminated sedimentary layers ranging from cm to sub-cm thickness, with alternating sequences of granular, organic-rich phosphatic layers and those with charcoal, ash, and knapped stone. Authigenic phosphate features occur throughout the sequence as nodules and reaction rims, contributing to the degradation of limestone and bone fragments. The arrangement of these layers suggests repeated, yet varied, episodes of human use of the cave contrasting with periods of non-anthropogenic deposition resulting in guano accumulation, indicating a complex history of LGM occupation dynamics at Boomplaas. Ultimately, these results will help to document changes in site use behaviors and occupation intensity of Robberg-using groups at Boomplaas and, more broadly, contribute to ongoing debates about the LGM's role in structuring hunter-gatherer mobility and technological strategies in South Africa and around the world.

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Median Axis Approaches to Paleotaxonomy

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Morphology-based taxonomic decisions in paleoanthropology depend on shape information. Variable choice, landmark definition, and trait scoring are decisions which ultimately impact how the geometry of fossil specimens or artifacts will be evaluated. Typically, shape analyses are often mathematical summaries (morphometric indices, regression coefficients, principal component scores) that are, at best, distillations of specimen geometries which necessarily entail a loss of information. Median axis techniques find the geometric "middle" of two-dimensional objects, which can present as single axes or any number of connected branches, depending on the details of the object outline. Any point on the outline is associated with a width function joining the median axis to a point on the contour. These linkages create a true transformation of the object shape, in which the original geometry can be completely described accessibly and intuitively. The fidelity of the methods are only limited by the precision of the source data. There are three algorithms from which to derive a median axis, each of which offer transparent biological insight from details of shape variation. The symmetric axis inscribes circles on object interiors, the centroids of which comprise the median axis and their radii comprise the width functions. The prairie fire algorithm digitally "burns" inward from object boundaries and extinguishes itself on the median axis, while the line skeleton uses angular bisectors of outline segments to find both the median axis and its width functions. We demonstrate the utility of these approaches for resolving taxonomic questions using South African fossil mandibles of australopiths and extinct South African bovids. Importantly, these approaches can be applied to fragmentary specimens provided a few homologous landmarks are identifiable. Rates of change in width functions along the median axis in particular enable the identification of idiosyncratic versus species-specific components of shape variation.

Correlating Woody Cover with *Australopithecus* Presence and Relative Abundance at Eastern African Fossil Sites

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Many hypotheses regarding *Australopithecus* adaptations revolve around the idea that these hominins were ecological generalists. The diversity of site-specific habitat reconstructions and the wide geographic range of the genus support this notion, indicating that it could tolerate variable ecological conditions. However, previous analyses of *Australopithecus* biogeography and paleoecology have relied on qualitative descriptions with poorly defined ecological terms that lack precision, such as "mosaic environment." Moreover, due to an imperfectly sampled fossil record, the observed absence of *Australopithecus* at a site could be due to one of two factors: (1) *Australopithecus* never lived at the site (true absence), or (2) it did but has not been discovered yet (false absence). This complicates our ability to understand the spatiotemporal distribution of *Australopithecus* and the ecological and environmental variables that enabled australopith populations to live and thrive at a given site. Here, we analyze 49 eastern African fossil sites ranging from 4.5 to 2 million years ago using two Bayesian hierarchical models, which model true and false absences as explicitly different states and quantify the probability of *Australopithecus* presence and relative abundance at a given site as a function of woody cover. We quantify woody cover using the site-level mean stable carbon isotope values ($\delta^{13}C$) of mammalian tooth enamel and the within-site spread of those values. Our analysis rigorously tests the idea that *Australopithecus* was ecologically flexible—while simultaneously accounting for an incomplete fossil record—which sheds light on the ecology and evolution of a genus that is central to the study of human origins.

Flat, Dry, and Full of Potential: Rethinking Deserts in Human Evolution

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The role of deserts in human dispersal remains poorly understood, as arid landscapes are often assumed to be barriers to movement. In Central Asia, the Betpak-Dala desert contains takyrs, dense clay surfaces that act as seasonal water catchments. Although takyrs are prominent in the landscape, they have not been systematically evaluated for their persistence, their potential to support mobility, or their possible importance during episodes of hominin expansion. This study uses Soviet-era topographic maps, satellite imagery, and spatial analyses to examine takyr persistence in the modern era and to assess their spacing in relation to movement across the Betpak-Dala. By comparing historic and contemporary imagery, we evaluate takyr visibility through recent decades of extreme warming and examine if their distribution aligns with foraging ranges documented for hunter-gatherers in other arid environments. While these data represent a contemporary time slice, they provide a basis for asking how takyrs shaped access to water and whether deserts such as the Betpak-Dala were always barriers or at times functioned as corridors for human movement.

Inferring the Combined Impacts of *Homo erectus* Carnivory and Increasing Grass Biomass on Mammalian Food Webs at Koobi Fora, Kenya

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Previous research has argued that top-down impacts of *Homo erectus* on mammalian food webs contributed to the downsizing of African faunal communities. Examples of these proposed impacts include the extinction of megaherbivore prey (e.g., Lyons et al. 2004) and large carnivoran competitors (e.g., Werdelin and Lewis 2013). Coinciding with these extinctions, however, is the expansion of grass biomass across Africa (Levin 2015), which may have disrupted food webs in a bottom-up fashion (e.g., extinction of large browsers and the carnivores that prey upon them; Faith et al. 2024). It is likely that top-down and bottom-up impacts are not mutually exclusive and that both affected ancient food webs over time, but no published studies have attempted to disentangle the two. Here, we use dynamic food web modeling (Gauzens et al. 2023) to quantify how different magnitudes of (1) *H. erectus* carnivory and (2) grass biomass increase affected food web structure over time. We infer fossil predator-prey links using a random forest model trained on a dataset of modern predator-prey interactions (Middleton et al. 2021). Rates of biomass flow through these links are derived from metabolic and feeding rates, which we estimate using published allometric equations. We then create a stable food web using mammalian fauna from Koobi Fora's upper Burgi Member (2.0–1.9 Ma), which we perturb with different combinations of *H. erectus* meat eating and increasing grass biomass. We quantify food web disruption with biomass changes of individual species and functional groups (e.g., megaherbivores) and compare simulated changes to those seen in the empirical Koobi Fora fossil record, i.e., from the upper Burgi Member to the KBS Member (1.9–1.6 Ma). Our study offers a new framework for understanding how hominin impacts and changing environments simultaneously shaped mammalian food webs through time.

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Technological Variation in the Okote Member in Area 129 of Koobi Fora, Kenya

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The emergence of the Acheulean represents a major evolutionary milestone as hominins begin to produce Large Cutting Tools from nodules and flake blanks greater than 10cm. The Acheulean Industry emerges in West Turkana 1.76 million years ago (Ma). In East Turkana, it does not appear until 1.38 Ma. However, the causes for the presence of this gap have not yet been studied. Given the size requirements associated with the Acheulean, the absence of Acheulean forms may reflect the absence of materials that are suitably large. Yet, this has never been systematically tested. Here, we present preliminary research examining the relationship between the presence of Acheulean forms and the availability of suitable materials within the Koobi Fora Formation of East Turkana, Kenya. To do so, we mapped the locations and documented the size of raw materials in ancient riverbeds, which serve as the primary source of tool stone in Area 129. By combining these data with site location data, and the characterizations of the associated lithic assemblages, we can explore the relationship between the availability of the stone and the presence of the Acheulean. Preliminary results indicate that, within Area 129, variation in the size of available stones does not predict the location of Acheulean sites. These results begin to foster a discussion regarding the mechanisms that drive technological diversity in the region and the scale at which they operate.

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Faunal Shifts Across the MIS 5 to 4 Transition at Pinnacle Point 5-6N (South Coast, South Africa)

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Marine Isotope Stage (MIS) 5 preserves early evidence of innovative human behavior across Africa, including stratified records of early symbolic activity and increasing technological complexity along South Africa's Southern Cape coast. At Pinnacle Point 5-6N (PP5-6N), the end of MIS 5 is marked by a rapid shift in lithic technology to heat-treated silcrete and the introduction of microlithic tools. Explanations for this behavioral change typically invoke environmental shifts and/or changes in human population dynamics. This study presents paleoecological and human subsistence evidence from the faunal remains recovered from MIS 5 and early MIS 4 levels at PP5-6N. A new quantitative model for assignment of fragmented long bone shafts to body size is employed to reveal patterns previously left unstudied. These data indicate intervals of environmental stability punctuated by episodes of turnover associated with the expansion and contraction of C_4 grassland habitats into the predominantly fynbos landscapes of the Southern Cape. Comparison with independent paleoenvironmental proxies provides a regional-scale perspective on environmental change.

Addressing Spatial Sampling Issues in Paleoecological Reconstructions: An Agent-Based Modeling Approach

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The mammalian fossil record provides ecological context for hominin morphology and behavior across space and time. Fossil assemblages are fragmented and taphonomically biased yet remain valuable for reconstructing past landscape ecology. Here, we present an agent-based model to explore how two sampling variables impact fidelity of fossil assemblages relative to the original landscape—size of sampling area and location of sampling area relative to water. We generated one model per depositional environment—channel, lake, and delta on a 40x40 pixel landscape containing the water source and associated habitats. In these three simulations, herbivores, classified by dietary functional type (DFT) (i.e., browsers and grazers), move around the landscape feeding on preferred vegetation, die at random, and fossilize based on the parameter of potential fossilization. We sample the resulting modeled fossil record across the landscape 100 times at eight spatial scales. Relative proportions of fossilized DFTs at each spatial scale are compared to the relative proportion of habitats across the whole landscape and within the area sampled. Modeled results show that when the scale of the data does not match the scale of the landscape reconstructed (i.e., using a spatially restricted sample to reconstruct the whole landscape), the mammalian fossil record does not accurately represent the original landscape. When the scale of the fossil data matches the scale of the reconstructed landscape, the modeled fossil record is a more accurate predictor of the original landscape. Additionally, small sampling areas proximal to water overestimate habitats supported by higher levels of soil moisture, and sampling areas distal to water overestimate drier habitats. Put simply, when the spatial scale of a paleoecological proxy does not match the scale of analysis, reconstructions are invalid. This highlights the need to explicitly investigate the spatial scale of each proxy when reconstructing ancient landscapes from fossil assemblages.

