

Fossil Skeleton From Africa Predates Lucy

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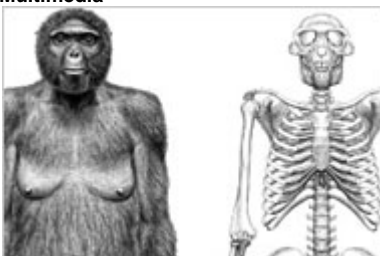
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Tim White, 2008, from the October 2 issue of Science

A fairly complete skeleton of *Ardipithecus ramidus*, which replaced Lucy as the earliest known skeleton from the human branch of the primate family tree. [More Photos »](#)

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Ardi, short for *Ardipithecus ramidus*, is the newest fossil skeleton out of Africa to take its place in the gallery of human origins. At an age of 4.4 million years, it lived well before and was much more primitive than the famous 3.2-million-year-old Lucy, of the species *Australopithecus afarensis*.

Since finding fragments of the older hominid in 1992, an international team of scientists has been searching for more specimens and on Thursday presented a fairly complete skeleton and their [first full analysis](#). By replacing Lucy as the earliest known skeleton from the human branch of the primate family tree, the scientists said, Ardi opened a window to “the early evolutionary steps that our ancestors took after we diverged from our common ancestor with chimpanzees.”

The older hominid was already so different from chimps that it suggested “no modern ape is a realistic proxy for characterizing early hominid evolution,” they wrote.

The *Ardipithecus* specimen, an adult female, probably stood four feet tall and weighed about 120 pounds, almost a foot taller and twice the weight of Lucy. Its brain was no larger than a modern chimp’s. It retained an agility for tree-climbing but already walked upright on two legs, a transforming innovation in hominids, though not as efficiently as Lucy’s kin.

Ardi’s feet had yet to develop the arch-like structure that came later with Lucy and on to humans. The hands were more like those of extinct apes. And its very long arms and short legs resembled the proportions of extinct apes, or even monkeys.

Tim D. White of the [University of California, Berkeley](#), a leader of the team, said in an interview this week that the genus *Ardipithecus* appeared to resolve many uncertainties about “the initial stage of evolutionary adaptation” after the hominid lineage split from that of the chimpanzees. No fossil trace of the last common ancestor, which lived some time before six million years ago, according to genetic studies, has yet come to light.

The other two significant stages occurred with the rise of *Australopithecus*, which lived from about four million to one million years ago, and then the emergence of *Homo*, our own genus, before two million years ago. The ancestral relationship of *Ardipithecus* to *Australopithecus* has not been determined, but Lucy’s australopithecine kin are generally recognized as the ancestral group from which *Homo* evolved.

Scientists not involved in the new research hailed its importance, placing the Ardi skeleton on a pedestal alongside notable figures of hominid evolution like Lucy and the 1.6-million-year-old Turkana Boy from Kenya, an almost complete specimen of *Homo erectus* with anatomy remarkably similar to modern *Homo sapiens*.

David Pilbeam, a professor of human evolution at [Harvard University](#) who had no role in the discovery, said in an e-mail message that the Ardi skeleton represented “a genus plausibly ancestral to *Australopithecus*” and began “to fill in the temporal and structural ‘space’ between the apelike common ancestor and *Australopithecus*.”

Andrew Hill, a paleoanthropologist at [Yale University](#) who was also not involved in the research, noted that Dr. White had kept “this skeleton in his closet for the last 15 years or so, but I think it has been worth the wait.” In some ways the specimen’s features are surprising, Dr. Hill added, “but it makes a very satisfactory animal for understanding the changes that have taken place along the human lineage.”

The first comprehensive reports describing the skeleton and related findings, the result of 17 years of study, are being published Friday in the journal *Science*. Eleven papers by 47 authors from 10 countries describe the analysis of more than 110 *Ardipithecus* specimens from a minimum of 36 different individuals, including Ardi.

The paleoanthropologists wrote in one of the articles that *Ardipithecus* was “so rife with anatomical surprises that no one could have imagined it without direct fossil evidence.”

A bounty of animal and plant material — “every seed, every piece of fossil wood, every scrap of bone,” Dr. White said — was gathered to set the scene of the cooler, more humid woodland habitat in which these hominids had lived.

This was one of the first surprises, said Giday WoldeGabriel, a geologist at [Los Alamos National Laboratory](#), because it upset the hypothesis that upright walking had evolved as an adaptation to life on grassy savanna.

