Human Evolution: Life-Styles and Lineages of Early Hominids

Primates that walked upright and are believed to be ancestors of human beings lived in Africa at least 3 million years ago. Because these early hominids have no living counterparts, anthropologists are trying to reconstruct their history from an ever-expanding collection of fossils and artifacts. Many now believe that the early hominids had behavior patterns that are distinctive characteristics of human beings. Moreover, some anthropologists postulate that at least two lineages of early hominids existed between 1 and 3 million years ago, but only one lineage survived and evolved into human beings.

According to evolutionary theory, early hominids evolved from apes and then into human beings who, for most of their past, have been hunter-gatherers. Some anthropologists, then, are trying to understand the cultural history of early hominids by making analogies with present-day nonhuman primates and hunter-gatherers. Traits that distinguish hunter-gatherers from nonhuman primates are being analyzed to see whether they may have been traits of the early hominids. And behavioral patterns shared by both nonhuman primates and hunter-gatherers are now believed to have been found among early hominids.

Human beings are different from all other animals because they alone leave behind an archeological record of their behavior, according to Glynn Isaac of the University of California at Berkeley. People leave tools, weapons, and other artifacts along with animal bones at their home bases. By analyzing which of these items occur at archeological sites and how they are distributed, investigators have been able to study activities and cultures of people who lived in the Stone Age. Now, artifacts have been found along with fossils of the early hominids, and, hence, Isaac believes, archeologists are realizing that they can study, in a similar way, the distinctly human component of activities of these beings.

Mary Leakey of Olduvai Gorge, Tanzania, and other investigators found stone tools and animal remains along with fossils of early hominids in East Africa. The animal remains intrigue the archeologists because they include bones from animals varying in size—as small as those of mice and as large as those of elephants. This is evidence that early hominids ate meat regularly and ate very large animals and indicates, Isaac believes, that the behavior of early hominids was different from the behavior of apes and chimpanzees. Chimpanzees and other such primates eat meat only occasionally and, when they do eat meat, consume animals much smaller than themselves.

Stone tools found with fossils of early hominids are considered good evidence that they were different from other primates. The functions of the various tools cannot always be determined; but, since tool are often found along with animal bones, many anthropologists believe that at least some of the tools were used to cut up meat. The patterns of distribution of these tools may also be signifiant.

Both Leakey and Isaac, working at different sites in East Africa, compared sites occupied at earlier dates to those occupied later, and discovered that the number and diversity of stone tools was greater at the sites occupied later. Isaac speculates that this could mean that more stone tools were made at later times, that sites were occupied for longer periods or were visited more often at later times, or that the later hominids developed better containers for carrying stones to the sites where tools were made.

John Yellen of the Smithsonian Institution in Washington, D.C., who studies the !Kung hunter-gatherers of Botswana, believes that some of the patches of artifacts found along with animal bones and hominid fossils in East Africa resemble camp sites of the !Kung. He emphasizes that both !Kung camp sites and some of the sites of early hominids are characterized by nonrandom distributions of material. At !Kung sites, this distribution indicates that different activities took place at different areas of the camp. Isaac also believes that the early hominids had camp sites or home bases. He suggests that the early hominid groups were, like hunter-gatherer groups, organized around such sites where they regularly shared food—another behavior pattern not found to any significant degree among nonhuman primates.

Alan Mann of the University of Pennsylvania, Philadelphia, believes that early hominids differed significantly from other primates because they had a delayed period of physical maturation. He studied the rate that their teeth developed by x-raying jaws from fossils of children. Molars that are beginning to develop but have not yet erupted can be seen in x-ray pictures. Mann found that the teeth of early hominids erupted slowly—at a rate typical of tooth eruption in people rather than apes or chimpanzees. Since the rates at which teeth erupt are linked to rates at which skeletons develop, Mann proposes that the early hominids had a slow rate of skeletal growth. This slow growth rate, he concludes, may indicate that young hominids evolved to have long periods of dependency on adults because the hominids had an adaptive pattern that demanded more learned behavior.

