



How Man Began

New evidence shows that early humans left Africa much sooner than once thought. Did Homo sapiens evolve in many places at once?

By **MICHAEL D. LEMONICK**

No single, essential difference separates human beings from other animals -- but that hasn't stopped the phrasemakers from trying to find one. They have described humans as the animals who make tools, or reason, or use fire, or laugh, or any one of a dozen other appealing oversimplifications. Here's one more description for the list, as good as any other: Humans are the animals who wonder, intensely and endlessly, about their origin. Starting with a Neanderthal skeleton unearthed in Germany in 1856, archaeologists and anthropologists have sweated mightily over excavations in Africa, Europe and Asia, trying to find fossil evidence that will answer the most fundamental questions of our existence: When, where and how did the human race arise? Nonscientists are as eager for the answers as the experts, if the constant outpouring of books and documentaries on the subject is any indication. The latest, a three-part Nova show titled *In Search of Human Origins*, premiered last week.

Yet despite more than a century of digging, the fossil record remains maddeningly sparse. With so few clues, even a single bone that doesn't fit into the picture can upset everything. Virtually every major discovery has put

deep cracks in the conventional wisdom and forced scientists to concoct new theories, amid furious debate.

Now it appears to be happening once again. Findings announced in the past two weeks are rattling the foundations of anthropology and raising some startling possibilities. Humanity's ancestors may have departed Africa -- the cradle of mankind -- eons earlier than scientists have assumed. Humans may have evolved not just in a single place but in many places around the world. And our own species, *Homo sapiens*, may be much older than anyone had suspected. If even portions of these claims prove to be true, they will force a major rewrite of the book of human evolution. They will herald fundamental changes in the story of how we came to be who we are.

The latest shocker comes in the current issue of *Nature*, where Chinese scientists have contended that the skull of a modern-looking human, found in their country a decade ago, is at least 200,000 years old -- more than twice as old as any *Homo sapiens* specimen ever found in that part of the world. Moreover, the skull has features resembling those of contemporary Asians. The controversial implication: modern humans may not have evolved just in Africa, as most scientists believe, but may have emerged simultaneously in several regions of the globe.

The *Nature* article came only a week after an even more surprising report in the competing journal *Science*. U.S. and Indonesian researchers said they had redated fossil skull fragments found at two sites on the island of Java. Instead of being a million years old, as earlier analysis suggested, the fossils appear to date back nearly 2 million years. They are from the species known as *Homo erectus* -- the first primate to look anything like modern humans and the first to use fire and create sophisticated stone tools. Says F. Clark Howell, an anthropologist at the University of California, Berkeley: "This is just overwhelming. No one expected such an age."

If the evidence from Java holds up, it means that protohumans left their African homeland hundreds of thousands of years earlier than anyone had

believed, long before the invention of the advanced stone tools that, according to current textbooks, made the exodus possible. It would also mean that *Homo erectus* had plenty of time to evolve into two different species, one African and one Asian. Most researchers are convinced that the African branch of the family evolved into modern humans. But what about the Asian branch? Did it die out? Or did it also give rise to *Homo sapiens*, as the new Chinese evidence suggests?

Answering such questions requires convincing evidence -- which is hard to come by in the contentious world of paleoanthropology. It is difficult to determine directly the age of fossils older than about 200,000 years. Fortunately, many specimens are found in sedimentary rock, laid down in layers through the ages. By developing ways of dating the rock layers, scientists have been able to approximate the age of fossils contained in them. But these methods are far from foolproof. The 200,000-year-old Chinese skull, in particular, is getting only a cautious reception from most scientists, in part because the dating technique used is still experimental.

Confidence is much stronger in the ages put on the Indonesian *Homo erectus* fossils. The leaders of the team that did the analysis, Carl Swisher and Garniss Curtis of the Institute of Human Origins in Berkeley, are acknowledged masters of the art of geochronology, the dating of things from the past. Says Alan Walker of Johns Hopkins University, an expert on early humans: "The IHO is doing world-class stuff." There is always the chance that the bones Swisher and Curtis studied were shifted out of their original position by geologic forces or erosion, ending up in sediments much older than the fossils themselves. But that's probably not the case, since the specimens came from two different sites. "It is highly unlikely," Swisher points out, "that you'd get the same kind of errors in both places." The inescapable conclusion, Swisher maintains, is that *Homo erectus* left Africa nearly a million years earlier than previously thought.

