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Interpreting Evidence

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The Copernican revolution, which had its beginning in 1543, represents a case study of how intuitive knowledge is ultimately replaced by scientific empiricism to produce a new theory of nature. From the time of Ptolemy, observations that planets, stars, sun, and moon traverse the day and night skies led to the misconception that these heavenly bodies circled a stationary earth. However, planetary orbits tabulated by Copernicus indicated that in actuality planets revolved around the sun. Known as the *solar system,* this understanding of nature was resisted for over a century as astronomers grappled with a succession of empirical observations by Tycho Brahe (1577), Galileo (1610), Newton (1687), and others who ultimately established the solar system as scientific fact.

The curious match between North and South America's continental outline and that of Europe and Africa caused comparable conflicting conclusions. A 1915 textbook written by Alfred Wegener examined fossil strata and living species on both sides of the Atlantic. Noting the strong similarities between them, he proposed a compelling view of geology called *continental drift* suggesting that these continents were adjoined in the distant past. Prominent geologists of the time argued that a geologic force capable of heaving about huge land masses did not exist. They brushed off the outlines' similarities as mere coincidence. These scientists hypothesized that in the past continents were linked together by long land bridges that allowed species to march across oceans and populate distant shores.

A half-century later, global seafloor maps revealed a striking pattern. New crust was forming and causing the seafloor to spread; the continents were in motion. In the mid-Atlantic, for example, the continental plates that once joined North and South America to Europe and Africa were being pushed apart. When these moving plates collided with other plates, at subduction zones, one slid under the other to form high-mountain ridges like the Andes and the Himalayas. Patterns frozen in the earth's crust established the science of *plate tectonics.*

Why would the Copernican revolution and plate tectonics be relevant to the field of anthropology? These scientific advances are a result of empirical data that challenged and replaced the intuitive views of nature espoused by older theories. Paleoanthropology, the field devoted to understanding the process of human evolution, is based on the intuitive assumption that human intelligence and the relatively large human brain are the result of evolutionary activities that took place at the ground. This article compares the terrestrial view with a new empirical interpretation of fossil, behavioral, anatomical, and archaeological evidence that indicates climbing activities must have had a profound influence on the evolutionary increase in human-brain size.

Terrestrial Theory

A century and a half ago, Charles Darwin (1871) developed the terrestrial theory of human evolution in his book, *The Descent of Man and Selection in Relation to Sex.* He summarized his theory as follows:

> The ancestors of man were no doubt, inferior in intellect, and probably in social disposition, to the lowest existing savages; but it is quite conceivable that they might have existed, or even flourished, if they had advanced in intellect, whilst gradually losing their brute-like powers, such as that of climbing trees. (p. 151)

Darwin noted that individuals from regions where tree climbing was practiced had a smaller brain size than Europeans who did not often climb in trees. Darwin postulated that it was our unique way of life at the ground rather than activities in trees that stimulated the evolutionary increase in our brain size.

This terrestrial theory about the origin of human intelligence has great intuitive appeal. After all, apes climb trees, have a smaller brain, and do not make sophisticated tools or speak. Stephen J. Gould (1981) examined 19th- and early 20th-century brain-size data in his book, *The Mismeasure of Man,* and showed that Darwin's conception of brain-size differences between forest and urban people was racially biased. Small forest people that regularly climb will naturally have a smaller average-brain size than large-bodied northern Europeans. Small-body size, not an ability to climb, explains the brain size of climbing cultures. Yet Darwin's observation was the primary support for the idea that climbing hindered human-brain evolution. Even though no new data has filled this void, the intuitive appeal of linking human-brain size and intelligence to evolution at the ground remains.

Given the importance of understanding the origin of intelligence, why is the intuitive terrestrial theory still embraced? As Thomas Kuhn (1962) pointed out in his book, *The Structure of Scientific Revolutions,* an accepted view is tenacious. Theories are erected to fill vacuums in our worldviews. If the terrestrial theory were abandoned, what would replace it? No other theory has come close to accounting adequately for the biological, fossil, behavioral, and archaeological evidence.