Exploring Hominin Landscape Scale Behavior at FxJj20: Phytoliths as an Environmental Proxy

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The control of fire played a critical role in shaping human behavior. It is important to know when and how hominins began to interact with fire. This interaction has implications for the specific kinds of biological and behavioral adaptations that are a consequence of human use of fire. The FxJj20 site complex in the Koobi Fora Formation of Kenya is an early Pleistocene archaeological site dated to 1.5 Ma with evidence of combustion. Rubified sediments, burned bone fragments, thermally altered lithics, and geological signatures

diagnostic of high temperatures are all found in close association. Evidence of combustion at an open-air archaeological site is not diagnostic proof of hominin use of fire. However, it can indicate fire was present concurrently with the timeframe of archaeological deposition. Multiple lines of evidence are needed to create a behavioral link between evidence of combustion and hominin activity. Here we provide evidence from phytolith analysis of samples collected within the excavation and the surrounding landscape (~0.5km radius around FxJj20). We compared phytolith assemblages from FxJj20AB and twelve contemporaneous landscape locations, using them as proxies for local environmental conditions. We reconstructed the landscape using Iph indices (moisture gradients), D/P indices (physiognomic differences), and Ic indices (C_3 to C_4 grasses). The presence of aquatic morphotypes can provide insights into the distribution of standing water on the ancient landscape. Morphotypes of burned phytoliths were used to identify fuel sources for combustion events in the excavation as well as the adjacent landscape. Collectively, these phytolith proxies for vegetation, moisture, and fuel availability refine the paleoenvironmental context of FxJj20 and help evaluate the behavioral context of the earliest hominin fire use.

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Bilateral Asymmetry of *H. naledi* Femora From the Lesedi Chamber of the Rising Star Cave, South Africa

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Femoral specimens of *Homo naledi* from the Lesedi Chamber of the Rising Star cave complex (U.W. 102a-001, U.W. 102a-003/004) have been previously assessed by Walker et al. (2019) for belonging to a single individual. The authors speculated that it is unlikely these femora would come from the same individual. However, given the excavation context, the validity of this claim warrants further examination. Here, we present results for bilateral asymmetry with the data derived from the diaphyseal cross-sectional analysis. The U.W. 102a-001 is a right proximal femur with preserved diaphyseal section measuring 77mm from the lesser trochanter distally. The U.W. 102-003 left proximal part preserves homologous section of the shaft as U.W. 102a-001. We extracted cross-sectional data from microCT images of both specimens. Standard cross-sectional parameters (sectional areas, second moments of areas, section moduli, etc.) were extracted for each slice and averaged across the analyzed section in both specimens. Additionally, we analyzed distribution curves for each parameter along the length of the section and across both individuals. The results show that the asymmetry in section areas is below 5%. In second moments of areas and section moduli, the % differences oscillate between 1 and 6, however, the largest differences are in the maximum and mediolateral second moments of area (I_{max} and I_y), where they reach 12%. This result is consistent with Walker et al. (2019), however, it seems that such a high asymmetry is exhibited only in the medio-lateral reinforcement and not in other cross-sectional parameters. This is further confirmed by distribution curves, which are rather similar in both specimens with differences exhibiting primarily in the uppermost section in the aforementioned parameters. Upon this re-examination, the probability that the U.W. 102a-001 and U.W. 102a-003/004 belong to a single individual is higher than previously assessed.

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Insights From ZooMS Analysis on Unidentified Faunal Remains From the Châtelperronian Layer at Roc de Combe (Lot, SW France)

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Zooarchaeology by Mass Spectrometry (ZooMS; Buckley et al. 2009) and traditional zooarchaeology offer two complementary pathways to faunal identification, with the potential to substantially refine taxonomic resolution when applied together, particularly in highly fragmented Paleolithic assemblages. Here, we apply ZooMS to 283 previously unidentified bone fragments from Châtelperronian Layer 8 at Roc de Combe (Lot, SW France). These remains originate from the 1966 excavations of Bordes and Labrot in squares H–K (Bordes and Labrot 1967), with areas I–K interpreted as the least disturbed portion of the Upper Paleolithic stratigraphy (Bordes 2002). Earlier zooarchaeological studies (Greyson and Delpech 2008; Soulier and Mallye 2012) have previously described the identifiable fauna, but as Roc de Combe is one of the few Châtelperronian sites with a substantial faunal record, it offers a uniquely valuable context in which to analyze the previously unidentified bone fragments with ZooMS and refine species representation. Collagen pres-

ervation was exceptionally high, with 99.65% of specimens producing interpretable spectra. ZooMS results broadly support published faunal identifications. In addition to confirmations of large herbivores and small carnivores we further document an avian and proboscidean specimen. Costal cartilage, a skeletal category typically difficult to assign to a taxon in visual taxonomic identification, also yielded reliable peptide fingerprints, opening avenues with ZooMS to provide better insights into skeletal representation and carcass transport strategies. To enable comparison across datasets, we calculated eNISP values following Discamps et al. (2024), integrating ZooMS identifications with previously reported data on species identifications. This combined framework illustrates how fragmentary rdeboraemains contribute meaningfully to faunal diversity estimates and site-use interpretations. Overall, this work highlights the value of ZooMS for refining species representation, expanding taxonomic visibility beyond morphological limits, and supporting ongoing discussions surrounding taphonomy and stratigraphic integrity at Roc de Combe.

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Quantifying the Degree of Size-Selectivity in Mammal Extinctions Over the Last Six Million Years in the East African Rift System

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One of the major paleoecological changes of the late Pleistocene was the extinction of large mammals. A growing body of literature asserts that size-selectivity in these extinctions implicates hominin-driven top-down control (e.g., Smith et al. 2018). While this line of thinking has historically been applied to late Pleistocene Eurasia, Australia, North America, and South America, research on African extinctions has often focused on losses that occurred earlier in time (Faith et al. 2020). Researchers have proposed that as ancient hominins underwent novel biological and cultural adaptations (e.g., increased brain size, elevated carnivory, new technology), they drove large mammals to extinction long before *Homo sapiens* (e.g., Smith et al. 2018). Some place the initiation of top-down anthropogenic control and related size-selective extinctions near the appearance of *Homo erectus* (e.g., Lyons et al. 2004). Size-selectivity in African Pleistocene mammal extinctions has been examined previously, but no published study has done so while adequately accounting for variable incompleteness and sampling effort in the fossil record. Such factors bias observed extinction dates to be too old relative to true extinction dates, which obfuscates our understanding of the degree and timing of size-selectivity in mammal extinctions. Here, we use capture-mark-recapture models (CMR) (Liow and Nichols 2010), which estimate and thus control for variable sampling effort, to analyze a presence-absence dataset of mammal species from the East African Rift System over the last six million years (Rowan et al. 2024). We use CMR to estimate time-varying extinction rates, which we model as a function of mammal body size. Our model enables us to quantify the degree of size-selective extinctions through time and to test the hypothesis that elevated size-selectivity appeared with the evolution of *Homo erectus*. Our study provides insight on when hominin impacts and top-down control first appeared in our evolutionary history.

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Understanding the Paleoecology of Boomplaas Cave, South Africa, Through Bovid Mesowear

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Boomplaas Cave, located in the southern Cape of South Africa, has a rich Pleistocene and Holocene fossil assemblage, which includes many grazing herbivores that are no longer found in the region today. Alongside evidence from other fossil sites, this has led many to argue that grassy ecosystems expanded across the region during the Last Glacial Period, with loss of grasses at the end of the Pleistocene contributing to grazer extinction and extirpation. Ongoing research suggests this interpretation may be oversimplified. Through dental mesowear analysis of present-day bovids and fossil specimens from Boomplaas Cave, we evaluate (1) how fossil herbivore diets since the Last Glacial Maximum compare to their modern counterparts and (2) how diets changed through time. Mesowear analysis is a method for reconstructing herbivore diets based on the macroscopic wear patterns on teeth, which differentiate between browsing (sharp, high cusps) or grazing (blunt, low cusps). We scored 157 teeth from 11 fossil bovids species and compared them to 17 modern bovid species. We find that many Pleistocene bovid taxa, such as Brink's extinct caprin, alcelaphins, and reduncins, have mesowear scores that match more closely those of present-day mixed-feeders. We also find that klipspringers (*Oreotragus oreotragus*) consumed more browse in the Pleistocene and more grass or abrasive material in the Holocene. These results demonstrate that many presumed grazers may be mixed-feeding, which contradicts previous paleoecological interpretations of the region in the Pleistocene. This suggests that the driving forces of faunal turnover is more complex than previously thought and forces a reconsideration of the environments in which human foragers lived.

