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Scientists discover oldest evidence of human stone tool use and meat-eating

New finds from Dikika, Ethiopia, push back the first stone tool use and meat-consumption by almost one million years and provide the first evidence that these behaviours can be attributed to Lucy's species - Australopithecus afarensis.

An international team of researchers, including Dr. Zeresenay Alemseged of the California Academy of Sciences in San Francisco (USA) and Dr. Shannon McPherron of the Max Planck Institute for Evolutionary Anthropology in Leipzig (Germany), has discovered evidence that human ancestors were using stone tools and consuming the meat and marrow of large mammals 1 million years earlier than previously documented. While working in the Afar region of Ethiopia, the Dikika Research Project (DRP) found bones bearing unambiguous evidence of stone tool use - cut marks made while carving meat off the bone and percussion marks created while breaking the bones open to extract marrow. The bones date to roughly 3.4 million years ago and provide the first evidence that Lucy's species, Australopithecus afarensis, used stone tools and consumed meat. The research is reported in the August 12th issue of the journal Nature.

Max Planck Society
for the Advancement of Science
Press and Public Relations Department

Hofgartenstrasse 8
D-80539 Munich
Germany

PO Box 10 10 62
D-80084 Munich

Phone: +49-89-2108-1276
Fax: +49-89-2108-1207
presse@gv.mpg.de
Internet: www.mpg.de

Head of scientific communications:
Dr. Christina Beck (-1275)

Press Officer / Head of corporate communications:
Dr. Felicitas von Aretin (-1227)

Executive Editor:
Barbara Abrell (-1416)

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On both the bones found in Dikika, Ethiopia, unambiguous evidence of stone tool use in the form of cut marks and percussion marks were found.

Image: Dikika Research Project

"This discovery dramatically shifts the known timeframe of a game-changing behaviour for our ancestors," says paleoanthropologist Alemseged. "Tool use fundamentally altered the way our earliest ancestors interacted with nature, allowing them to eat new types of food and exploit new territories. It also led to tool making - the precursor to such advanced technologies as aeroplanes, MRI machines, and iPhones."

Until now, the oldest known evidence of butchering animals with stone tools came from Bouri, Ethiopia, where several cut-marked bones date to about 2.5 million years ago. The oldest known stone tools, dated to between 2.6 and 2.5 million years ago, were found at nearby Gona, Ethiopia. Although no hominin fossils were found in direct association with the Gona tools or the Bouri cut-marked bones, at nearby Hadar an upper jaw from an early *Homo* species was found in deposits dated to about 2.4 million years ago and most paleoanthropologists believe the tools were made and used only by early members of the genus *Homo*.

The new stone tool-marked fossil animal bones from Dikika have been dated to approximately 3.4 million years ago. They were found a few hundred meters away from where Alemseged's team previously discovered "Selam" ("Lucy's baby"), a young *Australopithecus afarensis* girl who lived about 3.3 million years ago. The location and age of the stone tool-marked bones clearly indicate that members of the *A. afarensis* species made the cut marks. "The only hominin species we have in this part of Africa at this time period is *A. afarensis*, and so we think this species inflicted these cut marks on the bones we discovered," notes Alemseged.

The Dikika bones were found in the Andedo drainage, a natural gully system.

Image: Dikika Research Project

"Now, when we imagine Lucy walking around the east African landscape looking for food, we can for the first time imagine her with a stone tool in hand and looking for meat," says Dr. Shannon McPherron, archaeologist with the DRP and research scientist at the Max Planck Institute for Evolutionary Anthropology in Leipzig. "With stone tools in hand to quickly pull off flesh and break open bones; animal carcasses would have become a more attractive source for food. This type of behaviour sent us down a path that later would lead to two of the defining features of our species - carnivory and tool manufacture and use."

"We can very securely say that the cut-marked bones date to between 3.42 and 3.24 million years ago, and that within this range, the date of the bones is most likely 3.4 million years ago," says project geologist Dr. Jonathan Wynn from the University of South Florida.

To determine the age of the bones, Wynn relied on a now very well documented and dated set of tuffs (volcanic deposits). These same tuffs were previously used to determine Selam's age and are well known from nearby Hadar, where Lucy was found. The new find site is located in a drainage that contains only deposits older than a tuff securely dated to 3.24 million years ago. Below the find site is another tuff dated to 3.42 million years ago. This makes the age of the bones between 3.42 and 3.24 million years ago, but because the cut-marked bones are much closer to the lower tuff and below several other horizons, whose date can be estimated, the bones' estimated age can be further refined to 3.4 million years ago.

