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NEW DISCOVERIES IN PALEOANTHROPOLOGY: WHAT'S NEW, WHAT'S TRUE, AND WHAT'S IMPORTANT?

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The headline announces: *"New fossil shakes up our family tree."*

The evening news features an intense, lean and sun-tanned academic pointing out the features on this new lump of bone that will change everyone's view of human evolution. Thousands of young listeners imagine themselves walking across the desert, stumbling by chance on an important skull.

The last four years have witnessed an avalanche of new discoveries from fieldwork, paralleled by new discoveries in the lab. The new laboratory discoveries stem partly from more careful analytical techniques (e.g. refitting of bones and stones or cut mark analyses) and partly from a technological revolution in human origins studies, including computerized data bases, CT scans, extraction of ancient DNA, studies of modern DNA as a key to the past, studies of sediment chemistry, and new dates and dating techniques. Few realize that most of what's new in human evolution actually comes out of the lab, after months or years of painstaking research.

Are we better off now than four years ago when it comes to answering the big questions of human evolution: What *makes* us human? What is unique about our species *(sapiens)* or our genus *(Homo)*? What is shared with older ancestors or with the African apes? What *made* us emerge as human? How did humans evolve in time and space? Why did we evolve the way we did ? What allowed us to expand out of Africa and colonize so much of the world's surface that we now endanger the world itself? What gave us the edge over the Neanderthals? With the help of the new technologies and an expanding data base, we are now in a better place to begin to answer these questions than ever before, and we are also better able to understand the stories we read in the daily newspapers reporting "the latest finds."

FROM FIELD TO FRONT PAGE

Few fossils come to light intact or even in large pieces, and rarely does an excavation of an archaeological site yield any human fossils at all. Most hominid fossils have been found by chance or by walking over the landscape in large-scale surveys of fossil-bearing sediments determined by scientists to be of an appropriate age for hominids to have lived there. Field workers learn to recognize tiny fragments of skull or long bone as potentially human. They learn to detect the gleam of tooth enamel in the slanting light of the afternoon sun and to follow a trail of fragments uphill until it disappears into the hillside. The fossil on the table probably shattered and was dispersed as it eroded out onto the surface where a paleontologist could spot it.

One bit of human bone may result in a massive earth-moving operation, as the surrounding earth is scraped and sifted to recover every possible piece no matter how small. At the end of a day or after a week sifting, the archaeologist's bone bag bears little resemblance to the reconstructed skull on the newsroom table. Only after months of preparatory work — finding which pieces join together and modeling the

Smithsonian
National Museum of Natural History

missing parts— does the skull begin to take shape. Only then can it begin to undergo the comparative study that can answer the question: Is this really something new, something that means a new species or a new genus? Or is it the same as an earlier find, only bigger, perhaps a big male? While the palaeontologists piece together the fossil, other laboratory scientists are hard at work figuring out its age, its environment, and its behavior. These studies are based on the bones, stone tools, and associated sediments from which the fossils or tools eroded.

Publication of a new hominid species usually occurs in either the British journal *Nature* or the American journal *Science*. The controversy often begins immediately. Is the fossil actually associated with the material used to date it? What are the possible sources of error in the dating method used? Is it really different enough from existing fossils to justify assignment to a new species?

The question about a new species is especially difficult. In living organisms, a species is defined as a group of organisms that can mate and produce fertile offspring. But with fossils, unlike living organisms, there are no 'tests' for determining whether something new is or is not a separate species, and many morphological species indicators like plumage or coat color are missing. Designation of fossils at the genus level is even more controversial, as genus implies both shared morphological pattern, implying a common adaptive strategy and common descent from a distant common ancestor.

This article discusses new finds affecting our family tree, including two new species, one from Europe (Spain) and one from Africa (Ethiopia). A second major section, "News From the Lab," focuses on the re-analysis of research data using new technologies, reflected in news stories about chimpanzee learned behavior, large-scale mammalian extinction, and the relationship between brain size and body mass in understanding our early ancestors. Finally, a new look at *Homo habilis*, *Homo erectus* and the Neanderthals emphasizes once again that what we know in science always keeps growing as new information and technologies improve with time.

