Before 'Lucy,' there was 'Ardi': Oldest hominid skeleton provides new evidence for human evolution (w/ Video)

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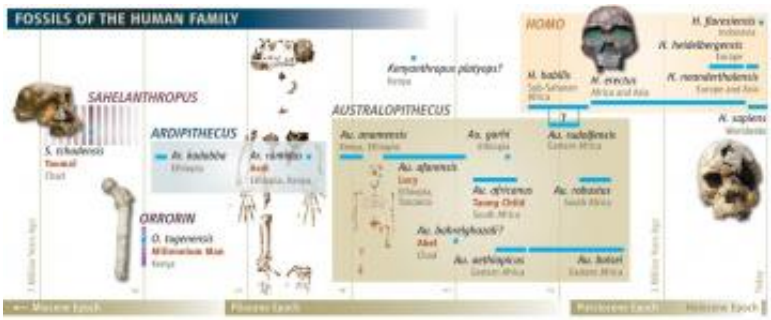
Partial skeleton of Ardipithecus ramidus, a hominid species living about 4.4 million years ago in Ethiopia. This female stood about 1.2 meters high. Eleven papers from an international team of authors published in print and online in this special issue describe the anatomy of this species and its habitat and discuss the implications for understanding human evolution. One result is that extant great apes are poor models for our last common ancestor with chimpanzees. See page 60 for an introduction. [Image: © T. White, 2008]

In a special issue of *Science*, an international team of scientists has for the first time thoroughly described *Ardipithecus ramidus*, a hominid

species that lived 4.4 million years ago in what is now Ethiopia. This research, in the form of 11 detailed papers and more general summaries, will appear in the journal's 2 October 2009 issue.

This package of research offers the first comprehensive, peer-reviewed description of the *Ardipithecus* fossils, which include a partial skeleton of a female, nicknamed "Ardi."

The last common ancestor shared by humans and chimpanzees is thought to have lived six or more million years ago. Though *Ardipithecus* is not itself this last common ancestor, it likely shared many of this ancestor's characteristics. For comparison, *Ardipithecus* is more than a million years older than the "Lucy" female partial skeleton of *Australopithecus afarensis*. Until the discovery of the new *Ardipithecus* remains, the fossil record contained scant evidence of other hominids older than *Australopithecus*.



Fossils of the Human Family: Timeline. This timeline shows the fossils upon which our current understanding of human evolution is based. The new fossil skeleton of Ardipithecus ramidus, nicknamed Ardi, fills a large gap before the Lucy skeleton, Australopithecus afarensis, but after the hominid line split from the line that led to today's chimpanzees. (Science magazine)

Through an analysis of the skull, teeth, pelvis, hands, feet and other bones, the researchers have determined that *Ardipithecus* had a mix of "primitive" traits, shared with its predecessors, the primates of the Miocene epoch, and "derived" traits, which it shares exclusively with later hominids.

Because of its antiquity, *Ardipithecus* takes us closer to the still-elusive last common ancestor. However, many of its traits do not appear in modern-day African apes. One surprising conclusion, therefore, is that it is likely that the African apes have evolved extensively since we shared that last common ancestor, which thus makes living chimpanzees and gorillas poor models for the last common ancestor and for understanding our own evolution since that time.

"In *Ardipithecus* we have an unspecialized form that hasn't evolved very far in the direction of *Australopithecus*. So when you go from head to toe, you're seeing a mosaic creature, that is neither chimpanzee, nor is it human. It is *Ardipithecus*," said Tim White of the University of California Berkeley, who is one of the lead authors of the research.

"With such a complete skeleton, and with so many other individuals of the same species at the same time horizon, we can really understand the biology of this hominid," said Gen Suwa of the University of Tokyo, Project paleoanthropologist and also a lead *Science* author.

"These articles contain an enormous amount of data collected and analyzed through a major international research effort. They throw open a window into a period of human evolution we have known little about, when early hominids were establishing themselves in Africa, soon after diverging from the last ancestor they shared with the African apes," said Brooks Hanson, deputy editor, physical sciences, at *Science*.

"*Science* is delighted to be publishing this wealth of new information,

which gives us important new insights into the roots of hominid evolution and into what makes humans unique among primates," said Hanson.