The discovery site, on what is now an arid floodplain along the middle stretch of the Awash River in Ethiopia, is 140 miles northeast of Addis Ababa and 45 miles south of Hadar, where Lucy was found in 1974 by Donald Johanson, with whom Dr. White collaborated in analyzing those fossils.

Gen Suwa, a paleoanthropologist now at the University of Tokyo, made the first discovery in 1992: a single upper molar. Yohannes Haile-Selassie, an Ethiopian curator of anthropology at the Cleveland Museum of Natural History, uncovered the first skeletal bones. A preliminary report on the new species was published in 1994.

But the fossils, which are housed at the anthropology museum in Addis Ababa, were so plentiful, fragmentary and potentially significant that Dr. White held back from further public discussion of the research, even while discoveries of older fossils were being made.

One discovery was of an earlier species of *Ardipithecus* from elsewhere in Ethiopia. Other finds, perhaps from more than six million years ago and given other species names, were excavated in Chad and Kenya. Their bones indicate that they also walked upright, scientists say, but the fossils are too few to draw any definitive conclusions.

Ardi's skull, Dr. Pilbeam said, appears to be more similar to the older Chad hominid than to younger australopithecines. This indicates that the fossils from Chad and Ethiopia possibly represent species of the *Ardipithecus* genus, or closely related genera.

From the new research, scientists inferred that Ardi was female, based on its small and lightly built skull and its canine teeth, which are small compared with other individuals at the site.

Dr. Suwa, a specialist in fossil teeth, said the more than 145 teeth collected at the site were of the size and shape and had wear patterns showing that the individuals were omnivorous eaters of plants and nuts, as well as small mammals, but were not as big consumers of fruits as are living chimps and gorillas. Ardi probably fed in trees and on the ground.

Dr. Suwa also noted that males had stubby canine teeth, more like those of modern humans, in contrast to the projecting tusklike upper canines of chimps and gorillas, suggesting that *Ardipithecus* teeth no longer functioned as weapons or displays in male-male or male-female conflicts. In fact, the male and female upper canines are similar.

This was seen as further evidence that the species had already evolved a distinctive trait of early prehumans. C. Owen Lovejoy, an anatomist at [Kent State University](#) and lead author of two of the journal reports, speculated that these hominids had a social system that involved less competition among males and that this suggested the beginning of pair bonding between males and females.

Dr. Pilbeam disputed this conjecture, saying, "This is a restatement of Owen Lovejoy's ideas going back almost three decades, which I found unpersuasive then and still do."

In his articles and an interview, Dr. Lovejoy described the five years he spent analyzing the *Ardipithecus* pelvis, which appeared to be in transition between a structure originally suited for life in trees and one modified for early upright walking. By contrast, the pelvis of the Lucy species had already evolved nearly all of the adaptations for bipedality.

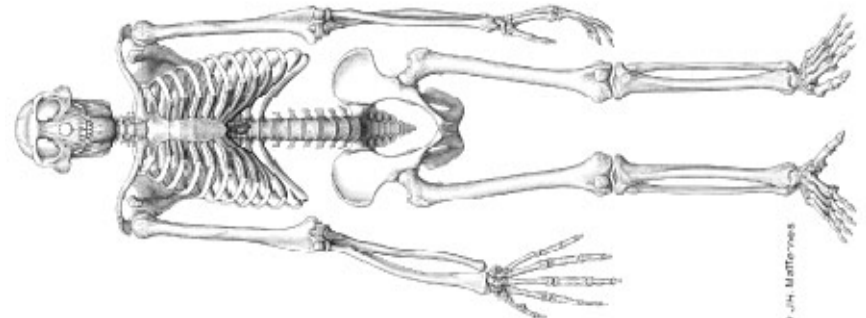
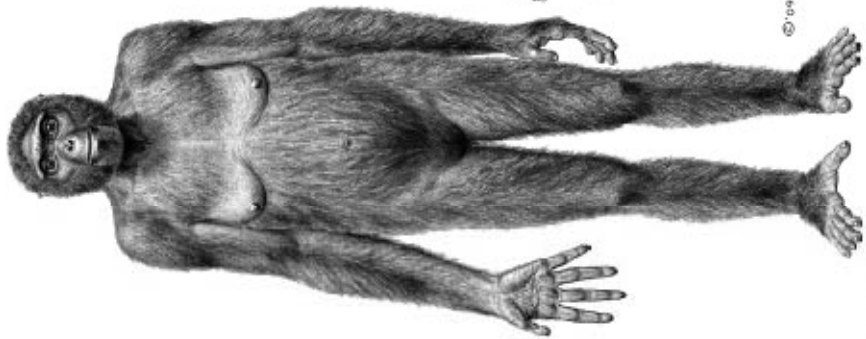
Asked at a news conference in Washington what Lucy might have said to her new-found "sister," Dr. Lovejoy replied, "She would have challenged her to a race, and Lucy would have won handily." Although the lower pelvis is still primitive, Dr. Lovejoy found, changes in the upper pelvis enabled the species to walk on two legs with a straightened hip, "but probably with less speed and efficiency than humans." A few scientists think this walking evidence to be only circumstantial. The lower part of the pelvis, "still almost entirely apelike," indicates retention of powerful hamstring muscles for climbing.

