Scavenger Hunt

As paleoanthropologists close in on their quarry, it may turn out to be a different beast from what they imaged.

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In both textbooks and films, ancestral humans (hominids) have been portrayed as hunters. Small-brained, big-browed, upright, and usually mildly furry, early hominid males gaze with keen eyes across the gold savanna, searching for prey. Skillfully wielding a few crude stone tools, they kill and dismember everything from small gazelles to elephants, while females care for young and gather roots, tubers, and berries. The food is shared by group members at temporary camps. This familiar image of Man the Hunter has been bolstered by the finding of stone tools in association with fossil animal bones. But the role of hunting in early hominid life cannot be determined in the absence of more direct evidence.

I discovered one means of testing the hunting hypothesis almost by accident. In 1978, I began documenting the microscopic damage produced on bones by different events. I hoped to develop a diagnostic key for identifying the post-mortem history of specific fossil bones, useful for understanding how fossil assemblages were formed. Using a scanning electron microscope (SEM) because of its excellent resolution and superb depth of field, I inspected high-fidelity replicas of modern bones that had been subjected to known events or conditions. (I had to use replicas, rather than real bones, because specimens must fit into the SEM's small vacuum chamber.) I soon established that such common events as weathering, root etching, sedimentary abrasion, and carnivore chewing produced microscopically distinctive features.

In 1980, my SEM study took an unexpected turn. Richard Potts (now of Yale University), Henry Bunn (now of the University of Wisconsin at Madison), and I almost simultaneously found what appeared to be stone-tool cut marks on fossils from Olduvai Gorge, Tanzania, and Koobi Fora, Kenya. We were working almost side by side at the National Museums of Kenya, in Nairobi, where the fossils are stored. The possibility of cut marks was exciting, since both sites preserve some of the oldest known archaeological materials. Potts and I returned to the United States, manufactured some stone tools, and started "butchering" bones and joints begged from our local butchers. Under the SEM, replicas of these cut marks looked very different from replicas of carnivore tooth scratches, regardless of the species of carnivore or the type of tool involved. By comparing the marks on the fossils with our hundreds of modern bones of known history, we were able to demonstrate convincingly that hominids using stone tools had processed carcasses of many different animals nearly two million years ago. For the first time, there was a firm link between stone tools and at least some of the early fossil animal bones.

This initial discovery persuaded some paleoanthropologists that the hominid hunter scenario was correct. Potts and I were not so sure. Our study had shown that many of the cut-marked fossils also bore carnivore tooth marks and that some of the cut marks were in places we hadn't expected—on bones that bore little meat in life. More work was needed.

In addition to more data about the Olduvai cut marks and tooth marks, I needed specific information about the patterns of cut marks left by known hunters performing typical activities associated with hunting. If similar patterns occurred on the fossils, then the early hominids probably behaved similarly to more modern hunters; if the patterns were different, then the behavior was probably also different. Three activities related to hunting occur often enough in peoples around the world and leave consistent enough traces to be used for such a test.

First, human hunters systematically disarticulate their kills, unless the animals are small enough to be eaten on the spot. Disarticulation leaves cut marks in a predictable pattern on the skeleton. Such marks cluster near the major joints of the limbs: shoulder, elbow, carpal joint (wrist), hip, knee, and hock (ankle). Taking a carcass apart at the joints is much easier than breaking or cutting through bones. Disarticulation enables hunters to carry food back to a central place or camp, so that they can share it with others or cook it or even store it by placing portions in trees, away from the reach of carnivores. If early hominids were hunters who transported and shared their kills, disarticulation marks would occur near joints in frequencies comparable to those produced by modern human hunters.

Second, human hunters often butcher carcasses, in the sense of removing meat from the bones. Butchery marks are usually found on the shafts of bones from the upper part of the front or hind limb, since this is where the big muscle masses lie. Butchery may be carried out at the kill site—especially if the animal is very large and its bones very heavy—or it may take place at the base camp, during the process of sharing food with others. Compared with disarticulation, butchery leaves relatively few marks. It is hard for a hunter to locate an animal's joints without leaving cut marks on the bone. In contrast, it is easier to cut the meat away from the midshaft of the bone without making such marks. If early hominids shared their food, however, there ought to be a number of cut marks located on the midshaft of some fossil bones.

Finally, human hunters often remove skin or tendons from carcasses, to be used for clothing, bags, thongs, and so on. Hide or tendon must be separated from the bones in many areas where there is little flesh, such as the lower limb bones of pigs, giraffes, antelopes, and zebras. In such cases, it is difficult to cut the skin without leaving a cut mark on the bone. Therefore, one expects to find many more cut marks on such bones than on the flesh-covered bones of the upper part of the limbs.

Unfortunately, although accounts of butchery and disarticulation by modern human hunters are remarkably consistent, quantitative studies are rare. Further, virtually all modern hunter-gatherers use metal tools, which leave more cut marks than stone tools. For these reasons I hesitated to compare the fossil evidence with data on modern hunters. Fortunately, Diane Gifford of the University of California, Santa Cruz, and her colleagues had recently completed a quantitative study of marks and damage on thousands of antelope bones processed by Neolithic (Stone Age) hunters in Kenya some 2,300 years ago. The data from Prolonged Drift, as the site is called, were perfect for comparison with the Olduvai material.

