Protohuman Activity Etched in Fossil Bones

Microscopic techniques reveal persuasive evidence of stone tool use on bones almost 2 million years old

Archeological sites from the early stages of human technological history, between 1 and 2 million years ago, can be strikingly unimpressive to the unprofessional eye: an apparently random scatter of bone and stone fragments. Skepticism is not unknown among professionals too, and those who would interpret such sites as evidence of protohuman activity are frequently challenged to prove that the association between bones and stones is more than casual. Two papers in a recent *Nature* describe work that offers such proof.

The evidence consists of marks on the fossil bones that unquestionably were made by the edge of sharp stone flakes used in a deliberate slicing, chopping, or scraping action. This class of archeological evidence is known, prosaically, as cutmarks.

"Cutmarks have been known for some time in paleo-Indian remains," says Richard Potts, of Harvard University, a coauthor of one of the papers. "Until recently no one thought of looking for them in fossils as old as a million years or more." Although the most ancient stone tools yet discovered are some 2.75 million years old from Ethiopia, the best putative campsites known so far are 2 million years old or later at Olduvai Gorge in Tanzania and the Koobi Fora area east of Lake Turkana in northern Kenya. It is from these two areas that evidence for ancient cutmarks comes.

Pat Shipman, a taphonomist at Johns Hopkins University, has been interested for some time in finding ways to read the history of fossilized bones: for instance, how much have they weathered while lying on the surface, and have they been burned at any time? While she was pursuing such questions through the fossil collections from Olduvai Gorge, which are stored in Nairobi, she noticed a nest of apparent cutmarks on the distal fragment of a femur from a wildebeest type of animal. The same fossil collection turned out to contain the skull of a juvenile baboon, on the top of which were scattered putative cutmarks. Potts was working in Nairobi at the same time, and he too was intrigued with the marks. "These discoveries really started the cutmark mania," he recalls.

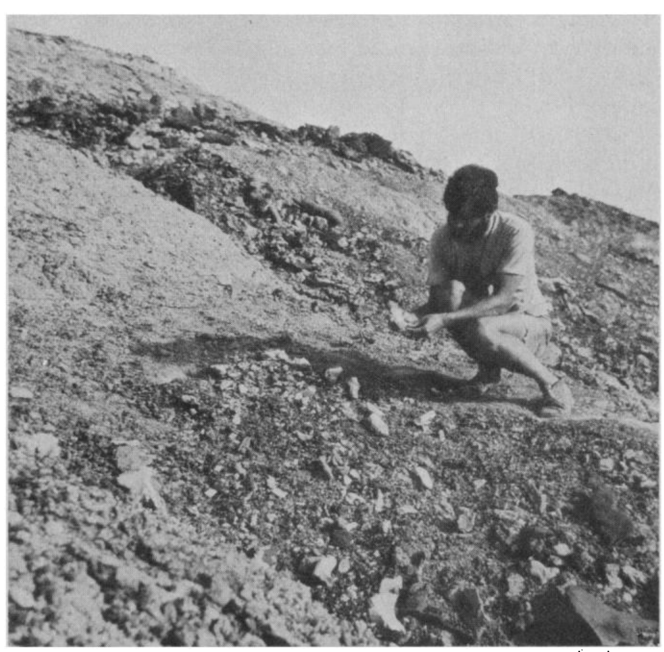
Meanwhile, Glynn Isaac, of Berkeley, was planning an archeological assault on some of the sites at Koobi Fora, specifically to try to answer the challenge of the casual versus causal association of bones and stones. One of his co-workers, Henry Bunn, assumed the task of examining the signs of damage in the fossil bones in search of clues to protohuman agency. Early in 1979, while doing some comparative studies on the fossil collections in Nairobi, Bunn came across a pygmy hippo femur that had many apparent cutmarks over its surface, particularly around the head, where it had articulated with the pelvis. "I quickly searched through the records to find out where the bone had been collected," he says, "and then a group of us went back to the site later that summer to look for more bones."