CORRECTION: The last issue of *AnthroNotes* should have been Volume 21 No. 1, not Volume 22.

OUR FAMILY TREE: NEWS FROM THE FIELD

Two new species joined the family tree between 1997 and 1999: *Homo antecessor* from Spain and *Australopithecus garhi* from Ethiopia.

Homo antecessor: A New Species From Europe

Homo antecessor is based on fragments from the TD6 level at the Gran Dolina cave, near Atapuerca, Spain. Its approximate date of 800,000 comes from the fact that the fossils lie below a magnetic change point. The sediments above have a magnetism similar to that of today's Earth, but the sediments below have a reversed magnetism, that is the "north" recorded by the sediments is actually "south" today. Evidence of magnetic reversals occurs in sediments all over the world and the most recent shift from "reversed" back to "normal" has been dated by argon laser techniques (see page 3) to 780,000-791,000 years. The fragments include the lower face of a child with several teeth, a fragment of frontal bone (forehead region), a small piece of a jaw and several long bone fragments. At least six individuals are represented, and some of the bones show cut marks made while the bone was fresh, a possible sign of cannibalism.

The discoverers of *H. antecessor* (Bermudez de Castro *et al.)* argue that the shape of the nose region is not that of *H. erectus* but instead resembles some features of *H. sapiens* and Neanderthals; hence the name "antecessor". They argue that it is the ancestor of both Neanderthals and modern humans before the two lines diverged. Others suggest that it may be the ancestor of a Neanderthal lineage that split off from the modern human lineage before *antecessor.* Without more pieces from Gran Dolina or other European fossils from the same time period, however, it is difficult to say whether its separate status will continue. It could also prove to be just an early form of a European species known as *H. heidelbergensis* that lived in Europe from about 500,000 to about 200,000. The dating is also only approximate since we do not know how much time elapsed between the burial of the fossil and the magnetic shift at 780,000.

The interesting question raised by the naming of a new European species at an early date is the antiquity of the separation between a European human lineage leading to Neanderthals and an African human lineage leading to modern humans. Were Neanderthals, who do

not appear until around 200,000 years ago, the final branch of a large European tree, all adapted to colder and more seasonal conditions than elsewhere in the Old World? Did the split between the two lineages occur after or before *antecessor?* In either case, if the split is ancient, how do we explain the later development of behavioral similarities between Neanderthals and their African and Near Eastern cousins? Could this be a case of parallel evolution? Or is this new member of the family tree just a temporary offshoot that died out without descendants?

A Second New Species

In Africa, another much older new species, *Australopithecus garhi*, was named by Asfaw *et al.* in 1999. The word *garhi* means 'surprise' in the local Afar language. *A. garhi* comes from a region on the west bank of the middle part of the Awash River, in the northern Rift Valley of Ethiopia. The partial cranium and possibly associated jaw and limb bones from a different site are dated to 2.5 million years ago by a highly accurate technique that uses lasers to release and measure tiny amounts of argon gas trapped in small crystals of volcanic sediments.

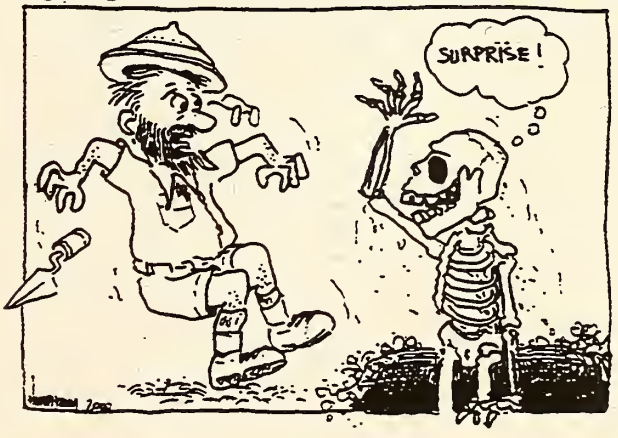
A. garhi was a surprise because it displayed a combination of features not seen before. Big cheek teeth (molars and premolars) with thick enamel and what may be a sagittal crest recall the robust australopithecines (*Paranthropus)* and place the fossil in the genus *Australopithecus.* The brain case is quite small (ca. 470 cc). However, unlike the robust australopithecines, *A. garhi* does not have reduced incisors, and the face does not have the bony reinforcements in the cheek that give the australopithecine face a concave or "dished" appearance. Arm and leg bones found 300 meters away from the skull are from a single individual, who may or may not belong to the same species as the skull. But the limbs are unique for the time period — arms as long as Lucy's for climbing, but much longer legs for walking bipedally, suggesting that bipedal walking was well-established before humans gave up the trees altogether. *A. garhi* possibly could be the ancestor of our own genus, but at least one skeptic has suggested it may be a female robust australopithecine.