Canopy Signposts

Our general body plan, bipedal walking, long arms and fingers, and our reduced dependence on olfaction are a few of the numerous arboreal aspects of human nature. These attributes are well-known, accepted evidence of our arboreal-primate roots. But it is generally believed that we abandoned our canopy home deep in the distant past, so long ago that our arboreal life could not have had any influence on the brain's evolution.

However, an aspect of human physiology is incongruous with the idea that archaic humans were strictly terrestrial. Menstruation is a good example. No terrestrial species has a monthly period. A variety of grizzly predators, such as large felines, cave bears, and hyenas, roamed the ancient landscape, and they easily detected and tracked blood. This is why women who are menstruating are routinely taken on bear-hunting expeditions in Alaska. A species with females that lacked claws, fangs, speed, and strength while experiencing a heavy blood flow for up to 7 days every month is a truly unique terrestrial adaptation.

Infants, too, appear ill adapted to life at the ground. Terrestrial young steadfastly adhere to a tenet of behavior that can be called "silence is golden." After dropping from the womb, they often remain quietly huddled under shrubs or in clumps of grass. Only in dire circumstances would an unguarded juvenile attempt to summon a parent, for the cry of defenseless young is sweet music to predators' ears. Human infants, however, boldly shriek for absentee parents. They have not been encoded with this terrestrial rule of life.

One reflex might be considered an anomaly if it were not viewed in light of our treetop origins. The *parachuting reflex* takes control when a young child falls forward from a standing position. The arms are flung instantly out to the sides. If this reflex had been selected for as the result of terrestrial falls, the child's arms would move straightforward to protect the head from striking the ground. This reflex is perfectly suited for catching a vine or branch at the beginning of a fall from a high position.

The parachuting reflex is complemented by several other behaviors that appear to have originated with an arboreal way of life: Children learn to climb and walk simultaneously, a newborn infant can hold its entire body weight while hanging onto a bar, children love tree climbing and tree houses, and they prefer playgrounds that mimic the structure and motions of an arboreal world.

Perhaps the most enigmatic infant behavior is the *Moro reflex.* Physicians activate the reflex by placing a baby on a table covered with soft, spongy material, supporting its head in cupped hands, then allowing the head to drop slightly but suddenly while still being held. (Do not attempt this.) The baby's arms are flung out sideways, its whole body stiffens, and a few seconds later, the baby relaxes and begins to cry loudly. This reflex disappears after a few months. The Moro reflex can also be triggered by sudden, nearby movements or a loud noise, both of which would indicate potential, impending doom to a canopy resident. In the forest, booming thunder and limbs crashing down would have been familiar loud sounds that caused concern. If a platform was struck by a falling limb, a resting infant could easily bounce off the platform's edge. Heavy selection would account for the sideways arm extension of the Moro reflex, along with a stiff body to minimize rolling and stabilize an infant. The startle reflex, as it is also called, makes little sense as an adaptation for terrestrial young.

Although the retention of active arboreal reflexes in infants strongly suggests that our ancestor's full-time terrestrial status must be a recent event, these behaviors and adaptations are sometimes dismissed as "evolutionary baggage" left over from an ancient era when protohuman ancestors were active tree climbers. But the evolutionary-baggage explanation does not square with the biological purpose of innate infant reflexes. These are potent genetic programs that ensure survival in the specific habitat where a newborn will grow and develop.

Scansorial Humans

The *Cambridge Encyclopedia of Human Evolution* (Jones, Martin, & Pilbeam, 1992) states that humans no longer use their arms for locomotion. It describes our upright posture and states that we are bipedal, walking and running on two legs. This definition claims that, unlike apes, we are 100% terrestrial.

In contrast, the zoological definition of human locomotion takes into account our full locomotor capabilities. Species that travel at the ground and climb in trees are known zoologically as *scansorial.* This form of locomotion is shared by bears, squirrels, raccoons, and humans. The word *scansorial* does not appear in the index of the *Cambridge Encyclopedia of Human Evolution.* Expunging the role of our arms in locomotion nullifies the entire spectrum of our scansorial nature, reflexes, behavior, and body form. For paleoanthropologists, the only habitat remaining where our relatively large brain could have originated is the ground. Likewise the structure of our foot is seen as 100% terrestrial, a view that even Charles Darwin would probably have found odd. Darwin (1871) was an astute observer and well aware that the human foot and hand are scansorial. He stated, "With some savages, however, the foot has not altogether lost its prehensile [grasping] power, as shewn (sic) by their manner of climbing trees" (p. 136). The human foot's prehensile ability is inborn. This ability is prominently displayed by people who have lost the use of their arms as children. They can use their feet like hands to open jars, write, and drive. Functionally, the human foot is still a scansorial appendage.

