

Archaeologists Rediscover Cannibals

At digs around the world, researchers have unearthed strong new evidence that people ate their own kind from the early days of human evolution through recent prehistory

When Arizona State University bioarchaeologist Christy G. Turner II first looked at the jumbled heap of bones from 30 humans in Arizona in 1967, he was convinced that he was looking at the remains of a feast. The bones of these ancient American Indians had cut marks and burns, just like animal bones that had been roasted and stripped of their flesh. "It just struck me that here was a pile of food refuse," says Turner, who proposed in *American Antiquity* in 1970 that these people from Polacca Wash, Arizona, had been the victims of cannibalism.

But his paper was met with "total disbelief," says Turner. "In the 1960s, the new paradigm about Indians was that they were all peaceful and happy. So, to find something like this was the antithesis of the new way we were supposed to be thinking about Indians"—particularly the Anasazi, thought to be the ancestors of living Pueblo Indians. Not only did Turner's proposal fly in the face of conventional wisdom about the Anasazi culture, but it was also at odds with an emerging consensus that earlier claims of cannibalism in the fossil record rested on shaky evidence. Where earlier generations of archaeologists had seen the remains of cannibalistic feasts, current researchers saw bones scarred by ancient burial practices, war, weathering, or scavenging animals.

To Turner, however, the bones from Polacca Wash told a more disturbing tale, and so he set about studying every prehistoric skeleton he could find in the Southwest and Mexico to see if it was an isolated event. Now, 30 years and 15,000 skeletons later, Turner is putting the final touches on a 1500-page book to be published next year by the University of Utah press in which he says, "Cannibalism was practiced intensively for almost four centuries" in the Four Corners region. The evidence is so strong that Turner says "I would bet a year of my salary on it."

He isn't the only one now betting on cannibalism in prehistory. In the past decade, Turner and other bioarchaeologists have put together a set of clear-cut criteria for distinguishing the marks of cannibalism from other kinds of scars. "The analytical rigor has

increased across the board," says paleo-anthropologist Tim D. White of the University of California, Berkeley. Armed with the new criteria, archaeologists are finding what they say are strong signs of cannibalism throughout the fossil record. This summer, archaeologists are excavating several sites in Europe where the practice may have occurred among our ancestors, perhaps as early as 800,000 years ago. More recently, our brawny cousins, the Neandertals, may have eaten each other. And this behavior wasn't limited to the distant past—strong new evidence suggests that in addition to the Anasazi, the Az-

thin the ranks of neighboring populations.

Not surprisingly, some find these claims hard to stomach: "These people haven't explored all the alternatives," says archaeologist Paul Bahn, author of the *Cambridge Encyclopedia* entry on cannibalism. "There's no question, for example, that all kinds of weird stuff is done to human remains in mortuary practice"—and in warfare. But even the most prominent skeptic of earlier claims of cannibalism, cultural anthropologist William Arens of the State University of New York, Stony Brook, now admits the case is stronger: "I think the procedures are sounder, and there is more evidence for cannibalism than before."

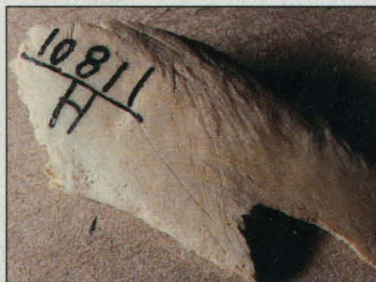
White learned how weak most earlier scholarship on cannibalism was in 1981, when he first came across what he thought might be a relic of the practice—a massive skull of an early human ancestor from a site called Bodo in Ethiopia.

When he got his first look at this 600,000-year-old skull on a museum table, White noticed that it had a series of fine, deep cut marks on its cheekbone and inside its eye socket, as if it had been defleshed. To confirm his suspicions, White wanted to compare the marks with a "type collection" for cannibalism—a carefully studied assemblage of bones showing how the signature of cannibalism differs from damage by animal gnawing, trampling, or excavation.

"We were naïve at the time," says White, who was working with archaeologist Nicholas Toth of Indiana University in Bloomington. They learned that although the anthropological literature was full of fantastic tales of

cannibalistic feasts among early humans at Zhoukoudian in China, Krapina cave in Croatia, and elsewhere, the evidence was weak—or lost.