Did Bipedalism Develop From Knuckle-Walking?

Recently researchers working in the collections of ape skeletons at the Smithsonian were studying a ridge on the wrist end of a forearm bone (radius) found in knuckle-walking apes. On a whim, they decided to see if this ridge was present in the 'Lucy' skeleton. To their surprise, Lucy and other australopithecine fossils had the ridge, suggesting that we may be descended from a knuckle-walking ancestor. Other scholars, however, argue that the knuckles on Lucy's hand-bones are not broad for weight-bearing like the knuckles of apes, making it unlikely that australopithecines actually used this form of locomotion. This study helps to reconcile evidence from anatomy with the strong DNA evidence that chimpanzees are more closely related to humans than to gorillas. It also raises the question of why upright walking would evolve from an ancestor that was already adapted to life on the ground.

"Always Something New Out of Africa" (Ancient Greek Proverb cited by Pliny the Elder and C. Darwin, 1859)

Although 2.5 million years ago (mya) is a critical time in the transition to a human way of life based on meat-eating and stone tool manufacture, it is not a well-documented period in human evolution. Relatively few fossils from this time period have been found in East Africa. *A. afarensis,* whose skeleton is known to the world as 'Lucy' but to Ethiopians as 'Dinkanesh', had disappeared by about 2.7 mya. Of the existing fossils dating to around 2.5 mya, most belong to a group called "robust australopithecines." These are sometimes grouped in the genus *Paranthropus* and are distinguished by their massive molars and premolars, used to chew tough vegetable foods. In South Africa, where the first



australopithecines were discovered back in the 1920s and 1930s, *Australopithecus africanus*, the first named species of *Australopithecus*, is the only known hominid in this time interval. *Australopithecus africanus* had large chewing teeth relative to *Homo*, but smaller teeth and a less massive jaw and face than the robust group.

Around 2.3 to 2.1 million years ago, a few fossils with larger brains and/or smaller chewing teeth have been included in our own genus *Homo*, in part because of the change in tooth and brain proportions, and in part because they were associated with crude stone tools. One of the most recently found and the oldest member of this group is a fossil upper jaw described by Kimbel *et al.* from the Hadar area of Ethiopia, also in the Awash Valley, associated with early flake tools and dated to 2.3 mya. Unfortunately, scientists have not found any part of the braincase, associated limbs, and other features that would help to determine its lifestyle and evolutionary relationships.

Another new, early African fossil is making headlines while still in the ground. Fossil foot bones from a very old layer—perhaps 2.8-3.1 mya—at the Sterkfontain cave near Johannesburg, South Africa, were published four years ago. Last year, the rest of the skeleton was discovered beneath where the foot bones were found. It is apparently an entire skeleton of an *Australopithecus africanus* that fell into the cave and lies crumpled on the floor head down and feet turned up. It will be years before scientists study all the details of this fascinating find, as the bones are encased in solid rock that formed around them and must be carefully picked apart.

Oldest Stone Tools

The oldest known stone tools come from Ethiopia, about 100 km to the north at Gona, near Hadar. Although a firm date of between 2.5-2.6 mya and a brief description were published in 1997, debate on the nature of these tools is suspended until they are published in more complete form by their excavator, S. Semaw. Other stone tools from the Lake Turkana basin in northern Kenya date to 2.3 mya. These tools from the site of Lokalelei were described in 1999 by Roche and coworkers as surprisingly elaborate, involving the removal of as many as 30 flakes from a single core. The record suggests that stone tools appear with and may even precede the appearance of members of our own genus, *Homo*. Previous work had suggested that the earliest toolmakers were not capable of elaborate toolmaking sequences involving many steps, but this new research suggested that toolmaking abilities were somewhat sophisticated even by 2.3 mya. The analysis of the older tools from Gona will be extremely interesting, particularly as no members of the genus *Homo* are known from this age.