The special collection of *Science* articles begins with an overview paper that summarizes the main findings of this research effort. In this article, White and his coauthors introduce their discovery of over 110 *Ardipithecus* specimens including a partial skeleton with much of the skull, hands, feet, limbs and pelvis. This individual, "Ardi," was a female who weighed about 50 kilograms and stood about 120 centimeters tall.

Until now, researchers have generally assumed that chimpanzees, gorillas and other modern African apes have retained many of the traits of the last ancestor they shared with humans - in other words, this presumed ancestor was thought to be much more chimpanzee-like than human-like. For example, it would have been adapted for swinging and hanging from tree branches, and perhaps walked on its knuckles while on the ground.

Ardipithecus challenges these assumptions, however. These hominids appear to have lived in a woodland environment, where they climbed on all fours along tree branches - as some of the Miocene primates did -- and walked, upright, on two legs, while on the ground. They do not appear to have been knuckle-walkers, or to have spent much time swinging and hanging from tree-branches, especially as chimps do. Overall, the findings suggest that hominids and African apes have each followed different evolutionary pathways, and we can no longer consider chimps as "proxies" for our last common ancestor.

"Darwin was very wise on this matter," said White.

"Darwin said we have to be really careful. The only way we're really going to know what this last common ancestor looked like is to go and

find it. Well, at 4.4 million years ago we found something pretty close to it. And, just like Darwin appreciated, evolution of the ape lineages and the human lineage has been going on independently since the time those lines split, since that last common ancestor we shared," White said.

This special issue of *Science* includes an overview article, three articles that describe the environment *Ardipithecus* inhabited, five that analyze specific parts of *Ardipithecus*' anatomy, and two that discuss what this new body of scientific information may imply for human evolution.

Altogether, forty-seven different authors from around the world contributed to the total study of *Ardipithecus* and its environment. The primary authors are Tim White of the University of California, Berkeley, Berhane Asfaw of Rift Valley Research Service in Addis Ababa, Giday WoldeGabriel of Los Alamos National Laboratory, Gen Suwa of the University of Tokyo, and C. Owen Lovejoy of Kent State University.

"These are the results of a mission to our deep African past," said WoldeGabriel, who is also Project co-Director and geologist.

On the trail of our ancestors
A Q&A with paleoanthropologist Leslea Hlusko

The groundbreaking discovery of the partial skeleton of Ardipithecus ramidus, a hominid species dating back 4.4 million years, is the latest in a long line of contributions UC Berkeley researchers have made toward the elucidation of the human ancestral tree. Some of the world's most significant hominid fossils, including Ar. ramidus, have been unearthed in Ethiopia's Middle Awash Valley, site of the Middle Awash Research Project, established in 1981 by the late J. Desmond Clark, pre-eminent archaeologist and UC Berkeley professor emeritus of anthropology. The project's research area extends along both sides of the modern Awash River in the Afar depression of Ethiopia, north of Gewane town.

With cooperation from the Ethiopian government, the project brings together an international team of paleoanthropologists, geologists and archaeologists to study human origins and evolution. To learn more about what it's like to be a hominid fossil hunter, Sarah Yang from UC Berkeley Media Relations interviewed Leslea Hlusko, associate professor of integrative biology and the associate faculty member of the Human Evolution Research Center at UC Berkeley. Hlusko is a co-author of the new Ar. ramidus studies being published in the Oct. 2 issue of *Science*.

Q. The Afar depression is an immense place to work. How do you find fossils there, and how do distinguish bone from rock?

A. The first time you are on the outcrop as a student, you can't help but worry that you won't be able to see the fossils on the ground. What you quickly learn, though, is that all of the training you've had in osteology helps tremendously - you look for rocks that are shaped like fragments of animal skeletons. But then you also realize that the texture of a fossil bone is quite distinct from rocks. Finding fossils can be quite

challenging, though, especially when they are covered in matrix and partly buried. Some people are definitely better at it than others. Everyone who has ever worked in the field stands in awe of the great fossil finders.

Q. The first fossil from this hominid, nicknamed "Ardi," was found in 1992. Why did it take 17 years to publicly announce the discovery?

A. This project was like a Polaroid photograph. The discovery of the site was the initial click of the camera, and then we had a lot of work to do to develop the final image. Given the vast amount of data recovered from the Aramis site where Ardi was found, 47 specialists were brought in to analyze these from every possible angle. These multiple research approaches take a long time to pursue, and then the pieces had to be reassembled into one cohesive picture. The process was similar to waiting for that Polaroid to develop - each piece coming into focus one by one, ultimately resulting in an incredible snapshot of Ardi's life and times.