Indeed, the weakness of the evidence had already opened the way to a backlash, which was led by Arens. He had deconstructed the fossil and historical record for cannibalism in a book called *The Man-Eating Myth: Anthropology and Anthropophagy* (Oxford, 1979). Except for extremely rare cases of starvation or insanity, Arens said, none of the accounts of cannibalism stood up to scrutiny—not



PHOTOS BY C. TURNER/BERKELEY



Cannibals' house? The Peñasco Blanco great house at Chaco Canyon, New Mexico, where some bones bear cut marks (upper left); others were smashed, perhaps to extract marrow.

tecs of Mexico and the people of Fiji also ate their own kind in the past 2500 years.

These claims imply a disturbing new view of human history, say Turner and others. Although cannibalism is still relatively rare in the fossil record, it is frequent enough to imply that extreme hunger was not the only driving force. Instead of being an aberration, practiced only by a few prehistoric Donner Parties, killing people for food may have been standard human behavior—a means of social control, Turner suspects, or a mob response to stress, or a form of infanticide to

even claims that it took place among living tribes in Papua New Guinea (including the Fore, where cannibalism is thought to explain the spread of the degenerative brain disease kuru). There were no reliable eye witnesses for claims of cannibalism, and the archaeological evidence was circumstantial. "I didn't deny the existence of cannibalism," he now says, "but I found that there was no good evidence for it. It was bad science."

Physical anthropologists contributed to the backlash when they raised doubts about what little archaeological evidence there was (*Science*, 20 June 1986, p. 1497). Mary Russell, then at Case Western Reserve University in Cleveland, argued, for example, that cut marks on the bones of 20 Neandertals at Krapina Cave could have been left by Neandertal morticians who were cleaning the bones for secondary burial, and the bones could have been smashed when the roof caved in, for example. In his 1992 review in the *Cambridge Encyclopedia*, Bahn concluded that cannibalism's "very existence in prehistory is hard to swallow."

Rising from the ashes

But even as some anthropologists gave the ax to Krapina and other notorious cases, a new, more rigorous case for cannibalism in prehistory was emerging, starting in the American Southwest. Turner and his late wife, Jacqueline Turner, had been systematically studying tray after tray of prehistoric bones in museums and private collections in the United States and Mexico. They had identified a pattern of bone processing in several hundred specimens that showed little respect for the dead. "There's no known mortuary practice in the Southwest where the body is dismembered, the head is roasted and dumped into a pit unceremoniously, and other pieces get left all over the floor," says Turner, describing part of the pattern.

White, meanwhile, was identifying other telltale signs. To fill the gap he discovered when he looked for specimens to compare with the Bodo skull, he decided to study in depth one of the bone assemblages the Turners and others had cited. He chose Mancos, a small Anasazi pueblo on the Colorado Plateau from A.D. 1150, where archaeologists had recovered the scattered and broken remains of at least 29 individuals. The project evolved into a landmark book, *Prehistoric Cannibalism at Mancos* (Princeton, 1992). While White still doesn't know why the Bodo skull was defleshed—"it's a black box,"

he says—he extended the blueprint for identifying cannibalism.

In his book, White describes how he painstakingly sifted through 2106 bone fragments, often using an electron microscope to identify cut marks, burn traces, percussion and anvil damage, disarticulations, and breakages. He reviewed how to distinguish marks left by butchering from those left by animal gnawing, trampling, or other wear and tear. He also



Unkind cuts. A Neandertal bone from Vindija Cave, Croatia.

proposed a new category of bone damage, which he called "pot polish"—shiny abrasions on bone tips that come from being stirred in pots (an idea he tested by stirring deer bones in a replica of an Anasazi pot). And he outlined how to compare the remains of suspected victims with those of ordinary game animals at other sites to see if they were processed the same way.

When he applied these criteria to the Man-cos remains, he concluded that they were the leavings of a feast in which 17 adults and 12 children had their heads cut off, roasted, and broken open on rock anvils. Their long bones were broken—he believes for marrow—and their vertebral bodies were missing, perhaps crushed and boiled for oil. Finally, their bones were dumped, like animal bones.

In their forthcoming book, the Turners describe a remarkably similar pattern of bone processing in 300 individuals from 40 different bone assemblages in the Four Corners area of the Southwest, dating from A.D. 900 to A.D. 1700. The strongest case, he says, comes from bones unearthed at the Peñasco Blanco great house at Chaco Canyon in New Mexico, which was the highest center of the Anasazi culture and, he argues, the home of cannibals who terrorized victims within 100 miles of Chaco Canyon, where most of the traumatized bones have been excavated. "Whatever drove the Anasazi to eat people, it happened at Chaco," says Turner.