What would a fully terrestrial foot look like? Nonclimbing, terrestrial feet are often rigid, raised up on the tips of elongated toes and capped by a hoof, as in horses and deer, or the last digit of each toe is bent and padded, like those of dogs and cats. Our feet lack this rigidity. With their ability to help secure us to a tree trunk and grip branches, our feet retain the arboreal competency that allowed our evolving ancestors to harvest canopy foods and climb to safety efficiently.

One arena in particular highlights human-scansorial status. We are unique in our ability to climb a 1,000-foot-high rock face without the safety of direct aid or ropes. No ape can climb this way. They lack both the balance and the purpose. We are one of the most advanced climbing machines in evolutionary history. There is a fundamental difference between apes and humans in our body design and climbing technique—human hands, fingers, toes, and body shape have been integrated over evolutionary time with highly advanced cognitive abilities. Humans and apes stand on equal but different evolutionary-climbing peaks in that we think our way up vertical surfaces, a form of locomotion called by some "cerebral-climbing." Since this is perhaps the newest primate-climbing method, it cannot be brushed off as evolutionary baggage.

Encephalization in the Canopy

Which was most important in the evolutionary expansion of the human brain, the treetops or the ground? An evolutionary biologist explores this quandary by examining the fossil and living record of other tetrapods (four-legged vertebrates). Over a 200-million-year span of evolution from the diminutive brain cavity of bulky dinosaurs to the optical bulges of bird skulls and pteranodons to the elaborate olfactory apparatus of mammals to the highbrowed primate foreheads, the largest relative brain sizes occurred only in species that once climbed trees.

The canopy habitat has been recognized as the premiere factory of brain evolution for well over a century. Harry Jerison (1973), of the department of Psychiatry and Biobehavioral Sciences at UCLA, formalized this broad understanding of brain evolution with equations (subsequently refined by others) that quantified the canopy's influence on the ballooning brain. There are many exceptions such as the opossum, which is an animal that has climbed for tens of millions of years without ever experiencing significant brain expansion. Nonetheless, relatively large-brained species have never sprung from the terrestrial habitat. The scientific implication of this remarkable observation is not found in theories of human-brain evolution.

One reason for this is that for over a century the evolution of human intelligence has been inseparably linked to bipedal posture. Darwin's claim that walking upright on the ground freed our hands and allowed for the subsequent manipulation and invention of tools was accepted for a long time. But there was evidence to the contrary. Kangaroos, kangaroo rats, bipedal dinosaurs, and prosimians stood up and walked or hopped on two feet. But rather than master the art of toolmaking, the hands and arms of these animals shrank in size while relative brain size remained the same. So evidence derived from nonhuman species does not support the view that walking upright and having free hands leads to encephalization.

Unlike the above groups, humans are unique in standing fully erect. Perhaps posture was the main ingredient in stimulating our brain expansion. Millions of years ago there existed at least two human genera, *Australopithecus* and *Paranthropus,* that also stood perfectly upright on two legs with free hands. Based on measured genetic distances between apes and humans, these early ancestors were at least 99% identical to living humans. Yet the fossil record shows that after millions of years of trudging around on the ground, their relative brain size stagnated, and they did not leave behind evidence of significant tool use. Neither standing perfectly upright nor a virtually identical genome promoted brain evolution. A critical evolutionary ingredient was still missing.

That ingredient was met by a species that followed australopithecines in the fossil record. *Homo habilis,* or handy man (a taxon that may represent several similar species), stood perfectly upright. It was during his tenure that the evolving human brain underwent its most rapid expansion. Something freed him from the stagnant mental plane of our ape forebears to embark on a revolutionary, intellectual path.

