Turkana Boy: A 1.5-Million-year-old Skeleton

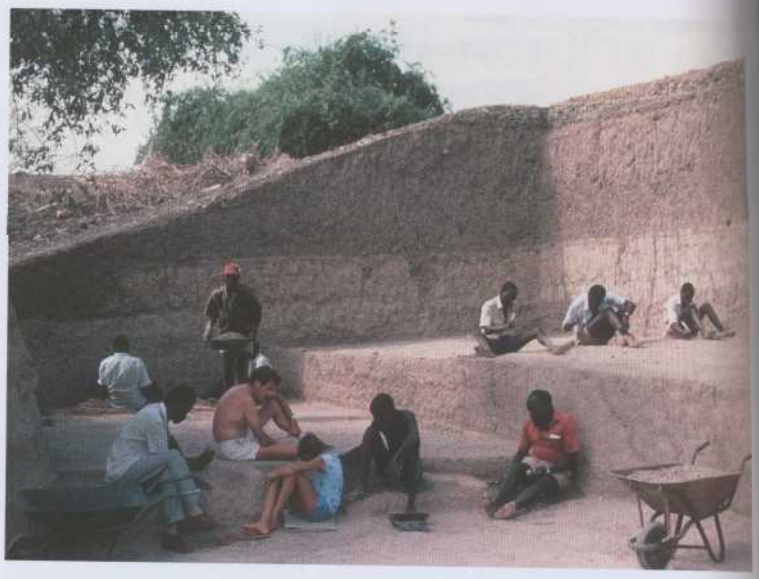
The Nariokotome site. Fossil hunters scouring the inhospitable terrain west of Lake Turkana in Kenya in 1984 were lured to the place by the promise of shade and a supply of underground water, not knowing that one of them would discover the almost entire skeleton of an early human.

Beating the Odds

Chances are stacked against the survival and recovery of the bones of early humans. For a start, they were rare creatures on the African landscape, and they did not bury their dead. Their corpses, even of those who did not succumb to predators, were quickly destroyed by scavengers and trampling animals, and the remaining bones crumbled through weathering and entanglement by vegetation. Occasionally, however, pieces of bone and, particularly, teeth survived long enough to be covered by sediments that protected them from the ravages of the open veld. Over time, minerals from the sediments seeped in and replaced their decaying organic materials until they turned to stone and became the fossil remains of once-living organisms. Then they wait — until their final resting place is exposed by erosion or excavation to the sharp eyes of a paleoanthropologist, a scientist who studies human evolution. The recovery of even a partial early human skeleton is rare; usually the remains are so fragmentary that simply trying to identify them can fuel lively debates among scientists..

Hitting the Jackpot

However, luck was on the side of the paleoanthropologists who had pitched camp beside the sandy bed of the Nariokotome River some 3 miles (5 kilometers) west of Lake Turkana in northern Kenya one August day in



RIGHT Working under the hot African sun, the excavation team carefully sifts through the sediments at Nariokotome to recover almost all the bones of a 1.5-million-year-old early human: only his feet and a few other pieces were not found.

1984. While taking a stroll, the experienced eyes of Kamoya Kimeu spotted a scrap of early human skull bone lying among pebbles on the banks of a dry tributary at a site named Nariokotome III (NK3). The team, led by Richard Leakey, then of the National Museums of Kenya, and Alan Walker, an American colleague, had on countless previous occasions stumbled on fragments of early human bone that invariably turned out to be isolated pieces. This time, their initial complacency turned to disbelief and eventually ecstasy when the painstaking investigation of 1,962 cubic yards (1,254 cubic meters) of sediments at the site over several seasons led to the piecemeal recovery of virtually an entire early human skeleton.

Recovering the Remains

Once the bones were exposed by careful excavation with dental tools and "Olduvai picks" - sharpened 6-inch (15.25-centimeter) nails attached to L-shaped pieces of wood - their position in relation to markers was noted. They were coated with plastic hardener and, in the case of the left thigh bone, encased in a plaster box, before being lifted. All the sediment was carefully washed through sieves to ensure that every scrap of bone was recovered. About 70 fragments of skull bones in addition to teeth, and 80 fragments of other bones belonging to a single early human skeleton, as well as numerous animal bones, were found and reassembled with glue, much as one would mend broken china. The skeleton was given the catalog number KNM-WT 15000 (KNM for Kenya National Museum and WT for West Turkana), and suffixes added as each piece was located and delivered to the museum in Nairobi. The skull is KNM-WT 15000 A, the lower jaw KNM-WT 15000 B, and so on to AA, AB, AC and, eventually, CB. The entire skeleton is also known as "the Turkana Boy."

