Origins of Genus *Homo*

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ABSTRACTS

Homo – What, Who, When, Where?

Bernard Wood, George Washington University

The search for the "origin of *Homo*" suggests we know what we are looking for, so unless we are clear about that, then how will we know when we have found it? It also conflates several "origins" problems. When did our ancestors and close relatives *look* the way we expect the earliest members of our genus to have looked? When did our ancestors and close relatives *behave* in the way we expect the earliest members of our genus to have behaved? The search for the origin of a living genus can be conducted either from the bottom up, or from the top down. Both strategies have their problems. This talk will explain what I am looking for when I look within the fossil record for the origins of our own genus, *Homo.*

Australopithecus and the Emergence of Earliest *Homo*

William Kimbel, Arizona State University

The age of origin of the *Homo* lineage is thought to have fallen in the time period between 2.5 and 3.0 Ma. The relevant fossil record in Africa is, however, notoriously poor, thwarting attempts to discern the pattern of earliest *Homo* evolution and delineate its proximate causes. Recent fossil discoveries in the Afar rift of Ethiopia push the *Homo* lineage back to 2.8 Ma. Although separated in time from *Australopithecus afarensis*, a potential ancestor, by only two-hundred thousand years, these fossils show derived dental and gnathic traits and occur in a strikingly more open paleoenvironmental setting than the ones usually occupied by early australopiths. Coupled with new discoveries of very early flaked stone tools at West Turkana, Kenya, contemporary with small-brained australopiths at 3.3 Ma, the Ledi fossil hominins open the possibility of a new evaluation of factors involved in the origin and early evolution of *Homo*.

Dmanisi, Variation, and Systematics of Early *Homo*

Philip Rightmire, Harvard University

Our genus evolved in Africa, and its members were confined to that continent for a long period. The site of Dmanisi in the Georgian Caucasus records the oldest known occupation of Eurasia, beginning ca. 1.85 Ma ago. At least five individuals are documented from skulls and postcranial bones preserved within a thin sedimentary succession, and there is archaeological and taphonomic evidence relating to the life ways of the Dmanisi hominins. A shared anatomical bauplan, comparisons of variation in craniofacial characters, and comprehensive resampling analyses suggest that the Dmanisi sample cannot reasonably be partitioned on morphometric grounds. A single taxon is present at the site. The paleobiological significance of the Dmanisi assemblage remains controversial. The fossils can most reasonably be attributed to *Homo erectus*, but several of the skeletons display primitive anatomy. Expanding the known *H. erectus* hypodigm has the effect of increasing the level of variation observed within this highly polytypic species. The boundaries between *H. erectus* and other early *Homo* taxa become less distinct, making it difficult to identify diagnostic traits. Such reassessment of characters hitherto deemed taxonomically important bears critically on the recognition of diversity in Plio-Pleistocene settings. Overall, it is the apparent overlap between groups evolving >2.0 to 1.0 Ma ago, rather than the presence of obvious species-level diversity, that characterizes the emergence of the *Homo* clade.

Adaptive Shifts Accompanying the Origin of *Homo*

Daniel Lieberman, Harvard University

Many aspects of the origin of the genus *Homo* are murky and cannot be resolved with the available data. There is no clear way to define the genus let alone its species, and the evolutionary relationships among the relevant taxa are open to question. Although few experts question the notion that *Homo* differs significantly from *Australopithecus*, there is little agreement on what adaptive strategies facilitated change within the *Homo* clade. Proposed behavioral differences include trekking, endurance running, tool-making, tool-using, hunting, cooking, throwing, language, slower life histories, pro-social cooperation, division of labor, and more. All of these are debated.

Here, I will make the argument and review the evidence that, fundamentally, the genus *Homo* differs from other early hominins through an integrated suite of behaviors, collectively termed hunting and gathering, that emerged sometime between 3 and 2 million years ago. Importantly, the hunting and gathering system (especially hunting) was made possible by selection for a combination of anatomical and physiological adaptations such as the ability to walk and run long distances efficiently, to dump heat effectively, to make and use tools, to process food, and to throw with speed and accuracy. The hunting and gathering system also requires a suite of cognitive and social skills such as the ability to cooperate with non-kin, and to use hypothetico-deductive logic. Although hunting and gathering did not arise instantaneously, and many of the adaptations that made it possible probably predate the genus *Homo*, its emergent properties made possible increased access to energy. More energy, in turn, drove positive feedback leading to further selection on costly characteristics typically associated with *Homo* such as increased brain size, larger body size, and slower life histories.