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Earliest Hominin Use of Wooden Hand-Held Tools Found at Marathousa-1 (Greece)

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The Middle Pleistocene is characterized by increasing behavioral complexity and the earliest unambiguous evidence of plant-based technologies. However, direct evidence for early wooden tool use remains exceptionally rare. We analyzed the wood assemblage excavated at Marathousa-1 (Greece), a Lower Paleolithic elephant butchering site dated to ca. 430 ka (MIS12 glacial), discovered in 2013 and excavated until 2019. Through a systematic morphological, microscopic, taphonomic, and taxonomic analysis of the sampled wood macroremains, two specimens were securely identified as modified by hominins—one small alder (*Alnus* sp.) trunk fragment exhibits clear working and use-wear traces consistent with a multifunctional stick likely used in digging at the paleo-lakeshore; and one very small willow/poplar (*Salix* sp./*Populus* sp.) artifact exhibits signs of shaping and potential use-wear. A third specimen, a large alder trunk segment, shows deep, non-anthropogenic striations interpreted here as claw marks from a large carnivoran. The wooden tools were excavated together with butchered elephant and other faunal remains, small lithic artifacts and debitage, and worked bone, underscoring the diversity of engagement with a variety of different raw materials for technological purposes. These finds represent the earliest known hand-held wooden tools, and document both the use of expedient larger hand-held tools as well as a much smaller, likely finger-held wooden tool, which is uniquely small for the Pleistocene. Thus, they expand both the temporal range and the known functional purposes of early wood technologies. Moreover, they highlight the Megalopolis Basin's exceptional preservation conditions and its role in understanding the evolution of hominin behavior and activities in a MIS12 glacial refugium. Furthermore, the alder trunk fragment with claw marks attests to carnivore presence and possible hominin-carnivore competition at the site. Our results demonstrate the importance of systematic investigation of early wood remains.

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Late Middle Paleolithic Behavioral Continuity From Arcy-sur-Cure (Yonne, France) Dental Remains?

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The Arcy-sur-Cure caves (Yonne, France) constitute a unique assemblage of sites in close spaciotemporal proximity, presenting each a rich collection of Neandertal remains, from the late Middle to early Upper Paleolithic, offering a rare opportunity to investigate behavioral continuity across closely neighboring cave occupations. This study mainly analyzes dental arches from the Grotte de l'Hyène and Grotte du Bison—two of four caves with late Middle Paleolithic deposits—attributed to classical "Quina-like" Mousterian to Late Mousterian techno-complexes. Dental wear patterns from a maxilla and mandible from the Grotte de l'Hyène, together with a hemi-maxilla and isolated teeth from the Grotte du Bison, provide detailed evidence of material processing, independently from the individuals age and provenance. All analyzed teeth display macroscopic and microscopic indicators of sustained interaction with hard materials, including occlusal pitting, chipping, angular wear basins, and striations. The Grotte du Bison specimen (GB-46), although comparatively less worn, exhibits pronounced pitting and edge chipping. In contrast, the Grotte de l'Hyène maxilla (GH-29) shows deep, angular wear basins and extensive occlusal reduction, accompanied by buccal fractures and mechanical deformation across the dentition. Severe hypercementosis and alveolar abscesses in GH-29 further attest the peculiar condition of the individual. The non-associated mandible (GH-28), moreover, presents striations indicative of repetitive contact with hard, likely ligneous, materials. Comparative wear topography across caves also reveals the sequential pattern of occlusal reduction. Lateralized loading signatures, inferred from asymmetric wear and hypercementosis distribution, point to stable, habitual tasks involving the anterior and posterior dentition. The intense occlusal pitting and zenithal occlusal reduction trends notably demonstrated by the preserved dental arches in Arcy-sur-Cure could be consistent with shared masticatory behaviors among the Neanderthal groups occupying the caves. These results together with material patterns of activities, such as hide processing, highlight behavioral continuity across spatially discrete occupations.

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Advancing Cryptotephra Analysis: Volcanic Glass Detection Through AI-Assisted Microscopy

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Advances in Artificial Intelligence present opportunities to address bottlenecks in laboratory methodological workflows across diverse scientific domains, including the analysis of cryptotephra currently constrained by labor-intensive processes. Cryptotephra are microscopic volcanic glass shards that can travel great distances (> 9000km) from the source eruption, forming thin layers or horizons at archaeological sites. The identification of cryptotephra has greatly expanded the capabilities of tephrochronology, a dating and correlative technique that traces volcanic material across the landscape. However, given their microscopic nature (10–20 microns in size), the extraction and identification of cryptotephra in archaeological sediments can be labor- and time-intensive. While previous efforts have focused on advancing extraction techniques (Smith et al. 2018), there has been minimal focus on stream-lining microscopy visual inspection. Training technicians to recognize cryptotephra under the microscope can take years and it remains prone to errors from microscope fatigue and technician bias. This slows research progress and hinders the application of cryptotephra in tephrochronological studies. In this project, we leverage Machine Learning (ML) to significantly improve the speed, reliability, and scalability of these processes. Our team developed an advanced Convolutional Neural Network (CNN) model to identify cryptotephra in high-resolution microscope imagery. Researchers and technicians can now feed new stitched microscope images to the trained model, which then generates possible shard locations to help technicians focus on samples with probable shards. By implementing ML-driven workflows, this project overcomes critical bottlenecks in the analysis of cryptotephra, thereby enhancing efficiency, reproducibility, and scalability, advancing research across this emerging paleoscience subdiscipline.

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The Peopling of the Western Hemisphere: A Population Ecology Approach

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The peopling of the Western Hemisphere took place within the context of modern human dispersal in interior and coastal regions of Northeast Asia and North America after 50,000 years ago. This vast region contains significant—even extreme—variations in local biological productivity, hunter-gatherer carrying capacity, and human fertility rates and, during the past 50,000 years, it has been subject to significant—even extreme—climate variations that affected all these variables. Additionally, modern human dispersal entailed an unprecedented pattern of rapid technological innovation that significantly altered local carrying capacity and fertility rate. Despite this highly variable spatial-temporal context, population ecology is rarely factored into discussions about the peopling of the Western Hemisphere. The most significant variability in productivity and carrying capacity in Northeast Asia and North America lies in the contrast between arctic and subarctic interior settings and northern temperate maritime areas, which support extreme differences in hunter-gatherer population density and fertility rates. The major interpretive models for the peopling of the Western Hemisphere are discussed from a human population ecology perspective.

The Taphonomic Effects of Characterizing Modern Ecosystems Through Game Camera Data

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When estimating faunal abundance and diversity of fossil populations, modern ecosystems provide some of the strongest, if imperfect, baselines. A growing strategy to characterize modern ecosystem biodiversity is through game camera data. Game cameras collect data without human presence and record more comprehensive nocturnal sightings than direct human observation. Game camera data allows new insights into the community richness of highly forested sites with high ape diversity, such as in western Africa, which have historically been difficult to characterize ecologically. Despite these benefits, game cameras are subject to biases that may be similar to the taphonomic biases in the fossil record, including capturing more data in open environments, larger body sizes, and animals that are more gregarious. To examine these biases across space, this study uses the eMammal database to estimate mammal species richness and compare it to the expected richness provided by the International Union for Conservation of Nature (IUCN) database's presence-absence data. Using the Mass of Mammals (MOM) database, we also characterize body size variation in mammal body size from game camera data compared to IUCN database estimates. Finally, the total number of individuals identified by game cameras versus number of total captures was compared between species of varying body sizes and gregariousness. We used cameras from several different projects in Kenya, Ghana, and Gabon, including the Kenya Wildlife Service's Arabuko-Sokoke Forest Project, Shimba Hills Reserve Project, the Kenya Dung Dependency Project's Mpala ranch data, and the Mount Kenya Survey data. Preliminary results of this analysis show that game cameras in the Mpala Game Reserve of Kenya capture only 23 of 151 mammal species. Most of these species are large mammals (above 44kg). These comparisons across eastern and western Africa allow us to explore the differences across game camera data between open and closed sites.

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The Use of FTIR Grinding Curves From Modern Experimental Samples to Identify Thermal Alteration and Diagenesis in Archaeological Bones

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Fourier Transform Infrared Spectroscopy (FTIR) has proven to be a powerful tool in the study of fire remains at archaeological sites and has been applied to various archaeological materials including bone (Stiner et al. 1995; Weiner 2010; Weiner and Bar-Yosef 1990). When using the KBr method, FTIR spectra produce detailed information on the effects of fire on faunal remains. By measuring the Crystallinity Index (CI), or Splitting Factor (SF), the atomic disorder of the sample can be evaluated and assessed for heat alteration. Unfortunately, these measurements can also be affected by diagenesis and grinding during the sample preparation process. This study uses the grinding curve method (Asscher et al. 2011) on modern experimental samples to overcome these two issues. The grinding curves of modern experimental bones, burned under controlled laboratory conditions, were compared to faunal samples from three Iberian Paleolithic sites spanning 400 ka to 20 ka. The results of this study provide insights for the use of FTIR for the interpretation and identification of burnt faunal remains across diagenetic environments.

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Comparative Morphology of Proximal Phalanx Entheses Across Primates

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Manual proximal phalanges are often studied in relation to locomotion, frequently in a limited or very specific context. One aspect of proximal phalanx that exhibits significant morphological variation are flexor sheath ridges, which serve as the attachment site of the A2 pulley ligament. This ligament is integral to the biomechanical function of the flexor digitorum profundus and superficialis. In this paper, we utilize Validated Entheses-based Reconstruction of Activity (VERA) 2.0 to investigate surface area variation of entheses on the manual proximal phalanges, including the A2 ligaments and the attachment sites of intrinsic hand muscles that attach to the base of the phalange. We analyzed 16 entheseal attachment sites on 119 primate specimens representing 46 species and 30 genera. The data demonstrate interesting patterns of entheseal morphology related to locomotor repertoire. Primates that practice arboreal quadrupedalism exhibit extremely generalized morphology, while other locomotor groups demonstrate more specialized adaptations. Overall, we found that entheseal surface area was influenced more by locomotion than phylogenetic relatedness. We also found that the digits, muscles, and ligaments cannot be evaluated separately to accurately assess the biomechanics of the hand.

