Anthro Notes

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WHAT'S NEW IN EARLY HUMAN EVOLUTION 5 TO 1 MILLION YEARS AGO?

by Alison S. Brooks

Where do we come from? What did our earliest ancestors look like and how did they behave? In the last ten years, a flood of evidence, accumulating at an increasing rate, suggests new answers to these old questions.

Until recently, the hallmarks of "humanness" were thought to have emerged early in human evolution: full bipedalism by 4 million years ago (mya), and, by 2 mya, tools, nuclear families, division of labor by sex, hunting, long periods of childhood and adolescent dependency, and maybe even primitive language. In addition, as recently as five years ago, the family tree itself seemed rather simple and straightforward; the most common model was a tree with only 7 or perhaps 8 species in all, and only one "side branch".

Most of the time, the hominid 'niche' was filled by only one species, except between ca. 2.6 and 1.3 mya, when related species occupied the "side branch". First there was "Lucy" (Australopithecus afarensis), from about 3.6 to 2.9 mya. Then, there were more "evolved" australopithecines who came in two varieties: the "gracile" type (Australopithecus africanus) and the "robust" type with huge teeth and a bony crest on top of the skull (Australopithecus robustus, A. boisei, and A. aethiopicus). The former group was thought to have evolved into an early form of our own species, Homo, while the latter "side branch" became more and more specialized, lived alongside early Homo for a while (for perhaps as much as a million years) and then died out. Early Homo, in turn, went through a direct progression from H. habilis to H. erectus, to H. sapiens, marked by increasing brain size and decreasing tooth size. Until about 1 mya, Africa, specifically eastern and southern Africa, was the only home of our ancestors, or so it was thought.

In the last five years, new finds, new dates, and new analyses have turned this simple tree into a complex bush, full of unseen connections, dead ends and mysteries. In addition, the bipedalism, bigger brains, omnivorous diets, tool-making, long period of childhood and learning, indeed the very "humanness" of early humans, have been challenged. The result has been a dramatic upheaval in our conceptions of our past. While the African roots of the family tree have remained firmly fixed, the timing and number of migrations out of that continent have been matters of considerable debate. In addition to the "where," "what," and "when" of human evolution, the "why" has also been challenged. Was it really so dry in Africa 4 mya that our ancestors had to leave the trees for the savanna? Did larger brains evolve so we could make tools?

This review of recent finds will cover five topics:

- the "oldest old" hominids;
- later stages of australopithecine evolution (news from South Africa);
- diversity in the early stages of Homo;
- when and why did big brains, tools and long childhoods evolve; and
- when did hominids expand out of Africa (and where did they go).

The Oldest Hominids

New finds from two regions have greatly expanded our knowledge of human evolution "B.L." (before Lucy). The first finds, announced in the fall of 1994, come from the Middle Awash region of Ethiopia, just south of Hadar where Lucy herself was found. Here, Tim White, Berhane Asfaw, and an international team of experts found the scattered and highly fragmentary remains of 16 small creatures with large molar teeth, slightly reduced canines, and a positioning of the skull on the vertebral column (backbone) suggesting upright posture. These features suggested human ancestry and an initial placement in the genus Australopithecus. Enough differences exist, however, for these fossils to be placed in a new species, A. ramidus (or "root" in Afar, the local language). For example, the enamel on the canines and molars is relatively thin, the canines relatively large for hominids, and the molars--especially the lower first deciduous or 'baby' molar--smaller than those of other Australopithecus and more elongated than square in shape. The skull opening for the ear was small as in apes rather than large as in Homo and Australopithecus.

The leader of the geological team, Giday WoldeGabriel, argues that the fossils are close to 4.4 mya, as far back in time from the actual Lucy find (3.18 mya) as Lucy herself was from the original Homo habilis at Olduvai Gorge (1.9 mya). While the teeth relate ramidus clearly to humans, the limb bones remain to be described. In recognition of the dental differences, White et al. recently suggested that the fossils also be placed in a new genus: Ardipithecus ramidus rather than Australopithecus. White has continued to work in the Middle Awash in 1994, 1995 and 1996, and has announced the recovery of at least one and perhaps several partial skeletons of different individuals.