A Potential Molecular Mechanism for the Speciation of Genus *Homo*

Pascal Gagneux, UC San Diego

The human species underwent a watershed change in the biochemical composition of its cell surfaces, via a genetic event estimated to have occurred ~2-3 million years ago, which is also the apparent period of the emergence of the genus *Homo*. A loss-of function mutation occurred in *CMAH* (responsible for transforming the cell surface sialic acid Neu5Ac into its derivative Neu5Gc), a change affecting many millions of molecules per cell, altering diverse biological functions. Analyses of fossil sialic acids confirm that Neanderthals also lacked Neu5Gc. Early *Homo* became a top predator and increased its exposure to pathogens from a broad prey basis. The initial CMAH mutation would have conveyed a strong survival advantage to homozygous individuals by providing resistance to pathogens using Neu5Gc as a target receptor in other animals. But how did the mutation become fixed, i.e. carried in two copies by every living individual of our ancestral population? Using mice with a human-like Cmah defect, we have shown that such a mutation can come under strong sexual selection, due to female immunity against sperm carrying the mismatched sialic acid. The radical makeover of cell surfaces in early *Homo* would thus have brought about a mismatch between females lacking, and males still expressing Neu5Gc, essentially providing a mechanism for reproductive isolation and speciation. Improved glycan biochemistry of African fossils may eventually help to differentiate contemporaneous lineages of the relevant period into two groups, and the ones deficient in CMAH products are most likely to have contributed to the origins of the genus *Homo*.

Southern Africa and the Origin of *Homo*

Steven Churchill, Duke University

In the last seven years, two hominin species possessing a mixture of primitive (australopith-like) and derived (*Homo*-like) morphology – *Australopithecus sediba* and *Homo naledi* – have been discovered in South Africa. Opinions differ as to the phylogenetic (evolutionary) position of these species and their relevance to our understanding of the origins of the genus Homo, and especially to the emergence of *Homo erectus*. Given that southern Africa is a center of mammalian endemism, and that convergent evolution (homoplasy) may be a common occurrence in evolutionary history, caution may well be warranted in accepting claims that these hominins share a phyletic relationship with *H. erectus*. In the context of broader African mammalian biogeography, however, southern Africa appears to play a major role in the evolutionary history of the extant fauna on the continent. Placing the South African fossils in this context suggests the need for new models in understanding the origins of *H. erectus*.

Evolution of Early Human Body Form

Carol Ward, University of Missouri

Upright walking is the hallmark of human evolution, with the earliest definitive hominins showing adaptations throughout their skeletons for habitual terrestrial bipedality. Yet the earliest committed bipeds, the australopiths, were not built exactly like the members of our genus, *Homo*. It has traditionally been argued that this means climbing trees was still important for australopiths, and the shift to a more fully human-like body plan signaled the abandonment of tree-climbing, even though there may be other adaptive explanations. Furthermore, the earliest members of the genus *Homo* were not as human-like in all ways as we had thought, and new fossil evidence of hominin diversity suggest that there was not a single transition to human-like body form in early *Homo*. Taken together, new fossils and new perspectives may be changing our ideas about the origins of our genus.

Evolution of Human Life History Patterns

Leslie Aiello, Wenner-Gren Foundation

Humans are unique in more ways than simply our large brains, language abilities or two-footed walking. We also differ in our life histories or in the tempo and mode of the lives we live. We occupy the slow lane and have unusually long childhoods and long lifespans, while at the same time weaning our infants early and producing the next offspring in relatively rapid succession. This strange life pattern relates specifically to the energy demands of the large human brain. We know that in modern humans, the rate of body growth in children is at its lowest when the energetic costs of the growing brain are at the highest. The long period of human childhood is therefore the direct energetic result of our large human brains. It also has a number of benefits including, for example, an extended time for childhood learning and the opportunity for early weaning and cooperative childcare that helps reduce the mother's energetic burden. The question is when this unique life history pattern emerged in human evolution. The fossils provide some clues and suggest that although cooperative childcare may have been present early in the evolution of the genus *Homo*, the full human life history pattern including both extended childhood growth and development and longevity were much more recent evolutionary developments.

Energetics and the Ecology of Early *Homo*

Herman Pontzer, Hunter College

Life takes energy: essential tasks like growth, maintenance, reproduction, and movement all require metabolic energy expenditure. Compared to our closest relatives, the great apes, humans have larger brains, faster reproduction, greater physical activity levels, and longer lifespans, indicating major evolutionary changes in the ways our bodies expend energy. In this talk, I investigate humans' evolving metabolic strategy and its origins in the fossil record. Comparisons with living apes show that humans burn more calories each day, providing the energy needed to fuel our larger brains and faster reproduction. Humans also exhibit adaptations to expend energy more efficiently, particularly during walking, and to store more energy as fat. Fossil and archeological evidence suggests these critical adaptations develop with the origin of the genus *Homo*. These findings help illuminate the ecological pressures shaping our genus and the evolutionary origins of obesity and metabolic disease.