Assisted by my technician, Jennie Rose, I carefully inspected more than 2,500 antelope bones from Bed I at Olduvai Gorge, which is dated to between 1.9 and 1.7 million years ago. We made high-fidelity replicas of every mark that we thought might be either a cut mark or a carnivore tooth mark. Back in the United States, we used the SEM to make positive identifications of the marks. (The replication and SEM inspection was time consuming, but necessary: only about half of the marks were correctly identified by eye or by light microscope.) I then compared the patterns of cut mark and tooth mark distributions on Olduvai fossils with those made by Stone Age hunters at Prolonged Drift.

By their location, I identified marks caused either by disarticulation or meat removal and then compared their frequencies with those from Prolonged Drift. More than 90 percent of the Neolithic marks in these two categories were from disarticulation, but to my surprise, only about 45 percent of the corresponding Olduvai cut marks were from disarticulation. This difference is too great to have occurred by chance; the Olduvai bones did not show the predicted pattern. In fact, the Olduvai cut marks attributable to meat removal and disarticulation showed essentially the same pattern of distribution as the carnivore tooth marks. Apparently, the early hominids were not regularly disarticulating carcasses. This finding casts serious doubt on the idea that early hominids carried their kills back to camp to share with others, since both transport and sharing are difficult unless carcasses are cut up.

When I looked for cut marks attributable to skinning or tendon removal, a more modern pattern emerged. On both the Neolithic and Olduvai bones, nearly 75 percent of all cut marks occurred on bones that bore little meat; these cut marks probably came from skinning. Carnivore tooth marks were much less common on such bones. Hominids were using carcasses as a source of skin and tendon. This made it seem more surprising that they disarticulated carcasses so rarely.

A third line of evidence provided the most tantalizing clue. Occasionally, sets of overlapping marks occur on the Olduvai fossils. Sometimes, these sets include both cut marks and carnivore tooth marks. Still more rarely, I could see under the SEM which mark had been made first, because its features were over-laid by those of the later mark, in much the same way as old tire tracks on a dirt road are obscured by fresh ones. Although only thirteen such sets of marks were found, in eight cases the hominids made the cut marks after the carnivores made their tooth marks. This finding suggested a new hypothesis. Instead of hunting for prey and leaving the remains behind for carnivores to scavenge, perhaps hominids were scavenging from the carnivores. This might explain the hominids' apparently unsystematic use of carcasses: they took what they could get, be it skin, tendon, or meat.

Man the Scavenger is not nearly as attractive an image as Man the Hunter, but it is worth examining. Actually, although hunting and scavenging are different ecological strategies, many mammals do both. The only pure scavengers alive in Africa today are vultures; not one of the modern African mammalian carnivores is a pure scavenger. Even spotted hyenas, which have massive, bone-crushing teeth well adapted for eating the bones left behind by others, only scavenge about 33 percent of their food. Other carnivores that scavenge when there are enough carcasses around include lions, leopards, striped hyenas, and jackals. Long-term behavioral studies suggest that these carnivores scavenge when they can and kill when they must. There are only two nearly pure predators, or hunters—the cheetah and the wild dog—that rarely, if ever, scavenge.

What are the costs and benefits of scavenging compared with those of predation? First of all, the scavenger avoids the task of making sure its meal is dead: a predator has already endured the energetically costly business of chasing or stalking animal after animal until one is killed. But while scavenging may be cheap, it's risky. Predators rarely give up their prey to scavengers without defending it. In such disputes, the larger animal, whether a scavenger or a predator, usually wins, although smaller animals in a pack may defeat a lone, larger animal. Both predators and scavengers suffer the dangers inherent in fighting for possession of a carcass. Smaller scavengers such as jackals or striped hyenas avoid disputes to some extent by specializing in darting in and removing a piece of a carcass without trying to take possession of the whole thing. These two strategies can be characterized as that of the bully or that of the sneak: bullies need to be large to be successful, sneaks need to be small and quick.

Because carcasses are almost always much rarer than live prey, the major cost peculiar to scavenging is that scavengers must survey much larger areas than predators to find food. They can travel slowly, since their "prey" is already dead, but endurance is important. Many predators specialize in speed at the expense of endurance, while scavengers do the opposite.

The more committed predators among the East African carnivores (wild dogs and cheetahs) can achieve great top speeds when running, although not for long. Perhaps as a consequence, these "pure" hunters enjoy a much higher success rate in hunting (about three-fourths of their chases end in kills) than any of the scavenger-hunters do (less than half of their chases are successful). Wild dogs and cheetahs are efficient hunters, but they are neither big enough nor efficient enough in their locomotion to make good scavengers. In fact, the cheetah's teeth are so specialized for meat slicing that they probably cannot withstand the stresses of bone crunching and carcass dismembering carried out by scavengers. Other carnivores are less successful at hunting, but have specializations of size, endurance, or (in the case of the hyenas) dentition that make successful scavenging possible. The small carnivores seem to have a somewhat higher hunting success rate than the large ones, which balances out their difficulties in asserting possession of carcasses.