The case for cannibalism among the Anasazi that Turner and White have put together hasn't swayed all the critics. "These folks have a nice package, but I don't think it proves cannibalism," says Museum of New Mexico archaeologist Peter Bullock. "It's still just a theory."

But even critics like Bullock acknowledge that Turner and White's studies, along with work by the University of Colorado, Boulder's, Paolo Villa and colleagues at another recent site, Fontbrégoua Cave in southeastern France (*Science*, 25 July 1986, p. 431), have raised the standards for how to investi-

gate a case of cannibalism. In fact, White's book has become the unofficial guidebook for the field, says physical anthropologist Carmen Pijoan at the Museum of Anthropology in Mexico City, who has done a systematic review of sites in Mexico where human bones were defleshed. In a forthcoming book chapter, she singles out three sites where she applied diagnostic criteria outlined by Turner, White, and Villa to bones from Aztec and other early cultures and concludes that all "three sites, spread over 2000 years of Mexican prehistory, show a pattern of violence, cannibalism, and sacrifice through time."

White's book "is my bible," agrees paleoanthropologist Yolanda Fernandez-Jalvo of the Museum of Natural History in Madrid, who is analyzing bones that may be the oldest example of cannibalism in the fossil record—the remains of at least six individuals who died 800,000 years ago in an ancient cave at Atapuerca in northern Spain.

Age-old practices

The Spanish fossils have caused considerable excitement because they may represent a new species of human ancestor (*Science*, 30 May, pp. 1331 and 1392). But they also show a pattern familiar from the more recent sites: The bones are highly fragmented and are scored with cut marks, which Fernandez-Jalvo thinks were made when the bodies were decapitated and the bones defleshed. A large femur was also smashed open, perhaps for marrow, says Fernandez-Jalvo, and the whole assemblage had been dumped, like garbage. The treatment was no different from that accorded animal bones at the site. The pattern, says Peter Andrews, a paleoanthropologist at The Natural History Museum, London, is "pretty strong evidence for cannibalism, as opposed to ritual defleshing." He and others note, however, that the small number of individuals at the site and the absence of other sites of similar antiquity to which the bones could be compared leave room for doubt.

A stronger case is emerging at Neandertal sites in Europe, 45,000 to more than 130,000 years old. The new criteria for recognizing cannibalism have not completely vindicated the earlier claims about Krapina Cave, partly because few animal bones are left from the excavation of the site in 1899 to compare with the Neandertal remains. But nearby Vindija Cave, excavated in the 1970s, did yield both animal and human remains. When White and Toth examined the bones recently, they found that both sets showed cut marks, breakage, and disarticulation, and had been dumped on the cave floor. It's the same pattern seen at Krapina, and remarkably similar to that at Mancos, says White, who will publish his conclusions in a forthcoming book with Toth. Marseilles prehisto-

rian Alban DeFleur is finding that Neandertals may also have feasted on their kind in the Moula-Guercy Cave in the Ardeche region of France, where animal and Neandertal bones show similar processing. Taken together, says White, "the evidence from Krapina, Vindija, and Moula is strong."

Not everyone is convinced, however. "White does terrific analysis, but he hasn't proved this is cannibalism," says Bahn. "Frankly, I don't see how he can unless you find a piece of human gut [with human bone or tissue in it]." No matter how close the resemblance to butchered animals, he says, the cut marks and other bone processing could still be the result of mortuary practices. Bullock adds that warfare, not cannibalism, could explain the damage to the bones.

White, however, says such criticism resembles President Clinton's famous claim about marijuana: "Some [although not all] of the Anasazi and Neandertals processed their colleagues. They skinned them, roasted them,



Close shave. Was flesh stripped from the 600,000-year-old Bodo skull in an act of cannibalism?

cut their muscles off, severed their joints, broke their long bones on anvils with hammerstones, crushed their spongy bones, and put the pieces into pots." Borrowing a line from a review of his book, White says: "To say they didn't eat them is the archaeological equivalent of saying Clinton lit up and didn't inhale."

White's graduate student David DeGusta adds that he has compared human bones at burial sites in Fiji and at a nearby trash mid-

den from the last 2000 years. The intentionally buried bones were less fragmentary and had no bite marks, burns, percussion pits, or other signs of food processing. The human bones in the trash midden, however, were processed like those of pigs. "This site really challenges the claim that these assemblages of bones are the result of mortuary ritual," says DeGusta.