Experts are now scrambling to decide how this discovery changes the already

complicated saga of humanity's origins. The longer scientists study the fossil record, the more convinced they become that evolution did not make a simple transition from ape to human. There were probably many false starts and dead ends. At certain times in some parts of the world, two different hominid species may have competed for survival. And the struggle could have taken a different turn at almost any point along the way. Modern *Homo sapiens* was clearly not the inevitable design for an intelligent being. The species seems to have been just one of several rival product lines -- the only one successful today in the evolutionary marketplace.

The story of that survivor, who came to dominate the earth, begins in Africa. While many unanswered questions remain about when and where modern humans first appeared, their ancestors almost surely emerged from Africa's lush forests nearly 4 million years ago. The warm climate was right, animal life was abundant, and that's where the oldest hominid fossils have been uncovered.

The crucial piece of evidence came in 1974 with the discovery of the long-sought "missing link" between apes and humans. An expedition to Ethiopia led by Donald Johanson, now president of IHO, painstakingly pieced together a remarkable ancient primate skeleton. Although about 60% of the bones, including much of the skull, were missing, the scientists could tell that the animal stood 3 ft. 6 in. tall. That seemed too short for a hominid, but the animal had an all important human characteristic: unlike any species of primate known to have come before, this creature walked fully upright. How did the researchers know? The knee joint was built in such a way that the animal could fully straighten its legs. That would have freed it from the inefficient, bowlegged stride that keeps today's chimps and gorillas from extended periods of two-legged walking. Presuming that this diminutive hominid was a female, Johanson named her Lucy. (While he was examining the first fossils in his tent, the Beatles' *Lucy in the Sky with Diamonds* was playing on his tape recorder.)

Since scientific names don't come from pop songs, Lucy was given the tongue-challenging classification *Australopithecus afarensis*. Many more remains of the species have turned up, including beautifully preserved footprints found in the mid-1970s in Tanzania by a team led by the famed archaeologist Mary Leakey. Set in solidified volcanic ash, the footprints confirmed that Lucy and her kin walked like humans. Some of the *A. afarensis* specimens date back about 3.9 million years B.P. (before the present), making them the oldest known hominid fossils.

The final clue that Lucy was the missing link came when Johanson's team assembled fossil fragments, like a prehistoric jigsaw puzzle, into a fairly complete *A. afarensis* skull. It turned out to be much more apelike than human, with a forward-thrust jaw and chimp-size braincase. These short creatures (males were under five feet tall) were probably no smarter than the average ape. Their upright stance and bipedal locomotion, however, may have given them an advantage by freeing their hands, making them more efficient food gatherers.

That's one theory at least. What matters under the laws of natural selection is that Lucy and her cousins thrived and passed their genes on to the next evolutionary generation. Between 3 million and 2 million years B.P., a healthy handful of descendants sprang from the *A. afarensis* line, upright primates that were similar to Lucy in overall body design but different in the details of bone structure. *Australopithecus africanus*, *Paranthropus robustus*, *Paranthropus boisei* -- all flourished in Africa. But in the evolutionary elimination tournament, the two *Paranthropus* species eventually lost out. Only *A. africanus*, most scientists believe, survived to give rise to the next character in the human drama.

This was a species called *Homo habilis*, or "handy man." Appearing about 2.5 million years B.P., the new hominid probably didn't look terribly different from its predecessors, but it had a somewhat larger brain. And, perhaps as a result of some mental connection other hominids were unable to make, *H. habilis*

figured out for the first time how to make tools.

Earlier protohumans had used tools too -- bits of horn or bone for digging, sticks for fishing termites out of their mounds (something modern chimps still do). But *H. habilis* deliberately hammered on rocks to crack and flake them into useful shapes. The tools were probably not used for hunting, as anthropologists once thought; *H. habilis*, on average, was less than 5 ft. tall and weighed under 100 lbs., and it could hardly have competed with the lions and leopards that stalked the African landscape. The hominids were almost certainly scavengers instead, supplementing a mostly vegetarian diet with meat left over from predators' kills. Even other scavengers -- hyenas, jackals and the like -- were stronger and tougher than early humans. But *H. habilis* presumably had the intelligence to anticipate the habits of predators and scavengers, and probably used tools to butcher leftovers quickly and get back to safety.