Initially *H. habilis* was considered 100% terrestrial, which conformed to the view that human-brain evolution took place at the ground. But this view flipped when it was discovered that *H. habilis* had long arms relative to modern humans as well as long, curved fingers. Most paleoanthropologists now accept that *H. habilis* regularly climbed trees, yet they have ignored the tight zoological link between climbing and encephalization.

Opposable Big Toe and Encephalization

It is a possibility that the rapid expansion of *H. habilis's* brain was accompanied by a radical change in foot morphology. The australopithecines, considered to be *H. habilis's* predecessors, had an opposable big toe. Even though they walked perfectly upright, their feet would have functioned like hands. The big toe was like a thumb that could grasp branches while climbing trees. They were climbing trees as apes would, and they had a relative brain size comparable to apes. Although they still climbed, limited evidence suggests that *H. habilis* may have been the first human taxon to lose an opposable big toe. This would mean they were the first primate to climb with opposable first digits limited exclusively to the hands. *H. habilis* had entered a much more stringent evolutionary-selective environment than all prior primates.

The loss of an opposable big toe as a potential stimulus for encephalization has not been considered adequately. Imagine how risk escalated when the number of appendages capable of grasping was reduced from four to two. This was a dramatic reduction in climbing equipment. To continue climbing with just two hands would require evolutionary compensation, and that compensation could not compromise safety. The enlarging brain, along with the loss of opposable big toes, functioned to integrate cognitive action with climbing. The combination initiated a unique intellectual safety net. From an evolutionary perspective, this was the dawn of cerebral climbing.

There is a lengthy list of selective forces that may have existed within evolving climbing culture that links neurological evolution with the origins of speech, advanced toolmaking, knot tying, social structure, advanced rock throwing, stone-tipped spear making, wooden-shelter construction, and rafting to name a few. Many of these speculative scansorial explanations for human-mental origins are found in the online book, *The Descent: The Untold Story of Human Origins* (Perry & Halsey, 2008).

Archaic Climbers

In numerous journal articles, paleoanthropologists judge the potential tree-climbing capability of possible human ancestors based on a dichotomy similar to those used in plant and animal keys. The reasoning goes something like this:

- If the fossil suggests modern-human skeletal anatomy, then the ancestor was not a climber.
- If the fossil suggests ape skeletal anatomy, such as long arms and curved fingers and toes, then it was a climber.

The long, apelike arms and curved fingers of *H. habilis* led anthropologists to conclude that these ancestors spent considerable time in trees. But as the successor to *H. habilis* in the paleontological record, *Homo erectus* (another taxon that may represent several species) was different. Its more humanlike body proportions inspired paleoanthropologists to christen this taxon as the first 100% terrestrial human. One glitch remains: *H. erectus's* hands and feet have not yet been found. Alan Walker and Richard Leakey (1993) presumed that these will prove to be humanlike, but as the fossil history of *H. habilis* amply demonstrates, surprises lurk in the fossil record. Apelike hands cannot be ruled out. So it is merely assumed that *H. erectus* did not frequently climb trees.

Even if *H. erectus* had shorter, humanlike fingers, would this indicate it was not an active climber? Baboons have humanlike fingers and hands, and they are active climbers. Dyak tribesmen climb barehanded over 100 feet above ground to collect honey and other products from the canopy. Strength is the essential ingredient that determines climbing prowess. Since archaic humans were much stronger than Dyaks, they would have had virtually unlimited access to the canopy. Ian Tattersall of the American Museum of Natural History, as well as other experts, conclude that before about 40,000 years ago, most of our potential predecessors had what are called *robust* skeletons. This has been interpreted to mean that they were as much as 2 to 3 times stronger than modern humans. There is no doubt that our archaic ancestors had the strength to be astounding climbers.

Understanding the climbing potential of robust human skeletons throws a different light on *H. erectus's* probable way of life. Although it is claimed that *H. erectus* was 100% terrestrial, investigators report apelike strength in the shoulder girdle and arms. M. F. Gengo (2009) of the University at Buffalo stated in a recent article that "[the] shape of the chest put the shoulders of *H. erectus* in a position adapted more for tree-dwelling than balanced bipedal walking" (p. 451). Also, its spine was weak, more like that of an ape. The spine may have been too weak for certain human activities that put tremendous pressure on the spine, such as fast running and jumping. Therefore, the evidence indicates that *H. erectus* may have been as proficient at climbing as walking.