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The Phylogeny of Orthognathic *Homo*

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The evolution of the orthognathic condition in the genus *Homo* represents an important transition toward the facial morphology of modern humans from that of earlier hominins, but the phylogenetic positioning of this transformation remains poorly understood. As an ancestral character of non-human primates, prognathism persisted in early hominins but variably evolved in later lineages, resulting in the appearance of aspects of orthognathic facial morphology across different taxa and populations. This study will investigate temporal trends in maxillary and mandibular prognathism in the genus *Homo*, and whether maxillary and mandibular shortening in East Asian *H. erectus* and later East Asian Middle Pleistocene *Homo* (e.g., *H. longi*) represent independent derivations of orthognathic morphology, thereby making orthognathism a homoplasy in the genus *Homo*. A sample of roughly 109 cranial and mandibular specimens spanning the Pleistocene will have linear and angular osteometrics either retrieved from literature if only available in prior studies or recorded from landmark data placed on surface models of specimens that are accessible to the authors. Analyses will evaluate correlations between maxillary and mandibular projection, explore temporal trajectories of facial morphology through principal component and non-parametric statistical analyses, and test the taxonomic affinities of East Asian specimens via distance-based and discriminant classification approaches. By integrating these comparisons, this research aims to clarify the evolutionary significance of orthognathism and evaluate whether this condition arose iteratively within *Homo*. The results of this research should contribute to debates surrounding the taxonomy of Middle Pleistocene hominins, the extent of convergent evolution in the hominin lineage, and the potential adaptive significance of orthognathic aspects of craniofacial morphology.

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Ancient Human Exploitation of Ostrich in Malawi

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The Zambezian Biome (ZB), is an open-canopy woodland ecosystem that stretches across central Africa, separating the savannas in eastern and southern Africa. Despite the role of this ecosystem as both a junction and barrier to human and animal movements, relatively little is known about human lifeways in ZB. Ostrich eggs offer a unique pathway to examining for forager behavior, as they intersect with technology (eggs as flasks), subsistence (eggs as food), and social connectivity (beads and flasks as trade items). Grasslands are the favored habitat of ostrich (*Struthio* spp.), which are absent today across most of the ZB, and which forms a barrier between the subspecies in the northeast and south (S.c. *massaicus* and *australis*). However, ostrich eggshell (OES) fragments from three archaeological sites, Hora-1, Mazinga-1, and SAY-1 in the Kasitu Valley (northern Malawi), appear in Pleistocene deposits (>10.5 ka), before disappearing from Holocene layers. This research examines the role of ostrich eggs in forager lifeways during the Late Pleistocene. We

provide a taphonomic assessment of the OES fragments, to distinguish the use-life of the eggs and untangle the effects of site formation processes, including unintentional heating and trampling, as well as anthropogenic activities including flask manufacture and cooking.

Analysis of Downslope Mass Movement Effects on Bone Fragment Microwear: Implications for Earlier Stone Age Bone Tool Identification

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Distinguishing between anthropogenic wear and pseudo-use-wear caused by natural, non-cultural processes is a significant challenge in the study of bone tools. While it has been suggested that the microwear patterns found on the Earlier Stone Age bone tools from the Cradle of Humankind (CoH) are a result of hominins extracting geophytes or digging in termite mounds, geogenic processes have the potential to produce surface modifications on bone that resemble patterns of use-wear including longitudinal striations, rounding, and polish. This study tested whether debris flows, a mass movement process that frequently occurs in the CoH, could produce patterns of microwear on a small sample of warthog (*Phacochoerus africanus*) bone fragments that resemble anthropogenic use-wear. Preexisting microwear and surface features were recorded before exposure to experimental debris flow conditions. The bones were mounted at offset positions from one another towards the bottom of a flume with a length of 1.6m, a width of 0.16m and a height of 0.11m. The flume was mounted at a 40º gradient to mimic the starting zones of debris flows. To replicate the depositional environment of the CoH, sediment was sourced from a surface excavation dump from Sterkfontein. The sediment was then combined with water to provide a mixture with a volumetric sediment concentration of approximately 38.29%. While some sediment loss occurred during the experiment, approximately 1000L of sediment and water were poured over the bones in 200 cycles of 5L sediment-water mixtures. A microwear analysis was performed after exposure and the results were compared to those documented on the CoH bone tools. While none of the experimental bone fragments presented the combination of microwear features diagnostic of the CoH bone tools, this study contributes more broadly to identifying pseudo-use-wear and distinguishing between anthropogenic and geogenic microwear.

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Linking Herbivore Traits to Selectivity of C_3 Versus C_4 Grass Consumption: Implications for Reconstructing Southern African Paleoenvironments

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Because of its rich Middle and Later Stone Age archaeological record, southern Africa is a focus of research on the relationships between climate change, terrestrial ecosystems, and human-environment interactions. However, our understanding of how rainfall seasonality in southern Africa changed across space and through time remains poorly understood. Because the seasonal pattern of rainfall is a key factor in determining the distribution of C_3 and C_4 grasses, which are respectively associated with winter and summer rains, a large body of research uses herbivore enamel $\delta^{13}C$ values to infer rainfall seasonality. Negative enamel $\delta^{13}C$ values are linked to more C_3 grasses and winter rainfall, whereas positive enamel $\delta^{13}C$ values are linked to more C_4 grasses and summer rainfall. However, the interpretations of herbivore enamel $\delta^{13}C$ values from the Last Glacial Maximum (LGM) in the southern Cape are not wholly consistent with other isotopic proxies nor with modeled grass cover estimates. This discrepancy between both empirical and modeled data may stem from a lack of understanding of how herbivore diets are related to C_3 and C_4 grass availability. Here, we model the proportion of C_4 relative to C_3 grass on the landscape based on modern herbivore enamel $\delta^{13}C$ values and functional traits related to dietary selectivity. We find that models incorporating herbivore dietary selectivity generate more accurate predictions than those using enamel $\delta^{13}C$ values alone, with herbivores selectively consuming vegetation out of proportion with its availability on the landscape. We then apply our model to the LGM at Boomplaas Cave and Nelson Bay Cave, broadly finding that our predictions differ from previous interpretations of the amount of C4 grass present on the landscape. These findings have broader implications for how herbivore enamel $\delta^{13}C$ values can be used in paleoenvironmental reconstructions, as well as for our understanding of LGM paleoenvironments in southern Africa.

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Middle Stone Age Shellfish Exploitation Strategies at Pinnacle Point Site 5-6N (100–50 ka), Mossel Bay, South Africa

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Coastal caves/rock shelters at Pinnacle Point, Mossel Bay, preserve some of the earliest evidence for the systematic exploitation of abundant and predictable marine foods, including intertidal shellfish, during the South African Middle Stone Age (MSA). The inhabitants of these sites developed a coastal adaptation focused on a triad of seasonally available resources—marine molluscs, underground storage organs of geophyte plants, and diverse plains game. These foods provided stable sources of protein and carbohydrates, sustaining hunter-gatherer populations in the Cape Floral Region even during harsh ecological conditions. Pinnacle Point (PP) Site 13B yielded archaeological deposits dating from ~162–90 ka, with the oldest known marine food residues recovered from layers dating to ~162 ka during Marine Isotope Stage (MIS) 6. The nearby PP5-6N offers a high-resolution sequence spanning ~100–50 ka (MIS 5–3). With 134 stratified layers dated by 169 OSL ages, Toba cryptotephra, and a Bayesian model, PP5-6N represents the most finely resolved MSA sequence in South Africa. The large total station plotted shellfish assemblage thus provides a fine-grained sequence of coastal resource use. This paper presents the first analysis of the PP5-6N shellfish assemblage, revealing continuity throughout much of MIS 5, with a focus on large sea snails, limpets, and especially brown mussels from mid-intertidal rocky shores. MIS 4 shows greater diversity in collection strategies, including a shift toward sand-burrowing white mussels for a brief time at ~70 ka. These changes align with speleothem records indicating lower environmental variability during MIS 5. The PP5-6 shellfish assemblage provides new insight into shellfish exploitation strategies during glacial and interglacial cycles and attests to the persistence and importance of coastal adaptations during the evolution of modern humans.

Two Late Pliocene Hominin Manual Phalanges from Ledi-Geraru, Ethiopia: Filling a Gap in the Origins of Modern Hand Morphology

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Understanding when and how the human hand acquired its modern functional configuration remains a central question in paleoanthropology. Although the earliest flaked stone tools appear during the late Pliocene, fossils directly documenting manual anatomy across this transition are sparse. Ledi-Geraru, in the lower Awash Valley of Ethiopia, provides a unique framework to address this issue, with a well-dated 2.9–2.6 Ma sequence that preserves early *Homo* remains at ~2.8 Ma and some of the earliest Oldowan artifacts in eastern Africa. Within this sequence, we describe two isolated hominin manual phalanges dating to ~2.63 Ma (proximal phalanx) and ~2.59 Ma (intermediate phalanx). Both fossils retain substantial anatomical information despite missing their distal ends. The proximal phalanx exhibits strong flexor sheath ridges and overall robusticity comparable to modern African apes and some *Australopithecus* specimens. However, its shaft curvature falls at the low end of the hominin range and overlaps with fossil and modern *Homo*, suggesting reduced bending loads associated with climbing. The intermediate phalanx exhibits linear proportions that align with those of early *Homo* and *Paranthropus* in multivariate analyses, differing from the more curved and mediolaterally narrow form characteristic of *Australopithecus afarensis*. Together, these phalanges reveal a mosaic pattern—they retain primitive robusticity but also display derived morphological features of a human-like hand. The combination of lower curvature, altered shaft proportions, and intermediate phalanx morphology implies diminished arboreal engagement and potentially enhanced fine-manipulative capacity. Although the specimens cannot be assigned to a specific taxon, their anatomy occupies a critical position between earlier australopiths and later hands associated with habitual tool manufacture. These fossils help fill an important anatomical and temporal gap in the evolution of the hominin hand and provide new evidence for the emergence of modern-like manual capabilities near the onset of Oldowan technology.