No stone tools were found in direct association with *A. garhi*, but there was indirect evidence of their use. In the area that yielded the limb bones, there were a number of bones of extinct horses and antelopes that showed sign of butchery. Deep scratches with the characteristic sharp edges of stone tool cut marks indicate where meat and sinews had been sliced from the bone, and hammerstone impact fractures made while the bones were fresh show how they had been broken open for marrow. If this behavior can be attributed to *A. garhi*, then this hominid clearly shares behavioral features with later humans, even though its brain was still small and the teeth still large. It may be an early indicator of what we now recognize as a common pattern of *Homo*, in which new behaviors drive and select for changes in morphology— tools before brains.

Behavioral innovation in early hominids may not be so surprising. Assembly of a large database of chimpanzee behaviors allowed researchers to demonstrate last year that chimpanzees display a wide range of different behaviors across Africa, all of them learned and transmitted from one generation to the next. Some groups of chimpanzees use sticks to fish for termites; others use rocks and sticks to crack nuts. Some hunt small animals; others rarely do. To a certain extent, then, chimpanzee behavior fits the basic definition of human culture, habits and practices that are particular to each society and are passed on through learning.

OUR FAMILY TREE: NEWS FROM THE LAB

Some of the most important news on the hominid front does not derive from new fieldwork or fossil finds, but from laboratory experiments and from reinterpretations of existing finds using new technologies. These range from CT scans to statistical techniques made possible by huge computerized databases and new sophisticated computer modeling.

In a long-running laboratory experiment at Indiana University, a bonobo or "pygmy chimpanzee" named

Kanzi continues to learn stone tool making, although his favorite method is to throw the stone against something hard until it shatters. His abilities and the problem-solving experiments being conducted with orangs at the National Zoo in Washington, D.C. show that we have underestimated the cognitive abilities of our closest relatives. It also demonstrates how sophisticated the oldest tools at Lokalelei were, compared to those made by Kanzi.

A large database of mammalian fossils from the Turkana basin allowed researchers at the Smithsonian to test whether or not a major dry spell 2.5 million years ago caused the extinction of many East African animals and their replacement by savanna-adapted species, including early humans (e.g., *A. garhi).* The researchers found that the appearance of new species and the disappearance of old ones were spread throughout the 1 million year period between 3 and 2 mya in the Turkana basin, which offers the richest and best dated record of animal evolutionary change in Africa during this critical interval. Thus the hypothesis of a major "turnover pulse" at 2.5 mya was not supported by the data. The researchers found, however, that after a gradual rise in the number of species up to 2 mya, a significant drop in species numbers occurred, especially around 1.8 mya.

Recent research on the larger brain sizes that mark the emergence of *Homo* also utilizes new statistical databases and techniques for determining body mass from the upper leg bone (femur). When brain size is calibrated by body size, it turns out that brain size increases between 2.5 and 1.8 mya, but then remains relatively constant from 1.8 to 0.6 mya. Brains were not getting bigger through the early Pleistocene, people were! What is surprising, after more than a million years of roughly the same brain size, is the dramatic leap in brain size at around 600,000–700,000 years ago, as new species like *H. heidelbergensis* take over. What was the reason for this huge increase in relative brain size? New environments colonized? More variable environmental conditions? New social structures and ways of making a living? The data are unclear but new work in the Middle Pleistocene is suggesting an earlier and earlier emergence of complex abilities.