Their adaptations to the rigors of prehistoric African life enabled members of the *H. habilis* clan to survive as a species for 500,000 years or more, and at least one group of them apparently evolved, around 2 million years B.P., into a taller, stronger, smarter variety of human. From the neck down, *Homo erectus*, on average about 5 ft. 6 in. tall, was probably almost indistinguishable from a modern human. Above the neck -- well, these were still primitive humans. The skulls have flattened foreheads and prominent brow ridges like those of a gorilla or chimpanzee, and the jawbone shows no hint of anything resembling a chin. Braincases got bigger and bigger over the years, but at first an adult *H. erectus* probably had a brain no larger than that of a modern four-year-old. Anyone who has spent time with a four-year-old, though, knows that such a brain can perform impressive feats of reasoning and creativity.

H. erectus was an extraordinarily successful and mobile group, so well traveled, in fact, that fossils from the species were first found thousands of miles away from its original home in Africa. In the 1890s, Eugene Dubois, an

adventurous Dutch physician, joined his country's army as an excuse to get to the Dutch East Indies (now Indonesia). Dubois agreed with Charles Darwin's idea that early humans and great apes were closely related. Since the East Indies had orangutans, Dubois thought, they might have fossils of the "missing link."

While Dubois didn't find anything like Lucy, he discovered some intriguingly primitive fossils, a skullcap and a leg bone, in eroded sediments along the Solo River in Java. They looked partly human, partly simian, and Dubois decided that they belonged to an ancient race of ape-men. He called his creature *Anthropopithecus erectus*; its popular name was Java man. Over the next several decades, comparable bones were found in China (Peking man) and finally, starting in the 1950s, in Africa.

Gradually, anthropologists realized that all these fossils were from creatures so similar that they could be assigned to a single species: *Homo erectus*. Although the African bones were the last to be discovered, some were believed to be much more ancient than those found anywhere else. The most primitive Asian fossils were considered to be a million years old at most, but the African ones went back at least 1.8 million years. The relative ages, plus the fact that *H. erectus*' ancestors were found exclusively in Africa, led scientists to conclude that *H. erectus* first emerged on that continent and then left sometime later.

When and why did this footloose species take off from Africa? Undoubtedly, reasoned anthropologists, *H. erectus* made a breakthrough that let it thrive in a much broader range of conditions than it was accustomed to. And there was direct evidence of a major technological advance that could plausibly have done the trick. Excavations of sites dating back 1.4 million years B.P., 4,000 centuries after *H. erectus* first appeared, uncovered multifaceted hand axes and cleavers much more finely fashioned than the simple stone tools used before. These high-tech implements are called Acheulean tools, after the town of St. Acheul, in France, where they were first discovered. With better

tools, goes the theory, *H. erectus* would have had an easier time gathering food. And within a few hundred thousand years, the species moved beyond Africa's borders, spreading first into the Middle East and then into Europe and all the way to the Pacific.

The theory was neat and tidy -- as long as everyone overlooked the holes. One problem: if advanced tools were *H. erectus*' ticket out of Africa, why are they not found everywhere the travelers went? Alan Thorne, of the Australian National University in Canberra, suggests that the Asian *H. erectus* built advanced tools from something less durable than stone. "Tools made from bamboo," he observes, "are in many ways superior to stone tools, and more versatile." And bamboo, unlike stone, leaves no trace after a million years.

The most direct evidence of the time *H. erectus* arrived in Asia is obviously the ages of the fossils found there. But accurate dates are elusive, especially in Java. In contrast to East Africa's Rift Valley, where the underground record of geological history has been lifted up and laid bare by faulting and erosion, most Javan deposits are buried under rice paddies. Since the subterranean layers of rock are not so easy to study, scientists have traditionally dated Javan hominids by determining the age of fossilized extinct mammals that crop up nearby. The two fossils cited in the new *Science* paper were originally dated that way. The "Mojokerto child," a juvenile skullcap found in 1936, was estimated to be about 1 million years old. And a crushed face and partial cranium from Sangiran were judged a bit younger.

These ages might never have been seriously questioned were it not for a scientific maverick: the IHO's Curtis, one of the authors of the *Science* article. In 1970 he applied a radioactive-dating technique to bits of volcanic pumice from the fossil-bearing sediments at Mojokerto. Curtis' conclusion: the Mojokerto child was not a million years old but closer to 2 million. Nobody took much notice, however, because the technique is prone to errors in the kind of pumice found in Java. Curtis' dates would remain uncertain for more than two decades, until he and Swisher could re-evaluate the pumice with a

new, far more accurate method.