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Bone Tool Technologies in the Kasitu Valley, Northern Malawi

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The Kasitu Valley in northern Malawi, within the Zambezian open woodland belt of southern-central Africa, provides a rich archaeological record for exploring forager lifeways during the Middle and Later Stone Age. Our study analyzes 575 bone tools recovered from Hora 1, Mazinga 1, Sayile 1, Kadawonda 1, and Fingira 1, primarily dated between 37,000 and 8,000 years ago. These assemblages span the Pleistocene-Holocene transition and exhibit a remarkable diversity in tool forms, as well as a wide range of manufacturing techniques. By documenting the variability of bone tools from the Kasitu Valley, this study highlights the key role bone technologies fulfilled in the subsistence strategies and cultural behaviors of ancient hunter-gatherers in an understudied part of Africa.

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Exploitation of Animal Resources by Mesolithic Foragers in the Central Balkans: An Archaeozoological Analysis of Crvena Stijena, Montenegro

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The Pleistocene-Holocene transition in Europe is often associated with significant environmental and faunal turnovers associated with the intensification of subsistence economies during the Mesolithic. However, in some regions of southern Europe, environmental conditions and faunal communities remain relatively stable across the Pleistocene-Holocene transition, perhaps facilitating stability in subsistence economies between Upper Paleolithic and Mesolithic communities. This study examines the foraging and carcass processing strategies of Late Upper Paleolithic and Mesolithic foragers at Crvena Stijena, Montenegro. Drawing on principles of Human Behavioral Ecology, particularly the Prey Choice Model, Patch Choice Model, and Marginal Value Theorem, this study evaluates shifts in prey selection and resource intensification across the Pleistocene-Holocene transition. Red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), and brown hare (*Lepus europaeus*) are the most commonly identified taxa in the assemblages. Zooarchaeological analyses suggest that Upper Paleolithic and Mesolithic foragers at Crvena Stijena exploited many of the same prey species, supporting claims of long-term environmental stability in the region. However, there is evidence that the Mesolithic foragers engaged in more intensive subsistence strategies than those of Upper Paleolithic, particularly through more frequent inclusion of lower-ranked prey types such as the brown hare. Overall, this research contributes to broader debates concerning the nature of postglacial economic intensification, particularly in regions considered environmental refugia.

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A Preliminary Analysis of *Kenyapithecus* Astragali from Maboko, Kenya

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Fossil remains from Maboko, Kenya, have long provided an important lens into the paleobiology of East African Middle Miocene catarrhine primates. These include numerous cranial and postcranial remains attributed to the hominoid genus *Kenyapithecus*. Given debates surrounding the development of later African ape locomotor behaviors, the Maboko hominoid remains are of particular interest, as it has been suggested they may indicate a form of terrestrial knuckle-walking. In this study, we investigate the morphological and potential locomotor affinities of two unpublished catarrhine astragali from Maboko, provisionally attributed to *Kenyapithecus*. We use 29 homologous x, y, z landmarks, and a broad comparative sample of extant anthropoid taxa representing a range of positional behaviors (including *Alouatta, Colobus, Erythrocebus, Gorilla, Hylobates, Macaca, Mandrillus, Pan, Papio,* and *Pongo*). The fossil sample includes the two astragali from Maboko (KNM-MB 2474 and KNM-MB 31331), attributed to *Kenyapithecus*, and specimens from the Early Miocene Kenyan sites of Rusinga (*Ekembo heseloni*), and Songhor (*E. nyanzae*). Our results from multivariate analyses of the registered landmark data indicate that KNM-MB 2474 is distinct from extant African apes, and groups with generalized quadrupedal cercopithecoid taxa, as well as *Ekembo*. The larger specimen KNM-MB 31331 differs and shows affinities with extant great apes based on trochlear shape and angulation between the trochlea and the posterior calcaneal facet. Together, our preliminary results suggest two astragalar morphotypes at Maboko. Our results are discussed within the context of both taxonomic and locomotor diversity in the broader Maboko catarrhine sample from the early Middle Miocene.

A Multi-Proxy Record of Vegetation and Climate Changes at Kisese II Rockshelter During the Last Glacial Maximum

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The Last Glacial Maximum (LGM, ~26–18 ka) in Eastern Africa was characterized by drier, cooler conditions that influenced local vegetation, but how these ecological changes impacted resource availability for human populations remains unclear. Kisese II rockshelter in north-central Tanzania documents both environmental and behavioral changes during this period, preserving extensive fossil fauna, ostrich eggshell (OES) fragments, and lithics and ochre artifacts recovered from 1956 excavations. Prior OES $\delta^{13}C$ analyses indicate stable variation around a mix of C_3/C_4 plant communities through time, while OES $\delta^{18}O$ minima from ~18.1–4.2 ka indicate lower evapotranspiration and cooler or wetter conditions. OES nitrogen isotope ($\delta^{15}N$) data suggest that peak precipitation estimates occurred earlier, around 22 ka. There is no significant change in enamel $\delta^{13}C$ and $\delta^{18}O$ values from 93 fossil herbivore enamel samples (30 taxa) when analyzed together and as separate feeding guilds, further supporting a lack of change in the vegetation community during this period. Pilot phytolith data from the Silty Sands with Micritic Calcite (SSMC) stratigraphic unit, in the Late Pleistocene (16.6–26.1 ka), suggest C_4 grass dominance with C_3 Pooideae grasses increasing around 18 ka, aligning with the OES $\delta^{18}O$ minimum and reinforcing evidence for a cooler and/or relatively drier interval. Phytolith paleoenvironmental reconstructions correspond to a subset of the reconstructions from OES and enamel datasets; however, further research is needed to infer ecological resource availability accurately. Collectively, these data underscore the importance of multi-proxy approaches for reconstructing paleoenvironmental conditions. Future research requires integrated ecological models using high-resolution paleoenvironmental data and expanded taphonomic investigations to better understand these complex interactions between environmental processes and hominin adaptive strategies across spatiotemporal scales.

Changes in Carnivore Niche Overlap During the Late Cenozoic of Eastern Africa

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The eastern African carnivore guild experiences devastating losses in the Early Pleistocene, leading to a paucity of these animals still seen in ecosystems today (Faith et al. 2024; Lewis and Werdelin 2007; Werdelin and Lewis 2013). One hypothesis to explain these losses is that long-term changes in the functional makeup of herbivore communities (e.g., loss of megaherbivores) resulted in increasing interspecific competition among carnivorans, which led to their extinction. Here, we evaluate the viability of this proposed mechanism by quantifying the consequences of changes in herbivore communities on dietary niche overlap within a functionally diverse hypothetical carnivore guild. This hypothetical carnivore guild captures most functional morphotypes of large carnivorans present in Pliocene eastern Africa. Drawing from eastern Africa's rich late Cenozoic fossil record (7–0.01 Ma), we estimate carnivore diets using random forest modeling of predator and prey functional traits. We find that empirically observed changes in herbivore community composition translates to increasing dietary niche overlap within the hypothetical carnivore guild by the Early Pleistocene, exceeding the magnitude of niche overlap observed in modern African ecosystems. This results from a decline in functional diversity of African Plio-Pleistocene herbivores and coincides with the empirically observed collapse of carnivore functional diversity. Conversely, when we quantify dietary niche overlap within the empirically observed carnivore guild (i.e., as opposed to our hypothetical carnivore guild), we find that the degree of overlap broadly falls within the range of present-day African ecosystems, suggesting a potential constraint on the magnitude of dietary overlap among coexisting carnivores. Although our results do not allow us to exclude potential top-down forces (e.g., hominin impacts), they demonstrate the feasibility of bottom-up processes as a potential driver of eastern Africa's large carnivore extinctions.

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Herbivore Enamel Isotopes Suggest Dietary Niche Conservatism in the Eastern African Rift System Across the Last 10 Million Years

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The expansion of C_4 grassy ecosystems in the Eastern African Rift System across the past 10 million years (Myr) is thought to be an important evolutionary driver for mammalian communities, and hominins in particular. However, how different clades responded to this environmental change—whether by shifting their diets or by replacement of browsing clades with grazing clades—on evolutionary timescales (106 yrs) remains poorly understood. Some hypotheses frame dietary change through time as a gradual shift in response to changing vegetation, mediated by evolving functional traits. Meanwhile, other hypotheses suggest that phylogenetic niche conservatism constrains species responses to environmental change, such that diets are conserved within clades through time. Evaluating competing hypotheses about community responses to C_4 expansion remains a challenge due to the scale-dependent nature of the relationships between clade membership, functional traits, and diet, and the wide range of temporal, spatial, and taxonomic scales across existing published studies. Here, we draw on a 10-Myr record of large-bodied mammalian herbivore carbon enamel isotope data from the Eastern African Rift System to understand the relative influence of environment, functional traits, and phylogeny in shaping dietary responses to the expansion of C_4-dominated ecosystems. We found that on evolutionary timescales, diet was much less sensitive to environmental change than might be expected and that diet was conserved within herbivore clades. Our results suggest that dietary niche differentiation among African herbivore clades arose early in their evolutionary histories, and despite the dramatic rise of C_4-dominated ecosystems, environmental change and subsequent trait evolution did not override the tendency for lineages to retain ancestral niches. Many browsing clades declined or went extinct, rather than changing their diets. These results complement other recent analyses showing that hominins evolved within mammalian communities that were in compositional flux as C_4-dominated ecosystems expanded.