Identifying and Dating the Skeleton

KNM-WT 15000 compares favorably with bones of creatures with thick skulls, heavy brow ridges and massive, projecting faces that occupy a position on the human family tree between our first upright walking ancestors and ourselves. The first fossil of these to be discovered was a skull cap found by Eugene Dubois in Java in 1891. He gave it the scientific name *Pithecanthrppus erectus* — literally, "upright ape man," known today as *Homo erectus.* Depending on which features are thought significant for showing relationships between fossils on the human family tree, some researchers consider the Turkana Boy to be very like *Homo erectus;* others consider that he more closely resembles a similar African species, *Homo ergaster,* "the workman," named after a jaw bone found on the eastern side of Lake Turkana.

Luckily for paleoanthropologists, the Turkana Boy lived in a region of active volcanoes whose deposits can be dated. When ash or lava from a volcano has cooled, radioactive potassium 40 in the material begins to decay at a known rate to stable argon 40. By measuring the proportions of potassium 40 and argon 40 present today, scientists can determine how much time has elapsed since the rock formed, and, by inference, the age of fossils found in or between the rock layers. In recent decades, a refinement to the technique has involved measuring the ratio of artificially made argon 39 to argon 40. Both conventional potassium-argon and argon-argon dating were used to determine that the Turkana Boy was sandwiched between volcanic ashes respectively dated to about 1.88 million and about 1.39 million years ago. By using measurements of how distant the skeleton was from each of these layers and assumptions about how fast the intervening layers would have formed, an estimated age of about 1.53 million years was obtained.

BELOW The base of the skull of the Turkana Boy. This was the first early human found with a skull sufficiently complete to provide an accurate measurement of the size of the brain.

The Skeleton Speaks

Age at Death

When the Turkana Boy died, his permanent teeth had not yet fully erupted; the lower jaw contains permanent incisors, canines and premolars as well as the first and second molars, but only some are completely formed, while the upper jaw still has milk canines. The third molars are absent. For the skeletons of living humans there are several ways of estimating

RIGHT The lower jaw of the Turkana Boy is very similar to remains of *Homo ergaster* from sites east of Lake Turkana. It provides the only known clue to the possible cause of his demise: a lesion on the right side indicates he suffered inflammatory gum disease.

age using sequences and age ranges for tooth eruption and wear from many populations Had the Turkana Boy been a living human, some methods indicate he was 10% to 11 years old, while other methods indicate an age of 11 to 12 years. On the other hand, ape scales of tooth eruption suggest a slightly younger age, about six to nine years, although the canines are too advanced in comparison with the other teeth by ape standards.

All long bones have an epiphysis, or separate center of bone formation, at one or both ends. The joining or fusion of the epiphyses with the midsection of long bones is another useful criterion for estimating the age of juvenile skeletons of living humans, because it occurs in known sequences and within certain age ranges. In the case of the Turkana Boy, most of the centers of bone formation had appeared but most of the epiphyses remained unfused, particularly those of the hip bones, although those of one end of the upper arm bone and part of the elbow joint were in the process of fusing. This state of skeletal maturation occurs between about 11 and 15 years in living humans but between only seven and eight years in apes.

A third feature that can be used to indicate the age of juvenile skeletons is height or stature, which is estimated from the length of the long bones. Using the Turkana Boy's thigh bone length of 17 inches (43.2 centimeters), he was about 5 feet, 3 inches (160 centimeters) tall at death, a stature typical of modern late adolescent 15-year-olds, and he would have been about 6 feet, 1 inch (185 centimeters) tall had he survived to adulthood.

The paleoanthropologists initially thought they had found an unusually tall individual, but reexamination of other early human remains from the same period confirmed that the Turkana Boy's kind were as tall as ourselves. Nevertheless, the skeleton probably represents the tallest early human known. Although it is difficult to estimate weight, by factoring in projected body breadths it seems likely the boy weighed some 106 pounds (48 kilograms) at death and could have reached about 150 pounds (68 kilograms) as an adult.

In terms of dental and skeletal development, the Turkana Boy is clearly adolescent but not a perfect match for either living humans or apes. Rather, he can be considered to have patterns of aging that fall between those of living apes and humans.

Sex

The most reliable body part for identifying the sex of an adult skeleton is the hip girdle, because it has been adapted in females to facilitate childbearing — for example, by the presence of a wide, spreading greater sciatic notch, an identation found on the lower border of the hip bone. The narrowness of the Turkana Boy's greater sciatic notch clearly indicates that he was male rather than female. Maleness is also suggested by his tall stature and general robustness.

Body Size and Shape

Modern humans who live in colder climates tend to have shorter limbs, while those living in more tropical regions have longer limbs, which result in more body surface area and hence promote heat loss. The tall, thin body and long limbs of the Turkana Boy are completely unlike those of earlier human ancestors but like those of modern tropical populations. They suggest he was adapted for living in a hot climate with extremely high mean annual temperatures of the order of 87.4°F (30.8°C). His body proportions are, in fact, almost identical to those of the tall Dinka people of southern Sudan, who live about 124 miles (200 kilometers) west of the Nariokotome River. However, the resemblance is physiological rather than genetic, as the Dinka are no more closely related to early humans than any other modern people.