The Importance of Plant Foods

While most archeologists recognize the probable importance of plant foods to the early hominids, a popular misconception has arisen of these beings as "killer apes"—the carnivorous male hunters who brought home huge carcasses to their dependent females and offspring. This scenario is questioned by Adrienne Zihlman and Nancy Tanner of the University of California at Santa Cruz. They point out that both hunter-gatherers such as the !Kung and primates such as chimpanzees rely on plant foods rather than on meat for most of their calories and nutrients. And plant foods are usually gathered by females who, far from being dependent on the males, are crucial to the survival of the group. Moreover, social groups of primates such as chimpanzees and of hunter-gatherers such as the !Kung are not tightly structured units, organized around bonds between males and females. Instead these groups have variable compositions; the members of the groups disperse and aggregate according to ecological conditions and the groups are structured around bonds between mothers and their offspring and among siblings. By analogy, early hominids were likely to have had similar diets, organizational flexibility, and social bonds, Zihlman and Tanner believe.

No definitive evidence of the social structure of early hominid groups can be obtained. However, Tanner and Zihlman contend that it is most likely that plant foods rather than meats were of the greater importance to hominids. The early hominids had enormous cheek teeth, and these, according to many anthropologists, were probably used to grind plant roots, seeds, and tubers.

Early hominid fossils exhibit a great deal of variability. Adults ranged in size from about 3 to 6 feet (1 foot = 0.3 meter) tall, according to Milford Wolpoff of the University of Michigan, Ann Arbor, and various hominids differed greatly in their cranial capacities and the sizes of their cheek teeth. Analyses of this variability have led to a controversy among anthropologists as to whether the fossils represent more than one lineage of hominid.

Speaking of Science

Sports: Introducing the "Happy Non Hooker"

Sports is one of the most pervasive features of modern life, but, with the possible exception of engineering improvements in automobile racing and chemical innovations on athletic fields, there has apparently been little effort to apply scientific principles to its refinement. Aluminum may have replaced wood in baseball bats and tennis rackets and the pole valuter's pole may have acquired many of the characteristics of a spring, but beyond that it is hard to find examples of technological improvement.

Now, however, two scientists from California (where else?) have combined their scientific training and a great deal of technical ingenuity to make what appears to be a significant improvement in one of the oldest modern sports—the game of golf. Fred E. Holmstrom, a physicist at San Jose State University, and Daniel A. Nepela, an advisory chemist at IBM Corporation in San Jose, are both nongolfers, but they may have solved one of the greatest plagues of amateur golfers by inventing a ball that resists hooking or slicing.

The modern golf ball, as defined by the United States Golf Association (USGA), must meet only three requirements: It must weigh no more than 1.62 ounces, must measure no less than 1.68 inches in diameter, and must not exceed a velocity of 250 feet per second when subjected to a standard impact. Within these constraints, modern golf ball manufacturers have produced what is considered to be the optimum ball by covering the rubber surface with dimples that provide aerodynamic lift and thus yield the maximum distance. If the ball is not hit squarely, however, the club face imparts an unwanted spin in which these dimples exert a sideways thrust. The principle is the same as that employed by a baseball pitcher in producing a curve ball, but the dimples accentuate the effect substantially.

The dimples produce a turbulent air flow around the ball that is markedly different from the laminar flow around the smooth surface of, for example, a Ping-Pong ball. Theoretical equations describing laminar flow can be solved relatively easily, but those for turbulent flow, Holmstrom and Nepela found, were far too difficult for them to make any realistic attempt to solve them. But they found that simpler equations could be used in conjunction with experimental results to predict the effect of small changes in the surface. What they found when they analyzed golf balls, in simplest terms, is that removing some of the dimples will decrease the tendency to hook or slice, but reduces the potential distance that the ball can travel.