Local Variation in *Australopithecus afarensis* Habitat - Insights From the Isotopic Composition of Bovid Teeth

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Australopithecus afarensis was a widespread hominin with a fossil record spanning 1 myr and included a wide dietary breadth. Establishing the habitat of *Au. afarensis* is key to understanding the environmental conditions of its persistence and dietary flexibility. However, our current view of *Au. afarensis* habitat draws on data from sites that span large amounts of space and time, preventing a full understanding of the heterogeneity of *Au. afarensis* habitat at any one given time interval. The recovery of *Au. afarensis* fossils from localities in Hadar and Woranso-Mille in the Afar region of Ethiopia that overlap in age gives us the chance to investigate habitat heterogeneity. We compared new (n=77) and published (n=72) $\delta^{13}C$ values of bovid tribes from two sets of contemporaneous fossil assemblages—Sidi Hakoma submembers 1 and 2 (SH-1/SH-2) and Denen Dora Member (DD) at Hadar and Leado Dido'a (LDD) and Nefuraytu (NFR) at Woranso-Mille (~3.4–3.2 Ma). Our results indicate that bovid $\delta^{13}C$ values span the full range expected for herbivores with diets composed of pure C_3 to C_4 plants (-12.6 and +3.7 ‰). While some bovid tribes yield $\delta^{13}C$ values that are invariant among sites (e.g., Acelaphini), suggesting a constant diet regardless of environmental differences, the $\delta^{13}C$ values of other tribes vary between sites. Notably, the mean $\delta^{13}C$ values of Tragelaphini and Reduncini are >2‰ and >4‰ more negative, respectively, at SH-1/SH-2 than other assemblages, whereas the mean $\delta^{13}C$ values of Tragelaphini at LDD are >2.5‰ more positive than those from other assemblages. These results suggest potential distinctions in *Au. afarensis* habitats in nearby contemporaneous assemblages and show promise for exploring how variation in $\delta^{13}C$ values among certain bovid tribes may reflect *Au. afarensis* habitat distinctions.

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Lithic Attributes in the Presence of Task Driven Choices During Stone Tool Production

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The evolution of human behavior is largely understood through the information inferred from stone tools, often in the form of early simple core and flake technology. There is a consensus that hominins predominantly employed direct free-hand percussion alongside lesser-used techniques such as bipolar, throwing, and passive hammer, yet conditions under which techniques are applied remain unexplored. We present a study that investigates the factors influencing production technique among current expert stone tool makers from the Daasanach community of Northern Kenya. By observing task-driven production demonstrations, our study provides insight into choices made in stone tool making from a traditional knowledge base, showing that the techniques applied stand in contrast to those once considered dominant. Analysis of demonstrations and reduction sequences show that choices in technique are related to core and hammerstone size, shape, and individual preference. The results call for consideration of alternative techniques in creating the archaeological assemblages that we study, highlighting the continued importance of traditional ecological knowledge for understanding the past. Results show that while measurements of a flake do not directly indicate that it was made with resting percussion or passive hammer, there is a trend that higher mass flakes tend to be knapped using passive hammer reduction. Despite this, the heaviest flakes at over 2 kilograms were knapped using resting percussion. Similarly, flakes with a higher maximum length also tended to be produced through passive hammer techniques, possibly due to the technique lending itself to higher flake output with longer cores. This research contributes to the opening of the current repertoire of viable knapping techniques. Through task-driven production (i.e., making tools for butchery or woodworking), knappers with a traditional knowledge base employed a number of reduction techniques that vary from the status quo that has long focused on freehand percussion's presence in the archaeological record.

Reconstructing Early Pleistocene Fire: Insights from Morphometric and Spectral Analysis of Charcoals From the Koobi Fora Formation, East Turkana, Kenya

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The ability to create and use fire is a unique feature of human life. Yet, how and when pyrotechnology (controlled use of fire) was incorporated into the hominin behavioral repertoire is highly debated. The Pyrophilic Ape Hypothesis proposes that hominin fire use began with hominins taking advantage of living in fire-prone landscapes, potentially leading to hominins' eventual control of landscape burning as a form of niche construction. Evidence for hominin landscape burning is geographically extensive, spanning temperate, tropical, highland, and forested habitats (~125–44 ka), suggesting the practice was a ubiquitous part of hominin adaptation. The lack of archaeological evidence of this behavior 3.6–1.4 Ma in a savannah environment may be due to current methods, focusing on identifying burning on archaeological sites rather than landscape burning. Charcoal, an inert byproduct of incomplete plant combustion, serves as a common proxy for studying past fire activity. Morphometrics and Spectral properties (Fourier Transformed Infrared Spectroscopy) of charcoal from open-air experiments and a lightning-struck tree established a modern reference for comparing charcoal from early Pleistocene archeological sites and paleolandscapes in the Koobi Fora Formation, Kenya. For the modern reference, charcoal's morphometric analysis of length/width ratios correctly identified wood as the primary fuel source in all experimental fires and the lightning-struck tree. Morphometric analysis also showed a correlation between smaller area/perimeter ratios and higher temperatures. Spectral analysis was able to reconstruct the wide range of temperatures observed in the open-air fires, compared to the smaller range of temperatures from the lightning-struck tree. For charcoal recovered from an early Pleistocene context, we obtained morphometric and spectral data that fall within the range of the modern reference material. These results demonstrate the potential of these methods for investigating landscape burning in deep time and reconstructing the origins of hominin pyrotechnology.

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Phylogenetic Simulation Estimates Recovered Morphological Variation in the Hominin Fossil Record

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Despite thousands of fossils and numerous taxa recovered, the hominin fossil record will never contain the full taxonomic and morphological diversity of the lineage. For this reason, we are unable to quantify how much of the true hominin morphological variation is known. Here, we use phylogenetic simulation to estimate the percentage of the hominin morphospace covered by the currently known hominin fossil record. We used 1,000 phylogenetic trees sampled from the hominin phylogenetic posterior distribution in Raskin et al. (2025). This procedure accounts for uncertainty in the hominin phylogeny. To represent up to a "worst-case scenario" in which the hominin fossil record preserves only 10% of the total diversity, we pruned the primate outgroups, leaving 16 hominin OTUs, and then simulated 144 additional tips onto the pruned phylogeny. Following Raskin et al. (2025), we simulated two- and three-dimensional shapes on this 160-tip phylogeny. We then conducted a principal component analysis on the simulated dataset and calculated the convex hull volume occupied by the 16 known hominin OTUs across the first three principal components. We then randomly sampled a simulated OTU to "discover," and recalculated the morphospace occupied by our "known" hominins. We repeated sampling without replacement until we recovered the simulated full phylogeny. This procedure repeats 100 times to account for variation due to order of discovery. We find that the known 16 hominins cover, on average, 75% of the morphospace if there remain five undiscovered hominins, 60% if there are 11 (matching the upper bound of hominin taxa estimated by Bokma et al. 2012), 44.5% if there are 25, 34% if there are 50, and 24% if there are 144 additional hominins to be discovered. Therefore, despite the incompleteness of the hominin fossil record, currently known hominins likely represent a substantial percentage of the true hominin morphospace.

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Mapping 424,000 Years of Vegetation Change in the Cape South Coast (South Africa): Implications for Early Modern Humans

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Understanding how terrestrial ecosystems responded to environmental change during the Middle to Late Pleistocene is essential for interpreting the ecological settings of early modern humans on the Cape south coast of South Africa. This region, which includes the now-submerged Paleo-Agulhas Plain (PAP), experienced repeated cycles of shoreline exposure and shifting rainfall regimes that shaped resource availability for foragers. To reconstruct how glacial-interglacial dynamics shaped terrestrial ecosystems in this region, we integrated global precipitation data, time-varying sea-level reconstructions, regional fine scale geological substrates, and an expert rule-based vegetation model. We generated spatially explicit vegetation maps at 1,000-year intervals over the past ~424,000 years, revealing how interactions among rainfall regime, substrate, and coastline position may have structured terrestrial ecosystems through time. Applying the model through multiple glacial-interglacial cycles highlights recurrent patterns of ecological stability and exposure on the PAP, with extensive arid vegetation during glacial low stands, frequent turnover between summer and winter rainfall-driven vegetation, and relative stability of fynbos and thicket. Modeled vegetation trajectories broadly agree with speleothem isotope records from the Pinnacle Point Site Complex. These reconstructions provide the first continuous, spatially explicit view of vegetation change across a landscape that shaped human evolution, offering new insights into how alternating phases of ecological stability and variability structured habitats that supported innovation, foraging, and adaptive behavior.

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Patterning of Dental Microwear Textures Among the Epigravettian Individuals From Arene Candide Cave, Liguria, Italy

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Arene Candide is part of a sizable cave system near the shore of the Ligurian Sea in northwest Italy and is a fundamental site for understanding Late Upper Paleolithic funerary behaviors in Europe. At least 20 individuals, including adults and subadults, were buried with abundant grave goods during the Epigravettian. Recent AMS dating places the burials to 12,900–11,600 cal YBP, within the Younger Dryas cooling event. Mortuary behaviors were complex; there were at least two double inhumations, both including an adult and a child, and graves were repeatedly reworked, placing their skeletal elements on subsequent burials. It has been theorized that funerary behavior revolved around "exceptional people and events," including pathological individuals. This study explores patterning of dental microwear textures for seven Epigravettian burials. Microwear texture data collection followed standard procedures and the variables were complexity, anisotropy, scale of maximum complexity, heterogeneity 9, and heterogeneity 81. For most individuals, diets included hard foods and were moderately diverse (mean complexity=2.21, mean anisotropy=0.0026, Hasfc9=0.3890). This is true for AC 24, a 9-year-old whose diet was comparable to that of the adults. Early and late burials have similar signatures, indicating centuries of dietary stasis. However, Burial AC 5 had a distinctly low complexity value, indicating he died after an extended period of consuming non-brittle foods. Many factors affect dietary proclivities including season of death, food availability, and perimortem illness. Low complexity values, among an otherwise hard-food consuming population, point to a prolonged period of eating easy-to-chew foods. Interestingly, AC 5 showed no sign of pathology. In contrast, neither AC 2 nor 3—both of whom are thought to have hypophosphatemic rickets—had an unusual dietary signature. If an illness, indeed, affected AC 5's microwear textures, it plausibly took hold a few months prior to death.