Water Holes?

There has been endless speculation concerning the function of one of the most common artifacts of the Paleolithic period, the *hand axe.* The most widely accepted idea is that it was a multipurpose tool, but the hand axe lacks any obvious multipurpose use. Earlier varieties were too heavy to be thrown effectively, and hand-holding the stone to strike prey or aggressors or to dig roots would have produced lacerated hands. The tool has even been classified as an ancient religious object.

Several sites contain a preponderance of these tools such as Olorgesailie, Africa, where hundreds of hand axes lie together at the bottom of a large mud hole in an ancient streambed. A prominent terrestrial assumption is that these human-made deposits represent caches in what are thought to have been dry watercourses. But a more likely assumption is that those streambeds were flowing with water during the hand-axe era. In that case, rather than a tool-storage site, the mud hole would have served the same function as today. Mud holes are often excellent fishing/hunting locations.

This would explain the peculiar design of the hand axe. Early hand axes that weighed several pounds and possessed a sharp-edged perimeter were perfect weapons that could be dropped on prey from a high perch. The hand axe's fusiform profile (in contrast to rounded stones) may well represent the first high-powered projectile that could enter the water with the killing force of a rifle bullet. The perimeter's cutting edge maximized the possibility of killing or maiming surface-feeding fish and other prey. Even large prey that visited water holes to drink could have been overcome by the massive hand axes that have occasionally been discovered. No other plausible explanation has accounted for the purpose of these large stones. After the tools were dropped, some inevitably became lost in the mud, or if large reptiles were lurking about, it may have been too dangerous to retrieve them.

The terrestrial theorist, Milford Wolpoff, a professor of anthropology at the University of Michigan, believes this function is implausible since he has had personal and unsuccessful experience in throwing stones at fish. He feels that a hand axe used as a dropstone would be ineffective as an arboreal-hunting weapon. But further consideration reveals that high-velocity rock throwing involves rapid movements of the body and arms that are guaranteed to frighten fish. In comparison, the use of dropstones is somewhat like hunting with a bow and arrow. The hunter would have been silent, hidden, and motionless up to and including the moment of the stone's impact. Since streams were usually embedded in forest in ancient times, trees would have been present to support this form of canopy fishing/hunting.

The dropstone's ability to kill or maim prey combined with the robust bodies of our ancestors (presumably *H. erectus*) represent an exciting new interpretation of life during the Paleolithic period. The perception of an early human-canopy hunter contrasts vividly with the popular notion of an ancestor who scavenged food from predator kill sites due to a lack of effective weaponry.

Tree Houses

Many researchers have noted that predation was a frequent and serious threat in ancient times, which brings up the question of where our ancestors slept. Before around 40,000 years ago there is little evidence of fire use and virtually no evidence of fortified terrestrial shelters that would have provided protection from large predators.

Heading back in time, it turns out that caves were used less and less frequently. Several categories of evidence are found in cave deposits. Prior to 40,000 years ago, evidence of cave use by human ancestors is minimal. Some evidence indicates ritual burial rather than occupation. Other evidence reveals that early humans were dragged into caves and eaten by predators. Stratigraphic analysis of the infrequent cave that indicates genuine occupation, such as Combe-Grenal in Europe, suggests that caves were occupied only a few days per year. Some caves hold only animal remains; others are empty. Overall, this apparent lack of evidence has led many, including Ian Tattersall as well as Jeffrey Schwartz, of the University of Pennsylvania at Pittsburgh, to conclude that Neanderthals were not cavemen.

If these archaic humans were not living in caves, then they were living either in terrestrial shelters or tree houses. Although the archaeological record has been extensively examined for evidence of human-made terrestrial shelters for over a century, few have been found that are older than 40,000 years. Paleoanthropologists have never examined the archaeological record for tree-house remains. Of course one wouldn't expect to find evidence of a prehistoric, wooden tree house, while the crumbled walls of stout, terrestrial rock shelters should be ubiquitous. Serious consideration should be given to canopy sleeping shelters.

