On their own 2 feet: 3.2 million-year-old fossil foot bone supports humanlike bipedalism in Lucy's species

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This image shows the position of the fourth metatarsal *Australopithecus afarensis* (AL 333-160) recovered from Hadar, Ethiopia, in a foot skeleton. Credit: Carol Ward/University of Missouri

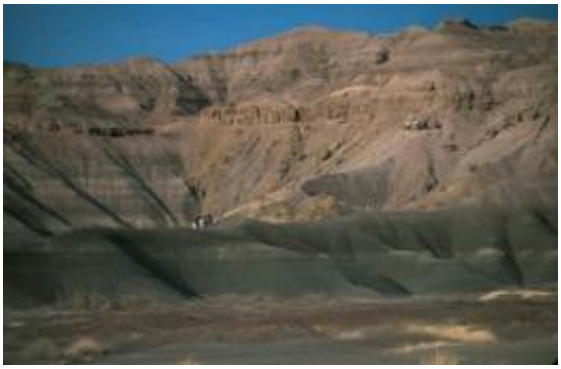
A fossilized foot bone recovered from Hadar, Ethiopia, shows that by 3.2 million years ago human ancestors walked bipedally with a modern human-like foot, a report that appears Feb. 11 in the journal *Science*, concludes. The fossil, a fourth metatarsal, or midfoot bone, indicates that a permanently arched foot was present in the species Australopithecus afarensis, according to the report authors, Carol Ward

of the University of Missouri, together with William Kimbel and Donald Johanson, of Arizona State University's Institute of Human Origins.

The research helps resolve a long-standing debate between paleoanthropologists who think A. afarensis walked essentially as modern humans do and those who think this species practiced a form of locomotion intermediate between the quadrupedal tree-climbing of chimpanzees and human terrestrial bipedalism. The question of whether A. afarensis had fully developed pedal, or foot, arches has been part of this debate. The fourth metatarsal described in the *Science* report provides strong evidence for the arches and, the authors argue, support a modern-human style of locomotion for this species. The specimen was recovered from the Hadar locality 333, popularly known as the "First Family Site," the richest source of A. afarensis fossils in eastern Africa, with more than 250 specimens, representing at least 17 individuals, so far known.

"This fourth metatarsal is the only one known of A. afarensis and is a key piece of evidence for the early evolution of the uniquely human way of walking," says Kimbel. "The ongoing work at Hadar is producing rare parts of the skeleton that are absolutely critical for understanding how our species evolved."

Humans, uniquely among primates, have two arches in their feet, longitudinal and transverse, which are composed of the midfoot bones and supported by muscles in the sole of the foot. During bipedal locomotion, these arches perform two critical functions: leverage when the foot pushes off the ground and shock absorption when the sole of the foot meets the ground at the completion of the stride. Ape feet lack permanent arches, are more flexible than human feet and have a highly mobile large toe, important attributes for climbing and grasping in the trees. None of these apelike features are present in the foot of A. afarensis.



Paleoanthropologists report in the Feb. 10 edition of *Science* on the recovery of a fossilized foot bone recovered from Hadar, Ethiopia, locality 333, popularly known as the "First Family Site," the richest source of *Australopithecus afarensis* fossils in eastern Africa. Credit: Donald Johanson/Institute of Human Origins/Arizona State University

"Understanding that the foot arches appeared very early in our evolution shows that the unique structure of our feet is fundamental to human locomotion," observes Ward. "If we can understand what we were designed to do and how natural selection shaped the human skeleton, we can gain insight into how our skeletons work today. Arches in our feet were just as important for our ancestors as they are for us."

This species, whose best-known specimen is "Lucy," lived in eastern Africa 3.0–3.8 million years ago. Prior to A. afarensis, the species A. anamensis was present in Kenya and Ethiopia from 4.2 to 4.0 million years ago, but its skeleton is not well known. At 4.4 million years ago, Ethiopia's Ardipithecus ramidus is the earliest human ancestor well represented by skeletal remains. Although Ardipithecus appears to have been a part-time terrestrial biped, its foot retains many features of tree-dwelling primates, including a divergent, mobile first toe. The foot of A. afarensis, as with other parts of its skeleton, is much more like that of

living humans, implying that by the time of Lucy, our ancestors no longer depended on the trees for refuge or resources.

This is the fossilized foot bone -- fourth metatarsal of *Australopithecus afarensis* (AL 333-160) -- recovered from Hadar, Ethiopia. Credit: Elizabeth Harmon/Arizona State University

The Hadar project is the longest running paleoanthropology field program in the Ethiopian rift valley, now spanning more than 38 years. Since 1973, the fieldwork at Hadar has produced more than 370 fossil specimens of Australopithecus afarensis between 3.4 and 3.0 million years ago – one of the largest collections of a single fossil hominin species in Africa – as well as one of the earliest known fossils of Homo and abundant Oldowan stone tools (ca. 2.3 million).

Through ASU's Institute of Human Origins, the Hadar project plays an important role in training Ethiopian scholars by offering graduate degree and postdoctoral opportunities in the U.S. Promotion of local awareness of the global scientific importance and Ethiopian cultural heritage value of the Hadar site is also a project priority. Additionally, the fundraising phase of a planned "Hadar Interpretive Center" at Eloaha town, 30 kilometers from the site, was successfully completed in January 2011.

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Provided by Arizona State University

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