The site, which had been formed some 1.6 million years ago in lake margin sediments, turned out to contain more than 200 fossil fragments, ten of which bore the telltale cutmarks. Interestingly, no stone flakes were found at this site. "The nearest good source of cobbles for making tools was at least 10 or 15 kilometers distant," says Bunn, "so perhaps the hominids who were here were careful to curate their tools."

The principal interest of the archeological assault, however, was a location known as site 50, a supposed campsite on which fragments of bones and stones were buried in flood sediments in the crook of a winding river 1.5 million years ago. At this carefully excavated site, Bunn has found a number of bones bearing what appear to be cutmarks. One of the bones, the humerus of a large extinct antelope, also has distinctive signs of percussion, as if the dwellers at site 50 had smashed the bone with a heavy stone, thus giving access to the marrow. Bunn has been able to produce strikingly similar breakage patterns on modern bones.

By this time Potts and Shipman had pushed on with a project that they hoped would put the cutmarks they had seen on a secure analytical footing. "Bones can suffer all kinds of modification in the process of fossilization and excavation," says Potts. "Root etching, sandblasting, carnivore gnawing, and accidental contact with an excavation tool can all produce grooves that look like cutmarks." They decided that they would exploit a scanning electron microscopic technique developed by Alan Walker, also at Johns Hopkins University. And for comparison with the fossils, they indulged in some stone knapping to produce stone flakes with which to make slicing, chopping, and scraping marks on modern bones.

Walker's technique involves making a high precision rubber impression of the



The search

Henry Bunn examines specimens at a 1.6-million-year-old lake margin site which contained cutmarked bones but no stone tools.

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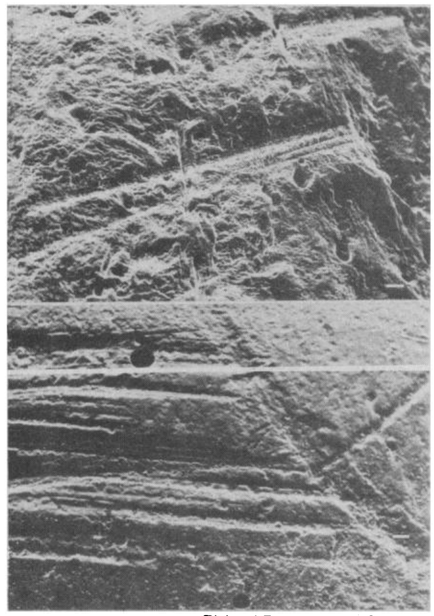
bone surface, which is then used to produce an epoxy replica. Coated with a 200-angstrom layer of gold palladium, the replica then becomes the object of study in the electron microscope, usually with magnifications in the range of 30 to 50 times. The resolution obtained with the technique is close to 0.25 micrometer.

In their *Nature* paper (18 June, p. 577), Potts and Shipman report on 75 fossil fragments with possible cutmarks that were excavated from a range of levels, spanning the period 1 to 2 million years ago, at Olduvai Gorge. They report that of the material they studied, "24 percent . . . possessed marks more similar to those produced on modern bones by slicing, chopping, or scraping than to those produced by any other cause yet investigated." Of the grooves that were not made by protohuman tools, most were inflicted by carnivore or rodent teeth.

The diagnostic features of cutmarks are several and depend on how the stone flake was applied to the bone. A slicing action, for instance, produces a V-shaped groove, the bottom of which is scored by a series of parallel lines. "These striations are produced because the edges of these artifacts are not perfectly straight, but rather include many small deviations to one side or the other," write Potts and Shipman. When a sharp stone implement is used in a chopping action it inflicts a short groove, V-shaped in cross section, but characterized by "small fragments of bone crushed inwards at the bottom of the main groove." Chopping marks do not show the parallel striations seen in slice marks. A scraping action with a stone flake leaves "multiple, fine, parallel striations across a broad area of bone rather than confined to a single, elongated main groove."