One of the most interesting features of the ramidus find is the apparent **absence** of a savanna environment, at least in the immediate vicinity. The animal bones and plant remains reflect a forest with colobus monkeys, kudus, bats, a primitive bear, and a number of small mammals but relatively few large savanna mammals such as giraffes, hippos, elephants, rhinos, or primitive horses.

In 1995, palaeontologist Meave Leakey and colleagues also announced a new species from ca. 4.1 mya, this one from several localities around Lake Turkana. Called Australopithecus anamensis (after 'anam' or 'lake' in the Turkana language), it was differentiated from afarensis because the lower canines were larger, the lower front premolars more asymmetrical, the molars more sloping towards their crowns, the chin region a different shape, and the earhole small as in ramidus. On the other hand, it was distinguished from ramidus by the thicker tooth enamel, larger molars and squarer molar shape.

From the asymmetry and angle of the upper part of the shin bone in the region of the knee, however, this form was clearly bipedal . Bipedal knees are quite distinctive because they are shaped so as to allow you to lock ("hyperextend") your knees "straight" while standing and to balance easily over one leg while stepping out with the other. (It was just such a knee joint that led to the finding of Lucy in 1974.) The environment of A. anamensis was less densely forested than that of ramidus, closer to the open savanna envisioned in the earlier scenarios.

Which of these two led to Australopithecus afarensis and thence to Homo habilis? This may be a moot question, as Australopithecus afarensis and Homo habilis themselves are challenged as single

species stages on the road to modern humans. Is there more than one variant of Lucy, like the multiple species of monkeys and of chimpanzees that co-exist in Africa today? A recent find of a much larger hominid (ca. 24-25% larger than Lucy) at Hadar was interpreted by Kimbel, Johanson and Rak as a male afarensis, but could Lucy's son or brother really have been so different? Or are there two different species of Australopithecus at this time as well? A recent argument by Richmond and Jungers for multiple hominid species in the time range of Lucy suggests that new studies of Lucy's pelvic anatomy indicate that she was actually a "he". Two males of very different sizes would certainly argue for at least two species.

Kimbel et al., however, contend that Lucy's pelvic shape is due to her posture while walking and not to an incorrect determination of her sex. Differences in limb anatomy could mean not different species but simply that the heavier males spent more time on the ground while females spent more time in the trees. Furthermore, they argue, not only do all the fossils attributed to afarensis belong in a single species, but the species lasted unchanged for almost a million years. This conclusion is based on comparisons between a new almost complete skull from Hadar at 3.0 mya and a new frontal (forehead and brow regions) from Belohdelie in the Middle Awash region just south of Hadar, dated to 3.9 mya.

If early australopithecines were not restricted to savanna environments, were they confined to east Africa? A recent paper describes a new fossil from Bahr el Ghazal in the west African country of Chad, more than 1500 miles west of the east African rift valley sites. The fossil mandible is comparable to afarensis but with thinner tooth enamel and other distinctive traits so it could represent another new species. It is dated to around 3.0 to 3.4 mya on the basis of the primitive elephants, horses, pigs, hippos and rhinos found with it. These are interpreted as indicating a mixed forest and woodland with some grassy areas, rather than an open savanna. Further exploration will probably expand both the range of the ancestral hominids and their variety.