To offset the distance penalty, they also incorporated a principle from Newtonian mechanics that might be termed the "spinning dumbbell rule." In simple terms, this rule predicts that two rigidly connected weights tend to spin around only one axis at a time. This angular stability is observed, for instance, when a twirled baton is tossed into the air: the baton continues to twirl in only one plane.

Combining the two concepts, then, Holmstrom and Nepela designed a ball in which dimples covering about 50 percent of the surface are confined to a band around the equator of the ball, with the poles remaining smooth. The mass of the skin, furthermore, is so distributed that there is a very slight concentration of mass in each of the poles. The ball is still spherical, however, and the changes do not effect putting.

In use, the ball is placed on the tee with the band of dimples in a vertical plane so that one pole faces the golfer. Most golf clubs are designed so that striking the ball imparts a backspin around the horizontal axis connecting the poles. With this configuration of the dimples, the spin produces lift. If the ball is not struck squarely, it would normally also spin (more slowly) around a vertical axis. But the gyroscope-like effect of the additional mass at the two poles resists this spin and keeps it to a minimum. The net effect of the changes in the surface and mass distribution is a sharp reduction in the tendency to hook and slice.

In tests by a professional golfer, the ball—dubbed the "Happy Non Hooker"—achieved more than 90 percent of the distance of a conventional ball. Holmstrom argues that the potential distance could be made comparable by minor refinement of the design. Most important, though, hooking and slicing were reduced by about 75 to 80 percent. With one golfer, for instance, the amount of slice in a 200-yard drive was reduced from 50 yards to about 10 yards.

The revolutionary ball, U.S. Pat. 3,819,190, was inspired by a trade-journal article on the aerodynamics of golf balls; it was conceived over lunch and developed in 2 years of the men's spare time. It can be manufactured for substantially the same price as conventional golf balls and theoretically should meet all requirements of the USGA, although it has not yet been submitted to them for testing. Several ball manufacturers are interested and, if further testing is successful, the ball may be manufactured in the near future. The potential financial reward for the two inventors is quite high, but their expenses are a model of frugality in science that would have pleased Benjamin Franklin. Their total expenditures—for rubber bands, plastic kitchen wrap, and household adhesive—were approximately $2.75.

—Thomas H. Maugh II

According to Wolpoff and his colleague C. Loring Brace, there was only one lineage of early hominid. They reason that because of the small sample of the fossils of hominids that lived in East and South Africa between 1 and 3 million years ago, the data are insufficient to permit a distinction between different hominid lineages. Wolpoff and Brace believe that the early hominids appear to be more similar to than different from each other. They attribute the morphological variability among the early hominids to differences between males and females and to natural variations among members of a population and between populations. To postulate more than one lineage of hominids, they contend, is to raise more problems than can be resolved.

If two lineages of hominids lived in the same area, say Brace and Wolpoff, they would compete with each other for food and other resources. This competition would result in one of three outcomes: the extinction of one lineage, the dislocation of one population, or niche divergence—that is, the exploitation of different resources by members of the different lineages. The first two possibilities, they believe, can be ruled out. The two lineages apparently lived together in East Africa, at least, for 1 million years or more. The third possibility—that the hominids occupied different ecological niches—they believe is not yet proved. Hominids, Brace and Wolpoff explain, were probably like human beings in that they were able to utilize a wide variety of resources. This ability would have been enhanced by their propensity to make and use tools, to protect each other from predators, and to share food and communicate.

The argument that hominids of different lineages would have had to exploit different ecological niches is controversial, however. Alan Walker of Harvard University in Cambridge, Massachusetts, is among those who claim that niche divergence is not a reasonable issue in early hominid evolution. He cites numerous examples of closely related species that live in the same areas. Niche separation need not be specified in these cases because it is a theoretical construct and, as such, is not precisely mirrored in the field. Moreover, Walker proposes that those who go by the fossil record are more likely to err in the direction of counting fewer species than existed. Since closely related species often have nearly identical skeletons, Walker believes that the extreme diversity of early hominids is indicative that more than one lineage existed.