Both of the marked bones came from large mammals. One fossil is a rib fragment, the other a femur shaft fragment. Both are marred by cut, scrape, and percussion marks. Microscope and elemental analysis using secondary electron imaging and energy dispersive x-ray spectrometry demonstrated that these marks were created before the bones fossilized meaning that we can eliminate recent damage as the cause of these marks. Dr. Hamdallah Bearat from the Ira A. Fulton Schools of Engineering at Arizona State University determined that one cut mark even contained a tiny, embedded piece of rock that was likely left behind during the butchering process.

"Most of the marks have features that indicate without doubt that they were inflicted by stone tools," explains Dr. Curtis Marean from the Institute of Human Origins at Arizona State University, who performed the mark identifications. "And the range of actions includes cutting and scraping for the removal of flesh, and percussion on the femur for breaking it to access marrow."

"The bones come from 2 animals, one (a femur) the size of a goat and the other (a rib) at least the size of a cow," notes Marean. "Our closest living relatives, the chimps and bonobos, don't hunt or scavenge animals this size, so this suggests that the Dikika australopithecines had already begun to engage in hunting or scavenging larger mammals. This places them in competitive and risky contexts."

While it is clear that the australopithecines at Dikika were using sharp-edged stones to carve meat from bones, it is impossible to tell from the marks alone whether they were making their tools or simply finding and using naturally sharp rocks. So far, the research team has not found evidence of stone tool manufacture at Dikika from this early time period. This could indicate that the Dikika residents were simply opportunistic about finding and using naturally occurring sharp-edged stones. However, the sedimentary environment at the site suggests another potential explanation.

"For the most part, the only stones we see coming from these ancient sediments at Dikika are pebbles too small for making tools," says McPherron. "The hominins at this site probably carried their stone tools with them from better raw material sources elsewhere. One of our goals is to go back and see if we can find these locations and evidence that at this early date they were actually making, not just using, stone tools."

"Tool use in *A. afarensis* demonstrated by our discovery adds uniquely to the accumulating evidence that the Selam and Lucy species was ancestral to tool-making species including our genus *Homo*," says Alemseged.

While many questions remain about the history of tool use and tool making and about the timing and motivation of dietary changes among human ancestors, this discovery adds a rich new chapter to the story - a story that is deeply relevant to what makes us unique as a species.

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Ethiopian paleoanthropologist Zeresenay Alemseged, currently chair of the Anthropology Department at the California Academy of Sciences, started the Dikika Research Project in 1999 and has annually conducted field seasons there with an international team of researchers specializing in paleoanthropology, palaeontology, geology, and archaeology.

This group's goal is to unravel critical questions in human evolution pertaining to hominin biological and behavioural transformations across time and space that ultimately resulted in what humans are today and in

how these transformations may be related to palaeo-environmental and palaeo-ecological dynamics. In 2006 the team published in *Nature* the oldest and most complete juvenile skeleton of *A. afarensis*, dubbed "Selam" and also know as Lucy's child.

The Dikika Research Project is conducted under the auspices of the ARCCH/Ministry of Culture and Tourism. Financial support for field and laboratory work is provided by the California Academy of Sciences.

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Original work:

Shannon P. McPherron, Zeresenay Alemseged, Curtis W. Marean, Jonathan G. Wynn, Denné Reed, Denis Geraads, René Bobe & Hamdallah A. Béarat
Evidence for stone-tool-assisted consumption of animal tissues before 3.39 million years ago at Dikika, Ethiopia
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Contact:

Sandra Jacob, Press and Public Relations
Max Planck Institute for Evolutionary Anthropology, Leipzig
Tel.: +49 (341) 3550 - 122
Fax: +49 (341) 3550 - 119
E-mail: jacob@eva.mpg.de

Shannon McPherron, Department of Human Evolution
Max Planck Institute for Evolutionary Anthropology, Leipzig
Tel.: +49 341 3550 363
Fax: +49 341 3550 399
E-mail: mcpherron@eva.mpg.de

Zeresenay Alemseged, Director of Anthropology
California Academy of Sciences, San Francisco, USA
Tel.: +251 911 862386 or +251 911 448183 (Addis Ababa)
Fax: +1 415 379 5760
E-mail: zeray@calacademy.org