News from South Africa

The first australopithecus find in 1924 consisted of a child's face, brain cast, and mandible from the South African site of Taung (Australopithecus africanus). The first recognition of different robust (r) and gracile (g) australopithecine species was also based on South African sites: Sterkfontein (g) and Kromdraai (r) in the 1930s, Makapan (g) and Swartkrans (r) in the 1940s. In recent years, although work continued at these four sites, the main action appeared to have shifted to east Africa, where periodic volcanic eruptions and rift valley sedimentation allowed palaeoanthropologists to find and date actual surfaces where australopithecines had lived. Dates and ancient landscapes were much harder to reconstruct in the cave sites of South Africa. Also, for much of the 1980s and early 1990s, South Africa was isolated from the rest of the scientific community for political reasons.

This year, South Africa is suddenly in the early human news again with new finds that shift the picture of human evolution. There are two new fossil sites: Gladysvale and another site as yet unpublished, each with a new series of human remains. Sterkfontein, the first site to yield an adult australopithecine of the gracile variety ("Mrs. Ples"),

now contains evidence that more robust forms were there as well at the same time. And at least some of these human ancestors may have been able to hold onto things (like tree branches) with their feet. Newly published foot bones from one of the oldest levels (member 2 ="level") at Sterkfontein, comparable in age to Lucy, show a big toe that stuck out at a slight angle to the other toes. Were there any trees to hold onto? New paleobotanical studies at Sterkfontein from the main australopithecine level (member 4) recovered fossilized vines or lianas (the kind that Tarzan swings on in the old movies) that today occur only well inside the tropical forest far to the north. No open savannas here either!

In addition, the younger horizon at Sterkfontein (member 5) has now yielded Oldowan tools dated to about 2.0 million years, slightly older than Olduvai and more "primitive" in their manufacture. Sterkfontein's archaeologist, Kathy Kuman, has suggested most of them were made by smashing quartz cobbles on a hard surface and picking out the good flakes. Who made these tools? Sterkfontein yielded another hominid, younger than the tools and provisionally classified as Homo, but Ferguson has suggested that it may be too robust for Homo and might possibly be reclassified with Australopithecus.

Was Mrs. Ples, who comes from the underlying horizon dating to 2.5-3.0 mya (or someone like her but slightly later) the toolmaker? Since gracile australopithecines were supposed to have been ancestral to Homo, while the robust forms were on a side branch, many scenarios had the late gracile forms experimenting with tools, despite the absence of any evidence for tools in gracile sites. (Tools do occur with later robust forms!) Like Lucy, Mrs. Ples may soon undergo a sex change operation and, at the very least, assume a new identity. A recent careful examination of the top of her skull suggested that something was missing. Fortunately, the piece of rock that once encased her skull had been saved. Stuck into this rock were the remnants of a small sagittal crest. Gracile females did not have this feature. Either "Mrs. Ples" was really "Mr. Ples" or else she is one of the earlier members of the South African robust line.

At this point, the taxonomy becomes really confusing. If the Homo from Sterkfontein is really Australopithecus, and if the type fossil of an adult Australopithecus africanus is really a robust form like Australopithecus (or Paranthropus) robustus, then who is Australopithecus africanus anyway? Since the original A. africanus was a child's skull and braincase, we really have no way of knowing exactly what it would have looked like when it grew up. There will certainly be many years of arguments before these and other queries surrounding the fossils we now have are resolved, let alone the questions raised by new finds.

One postscript to the Taung story involves a fascinating bit of detective work. Most South African sites consist of remains of the lairs of predators who ate australopithecines for dinner, as suggested by the many carnivore tooth marks on hominid skulls and bones. Taung was always different from the others. Despite the mining of what was probably the entire cave, only the three pieces of the Taung "baby" were recovered. No larger or more complete fossils of anything ever turned up. The damage on the Taung skull was also different -- sharp triangular nicks on the edges of the bone, and a distinctive dent in the top of the skull where the thin cranial bone was pushed into the brain. What could have made this damage? Ron Clarke and Lee Berger studied damage from many different types of carnivores and concluded that the only possible agent of destruction was a large eagle, whose talons poked a hole in the skull, and whose curved beak took distinctive bites out of the bone. This would explain why no australopithecine (or other large mammal) adults ever turned up there -- they were too big for an eagle to carry.