David Pilbeam of Yale University in New Haven, Connecticut, and Stephen Gould of Harvard University are proponents of a hypothesis that there were two lineages of early hominids in Africa. According to these investigators, individuals of one of the two lineages evolved only in the direction of greater size and they eventually died out. The other lineage evolved so that the individuals became larger, had a proportionately larger cranial capacity, and had smaller cheek teeth. This lineage, Pilbeam and Gould propose, subsequently evolved into human beings.

When an animal evolves to grow larger, different parts of its anatomy change in different ways. For example, limb bones become relatively thicker, and the ratio of brain weight to body weight becomes smaller. In order to argue that one lineage of early hominids—classified by many anthropologists as Australopithecines—evolved only to become larger, Pilbeam and Gould had to define how parts of an animal's body change to scale when it grows. They focused on changes in cranial capacities and cheek teeth areas.

How the Hominids Grew

The way in which cranial capacities change to scale as primates grow larger has been determined. It turns out that, if cranial capacities increase proportionately with increases in body sizes, then the graph of cranial capacity plotted as a function of body weight will be a straight line with a slope of about 0.66. Australopithecines fall into three size classes. When estimates of cranial capacities were plotted as a function of body weights for these three sizes of hominids, Pilbeam and Gould obtained a line with slope about 0.66.

A second lineage of hominids, according to the scheme devised by Pilbeam and Gould, is represented by the genus *Homo*. A hominid of this genus —which has been called *Homo habilis* —lived in East Africa at the same time as the Australopithecines lived there. (Those who believe that there was only one lineage of early hominids do not distinguish between the Australopithecines and *Homo habilis*.) Pilbeam and Gould propose that *Homo habilis* was morphologically different from the Australopithecines and that it evolved into *Homo erectus* and then into *Homo sapiens*. When they plotted the rate of increase of cranial capacity of the *Homo* lineage, Pilbeam and Gould obtained a straight line with slope of about 1.73. A similar analysis of cheek teeth areas led these investigators to conclude that cheek teeth areas of Australopithecines increased proportionately as these animals increased in size. Cheek teeth areas of the *Homo* lineage, on the other hand, evolved to be both relatively and absolutely smaller.

D. Carl Johanson of Case Western Reserve University in Cleveland, Ohio, has recently acquired data on early hominids that may support the hypothesis that there were two lineages of these animals. Johanson has found fossils of hominids that lived in Ethiopia 3.5 million years ago, were most likely bipedal, and had small cheek teeth in relation to the sizes of their skeletons. He speculates that these fossils represent the oldest known specimens of the *Homo* lineage and that the *Homo* lineage had, then, diverged from the Australopithecines more than 3 million years ago.

What Do the Changes Mean?

The tendency for cranial capacities of the *Homo* lineage to increase as these beings evolved is generally considered to indicate increased intelligence. Interpretations of the decreases in the areas of cheek teeth as the hominids evolved are more speculative. Pilbeam and Gould and Wolpoff and Brace suggest that the smaller teeth could indicate that members of the *Homo* lineage had a decreased dependence on roots and tubers for food and increased dependence on meat. And this may mean that the diet of members of the *Homo* lineage was more like that of hunter-gatherers, who eat meat regularly, than like that of nonhuman primates, who rarely eat meat. Various anthropologists also suggest that an increased use of tools for processing plant foods before they were eaten may help account for a decreased need for large cheek teeth in members of the *Homo* lineage.

Some anthropologists are skeptical of the arguments advanced by Pilbeam and Gould favoring the hypothesis that there were two lineages of early hominids. Wolpoff and Brace, for example, point out that, not only did Pilbeam and Gould fit curves to sets of three data points but, in five out of six of their data points, at least one of the variables is a guess. Pilbeam and Gould sympathize with such objections but, they write, "in a field as important yet as bereft of data as this one, one must work with what one has."

—Gina Bari Kolata