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Cutting through ancient evidence of human tool use

April 6 2012, By Chris Gorski

Nile crocodile manipulating a carcass of a cow prior to ingestion at a crocodile farm in Bagamoyo, Tanzania. Sharp, pointed teeth can inflict deep grooves with V-shaped cross sections that mimic cut marks. Credit: Courtesy of J.K. Njau

The earliest evidence of human tool use may be written on the bones of other animals, but in order to produce reliable conclusions, researchers are calling for improved tools and analysis, including an easy-to-access large collection of sample specimens and more unified standards.

Archaeologists and anthropologists look beyond the fossils of ancient human relatives to interpret the presence of our ancestors, including the items associated with day-to-day life, from discarded tools to the ashes from fire pits. The marks made by crude stone cutting tools on the bones of animals that early humans ate are another piece of evidence.

These markings have tremendous impact on the understanding of human evolution.

"Most of our interpretations of what early humans were doing depend on correctly identifying what they were doing on bones," said Manuel Dominguez-Rodrigo, an anthropologist and archaeologist at the Complutense University of Madrid, in Spain. "Detecting exactly how these marks were made on the bones is what makes us grant support to one model of human evolution or a different model of human evolution ."

These types of bone marks are difficult to interpret. Cutting tools leave marks on bones, but so can other factors, including other predators' teeth and weathering. This has led to notable disagreements about individual bone markings; one finding would, if verified, push back the date of the earliest known human tool use by almost a million years.

In 2010, a research group claimed that 3.4 million-year-old fossil bones found in Ethiopia showed evidence of cutting-tool use. Dominguez-Rodrigo and colleagues published months later claiming that trampling of the bones caused the marks.

The Olduvai Gorge site, also located in Ethiopia, is generally accepted as the location where the oldest tools -- about 2.6 million years old -- were found. However, some of the markings of bones found at that site are disputed.

Crocodile bite marks left on undigested bones. In this image, a deep groove with a V-shaped cross section is visible. Credit: Courtesy of J.K. Njau

For decades, researchers have scoured sites in Africa for both marked bones and ancient tools. They have also been experimenting on and collecting the bones of prey animals in order to better understand the effects of many factors, from the biting and tearing of a feeding crocodile to chemical processes.

"Butchery marks are as important as stone tools," said Jackson Njau, a paleoanthropologist at Indiana University in Bloomington and an associate researcher at the Stone Age Institute. "But stone tools are rocks; they don't decay."

Writing in this week's issue of Science, Njau calls for measures to help scientists make consistent, reliable determinations of the causes of marks.

Njau said that one aspect of the solution would be gathering together a large online collection of samples for making comparisons. He has made extensive efforts to document the marks left by crocodile teeth, which can create patterns similar to those made by stone tools. Because marks that look superficially similar reveal crucial differences under a microscope, researchers must compare a new mark to numerous others before making a firm determination of its origin.

If large collections now held by different researchers and museums were available in an online database of microscopic images, researchers could instantly access images of bones modified by many processes, such as the chewing action of different carnivores or cuts and slices made by researchers recreating butchery techniques with ancient-style tools.

"That would certainly be helpful," said Pat Shipman, a now-retired anthropologist who in 1981, published one of the first papers on microscopic analysis of bone markings. "How big your comparative sample is and how varied it is and how varied the conditions to which the bone was subjected all influences your ability to make a diagnosis of that mark."

Dominguez-Rodrigo said that Njau's ideas could help, but would not completely solve the issues. He emphasized that looking at published photographs cannot convey the same knowledge as looking through a microscope at many bones deformed in a wide variety of ways.

"Nothing replaces doing the experimentation," said Dominguez-Rodrigo.

"The subtleties are hard to capture and describe," said Shipman. "You do have to get that gut-level intuitive feel for it."

Njau said that comparisons are important, but also the criteria used by researchers. He emphasized the need for considering the contextual information of a bone marking in its interpretation so that additional indications of the history surrounding the fossil can be considered. He said that scientists must weigh additional factors when analyzing bones for evidence of tool use, including the presence in the same soil layer of stone artifacts, carnivore activity and other factors.

"We have these resources, it's time now to put this together to make it available," said Njau.

Source: Inside Science News Service

Citation: Cutting through ancient evidence of human tool use (2012, April 6) retrieved 10 April 2024 from https://phys.org/news/2012-04-ancient-evidence-human-tool.html