The new dates ended up validating Curtis' previous work. The Mojokerto child and the Sangiran fossils were about 1.8 million and 1.7 million years old, respectively, comparable in age to the oldest *Homo erectus* from Africa. Here, then, was a likely solution to one of the great mysteries of human evolution. Says Swisher: "We've always wondered why it would take so long for hominids to get out of Africa." The evident answer: it didn't take them much time at all, at least by prehistoric standards -- probably no more than 100,000 years, instead of nearly a million.

If that's true, the notion that *H. erectus* needed specialized tools to venture from Africa is completely superseded. But Swisher doesn't find the conclusion all that surprising. "Elephants left Africa several times during their history," he points out. "Lots of animals expand their ranges. The main factor may have been an environmental change that made the expansion easier. No other animal needed stone tools to get out of Africa."

Scientists already have evidence that even the earliest hominids, the australopithecines, could survive in a variety of habitats and climates. Yale paleontologist Elisabeth Vrba believes that their evolutionary success -- and the subsequent thriving of the genus *Homo* as well -- was tied to climate changes taking place. About 2.5 million to 2.7 million years ago, an ice age sent global temperatures plummeting as much as 20F, prompting the conversion of moist African woodland into much drier, open savanna.

By studying fossils, Vrba found that the populations of large mammals in these environments underwent a huge change. Many forest antelopes were replaced by giant buffalo and other grazers. Vrba believes that early hominid evolution can be interpreted the same way. As grasslands continued to expand and tree cover to shrink, forest-dwelling chimpanzees yielded to bipedal creatures better adapted to living in the open. *H. erectus*, finally, was equipped to spread throughout the Old World.

If early humans' adaptability let them move into new environments, Walker of Johns Hopkins believes, it was an increasingly carnivorous diet that drove them to do so. "Once you become a carnivore," he says, "the world is different. Carnivores need immense home ranges." *H. erectus* probably ate both meat and plants, as humans do today. But, says Walker, "there was a qualitative difference between these creatures and other primates. I think they actively hunted. I've always said that they should have gotten out of Africa as soon as possible." Could *H. erectus* have traveled all the way to Asia in just tens of thousands of years? Observes Walker: "If you spread 20 miles every 20 years, it wouldn't take long to go that far."

The big question now: How does the apparent quick exit from Africa affect one of the most heated debates in the field of human evolution? On one side are anthropologists who hold to the "out of Africa" theory -- the idea that *Homo sapiens* first arose only in Africa. Their opponents champion the "multiregional hypothesis" -- the notion that modern humans evolved in several parts of the world.

Swisher and his colleagues believe that their discovery bolsters the out-of-Africa side. If African and Asian *H. erectus* were separate for almost a million years, the reasoning goes, they could have evolved into two separate species. But it would be virtually impossible for those isolated groups to evolve into one species, *H. sapiens*. Swisher thinks the Asian *H. erectus* died off and *H. sapiens* came from Africa separately.

Not necessarily, says Australia's Thorne, a leading multiregionalist, who offers another interpretation. Whenever *H. erectus* left Africa, the result would have been the same: populations did not evolve in isolation but in concert, trading genetic material by interbreeding with neighboring groups. "Today," says Thorne, "human genes flow between Johannesburg and Beijing and between Paris and Melbourne. Apart from interruptions from ice ages, they have probably been doing this through the entire span of *Homo sapiens*' evolution."

Counters Christopher Stringer of Britain's Natural History Museum: "If we look

at the fossil record for the last half-million years, Africa is the only region that has continuity of evolution from primitive to modern humans." The oldest confirmed fossils from modern humans, Stringer points out, are from Africa and the Middle East, up to 120,000 years B.P., and the first modern Europeans and Asians don't show up before 40,000 years B.P.

But what about the new report of the 200,000-year-old human skull in China? Stringer thinks that claim won't stand up to close scrutiny. If it does, he and his colleagues will have a lot of explaining to do.

This, after all, is the arena of human evolution, where no theory dies without a fight and no bit of new evidence is ever interpreted the same way by opposing camps. The next big discovery could tilt the scales toward the multiregional hypothesis, or confirm the out-of-Africa theory, or possibly lend weight to a third idea, discounted by most -- but not all -- scientists: that *H. erectus* emerged somewhere outside Africa and returned to colonize the continent that spawned its ancestors.

The next fossil find could even point to an unknown branch of the human family tree, perhaps another dead end or maybe another intermediate ancestor. The only certainty in this data-poor, imagination-rich, endlessly fascinating field is that there are plenty of surprises left to come.

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