Studies of the kinds of sediments, fossil pollen and animal bones indicate that the Nariokotome area has had the same hot climate as today for the past 1.5 million years. This means that if the Turkana Boy cooled off by sweating, as modern people do, he would have needed a great deal of water (the field crew who excavated him can confirm this!).

ABOVE It was once thought that early humans were small creatures and that humans grew gradually taller over the millennia. However, the long limbs of the Turkana Boy indicate that our ancestors had modern body proportions and were as tall as ourselves by 1.5 million years ago.

Sediments from the site indicate that shallow bodies of water appeared for short periods, such as one would find on a marshy floodplain that became seasonally inundated, 1.5 million years ago. The heat would also have caused the Turkana Boy to lose large amounts of salt, which he could have replaced by eating salt deposits or animal blood and tissues. The kinds of animal bones and how they were damaged at sites where early human stone tools are also present suggest that, although early humans consumed meat, much of it and particularly that from big game animals was probably more usually scavenged than hunted.

Posture and Locomotion

The upright posture and bipedal, or two-legged, locomotion of living humans require the trunk to be balanced over the legs by a series of curvatures and other adaptations in the spine and hips. The curvatures of the spine, the orientation and balancing of the hips, and the presence of a barrel-shaped rib cage like that of modern humans rather than a funnel-shaped one like apes indicate that the Turkana Boy was fully adapted to habitual upright walking; his locomotion was strikingly like that of modern humans.

However, two notable differences exist between the spine of the Turkana Boy and that of modern humans: 96 percent of us have five bones in the lower back region of our spines, but the Turkana Boy had six. It is thought that the extra bone may have initially faclitated the development of the spinal curvatures necessary for effective bipedalism, but that it disappeared after the time of the Turka na Boy. His back bones also had relatively smaller spines than those of modern humans and enclosed a narrower canal for the spinal cord. This would have reduced the number of nerves to the chest, which may have in turn limited his ability to regulate air passing from the lungs to the mouth and hence prevented him from speaking as we do.

Brain

Modern humans are distinguished by their relatively large, complex brains, which have an average volume of 82 cubic inches (1,350 cubic centimeters) in comparison with that of some 27.5 cubic inches (450 cubic centimeters) for apes. Despite the surprising similarities between the skeleton of the Turkana Boy and that of modern humans, his brain capacity of about 53.7 cubic inches (880 cubic centimeters) is only some two-thirds that of ours, which means that his behavior could have been very different from ours. The inside surfaces of his skull show the existence of areas of the brain associated with speech in modern humans, but these areas could have been involved with motor programming rather than language. Interestingly, the structure of his brain has a number of asymmetries typically associated with right-handed modern human males.

How Did the Turkana Boy Die?

Although the floodplain grasslands around Nariokotome would have been home to a wide variety of animals, the completeness of the Turkana Boy skeleton strongly suggests that he was not the victim of a predator. The only hint of how he may have met his death is damage suggestive of a gum infection on the right side of his lower jaw. This could have happened not long before his death when he lost his second milk molar. Two small marks indicate that pieces of the roots were left behind and the upcoming permanent premolar had difficulty erupting. The resulting inflammation could have become infected, resulting in septicemia (blood poisoning), a common cause of death before the development of antibiotics.

The skeleton was found in a scatter of broken bird and mammal bones together with some remains of fish and aquatic reptiles. The teeth were clustered in a hollow about 9.8 feet (3 meters) away from the main concentration of bones. Almost all the bones are broken, but they are not weathered. This context suggests that when the boy died, his corpse either fell or was washed into a marsh, where it floated face down decomposing for a time. The teeth dropped out and were washed into a hollow probably formed by an animal footprint, while the body continued to drift slowly back and forth. It was trampled by large animals and, when only a few bones were still connected by ligaments, the remains were washed into a concentration in the shallows, where they became embedded in mud and remained until they began to erode out 1.5 million years later. The Turkana Boy's skeleton defied the odds and survived to provide us with a remarkably complete image of ancestors we previously knew only from isolated fragments of bone.

Despite his great antiquity his body, apart from his skull, is surprisingly like our own and shows that early humans had already reached our size 1.5 million years ago. A paleoanthropologist has even quipped that, if suitably dressed, the Turkana Boy could pass unnoticed in a commuter crowd, provided he concealed his low forehead and large brow ridges under a cap. However, his behavior could have made him stand out, and he would probably have had difficulty reaching his destination, as his kind had not yet evolved the large, complex brains that are our hallmark.