NEWS OF *HOMO HABILIS*, *HOMO ERECTUS*, AND THE NEANDERTHALS

Is *Homo habilis* really *Homo?*

The earliest members of the genus *Homo* are *Homo habilis*, defined on the basis of Olduvai Gorge specimens in 1964, and *Homo rudolfensis*, defined on the basis of East Lake Turkana specimens in 1986. Since 1985 accumulating evidence has demonstrated that at least one of these species still maintained a number of specializations for life in the trees, like long arms, short legs and curved fingers. In addition, these hominids exhibit very little of the marked reduction in tooth size that characterizes our genus and leads to our smaller faces. *Homo* was supposedly characterized by large brains, language, tool-dependence, and manual dexterity. New data have shown that the brains of these fossils are not large compared to their body mass, and that we cannot determine whether or not they had language abilities to a greater extent than the apes. Tools now appear before the first fossil attributed to *Homo* and occur with *Australopithecus* and *Paranthropus* as well. New studies of hand function show that either the hand of *H. habilis* was not as fully modern as we had supposed or that apes possess many of the same manipulative abilities. In a major review of these issues, Wood and Collard suggest that *H. habilis* and *H. rudolfensis* do not share the adaptations characteristic of later members of the genus *Homo* and should be grouped instead with *Australopithecus.*

Homo Erectus: Fuel for Thought?

If Wood and Collard's proposed reassignment of *H. habilis* and *H. rudolfensis* to the *Australopithecus* genus is widely adopted, the first member of the genus *Homo* will be the species H. erectus or its African relative *H. ergaster.* These fossils are best represented by the almost complete skeleton of an adolescent boy from Kenya dated to 1.5 mya. He was tall and larger-brained and had reduced chewing teeth. A controversial recent article cites these features to suggest that cooking was already part of the *erectus* cultural repertoire and may have been an essential adaptation allowing *H. erectus* to spread out of Africa. There is no direct archaeological evidence for cooking at early African sites, with the possible exception of some burned bones from South Africa (see *AnthroNotes 18(2)* Spring 1996.) At Koobi Fora, on the

east side of Lake Turkana, other support for early human use of fire comes from burned patches whose magnetic properties studied in the laboratory may indicate the use of fire by humans, since human-tended fires have a higher temperature and longer "burn-time" in a very small area than most bush fires. Natural bush fires, however, cannot be entirely ruled out as causes of either the burned features or the charred bones.

Even thick beds of what appears to be ash may not indicate fire. "Ash" from Zhoukoudian in China, the *Homo erectus* site listed in most textbooks as the oldest site with controlled fire, may not be the remains of fire after all, although it is only about 500-300,000 years old. The sediment, studied by a new infrared technology, does not have the chemical constituents or characteristics of wood ash. Some of the bones, however, were charred and may have been burned somewhere else and carried or rolled into the area of the cave sampled, indicting that fire was at least in use by this time.

When did *H. erectus* arrive in Asia? Or was it an earlier species that made the trip? Stone tools reported from the southeast Asian island of Flores in 1998 would seem to suggest that not only was *erectus* in the region by 1.5 mya, but also came in boats or had the capacity to make them! This is a good example of a story that has not been widely accepted. Are the stone tools really tools? Or just chipped rocks from a stream bed? Is the date a good one? (The *next oldest* tools in southeast Asia are less than 700,000 years old and may be only 40,000 years old!). There is mounting evidence from both Java and China, however, that hominids were in east and southeast Asia by about 1.5 mya.

Another new Asian find that is challenging current models are the stone tools from the Bose basin, South China. For over a half century, archeologists have thought that large bifacial handaxes characterized the stone technology of Africa and western Asia and Europe for most of the Pleistocene, while simpler stone technology typified East Asia. The boundary between western bifaces and the more casual flake-and-core industries in the east is known as the "Movius line," after the Harvard prehistorian who first described it in the 1940s. The Movius line has been used to suggest that Asian populations of *Homo erectus* and later hominids did not have the same capabilities as hominids in the west. Excavations by Potts, Huang, and their team from the Smithsonian and the Chinese Academy of Sciences have shown, however, that large bifaces were made in South China around 800,000 years ago. The total collection of stone tools from the Bose basin differs in detail from the Acheulean handaxes collections in the west. But in stone flaking ability and the overall shape and size of the large tools, the Bose tool collection is strikingly similar to stone technologies made at the same time in Africa.