Early Homo: How Many Species?

The early evolution of our own species was also once thought to be a simple affair. Tool making, an enlarged brain and smaller teeth marked the emergence of Homo habilis at 1.9 mya. These features were functionally linked together by reasoning that teeth could not be smaller on a larger creature unless some "food-processing" was done outside the mouth, i.e. with tools. By 1.5 mya, even larger brains and modern body size marked the appearance of Homo erectus, who subsequently spread out of Africa. Finally, by about 500,000 years ago, early forms referred to as "archaic" Homo sapiens appeared in both Europe and Africa.

The number of species suggested for our own genus has also increased recently, and the relations between them have grown more complicated. What used to be called Homo habilis is divided into at least two, and possibly three, species, while the early Homo erectus fossils from Africa are sometimes put in their own species, Homo ergaster. In the later stages of Homo, once all grouped in the species sapiens, some authors place the early "archaics" in a separate species, "Homo heidelbergensis," and may further delineate the later Neanderthals as "Homo neanderthalensis." The species designation "sapiens" is reserved by these authors for modern humans only. Were all of these groups separate species that could not interbreed and had different adaptations? Did our previous "single species" view of the evolution of Homo obscure what was really happening?

Within a few years of finding the original Homo habilis at Olduvai, a very different early form had turned up to the north at east Turkana. This form, dated to the same time, had a larger brain but retained rather large teeth. The Olduvai fossils had small teeth, but brain sizes only slightly bigger than those of australopithecines. Bernard Wood has argued for the name "Homo rudolfensis" (after the old name for Lake Turkana) for the larger-brained Turkana form, and retains the name habilis for the smaller form, whose skeleton, recovered in 1985, suggests Lucy-like proportions of arms and legs. How did these two differ in their behavior? The record is not yet complete enough to tell. Both used simple stone tools and occur in the same kinds of environments, usually more open and grassy than those prevailing before 2.5 mya. The difference is not due to geographical separation; a very early example of rudolfensis dating to over 2.0 mya was reported in 1993 from the Malawi sector of the east African rift, well to the south of Olduvai. Which one led to modern humans? This, too, is unclear, and may never be determinable if new early species continue to be found. Perhaps more detailed environmental and behavioral studies now underway will reveal some answers.

Why bigger brains?

Theories about the origin of the large human brain have focussed on many aspects of behavior that were supposed to have driven this change. An early view pointed to hunting. When it was shown that early humans were more likely to have been scavengers, the focus changed to tool-making. Recent dates of 2.5 mya for the earliest tools, at the Gona sites near Hadar in Ethiopia, predate the earliest evidence for an enlarged brain, and suggest that tool-making came first, brains may only have followed hundred of thousands of years later. (New early fossils of Homo from Malawi, as well as from Ethiopia, may change this perspective as well.) Another theory is that brains became larger to take advantage of a longer period of learning and childhood development. New ways of studying growth rates in early humans, however, have shown that australopithecines were more like apes than like modern humans in their growth patterns, and that even Homo erectus was not yet fully human in this respect.

Scholars have tended to assume that the reason that brains did not get larger earlier is that they were not needed. A new theory, the "expensive tissue hypothesis" has argued instead that brains could not become larger earlier, because they used up too much of the body's energy -- ounce for ounce, the mammalian brain uses nine times as much energy as the rest of the body, on average. Leslie Aiello and Phillip Wheeler point out that five major organs or organ systems use up 60-70% of the body's energy at rest, although they account for only 7% of the body's total mass. These "expensive" organs are the

gut, the heart, the liver, the kidney and the brain. (Lungs are also quite "expensive.") Unless the animal eats a lot more high calorie foods (very unlikely in the case of humans, to judge from the teeth) *or* one of these organs gets smaller, there is no energy budget left to feed a larger brain.

