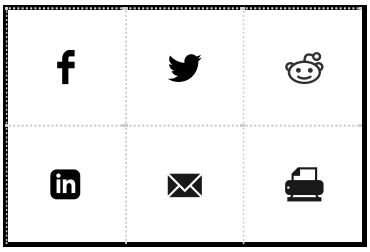
EVOLUTION

Long-Awaited Research on a 4.4-Million-Year-Old Hominid Sheds New Light on Last Common Ancestor

Fifteen years in the making, a dossier of papers on "Ardi" published in *Science* suggest that like humans, chimpanzees have undergone substantial evolutionary change

By Katherine Harmon on October 1, 2009



The first full analysis of a 4.4-million-year-old early human paints a clearer picture of what the last common ancestor of humans and chimpanzees may have looked like, which is not, after all, that much like a chimp at all. The ancient *Ardipithecus ramidus* ("Ardi", as the most complete female specimen is known) is described in 11 research papers published online today in *Science*. The prodigious research effort combines Ardi's fossils with those from many other *Ar. ramidus* individuals—both male and female—found near the Awash River in the Afar Rift region of Ethiopia.

Ar. ramidus, although likely millions of years more recent than the so-called missing link between chimpanzees and humans, represents "coming as close as we've ever come to that last common ancestor," Tim White of the University of California, Berkeley, one of the studies' lead authors, said in a recorded interview for *Science*.

Ardi is, in fact, "so rife with anatomical surprises, that no one could have imagined it without direct fossil evidence," wrote C. Owen Lovejoy, a professor of anthropology at Kent State University in Ohio, and his colleagues in a summary of one of the papers.

Among the surprises: Ardi's jaw and limbs show she was a forest-dwelling omnivore, not a fruit-eater like today's chimps or an open savanna–dweller like other early hominids. Ardi had a brain about the size of a modern chimp's relative to body size (about a third the size of a modern human's). And *Ar. ramidus*'s foot is strikingly unlike that of a modern chimpanzee, the authors of another paper (led by Lovejoy) explain.

For a primitive cousin who likely stood at only about 120 centimeters and weighed about 50 kilograms, Ardi is likely to make a big impact in the field of paleoanthropology. For instance, Ardi's physical form also has implications for many other ancient animals, including the controversial six-million- to seven-million-year-old *Sahelanthropus tchadensis*, discovered in Chad in 2001. The similarities in skull size and shape among these two species now has prompted the researchers of one of the new papers (led by Gen Suwa, a professor at the University of Tokyo) to conclude that *S. tchadensis* was, indeed, an early hominid, rather than a female ape as others have suggested.

Slide Show: Images of Ardi

Fragile fossils

First announced 15 years ago with only scant tooth and jaw fragments, *Ar. ramidus* had remained a relative paleoanthropological secret amidst growing literature on other early hominids, such as the well-known Lucy, a 3.2-million-year-old *Australopithecus afarensis*.

For the new papers, an international team of researchers assembled and described the more than 110 pieces of Ardi's skeleton, including portions of the skull, hands, feet, arms, legs and pelvis, and those of other *Ar. ramidus* specimens and surrounding plants and animals.

"It's an amazing amount of material," says Carol Ward, an associate professor and integrative anatomy specialist at the University of Missouri–Columbia (M.U.). "That in itself is astonishing."

The recovery efforts themselves took some "heroic efforts," says Brian Richmond, of George Washington University's Center for the Advanced Study of Hominid Paleobiology (CASHP), in Washington, D.C. Poorly fossilized, many of the bones would crumble with a normal human touch, so they were carefully removed, cast and scanned.

Long before the fossils were unearthed, they sustained quite a bit of damage, leaving the skull and the pelvis crushed and distorted. Close study and computer modeling helped researchers put the pieces back together, but, Richmond notes, "it takes a substantial amount of reconstruction," and a bit of guesswork to assemble the body—and movements—of a creature long extinct.

By hand or by foot

Perhaps one of the biggest questions that remains in the field of human evolution is how the modern two-legged gait came to be, and Ardi complicates some common assumptions made in the past by anthropologists.

Today's chimpanzees and gorillas get around on the ground by walking on the hind feet and the knuckles of their hands, leaving many to speculate that early humans may well have done the same. "It has long been assumed that our hands must have evolved from hands like those of African apes," Lovejoy and his co-authors wrote in one paper summary. Other early specimens have lacked sufficient hand bones to establish if they were transitioning from knuckle walking, note the authors of one of the papers.

The more complete hands of Ardi, however, throw another wrench into this theory. The stiff but strong hands of modern great apes are well-adapted to navigating life in the treetops. Humans, however, have weaker but more flexible hands, allowing for better dexterity and tool use. The hands of *Ar. ramidus* were indeed strong enough to hang from tree branches but don't show any indication of knuckle-walking, and in some ways they may have been more flexible than our own, Lovejoy and co-authors note.

So does that mean that Ardi was walking on two legs? By the time Lucy came along about 3.2 million years ago, her cadre was already fairly well-adapted to bipedal walking (although not quite so well as modern humans). The researchers suggest that Ardi was, in fact, an upright walker and that "*Ar. ramidus* could walk without shifting its center of mass from side to side," a hallmark of latter hominids, wrote Lovejoy and his colleagues.

M.U.'s Ward is not convinced that Ardi was quite as steady on her feet as the authors suggest. After examining some of the figures, Ward notes that the specimen's knees may

actually have been spaced farther apart, making Ardi less able to flow from one foot to another without making the large adjustment of body weight.