Claims that early humans preferred sleeping on the ground or in caves assume they had given up their great-ape heritage of building tree platforms, often called *nests.*

Platforms are built by all great apes, with the exception of gorilla males, which become too large to sleep in trees. Yet gorilla females and young still sleep on tree platforms to escape predation. Early humans were small and never approached gorilla size, so comparative evidence leans toward the enhanced safety of sleeping above ground.

Actually, ancient tree-house locations may have already been discovered. There are several sites where tools and debris from human activities have been found in streambeds. While a dry, sandy streambed would be a comfortable location to work and camp, it would not be as safe as a tree platform. When one assumes that streams were flowing with water, the debris is best explained as having fallen off an aerial platform or dropped from a limb.

Cracking the Human Evolutionary Code

If *Homo sapiens* recently began to build shelters at the ground rather than in trees, the archaeological and fossil record should reveal the timing of this event. An increase in terrestrial shelters and sweeping skeletal changes in evolving humans would be two types of evidence to look for. The latter would be caused by a dramatic drop in mechanical loading as a result of less climbing. Both types of evidence are prominent features of a cultural event known as the *creative explosion* that began around 40,000 years ago.

The present interpretation of this evidence is that the increase in terrestrial shelters was due to a population increase and/or migration into Europe, while the dramatic decrease in body strength of the evolving human skeleton is seen as evidence of a "less arduous" life. But these explanations are illogical. A move from southern, more hospitable climates into colder, northern zones (the generally accepted direction of this migration) would undoubtedly have led to a greater workload and a more arduous way of life. Preparations for winter would have required months of strenuous effort. Materials would have to be gathered to reinforce terrestrial shelters, animal carcasses would have to be dragged in and stowed, and greater amounts of firewood would have to be gathered. Except for the paradoxical weakening of the skeleton, there is no evidence to suggest that our ancestors' lifestyle had become less arduous. So why would the evolving human skeleton become dramatically weaker as terrestrial shelters were increasing in number and daily life was becoming increasingly arduous?

J. Lee Kavanau, of the University of California, Los Angeles, thinks much more attention needs to be given to zoological factors that cause changes in body form of evolving species. A good primer is Gregory Paul's (2002) book, *Dinosaurs of the Air: The Evolution and Loss of Flight in Dinosaurs and Birds,* which helps resolve this paradox. Paul painstakingly describes the skeletal changes expected when dinosaur species gave up using their arms for climbing and spent more time walking upright at the ground. In such an event, mechanical loading shifts away from the upper torso, hands, arms, and shoulders, weakening all of them. Legs and feet adapt in ways that facilitate travel on the ground. Paul's observations may be generalized to include all species, including human, that have undergone a similar change in mechanical loading. This evolutionary change can be called an *arbo-terrestrial transformation.*

An examination of this transformation in our lineage begins with thighbone cross sections from Neanderthals. (There is ongoing debate about whether or not Neanderthals were direct ancestors of modern humans. However, most theorists believe that our direct archaic ancestors would have had Neanderthaloid skeletal structure.) Neanderthal leg bones have uniformly thick walls that have been compared to those of apes. Climbing produces this type of leg-bone architecture.

Terrestrial theorists struggle ineffectually to explain the apelike, leg-bone structure of Neanderthals. One attempt claims that Neanderthals ran up and down mountain slopes and jumped between large rocks. But this lifestyle is comparable to modern humans who live in mountainous regions, and no data demonstrates that they have Neanderthal-like, leg-bone structure.

Neanderthals had exceptional strength from head to toe, not just the legs. The fingertips had broad apical tufts, fingers and hands were very strong, and the arms and shoulder girdle possessed tremendous strength. Long spines on the vertebrae indicate a powerful neck and the specialized shoulder blade sports a unique bony ridge.