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Reconstructing the Paleoenvironment of Area 123, Koobi Fora, Kenya

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The Turkana Basin in Kenya preserves one of the most extensive and informative fossil and sedimentary records for understanding human origins. Within the Koobi Fora Formation, Area 123 is known for its remarkable fossil preservation and has been extensively studied. It preserves abundant mammalian fossils, including multiple hominin specimens such as the *Homo habilis* cranium KNM-ER 1813. Here, we analyze the taxonomic composition of Area 123 through time, as well as how species abundance and diversity alongside collection biases affect interpretations of community structure and paleoecology. We observed an increase in the relative abundance of some bovid taxa, including Tragelphini and Reduncini through time, suggesting a shift toward increased mixed woodland environments between the Upper Burgi (1.98–1.87 Ma) and KBS Members (1.87–1.56 Ma). We also see a decrease in Alcelaphini and Bovini bovids, as well as Equid species, which suggests a decrease in open grasslands. We find that certain monkey species (*Cercopithecus* sp.) decreased in presence between members. However, this may be a consequence of collection biases rather than a true ecological shift, as comparisons between the Turkana Public Database and our recent collections suggest that earlier work placed greater emphasis on collecting primate fossils. These findings support the hypothesis of pulsed environmental instability that played a key role in shaping primate community structure within the Koobi Fora Formation during a critical period of hominin evolution. This study also underscores the necessity of accounting for possible collection biases to generate accurate and robust paleoecological models.

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Sr/Ca in Modern and Fossil Dental Enamel in the Context of Growth: Implications for Interpretation of Fossil Hominin Data

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The alkaline earth ratios (AERs) Sr/Ca and Ba/Ca have long been explored in skeletons as paleodietary indicators. Early studies focused on bone because the discrimination factor (Observed Ratio, or OR) at the level of intestinal absorption and kidney excretion was relatively constant in adults. While early results were promising, increasing concern about the susceptibility of bone to diagenesis limited applications, and subsequent AER studies shifted to analyses of enamel. However, virtually all investigations of AERs in enamel are complicated by the observation that AER discrimination is lessened when calcium homeostasis is challenged, notably during growth. Raw enamel Sr/Ca data from numerous studies do not correspond to known trophic phenomena. Here, we review the theoretical and experimental background to establish a relationship between OR and growth velocity (GV). In turn, we hypothesize that GV may be used as a lens, or "Rosetta Stone" to adjust measured enamel Sr/Ca in growing teeth for any given age so as to reflect dietary phenomena. The hypothesis was explored by transforming available Sr/Ca data in human and chimpanzee dental enamel with species-specific GV. The results indicate a much-improved relationship between enamel Sr/Ca and trophic phenomena. We then applied this transformation to both *P. robustus* and early *Homo* dental chronologies, using alternative human and chimpanzee GV models. By controlling for trophism, it is possible to make inferences regarding growth. Applying this concept to existing early hominin chronologies, we note that (i) both *P. robustus* and early *Homo* GV appear to drop precipitously after birth in a manner more consistent with humans than great apes, and (ii) *P. robustus* does not appear to have a delayed adolescent growth spurt. In this way, it is more similar to great apes than humans. We conclude that this species may present a mosaic of human and ape-like features in its pattern of growth.

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The Demise of *Australopithecus afarensis* and the Appearance of New Species Through Time in the Lower Awash Valley

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The deposits of the Ledi-Geraru Research Project (LGRP), Afar Region, Ethiopia, preserve Plio-Pleistocene fossils from the Hadar Formation (3.4 Ma–2.95 Ma) and sedimentary packages ranging from 2.9 Ma–2.59 Ma. Only *Australopithecus afarensis* has been recovered from the Hadar Formation at LGRP and Hadar. *Homo* and *Australopithecus* sp. have been recovered from younger LGRP sediments, coeval with Oldowan stone tool sites dating to 2.61–2.56 Ma, including those at the LGRP Ali Toyta site and nearby Gona. We investigated how habitat change and climate fluctuations may have contributed to the disappearance of *A. afarensis* and the appearance of new hominin taxa in the region. We examined mammalian communities from various locations and all time periods in the LGRP and from ~3.1 Ma to 2.95 Ma at Hadar using 1) Paleo- and Bio-Clim to identify changes in precipitation and temperature; 2) dietary and substrate functional traits of the herbivore communities. In addition, we examined changes in mammalian community structure before and after the appearance of Oldowan stone tools. Results suggest that earlier communities at Hadar (ending at 2.95 Ma) supported *A. afarensis* with fluctuating rainfall and variable tree cover and riverine forest habitats. Younger periods from the Kada Hadar Member forward, including the LGRP Gurumaha, Lee Adoyta, and Giddi Sands sedimentary packages (2.78–2.59 Ma) as well as the Ali Toyta region (2.61 Ma–2.55 Ma), include more open habitat taxa living alongside *Homo* and *Australopithecus*. While there are broad trends towards aridity, there is also habitat variability that may have facilitated diversification and/or appearances of hominin species. While any *Australopithecus* species could have eaten meat occasionally, we note that only *Homo* is present at the same time as stone tool localities with evidence of knapping in the Lower Awash Valley.

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Physical Foundations of *Chaînes Opératoires*: An Alternative to Mental Template Explanations of Lower Stone Age and Early Paleolithic Technologies

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Leroi-Gourhan's (1993 [1964]) original conception of *chaînes opératoires*, or operational sequences, attempts to explain the common origins and evolution of human language and lithic technologies. His account drew on contemporary neuroscience but this fact appears to be less prominent, if not entirely neglected, in the literature that cites his original use of the concept. Instead, the *chaînes opératoires* concept has been interpreted or applied by different archaeological and paleoanthropological traditions that instead focus on the discrete sequential steps of lithic manufacture, lithic acquisition, procurement, geographic distribution, use, and discard. What both theory

and pedagogy of these restricted instances of *chaînes opératoires* often have in common is an assumption of (or inference to) the existence of mental templates, by which standardization of lithic tool types, and accurate reproduction thereof, is made possible. I argue that the notion of mental templates is an extremely problematic explanatory concept that should be rejected. In fact, this kind of problematic attempt at explanation can be traced to Leroi-Gourhan's discussion of Acheulean bifacial technology. As Clive Gamble (1999) has aptly noted, Leroi-Gourhan's Cartesian position is paradoxical, if not inherently contradictory, given his non-Cartesian emphasis on the neuro-physical elements of his account, including his idea of ``neural templates.'' After rejecting the non-physical and non-causal model of Cartesian-based mental templates, I argue in favor of an exclusively physical model of *chaînes opératoires* that is motivated by Leroi-Gourhan's original insights. The latter account pursued in this presentation aims at outlining a few central neuroscientific causal features of the kind of sensory-motor and social behavior that underlie the origins, learning, skillful production, cultural transmission, and evolution of Lower Stone Age and Early Paleolithic technologies.

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New Perspectives on Oxygen Isotopes for Human Evolutionary Biology

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Tooth enamel records dietary inputs throughout formation, does not remodel during life, and largely resists diagenesis, yielding the natural environmental variation of ingested water via isotopic analysis. Sensitive High Resolution Ion Microprobe (SHRIMP) measurements of oxygen isotope compositions ($\delta^{18}O$) can be related to daily enamel increments to facilitate sequential weekly sampling over years of growth. We have used this approach to establish that primate enamel $\delta^{18}O$ values do not typically peak during exclusive suckling (Smith et al. 2018; 2025; Vaiglova et al. 2024), unlike expectations from other mammals. Such records can be extended to identify short term physiological changes, including birth and gastrointestinal disruptions, and may also permit the estimation of birth seasonality in some instances (Smith et al. 2018; 2022; 2025; Vaiglova et al. 2024). Studies of wild primates demonstrate that enamel $\delta^{18}O$ values may track bimodal and annual rainfall patterns with good fidelity (Green et al. 2022; Smith et al. 2025). Moreover, primate teeth appear to record meteorological events such as extreme rainfall events, sustained droughts, and supra-annual ENSO cycles (Green et al. 2022; Smith et al. 2024; 2025). We also identified instances of changing climates over geological time, beginning with comparisons of Neanderthals and a modern human in southeastern France (Smith et al. 2018). Studies of fossil apes led to inferences of increasing seasonality and aridity in Kenya during the Early Miocene (Green et al. 2022) and drier environments with reduced monsoon intensity in Malaysia at the start of the Holocene (Smith et al. 2024). Recent work pairs $\delta^{18}O$ values with trace elements, revealing that inferences of 'seasonal stress' from trace elements alone should be regarded with caution (Avila et al. in press; Bharatiya et al. in press). Ongoing work on human teeth from a range of archaeological sites does not support the sole use of $\delta^{18}O$ values for geolocation—particularly from bulk samples, as our fine-scaled measurements show large intra- and inter-individual $\delta^{18}O$ variation, mainly due to seasonal hydrology (Avila et al. in press; Vaiglova et al. 2024). This foundational SHRIMP work will now allow for more nuanced insights into the paleobiology of fossil apes and hominins.