Dr. White, Berhane Asfaw of the Rift Valley Research Service in Ethiopia and other team members concluded that "despite the genetic similarities of living humans and chimpanzees, the ancestor we last shared probably differed substantially from any extant African ape."

As Dr. Hill of Yale said, "It is always new specimens, particularly those from little known time periods or geographic areas, that provoke the greatest changes in our ideas."

Looking ahead, Dr. White lamented that there were so few sites in Africa known to have fossil deposits six million to seven million years old. "We are getting so close to that common ancestor of hominids and chimps, and we'd love to find an earlier skeleton," he said.



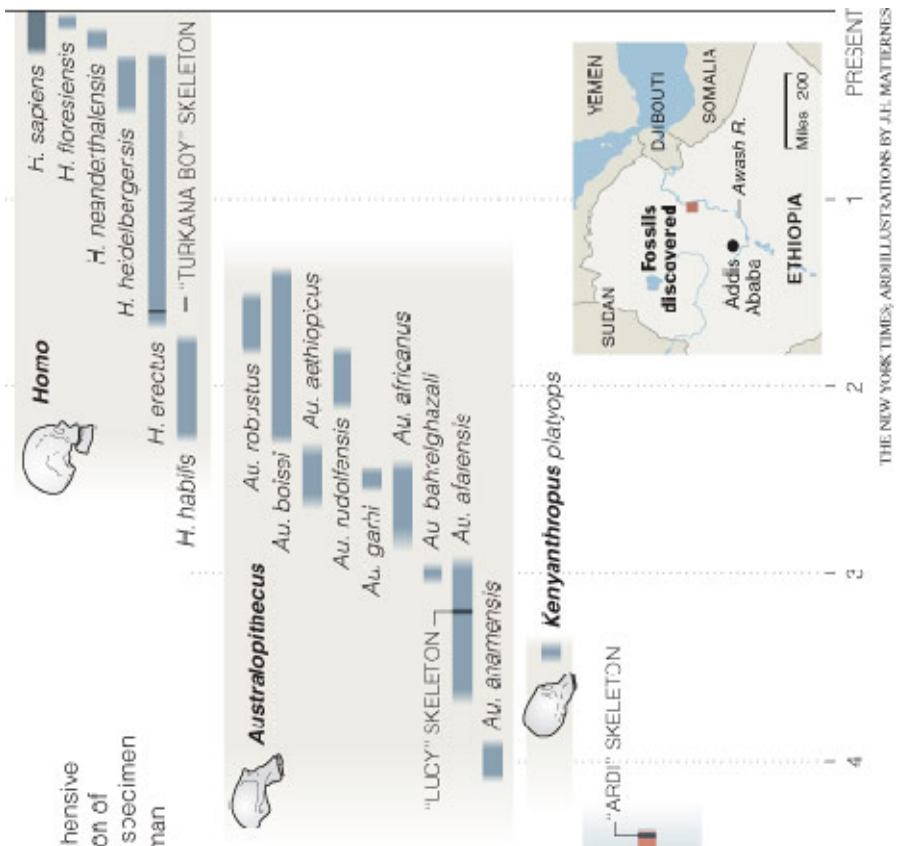


An Early Hominid

Scientists have published the first comprehensive description of a 4-million-year-old skeleton of *Ardipithecus ramidus*. Known as Ardi, the specimen is the earliest known skeleton from the human branch of the primate family tree.