From a zoological perspective, it is unsound to attempt to explain the strength of the legs, or any other parts, in isolation from the rest of the body. The bony ridge found on the Neanderthal scapula, for example, is explained as an adaptation to allow for a forceful, downward spear thrust. But what form of hunting would require that behavior? The principal location where a strong, downward spear thrust might be advantageous would be hunting from on top of a tree limb. However, this entails climbing, which would make climbing the preferred evolutionary explanation for Neanderthal upper-body strength and shoulder blade structure.

A related anomaly of Neanderthal skeletons is that they have many broken bones. These are similar to fractures found in ape skeletons, which strongly suggests that Neanderthal bone fractures were caused by falls from trees. But because discussions of an apelike, climbing, human ancestor are taboo, more fanciful explanations that suit our postape status are proposed. Rodeo contestants suffer bone breaks that resemble those of Neanderthals, so one explanation claims that Neanderthal body and hand strength were adaptations for riding bareback on wild animals. It is extremely difficult to imagine that an early human would be able to mount a wild animal and harder still to imagine that the enraged animal could be killed.

The temptation to provide independent terrestrial explanations for evolving human features has been taken to an extreme. It has been widely reported, for example, that the reduction in the strength of the smaller toes around 26,000 years ago was the evolutionary result of wearing shoes. Wearing shoes, however, would not result in weakened toes. This is a Lamarckian explanation, since it implies that acquired characteristics are inherited. A genetic change could result only if shoes had killed strong-toed people before they reproduced. In any case, archaeological evidence of shoes has not been found from that era. Footprints dated to that time have been found embedded in mud on cave floors. They are always barefooted. A more pervasive evolutionary-selective force than shoes was afoot.

Evolutionary change swept over the evolving human body to reduce its many climbing adaptations. The hip joint of archaic humans allowed the legs to spread laterally. They had a humanlike foot with strong, smaller toes for gripping tree bark and small branches; extremely strong legs with pivoting ankles that allowed the feet to clamp against vertical surfaces; a muscular upper torso with powerful arms; broad hands and strong fingers with large apical tufts for bearing climbing forces at the fingertips; a sturdy neck with enlarged vertebral spines; and a powerful shoulder blade. This suite of interdependent adaptations, along with overall greater strength and appendicular mobility, confirms that archaic humans were excellent climbers.

The shift to a nearly full-time life at the ground set in motion extensive change in the archaic body. The strength needed for the rigorous demands of rapid climbing was excessively overpowered for a terrestrial existence. It became reoptimized for much less arduous activities, including fast, terrestrial locomotion. During this optimization, as much as 60% of the strength for rapid climbing was shed in an overall weakening of the shoulders, arms, hands, fingers, neck, torso, and smaller toes. Yet the skeleton maintained strength in the big toes and legs as the modern-human skeleton became a leaner, faster terrestrial machine.

Cro-Magnons, the first postarchaic humans, were more terrestrial than Neanderthals. This is demonstrated by their thighbone cross sections, which resemble those of modern humans. They traveled farther than archaic humans, such as Neanderthals, because their increased leg length allowed a longer stride. This is demonstrated by the fact that Cro-Magnons traveled long distances to collect stone for tool manufacture, whereas the origin of raw stone for Neanderthal tools was local.

Because Cro-Magnon populations increased while those of Neanderthals decreased, it is sometimes suggested that Cro-Magnons exterminated Neanderthals. But extensive studies show that around the time Neanderthals disappeared, average annual European temperatures were dropping, and forests were receding dramatically in response to the latest Ice Age. By 14,000 years ago, forests had almost completely disappeared from Europe, and as would be expected, the forest-dependent, Neanderthal body form vanished as well.

Korowai

Many doubt the intelligence of Neanderthals, though their brains were larger than those of modern humans. This is due to the Neanderthal archaeological record, which shows little inventive headway for over 150,000 years. There are those who feel that a few types of stone points and scrapers expressing little variation in design indicate intellectual stagnation and stupidity.

The Korowai, a tribe of modern-day humans that live in Irian Jaya, Papua New Guinea, cast doubt on that view. These forest dwellers live in tree houses that are marvels of invention and engineering. Some are built as high as 150 feet above ground. But the bare-bones existence of the Korowai depends only on the bow and arrow, a few trinkets, and a couple of stone tools.