What got smaller around 2 mya that allowed the brain size to finally increase? The heart, liver and kidney are scaled to body size (mass); they cannot get smaller unless you do. The only remaining possibility is the gut, which could become smaller if foods were either higher quality or partially "digested" outside the body by tools. Lucy's rib cage suggests that her gut was enormous, and that her body proportions were more similar to those of a gorilla than to a modern human. No wasp-waists or hourglass figures among the australopithecines -- indeed no waists at all! On the other hand, the oldest relatively complete skeleton of early Homo, the 'boy' from Lake Turkana (see *Anthro.Notes*, vol. 9, no. 3, fall 1987, pp. 11-15) while much larger than Lucy, has both a larger brain **and** a delicate waist and flattened rib-cage like ours.

But if changing food patterns made big brains possible, what made them desirable? A new book by Rick Potts of the Smithsonian's Human Origins Program argues that the major adaptation of early Homo was the ability to deal with rapidly changing climates and diverse environments, what he calls "variability selection." As climate swings became more severe, brain size and body size increased, and learning rather than instinctive behavior was at a premium. The major shift towards greatly expanded brains relative to body size took place not in the early stages of human evolution but around 500,000 years ago, with the onset of the dramatic climate changes associated with major ice ages and associated changes in the tropics.

Out of Africa: When and to Where?

When did humans first expand out of Africa, and where did they go? Only a few years ago, the general patterning seemed to indicate that the exodus was just before 1 mya, that the human type involved was Homo erectus and that the destination was Asia, not Europe. The earliest well-dated sites with definitive traces of human activity in Europe all appeared to cluster in the Middle Pleistocene after about 730,000 or even 500,000 years ago. New dates for both Asia and Europe as well as new finds suggest that this scenario, like the others mentioned in this article, may be far too simplistic.

The most widely accepted early dates in Asia are for `Ubeidiya, a well-known site in Israel where Oldowan artifacts appear to go back to ca. 1.4 mya based on faunal comparisons with Africa. New chronometric dates for the eastern part of the continent have been even more surprising. Carl Swisher and Garniss Curtis of the Berkeley Geochronology Center have published several dates older than 1.0 mya for the Modjokerto child, an early Homo erectus find from Java. These cluster around 1.8 mya. Some who disagree with these dates have argued that while there is indeed a volcanic ash near the site of the find that is of this age, it is far from clear how that relates to the age of the find, which was made by a local farmer in the 1930s. Swisher and Curtis have responded that the ash that lines the skull is a close match chemically to the dated ash; others have either disputed their conclusions or pointed out that **both** the ash **and** the skull could have washed into the site together. In the latter case the skull could be much younger than the ash. The continuing accumulation of new dates for other sites in Java such as Sangiran, however, appear to confirm the presence of Homo erectus in Java between 1.4 and 1.8 mya.

An even more controversial site, Longgupo, in South China, was recently described by Huang, Ciochon and others in both *Nature* and *Natural History*. This site contains a small jaw fragment of what the authors argue is early Homo, either habilis or ergaster, the first such fossil outside Africa. The find was associated with early Asian mammals (Late Pliocene to early Pleistocene in age) including a giant ape (Gigantopithecus). Also found were two very minimally fashioned objects of stone that the authors argue are tools. The possible attribution to habilis is based on the size and forward position of the cusps of the second premolar together with its double root. Others point out that these characteristics are not unknown from Homo

ergaster or early erectus, or even some early Asian apes.