Q. I imagine that the fossils are extremely fragile. How do you extract them from the rock, and how do you keep the specimens intact while doing that?

A. We first survey the sediments to determine whether or not there are fossils eroding out - many of the bones found on the surface at that stage are quite hardy. They've survived man and many years of rain. However, this often leads us to find fossils embedded in the sediments that are extremely fragile and that would be destroyed when they reach the surface. The Ardi skeleton was definitely one of these. I wasn't in the field the years they excavated the skeleton, but I am awed by the fact that the team was able to recover bones that were so fragile; just breathing on them would cause disintegration. I've seen bones like that in the field, and they pose a serious challenge. You have to first identify it

as a bone before too much of it is exposed, and then immediately use preservative to harden the bone and the surrounding matrix. Then you excavate around the bone, giving it a wide berth, so the matrix that you solidified continues to hold it all together. We use plaster bandages, like the kind doctors used to set broken arms. These bandages get wrapped around the matrix block. Once set, we carefully remove the block and pack it up for the long trip back to Addis Ababa to place into the National Museum's collection. In the comfort and controlled environment of the lab, the matrix is very carefully removed grain by grain from the fossil bone. It takes a lot of patience, and is incredibly time consuming. There is definitely an art to this, as well, and Professor Tim White is the best in the world at this. He was the one who did all of the preparation work for the Ardi skeleton.

Q. Pieces of Ardi were smashed and damaged when found. How can one possibly reconstruct a skeleton, particularly the skull, from all of these fragments?

A. Thankfully, modern technology has significantly improved our options for resolving this problem. Professor Gen Suwa in Tokyo set up a micro-CT lab in which the crushed bones were scanned. From these scans, the individual bone fragments were digitally put back into anatomical position. The work required amazing attention to detail and took years to reach consensus among the hominid team. (I studied the monkey fossils, so I watched this part of the analysis from the sidelines). Simultaneous to the micro-CT research, Professor White worked with plaster casts of the squashed specimen, cutting the plaster pieces apart and then gluing them back together into anatomical position. After years of this meticulous work, White and Suwa compared their two reconstructions and found that they had reached the same configuration. It was a nice way to independently test their abilities to reconstruct such damaged fossils.

Q. How many people work at the site, and where are they from?

A. Hundreds of people have worked at Aramis over the duration of the project, including many local Afar people, graduate and undergraduate students, scientists from many different countries, and Ethiopian government officials. Not only has there been a lot of research done here, but also a lot of training. I learned most of my field paleontology skills from the years I've work on the Middle Awash project, and now I'm co-directing a project in Tanzania with Jackson Njau, who is also an author on the Aramis taphonomy paper and who has worked in the field in Ethiopia.

Q. Are these excavations conducted all year round, rain or shine? What are the biggest obstacles you've encountered in this line of work?

A. We go to the field during the dry season, so as to avoid having to cross rivers with flowing water. But it is a balancing act - arriving soon after the rains end but not too late, as it gets very, very hot come February. The field seasons typically ran from October through January every year. The team has spent a lot of Jewish and Christian holidays in the Afar (the Afars are Muslim). Luckily, everyone on the project loves a good celebration, no matter the reason.

Q. What advice can you give to the budding paleoanthropologists out there? What are the skills and characteristics best suited to this line of work?

A. The research published in the Ardipithecus package this week is a wonderful example of the inter- and multi-disciplinary nature of modern paleontology. This project relied on the skill sets of 47 scientists. No one individual could ever hope to be able to master all of these research areas themselves; we work in teams. Good paleontology is not done by the lone paleontologist hiding up in his or her attic. So, as a budding

paleontologist, it is critical to approach the field as one in which you build collaborations at multiple levels: with a scientific team, with the host governments, the local people, etc.

That said, you should also build your knowledge base so that it is as broad as possible. You definitely need a strong understanding of geology, anatomy, evolutionary theory and genetics, to list just a few. And you will also want to know how to drive a stick-shift, change a tire, use a shovel, shower with just 1 liter of water - when you can get it - and, of course, identify poisonous snakes.

Source: American Association for the Advancement of Science, UC Berkeley

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