Einstein resorted to thought experiments because it is difficult to test ideas about time, the speed of light, and gravitational fields. Thought experiments can be used in anthropology as well. Imagine that an anthropologist who is an advocate of the terrestrial view has just been catapulted 10,000 years to the archaeological site of a Korowai tree house. Assume that this person knows nothing about the Korowai.

Because the marvelous tree house and even the tree itself would have long since decomposed, the investigator sifts through a scattering of refuse at the ground. This reveals a meager distribution of simple tools and bone. No defined sleeping or living areas can be found, and there is little indication of how the people lived. Due to the paucity of tool types and a lack of inventive design, the scientist assumes the people are of low intelligence, nearly on a par with Neanderthals. The scattering of tools and bones are considered proof that the Korowai lived in modest shelters at the ground or were nomadic. Nearby, a full skeleton is found. The anthropologist classifies the Korowai's modern-human skeleton as 100% terrestrial with complete confidence, adding that perhaps they may have climbed trees, but trees played little role in their culture.

The terrestrial view fails dismally at reconstructing the Korowai way of life; therefore, it cannot be used to reconstruct our ancestors' more scansorial way of life.

Conclusion

Just as geologic patterns in the seafloor established unequivocal evidence of continental drift, the pattern of change in the evolving human skeleton confirms that robust humans spent a considerable amount of time climbing trees. By around 40,000 years ago, our ancestors began to spend much more time at the ground. This altered the mechanical loading on the evolving human skeleton resulting in a specific pattern called an arbo-terrestrial transformation. The upper torso weakened by as much as 60% as a rigorous climbing lifestyle employing the arms, hands, shoulders, legs, feet, and toes was nearly abandoned. Meanwhile, leg length increased in correlation with time spent walking on the ground. As a result, the evolution of *Homo sapiens* produced a much weaker species.

Canopy theory unites behavioral, fossil, and archaeological data into a coherent framework about human physical origins that identifies the habitat of human-brain evolution. The living and fossil records from dinosaurs to primates, including humans, indicate that only climbing species have attained a relatively large brain. Empirical evidence indicates that climbing in trees, not walking at the ground, set the stage for modern-human intelligence.

Future Directions

Tree House Locations

Existing data from certain *open air* sites might represent debris that fell off ancient aerial platforms. To determine the pattern of dispersion of fallen objects, platforms of various sizes placed at various heights could be built. Objects would be dropped or thrown from these platforms and the resulting dispersal patterns measured and then compared to that of open air sites. Existing Korowai tree houses could be studied for the patterns of dispersion of items lost and buried in the muddy earth below to see if the pattern of their fallout is similar to open-air sites.

Dropstones

Hand axes can be tested to see whether they function as dropstones. Early, large, hand-axe sizes and shapes would be the size of choice. Platforms can be built in trees over a productive water hole. Hand axe replicas can be dropped from these platforms to determine the killing or maiming potential of these weapons on surface-feeding fish. Models of mammals could be used to demonstrate impact, strength, and potential to kill prey. It is possible that hand axes were also slipped into the ends of shafts, using the heavy end of the stone as the weapon. Dropped from above, these would have been deadly weaponry that could penetrate the hide and crack the skulls of large game.

Bone Piles and Scatters

The function of cobbles, early hominid tools, can also be tested for effectiveness as dropstones. Platforms can be built at various heights. A pile of bones taken from predator kill sites can be put under a platform to attract game. One can then determine if rodents and larger mammals that arrive to scavenge at the bone pile can be killed by falling cobbles. Targets and models that measure force may be used. If one can successfully hunt in this manner, then some ancient-bone piles and scatters might represent bait sites where hunting from platforms took place. If so, then early humans had a potentially effective means of hunting.

Existence of Cavemen

Whether or not a population of archaic humans lived in caves prior to around 40,000 years ago has not been statistically demonstrated. It is probable that existing data may confirm that these humans must have been living someplace else. Data on number of available caves could be cross-correlated at the same stratigraphic time horizon. Categories of interest would be number of occupied caves and duration of occupation, number occupied by predators, number used by predators as places to feed on hominids, and number that represent burial sites. A reasonable population size based on population biology can be estimated and then this number compared to the above information.

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