Ardi was an adult female who likely stood four feet tall and weighed about 120 pounds. It walked upright but lacked the arch-like foot structure and efficient gait of later hominids, and its long arms, long hands and short legs allowed for agile tree-climbing.

The skeleton was discovered along the Awash River in Ethiopia, near where the Lucy skeleton was found in 1974.



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Probable life appearance of "Ardi," a drawing based on a partial fossilized skeleton from a female *Ardipithecus ramidus* who weighed about about 50 kilograms (110 pounds) and stood about 120 centimeters (just under 4 feet) tall.

[Illustration © 2009, J.H. Matternes]

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, was published today in the journal's 2 October 2009 issue. *Science* is published by AAAS, the nonprofit science society.

The package of research offers the first comprehensive, peer-reviewed description of the *Ardipithecus* fossils, which include a partial skeleton of a female, nicknamed "Ardi." Publication of the new research was the subject of simultaneous news conferences today in the Ethiopian capital of Addis Ababa, and at AAAS/*Science* headquarters in Washington, D.C., with major international news media quickly conveying the story to a worldwide audience.

"What we celebrate here today are the results of a scientific mission to the very deep past," said Tim White of the University of California Berkeley, one of the lead authors of the research, at the AAAS news conference.

The discovery and publication of the research is "an extraordinary event," Samuel Assefa, Ethiopian ambassador to the United States, said at AAAS. "The deeper point for all of us is a deeper sense of our interconnectedness."

Alan I. Leshner, chief executive officer of AAAS and executive publisher of *Science*, called the publication "truly a landmark event in our understanding of human origins."

The last common ancestor shared by humans and chimpanzees is thought to have lived six million or more 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 “Lucy,” the partial female skeleton of *Australopithecus afarensis*. Until the discovery of the new *Ardipithecus* remains, the fossil record contained scant evidence of other hominids older than *Australopithecus*.

- [Read the full package on *Ardipithecus ramidus*](#) in this week's special issue of *Science*.
- Read translations of this story in [Amharic](#), [Chinese](#), [Japanese](#), [Spanish](#), and [French](#).
- [Listen](#) to a 45-minute interview with Tim White, one of the lead authors. Or read a transcript of the interview in [English](#) or [Japanese](#).
- [Read summaries](#) of the 11 research articles or a [detailed background](#) briefing by the research authors.
- [Listen](#) to the *Science* Podcast.

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*,” said White, a professor at the Human Evolution Research Center and the Department of Integrative Biology at the

University of California at Berkeley. “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*.”

“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,” Gen Suwa of the University of Tokyo, the project paleoanthropologist and also a lead *Science* author, said in an interview.

C. Owen Lovejoy, a professor of anthropology at Kent State University in Ohio, reconstructed the “Lucy” skeleton and was a lead researcher and author on the “Ardi” project. He called the “Ardi” skeleton “a treasure-trove of surprises” and “one of the most revealing hominid fossils I ever could have imagined.”

Brooks Hanson, deputy editor for physical sciences at *Science*, hailed the importance of the work, calling it “one of those special and wonderful moments in science.”

“These articles contain an enormous amount of data collected and analyzed through a major international research effort,” Hanson said. “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.

“*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 is published 150 years after the publication of Charles Darwin's “On the Origin of Species.” The special issue 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 (110 pounds) and stood about 120 centimeters (just under 4 feet) 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,” he added. “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.”

The 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, 47 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,” WoldeGabriel, project co-director and geologist, said before his appearance at AAAS.

“Ardi's” bones will be quartered at the Ethiopian National Museum, where there's already a significant “Lucy” exhibit. WoldeGabriel reminded reporters at AAAS of the extensive collections of hominid fossils discovered in his nation, some dated to 6 million years ago. “Ethiopia can rightly claim to be the cradle of mankind,” he said.

The research was funded by the National Science Foundation; the Institute of Geophysics and Planetary Physics of the University of California at Los Alamos National Laboratory (LANL); the Japan Society for the Promotion of Science; and others.

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journals, [Science](#), [Science Signaling](#), and [Science Translational Medicine](#). AAAS was founded in 1848, and serves 262 affiliated societies and academies of science, reaching 10 million individuals. *Science* has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of 1 million. The non-profit AAAS is open to all and fulfills its mission to “advance science and serve society” through initiatives in science policy; international programs; science education; and more. For the latest research news, log onto [EurekAlert!](#), the premier science-news Web site, a service of AAAS.

Kathy Wren 1 October 2009