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Evaluation of Herbivore Diets at Boomplaas Cave, South Africa, Using Dental Microwear Texture Analysis Challenges Uniformitarian Assumptions

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Southern Africa's southern Cape has been a focus of research aiming to understand the relationships between Quaternary climate dy-

namics, ecosystem change, and modern human origins. Throughout the Late Pleistocene, changes in the temperate and tropical climate systems influenced rainfall and vegetation on the southern Cape of South Africa. Due to its location at the intersection of winter- and summer-dominated rainfall zones, the faunal record from Boomplaas Cave (>65 ka to recent) is well-positioned to contribute to our understanding of paleoecological dynamics in the region. Previous stable carbon isotope analyses of herbivore tooth enamel at Boomplaas were interpreted as indicating a dominance of C_3 grass, with varying proportions of C_4 grass throughout the sequence. However, this relies on uniformitarian assumptions about diet—namely that grazers today were also grazers in the past. To evaluate this assumption, we utilize Dental Microwear Texture Analysis of herbivore teeth from Boomplaas to infer diet (grazing, browsing, mixed-feeding) from microscopic tooth wear patterns. We find that presumed grazing herbivores, including the extinct caprin, Alcelaphini, and Reduncini, exhibit a greater amount of mixed-feeding compared to their extant counterparts. We utilize the DMTA to predict the percentage of grass in the diet and compare this to published estimates of the proportion of C_4 grass consumption from isotope mixing models. After accounting for a higher proportion of browse in the diet, C_4 grass makes up a larger portion of all grass consumed than previously thought, suggesting that either more C_4 grass was available on the landscape or that herbivores were preferentially selecting C_4 grass. These findings have implications for our understanding of rainfall seasonality, vegetation availability, and herbivore dietary flexibility in the context of Late Pleistocene human behavioral variability on the southern Cape.

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Using Agent-Based Models to Investigate the *Paranthropus boisei* Dietary Conundrum

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Our understanding of the paleoecology of *Paranthropus boisei* is at an impasse. On the one hand, decades of work on its highly derived masticatory morphology suggest an adaptation for processing hard foods. On the other hand, dental microwear and carbon isotope analyses seem most consistent with tough diets derived primarily from C_4/CAM resources like tropical grasses and/or sedges. Some researchers argue that underground storage organs (USOs), especially from sedges, were the primary source of C_4 carbon, while others maintain that these were unlikely to have been important components of *P. boisei*'s diet given its low complexity microwear and minimal dental chipping. One barrier to solving this problem is the difficulty of integrating data from the varied sources of dietary information in nutritional space. Agent-Based Modeling (ABM) allows this and provides a computational environment well-suited to evaluate hypotheses concerning hominin subsistence strategies. Griffith et al. (2010) published HOMINIDS ABM to explore *P. boisei* and *H. ergaster* diet and found that hominin agents had difficulty surviving the dry season unless they could access USOs. However, in this interpretation, the bulk of *P. boisei*'s calories came from C_3 foods, which was inconsistent with the carbon isotope data that became available soon after the HOMINIDS ABM was published. As a result, this elegant effort received less attention than was warranted. Here, we update the Griffith et al. (2010) model and introduce our own Forage! ABM framework for investigating the diets of hominins as part of broader mammalian communities. We focus on energy maximization, while paying heed to protein requirements, tooth wear, microwear, and isotopic composition to test the viability of proposed *P. boisei* diets, specifically exploring consumption of various C_4 resources, including grasses, sedges, and C_4 USOs. A crucial finding from our initial simulation is that preventing C_4 grass consumption by *P. boisei* agents is only possible when the model is configured to strongly tip the scales against grass utilization a priori.

A Preliminary Study of *Pierolapithecus catalaunicus* Phalangeal Cortical Bone Morphology

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Pierolapithecus catalaunicus (~12 Ma) is an extinct great ape with postcranial features linked to modern-ape orthograde postures but lacking key external features in the hand associated with specialized below-branch suspensory adaptations (e.g., elongated and highly-curved phalanges) (Almecija et al. 2009; Moyà-Solà et al. 2004). Since its discovery, *Pierolapithecus* has played an important role in theories of hominoid evolution, suggesting that vertical climbing and an orthograde body plan preceded suspensory adaptations (Moyà-Solà et al. 2004). As internal bone structure should be sensitive to differences in loading associated with climbing versus suspension (Ruff et al. 2006), here we examine cortical bone distribution (CBD) in the *Pierolapithecus* phalanges to assess whether this fossil ape can provide insight into loading patterns associated with climbing specifically. We analyzed the cortical bone structure of the proximal and intermediate phalanges of *Pierolapithecus*, alongside a comparative sample of great apes (*Pongo*=12; *Gorilla*=27; *Pan*=29) and baboons (N=4). CBD was calculated using paired semilandmarks placed on cross-sections of the phalangeal shaft's external and internal sur-

faces, derived from high-resolution micro-CT data, throughout the shaft, measuring the distance between each pair (Profico et al. 2021). *Pierolapithecus* shows the thickest cortical bone along the midshaft-to-distal palmo-radial and palmo-ulnar surface of the proximal phalanges (including the flexor sheath ridges), while the intermediate phalanx demonstrates thick cortical bone all along the palmo-radial and palmo-ulnar surface. This distribution resembles great apes more than baboons, which show thickening mainly at the distal shaft. Likewise, PCAs place *Pierolapithecus* near, but not within, the great ape clusters. Within the limited comparative sample examined here, *Pierolapithecus* most closely resembles the extant great apes. However, the cortical bone patterns emphasize the need for broader comparative samples, including species with a higher degree of climbing than suspensory behaviors, to clarify how climbing-related loading differs from suspensory loading, refining our understanding of *Pierolapithecus* hand morphology. Furthermore, analyses integrating shape and internal structure should further clarify functional signals of this pivotal Miocene ape.

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The Tangible History of Paleolithic Archaeology in the United States: Artifact Collections From the American School of Prehistoric Research

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The history of Paleolithic archaeology in the United States is relatively short and, prior to World War II, was restricted to a small number of professional scholars at universities and museums. Prominent among these was George Grant MacCurdy, a professor at Yale University who co-founded the American School for Prehistoric Research (ASPR) in 1925, which was based largely at his alma mater, Harvard University. Through the late 1920s–1930s, the ASPR provided students with field experience at excavations in France and a sort of 'grand tour' of European prehistoric sites that trained a generation of anthropologists, funded fieldwork in Europe and western Asia for projects directed by Dorothy Garrod, and supported a range of publication efforts. The ASPR was also central to supplying museums and universities with collections of Paleolithic artifacts. This effort built on MacCurdy's connections established as an artifact buyer for the American Museum of Natural History, but was uniquely combined with a fundraising subscription system, whereby individuals or institutions who supported the ASPR were provided annually with a portion of the artifacts recovered that year. In the US, this practice resulted in large and reasonably well-documented collections at Harvard, Yale, and the Smithsonian Institution. We focus here on the unusual circumstances that led to large and understudied collections from the two US institutions with the longest subscription histories to the ASPR, Wesleyan University and Mt. Holyoke College, using their composition and curatorial history to explore the period of intense collection-building that would later shape perceptions of which artifacts, sites, or regions were important and how the past was studied.

Stable Isotope Ecology of Eastern African Small Mammals: Implications for Reconstruction of Hominin Environments

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Rodents have the potential to serve as high resolution indicators of hominin paleoenvironments at eastern African fossil sites where they are commonly preserved by the activities of avian predators such as owls. Despite this potential, few studies have been dedicated to investigating whether the isotopic composition of rodent tissues reflect local vegetation in modern eastern African ecosystems. In this paper, we present new carbon isotopic measurements ($\delta^{13}C$) from raptor-accumulated small mammal teeth from the Serengeti, Tanzania (n=68), Amboseli, Kenya (n=11), and Turkana, Kenya (n=8). We also present new carbon and nitrogen isotopic measurements ($\delta^{13}C$ and $\delta^{15}N$) from small mammal hair originally collected in modern and historic Kenyan ecosystems and currently housed in natural history museums (n=66). To test if small mammal carbon isotope values reflect changes in vegetation cover, we compare our isotopic data to estimates of percent woody and percent herbaceous vegetation made using remote sensing products. Our results provide dietary data for 22 small mammal genera in 10 ecosystems including grasslands, wooded grasslands, and forests. Compared to published non-isotopic accounts of small mammal diet, isotopic data provides new insight on the dietary diversity and variability in African small mammals. Our results show that eastern African small mammals interact with local vegetation cover differently than large herbivores and consume significant amounts of C_3 vegetation even in ecosystems that are dominated by C_4 grasses. This study

emphasizes the need for additional ground truthed isotopic studies of modern eastern African small mammals and local vegetation to provide a robust foundation for reconstructing hominin habitats through isotopic studies of fossil small mammals.

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The Contribution of Information Transfer and Individual Invention in the Production of Oldowan Artifacts

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The emergence of Acheulean tools, approximately 1.76 million years ago, is considered a cornerstone of cumulative culture. Creating these bifacial tools involves complex, hierarchical steps that require advanced cognitive abilities. Some form of information-transfer mechanism (teaching through gestures, basic language, or imitation) may have been necessary to learn to make Acheulean tools. In contrast, Oldowan tools, also called simple core-and-flake technology, involve fewer production steps and may be within the cognitive abilities of non-human primates. Their production seems to depend on basic visual brain areas. Some have suggested that individual invention can explain the variability seen in these early industries, and that Oldowan tool production is a part of the "zone of latent solutions" for Plio-Pleistocene hominins. If that is true, then the variation in Pliocene assemblages may reflect long periods of trial and error. However, the role of information transfer in the production of the earliest stone tool industries has not previously been quantified. To bridge this gap, we investigated how different learning mechanisms affect the production of Oldowan-like artifacts by tracking proportions of knapping errors in stone assemblages. Over five weeks, we conducted knapping experiments with individuals of varying levels of expertise, documenting error frequency and variability across different information transfer mechanisms. A small percentage of knapping errors occur during all information transfer contexts but are more prevalent during individual invention. Interestingly, size-based patterns do not distinguish the different learning conditions. We also explored the frequency of knapping mistakes across the reduction sequence to identify how these independent variables interact. These results provide valuable insights into how learning mechanisms influence archaeological assemblages in Oldowan tool production. The industry may reflect patterns of sociality that facilitated the rapid adoption of Oldowan tool production throughout the African continent. More experiments are needed to understand how Oldowan toolmakers made technical decisions.

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