So far Potts and Shipman have discovered no processes "that mimic slicing, chopping, or scraping marks at the microscopic level." Marks left by carnivore teeth are generally broader than cutmarks, and the base of the groove is rounded and relatively smooth. Very fine tooth scratches appear on first inspection to be similar to the product of stone tool use and these "usually require magnification of at least ×20 before they are distinguishable from cutmarks." In all their work Potts and Shipman insist that electron microscopy is essential for differentiating between cutmarks and carnivore gnawing marks. Bunn begs to differ.

"Slow, thorough systematic examination of bone surfaces under a bright light



Richard Potts and Pat Shipman

Cutmarks under the microscope

(Top) Slice marks on a fossilized foot bone of an extinct giraffe. (Bottom) A fossil long bone bearing horizontal slice marks overlaid by a carnivore tooth mark running from middle top to bottom right. Bar represents 100 micrometers.

with the naked eye provides an adequate means for distinguishing fine, V-shaped linear grooves of approximately one-third millimeter width from relatively shallow, rounded or U-shaped linear grooves that are several times wider," says Bunn. "Macroscopic examination, not microscopic work, is the first step." Bunn readily agrees that microscopic examination is useful, either with a scanning electron microscope or a light microscope. "This will reveal features that are not visible with the naked eye. It is useful for helping to understand the dynamics of various processes that modify bone surfaces."

Bunn has spent a considerable amount of time studying the bone assemblages from Olduvai and Koobi Fora, and he has also worked briefly in a !Kung San (Bushman) village in Botswana, where he examined the process of bone damage in a modern day technologically primitive context. In his *Nature* paper (vol. 291, p. 574), Bunn reports agreement with Potts and Shipman on the type of modification that stone tool use produces on bones, but he differs in describing the frequency with which cutmarks can be found. From one site—the famous location where Mary Leakey found *Zinjanthropus* at Olduvai Gorge—Bunn claims to have recorded more than 300 fossils bearing cutmarks. Potts is more cautious and reports seeing only several dozen. Potts and Shipman put the frequency of bones bearing cutmarks in one assemblage at 2.9 percent. Bunn has figures from other collections closer to 10 percent.

Differences aside, the Berkeley and Johns Hopkins researchers agree that the recognition of cutmarks has important implications for the interpretations of ancient bone and stone assemblages thought to be camp or butchery sites. "This direct evidence of early hominid diet enables us to dismiss models of human evolution which do not incorporate meat-eating as a significant component of early hominid behavior," says Bunn. Potts and Shipman, in more restrained comment, write, "Evidence presented here supports [Mary] Leakey's conclusion that there is a direct causal association between the stone artifacts and fossilized bones [at Olduvai Gorge]."

Two intriguing aspects of interpretation emerge from Potts and Shipman's work. The first concerns possible competition between early hominids and carnivores. The second relates to the uses to which the protohumans put animal products.

A small number of the slicing marks on the fossils examined by Potts and Shipman were overlaid by tooth marks, and some bones that had been gnawed by carnivores were later worked on by hominids. Clearly, the hominids sometimes had first access to a carcass, and sometimes they followed carnivores. This is good evidence that at least some of the hominids' meat-eating was the result of scavenging in competition with carnivores rather than direct hunting.

There is apparently some indication that skin and ligaments from animals were important products for our ancestors, in addition to the meat they secured. Many of the cutmarks that Potts, Shipman, and Bunn see are readily consistent with systematic attempts to dismember a carcass and remove large muscles. But other marks pose a problem for such an interpretation. There are, for instance, extensive cutmarks on the lower parts of some fossil horse limbs that would have had virtually no meat, only tendons and skin. Tendons, notes Shipman, would be useful for tying bundles.

It has frequently been stated that one of the earliest technological inventions made by our ancestors must have been some form of carrier bag in which to transport collected plant foods, though evidence for such receptacles is virtually nonexistent. It is intriguing to speculate that some of these cutmarks do in fact constitute such evidence, indirect though it is.—ROGER LEWIN