Further damage to the Movius line comes from two sites in northern Japan, Takamori and Kamitakamori, dated to more than 250,000 years ago and possibly more than 500,000 years ago, in an island region of the world once thought to be occupied only towards the end of the Pleistocene. Located in the mountains west of Sendai, the tools include well-made symmetrical axes or adzes, chipped on both sides. This symmetrical and bifacial approach to tool-manufacture is characteristic of the Acheulean industry found from India to England and south to the Cape of Good Hope after 500,000 years ago. Such tools are not found in southeast Asia, at least not until very late in the Pleistocene.

The Japanese tools are not "Acheulean," and do not share the stylistic or functional attributes of "hand-axes," but they do exhibit similar capabilities. In addition, some of the small bifacial tools are grouped in discrete pits and include pieces of several different colorful raw materials. Not only have the raw materials been transported over many kilometers, but the arrangement suggests to the excavators (Kajiwara and others) an early example of symbolic behavior, indeed one of the earliest examples anywhere in the world. Others have questioned the age determination, the stratigraphy, and the association between the dated material and the artifacts, but a recent fact-finding expedition to the sites by an international team could not find any problems with the dating or associations. The combined Japanese and Chinese finds indicate that the Movius line model is flawed, and at the very least we must look for new interpretations of *H. erectus* behavior in Asia.

Neanderthal News

At the more recent end of the human evolutionary story, the finds are equally dramatic and equally split between new field results and restudy of older materials with new techniques. Views of the Neanderthals themselves have

been shaken up by a new fossil child from Portugal. Dated to only ca. 25,000 years ago, long after the Neanderthals are thought to have disappeared from Europe, the fossil child is said to display some Neanderthal features in its skeleton. In a heated exchange in the pages of the *Proceedings of the National Academy of Sciences*, Erik Trinkaus, the senior morphologist in the study, suggested it was an example of hybridization between Neanderthals and modern humans, while Ian Tattersall, another authority on Neanderthals, argued that this is not demonstrated.

The genetics revolution has also had an impact on views of the Neanderthals as well as on other developments in human history. Two recent studies of mitochondrial DNA (passed only through the female line), which was extracted from the original Neanderthal fossil, show that it is *very* different genetically from ourselves. The differences between us and the Neanderthals are so great that geneticists estimate that our ancestors split off from them at least 600,000 years ago!

More and more Neanderthal sites show evidence of cannibalism– human bones smashed and cut and treated like other faunal remains. This may confirm an analysis of the bone chemistry of Neanderthals published in 1992 that indicates they were almost exclusively carnivorous. The debate over Neanderthal language continues. One study by Kay *et al.* suggests that the bony canal containing the nerve for the tongue muscle used in speech was as large in Neanderthals as in ourselves and shows that they spent a lot of time in oral communication.

In Africa, the contemporaries of the Neanderthals were early *Homo sapiens*, with more modern morphology. One aspect of this morphology, perhaps *the defining* aspect, was the repositioning of the face beneath the braincase instead of out in front, creating a new relationship between the tongue and the back of the throat that facilitated speech. This new relationship as discussed by Lieberman can be most clearly seen in the morphology of the sphenoid, the bone that divides the braincase from the face and cradles the pituitary gland just behind the nose. Since most of this morphology is *inside* the skull, studying it requires CT scans of the fossils, a new application of this technology. Most hospitals have down times late at night when they are willing to allow use of their machines by paleontologists. The Smithsonian's division of physical anthropology has its own CT scanner. Some CT scans of important fossils are even available on the web [www.anthro.univie.ac.at/bodo/bodo/html.]

Africans may have looked modern when Neanderthals still occupied Europe, but whether or not their *behavior* was also modern is a major debate involving Brooks and others. New evidence from South Africa itself suggests that these early members of our species already were catching ocean fish and making bone-tipped spears, much like the inhabitants of several sites excavated by Brooks in the eastern Democratic Republic of Congo, dating from ca. 80,000. Other early sites of around this age have engraved and notched ostrich eggshells and bones, as well as masses of red ocher. Evidence for other sophisticated and complex behaviors by the African contemporaries of Neanderthals is accumulating rapidly as new regions of Africa are explored.

Journalists know the public is hungry for news about our human origins, and stories of our distant past appear with increasing frequency. The need to educate our students and the general public more broadly about science and anthropology has never been more clear.

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