In addition, the dating of Longgupo is based on paleomagnetism, which measures the direction and strength of the earth's magnetic field in samples of earth taken from around the bones. The earth's magnetic field periodically dissolves, reorganizes and changes direction; 800,000 years ago, for example, a compass needle would have pointed south rather than north. These reversals are encoded in newly forming sediments, as the atoms align themselves with the prevailing magnetic field at the time. The ancient magnetic signal is locked in to the sediment and can be measured in the lab. Precise dating of reversals in **volcanic** sediments using the potassium argon technique has led to a sequence of ages for 'normal' (north-oriented) and 'reversed' (south-oriented) periods. In **non-volcanic** sediments, such as those at Longgupo, researchers must try to guess which 'normal' or 'reversed' interval they are looking at, based on the entire sequence. The important levels at Longgupo are `normal', below a layer that is 'reversed' and several meters below a date of 1.02 mya, based on the decay of uranium isotopes in a sample of fossil tooth enamel and dentine. The researchers argue that the closest 'normal' period before 1.02 mya is the one at 1.78 to 1.96 mya. If the uranium series age is closer to 0.78 - 0.84 mya, which the authors admit is possible, then the earth around the 'human' bones could date to 0.9 to 1.0 mya, also a normal period, and much closer to the age of other old Chinese hominids.

What about Europe? The oldest European, and the only clear Homo erectus fossil from that continent recently turned up in the Republic of Georgia, in the Caucasus Mountains that separate Europe from the Near East. The fossil jaw, which looked very much like one from Kenya, was located above a basalt flow dating to 1.8 mya. in a normally polarized horizon. One additional problem is that the find was not in some undisturbed cave but in the wall of a medieval storage cellar in the town of Dmanisi. A recent expedition suggested that the fossil came from a series of burrows or dens, excavated by prehistoric mammals. Although the earth into which the dens were excavated is of normal polarity, the earth that fills the dens is reversed. This means that the fossil is **younger** than 1.8 mya (when polarity was normal) but must be older than 0.78 mya (polarity has been normal from that time to the present). The most likely estimate at the moment is ca. 1.4 mya, around the same age as `Ubeidiya.

A final European site in the news is much further into Europe than Dmanisi: the site of Atapuerca in northern Spain, where literally hundreds of human bones have been recovered from narrow fissures in the rock. Most relate to Middle Pleistocene times, but in the oldest site, the dating may suggest an age of 800-900,000 years ago. It is especially interesting that these are **not** classic examples of Homo erectus, but already suggest some specializations in the direction of Neanderthals, such as tooth row with a space behind the last tooth, deep pulp cavities in the teeth, semicircular brow ridges, and some enlargement of the middle face. How did all those human bones end up in this area? Excavation and analysis of this site are ongoing, and perhaps further publication will soon enlighten us.

Ex Africa Semper Aliquid Novi
(Ancient Greek proverb, "Always something new Out of Africa," cited by Pliny the Elder and Charles Darwin)

Just as we thought that the general picture of human evolution was becoming clear, new finds have suggested that our picture was too simplistic. The tree is more bushy, the causes more complex, and the migrations multiple and in several directions. These are very exciting times in palaeoanthropology, and we look forward with great anticipation to the next few years of research and analysis.

Readings

ramidus: White et al.(1994) *Nature* 371: 306-312 (and comments by Wood on p. 280-1), (1995) 375:88, WoldeGabriel et al.(1994) *Nature* 371: 330-333.
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New Species of early Homo: Wood(1992) *Journal of Human Evolution* 22: 351-398 **Malawi**: Schrenk et al. (1993) *Nature* 365: 833-836 (see also comment by Wood on pp. 780-790)
Expensive Tissue Hypothesis: Aiello and Wheeler (1995): *Current Anthropology* 36(2): 199-221 (with comments by 9 other scholars)
Variance Selection: Potts, Rick (1996) *Humanity's Descent: The Consequences of Ecological Instability*. New York: William Morrow & Co.
Out of Africa to Asia: Huang et al. (1995) *Nature* 378: 275-278 (and comment by Wood and Turner on pp. 239-240), Ciochon (1995) *Natural History* 104: 50-54, Larick and Ciochon (1996) *Archaeology* 49(1): 51-53, Swisher et al. (1994) *Science* 263: 1118-1121.
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SHAKING THE FAMILY TREE