She is not alone in her skepticism. "There is precious little to indicate that it was an upright walker," Richmond says, which actually surprised him, noting that there is other evidence of bipedality going back some four million years ago (work on fossils of *Orrorin tugenensis* even suggests bipedality going back some six million years). He also cites the lack of a knee joint as an unknown key to the species's locomotion capabilities.

Its hips do, however, appear to be moderately adjusted to accommodate some upright walking. But they were not as similar to modern human hips as those of *Australopithecus*. And the feet, although more primitive than a chimpanzee's, "certainly would have been capable of bipedal walking," Richmond says, although the presence of a large grasping toe and other aspects make it less well-suited to getting around upright.

Perhaps more fossil evidence will help to clarify the path from the tree branch to the

savannah, but in the meantime, Ardi has brought some welcome new evidence to the field, Ward notes. "The question is no longer, 'Why did our ancestors stand upright?'" she says. "It's, 'Why did they never drop down on all fours when they came out of the trees?'"

Forest dweller

Challenging long-held assumptions about where—and why—early humans dropped down from the trees and stretched their legs, *Ar. ramidus* appears to have lived not in a savanna but in a forest.

Previous excavation of early humans has often been in areas in which ancient deluges had mixed various biomes and layers together, providing a convoluted picture of each individual's original environment, U.C. Berkeley's White et al. wrote in one of the new papers. Ethiopia's Afar Rift location, however, had experienced no such archaic amalgamation, providing paleoanthropologists with a clearer picture of Ardi's world.

Analysis of the area's geology and other nearby fossils revealed ancient fig and hackberry trees as well as new species of mammals and birds. These findings, along with the dearth of grassland-dwelling species, such as the larger hoofed species found elsewhere, led the authors of one of the papers (led by Giday WoldeGabriel, a geologist at Los Alamos National Laboratory in New Mexico) to propose that the area "was humid and cooler than it is today, containing habitats ranging from woodlands to forest patches," they wrote in a summary.

Given that they did inhabit a largely wooded area, however, means that ground-based travel was probably secondary, Ward says. "The most important way of getting around for these animals was climbing trees." Nevertheless, it raises questions as to why these animals may have started perambulating upright before later hominids moved onto the grasslands, whereas ancestors of chimpanzees and other great apes eventually retreated deeper into the forest.

Social speculations

What can the outlines of Ardi's frame reveal about the daily lives of this species?

Researchers found an important indicator in the canine teeth from male *Ar. ramidus* specimens. Modern male chimpanzees and gorillas have long, sharp canine teeth, which they use in fights with other males to obtain female mates. *Ar. ramidus*—and to an even lesser extent, humans—don't have such fearsome teeth. In the papers, Lovejoy suggests that this may be a sign of the absence of such male-to-male competition and aggression over female mates and perhaps an indication that the males were starting to be more involved in the rearing process.

These ancient *Ar. ramidus* males also appear to have been nearly the same size of the females, another indication that they likely had a different social system than modern chimpanzees, whose aggression-based hierarchy had long been the foil for early hominids.

As White noted in his interview, the absence of these two key gender differences seems to be “signaling a new social structure.”

Others in the field agree that these two signatures are likely indicators of a different type of mating system than the one seen in modern African apes. However, recreating the details of a social system purely on fossil evidence is tricky, if not impossible, says Michael Plavcan, an associate professor of Anthropology at the University of Arkansas in Fayetteville. Some new world monkeys, for example also show little sexual body size or canine tooth dimorphism and pair off for life—“the family counsel’s animal of the year,” says Plavcan—others, with similar characteristics are, he explains, “intensely promiscuous.”

Next steps

Like any significant scientific discovery, *Ar. ramidus* raises more questions than it answers. "It's going to keep generations of students busy," CASHP's Richmond says of the research. It will also likely usher in a change in the common understanding that modern humans descended directly from chimpanzees—as popularized by the illustrated "quadrupedal monkey to upright man" sequence. Accepting the new view of human evolution that the Ardi analyses suggest, says Ward, will mean "tearing that [depiction] up and throwing it out the window."

This new evidence calls into question many assumptions that have been made about *Homo sapiens*'s assumed privileged evolution. Indeed, if anything, Ardi reveals that chimpanzees, too, have been on quite an evolutionary odyssey in the past seven million to 10 million years.

It also points the way toward more work outside of Ardi's clan. "This just highlights the need for more research to find the last common ancestor of chimpanzees and humans," Richmond says. "Ultimately we want to know where we first came from and what were

the factors that let us take our unique steps toward humanity," he says. But the fossil record will have to be the final arbitrator. "I think at this point it's premature to make conclusions about the common ancestor without having evidence," he says.

Indeed, even White noted that it is still too early to say for sure exactly how these evolutionary lines are related and how the hominids came to start walking upright.

The analysis of Ardi gives new poignancy to the notion, set forth nearly 150 years ago by Charles Darwin and Thomas Huxley, that there was likely a common ancestor quite different from both modern humans and great apes. Darwin knew, White noted in the recorded interview that, "the only way we're really going to know what this last common ancestor looked like is to go and find it."

ABOUT THE AUTHOR(S)

Katherine Harmon

Recent Articles

What's in Your Wiener? Hot Dog Ingredients Explained

The Puzzle of Pancreatic Cancer: How Steve Jobs Did Not Beat the Odds—but Nobel Winner Ralph Steinman Did

Are Zombie Bees Infiltrating Your Neighborhood?

READ THIS NEXT

Long-Awaited Research on a 4.4-Million-Year-Old Hominid Sheds New Light on Last Common Ancestor