After 30 years of research, Turner says it is a modern bias to insist that cannibalism isn't part of human nature. Many other species eat their own, and our ancestors may have had their own "good" reasons—whether to terrorize subject peoples, limit their neighbors' offspring, or for religious or medicinal purposes. "Today, the only people who eat other people outside of starving are the crazies," says Turner. "We're dealing with a world view that says this is bad and always has been bad. ... But in the past, that view wasn't necessarily the group view. Cannibalism could have been an adaptive strategy. It has to be entertained."

—Ann Gibbons

BIOPHYSICS

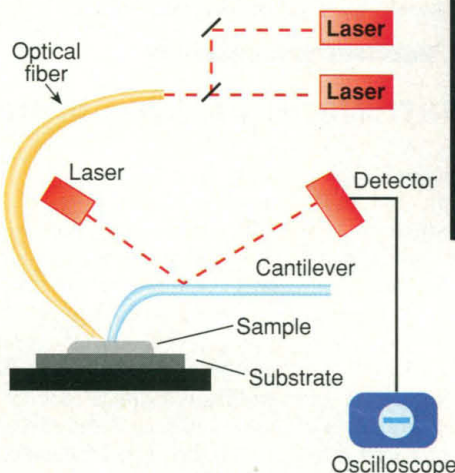
Feeling a Protein's Motion

There's a new way to watch proteins shimmy and dance as they carry out their biological tasks. Researchers traditionally follow these shape changes spectroscopically, deducing them from changes in the molecules' ability to absorb particular wavelengths of light. But in the 22 July *Proceedings of the National Academy of Sciences*, a group in Israel reports taking a more direct approach: planting the tip of an ultrafine glass fiber on top of the protein and actually feeling it move.

The technique gives researchers studying the rates and extent of conformational changes in proteins a new tool, sensitive to motions that spectroscopy cannot detect, says Mordechai Sheves of the Weizmann Institute for Science in Rehovot, Israel, a member of the group. Other researchers are intrigued, but say they want confirming evidence from other groups that the method really detects only protein motion.

The researchers—Aaron Lewis, Michael Ottolenghi, Sheves, and their colleagues at Hebrew University in Jerusalem and the Weizmann Institute—zeroed in on bacteriorhodopsin (bR), a protein found in the membranes of certain bacteria, where it responds to light by changing shape and pumping protons across the membrane. In order to "feel" these motions, the group used a variant of atomic force microscopy, a technique in which an ultrafine probe is scanned across a surface, sensing its atom-scale bumps and depressions to make an image.

For their experiment, however, Lewis and his colleagues kept the ultrafine probe in one place, poised atop a thin film of bR-filled membranes. In response to pulses of laser light, the proteins changed shape and then relaxed again in a matter of milliseconds. At the same time, another laser sensed a minuscule displacement of the probe tip. To show that the motion wasn't caused by



Fine touch. Monitored by a laser, a probe senses shape changes in a film of the protein bacteriorhodopsin (right) when struck by pulses from other lasers.

laser-induced heating, the group used a well-documented property of bR—that another, appropriately delayed laser pulse of the right wavelength can reverse the photoreaction, stopping the protein midcycle and sending it

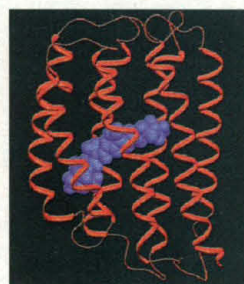
back to its initial state. The second pulse sent the tip back toward the sample, as expected; heating would have displaced the probe further outward.

Because the group's apparatus was equipped with an unusually stiff probe that is able to respond at high frequencies, they could track the protein motions on time scales of microseconds—unprecedented resolution for atomic

force microscopy. The time course of the probe motion doesn't quite match the data obtained spectroscopically, but some of their time constants are in rough agreement. According to Sheves, the group also detected stages of the protein's shape change that researchers have never reported before. These "spectroscopically silent" motions, says Sheves, point to a new model for the initial responses of the protein to light.

Sheves expects the technique to deliver similar insights into the contortions of other molecules. "It gives you a new direct probe to look at conformational changes in proteins," says Sheves. Robert Glaeser of the University of California, Berkeley, is intrigued by the new model for bR's reaction to light, which he calls "unprecedented," but he thinks the work still needs some "reality checks." For one thing, while the researchers know the tip moved, they didn't convert the laser signal into an actual distance.

—David Ehrenstein



M. SHEVES/WEIZMANN INSTITUTE