In addition to endurance, scavengers need an efficient means of locating carcasses, which, unlike live animals, don't move or make noises. Vultures, for example, solve both problems by flying. The soaring, gliding flight of vultures expends much less energy than walking or cantering as performed by the part-time mammalian scavengers. Flight enables vultures to maintain a foraging radius two to three times larger than that of spotted hyenas, while providing a better vantage point. This explains why vultures can scavenge all of their food in the same habitat in which it is impossible for any mammal to be a pure scavenger. (In fact, many mammals learn where carcasses are located from the presence of vultures.)

Since mammals can't succeed as full-time scavengers, they must have another source of food to provide the bulk of their diet. The large carnivores rely on hunting large animals to obtain food when scavenging doesn't work. Their size enables them to defend a carcass against others. Since the small carnivores—jackals and striped hyenas—often can't defend carcasses successfully, most of their diet is composed of fruit and insects. When they do hunt, they usually prey on very small animals, such as rats or hares, that can be consumed in their entirety before the larger competitors arrive.

The ancient habitat associated with the fossils of Olduvai and Koobi Fora would have supported many herbivores and carnivores. Among the latter were two species of large saber-toothed cats, whose teeth show extreme adaptations for meat slicing. These were predators with primary access to carcasses. Since their teeth were unsuitable for bone crushing, the saber-toothed cats must have left behind many bones covered with scraps of meat, skin, and tendon. Were early hominids among the scavengers that exploited such carcasses?

All three hominid species that were present in Bed I times (*Homo habilis, Australopithecus africanus, A. robustus*) were adapted for habitual, upright bipedalism. Many anatomists see evidence that these hominids were agile tree climbers as well. Although upright bipedalism is a notoriously peculiar mode of locomotion, the adaptive value of which has been argued for years (See Matt Cartmill's article, "Four Legs Good, Two Legs Bad," *Natural History*, November 1983), there are three general points of agreement.

First, bipedal running is neither fast nor efficient compared to quadrupedal gaits. However, at moderate speeds of 2.5 to 3.5 miles per hour, bipedal *walking* is more energetically efficient than quadrupedal walking. Thus, bipedal walking is an excellent means of covering large areas slowly, making it an unlikely adaptation for a hunter but an appropriate and useful adaptation for a scavenger. Second, bipedalism elevates the head, thus improving the hominid's ability to spot items on the ground—an advantage both to scavengers and to those trying to avoid becoming a carcass. Combining bipedalism with agile tree climbing improves the vantage point still further. Third, bipedalism frees the hands from locomotive duties, making it possible to carry items. What would early hominids have carried? Meat makes a nutritious, easy-to-carry package; the problem is that carrying meat attracts scavengers. Richard Potts suggests that carrying stone tools or unworked stones for toolmaking to caches would be a more efficient and less dangerous activity under many circumstances.

In short, bipedalism is compatible with a scavenging strategy. I am tempted to argue that bipedalism evolved because it provided a substantial advantage to scavenging hominids. But I doubt hominids could scavenge effectively without tools, and bipedalism predates the oldest known stone tools by more than a million years.

Is there evidence that, like modern mammalian scavengers, early hominids had an alternative food source, such as either hunting or eating fruits and insects? My husband, Alan Walker, has shown that the microscopic wear on an animal's teeth reflects its diet. Early hominid teeth wear more like that of chimpanzees and other modern fruit eaters than that of carnivores. Apparently, early hominids ate mostly fruit, as the smaller, modern scavengers do. This accords with the estimated body weight of early hominids, which was only about forty to eighty pounds—less than that of any of the modern carnivores that combine scavenging and hunting but comparable to the striped hyena, which eats fruits and insects as well as meat.

Would early hominids have been able to compete for carcasses with other carnivores? They were too small to use a bully strategy, but if they scavenged in groups, a combined bully-sneak strategy might have been possible. Perhaps they were able to drive off a primary predator long enough to grab some meat, skin, or marrow-filled bone before relinquishing the carcass. The effectiveness of this strategy would have been vastly improved by using tools to remove meat or parts of limbs, a task at which hominid teeth are poor. As agile climbers, early hominids may have retreated into the trees to eat their scavenged trophies, thus avoiding competition from large terrestrial carnivores.

In sum, the evidence on cut marks, tooth wear, and bipedalism, together with our knowledge of scavenger adaptation in general, is consistent with the hypothesis that two million years ago hominids were scavengers rather than accomplished hunters. Animal carcasses, which contributed relatively little to the hominid diet, were not systematically cut up and transported for sharing at base camps. Man the Hunter may not have appeared until 1.5 to 0.7 million years ago, when we do see a shift toward omnivory, with a greater proportion of meat in the diet. This more heroic ancestor may have been *Homo erectus*, equipped with Acheulean-style stone tools and, increasingly, fire. If we wish to look further back, we may have to become accustomed to a less flattering image of our heritage.

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