Out of Africa Again … and Again?

Africa is the birthplace of humanity. But how many human species evolved there? And where did they emigrate?

By **Ian Tattersall**

It all used to seem so simple. The human lineage evolved in Africa. Only at a relatively late date did early humans finally migrate from the continent of their birth, in the guise of the long-known species *Homo erectus*, whose first representatives had arrived in eastern Asia by around one million years ago. All later kinds of humans were the descendants of this species, and almost everyone agreed that all should be classified in our own species, *H. sapiens*. To acknowledge that some of these descendants were strikingly different from ourselves, they were referred to as "archaic *H. sapiens*," but members of our own species they were nonetheless considered to be.

Such beguiling simplicity was, alas, too good to last, and over the past few years it has become evident that the later stages of human evolution have been a great deal more eventful than conventional wisdom for so long had it. This is true for the earlier stages, too, although there is still no reason to believe that humankind's birthplace was elsewhere than in Africa. Indeed, for well over the first half of the documented existence of the hominid family (which includes all upright-walking primates), there is no record at all outside that continent. But recent evidence does seem to indicate that it was not necessarily *H. erectus* who migrated from Africa—and that these peregrinations began earlier than we had thought.

A Confused Early History

RECENT DISCOVERIES in Kenya of fossils attributed to the new species *Australopithecus anamensis* have pushed back the undoubted record of upright-walking hominids to about 4.2 to 3.9 million years ago. The most recent finds in Kenya and Chad may push this back to six million years ago or more. The *A. anamensis* fossils bear a strong resemblance to the later and far better known species *Australopithecus afarensis*, found at sites in Ethiopia and Tanzania in the 3.9- to 3.0-million-year range and most famously represented by the "Lucy" skeleton from Hadar, Ethiopia.

Lucy and her kind were upright walkers, as the structures of their pelvises and knee joints particularly attest, but they retained many ancestral features, notably in their limb proportions and in their hands and feet, that would have made them fairly adept tree climbers. Together with ape-size brains and large, protruding faces, these characteristics have led many to call such creatures "bipedal chimpanzees." This is probably a fairly accurate characterization, especially given the increasing evidence that early hominids favored quite heavily wooded habitats. Their preferred way of life was evidently a successful one, for although these primates were less adept arborealists than the living apes and less efficient bipeds than later hominids, their basic "eat your cake and have it" adaptation endured for well over two million years, even as species of this general kind came and went in the fossil record.

It is not even clear to what extent lifestyles changed with the invention of stone tools, which inaugurate our archaeological record at about 2.5 million years ago. No human fossils are associated with the first stone tools known, from sites in Kenya and Ethiopia. Instead there is a motley assortment of hominid fossils from the period following about two million years ago, mostly associated with the stone tools and butchered mammal bones found at Tanzania's Olduvai Gorge and in Kenya's East Turkana region. By one reckoning, at least some of the first stone toolmakers in these areas were hardly bigger or more advanced in their body skeletons than the tiny Lucy; by another, the first tools may

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have been made by taller, somewhat larger-brained hominids with more modern body structures. Exactly how many species of early hominids there were, which of them made the tools, and how they walked remain among the major conundrums of human evolution.

Physically, at least, the picture becomes clearer after about 1.9 million years ago, when the first good evidence occurs in northern Kenya of a species that is recognizably like ourselves. Best exemplified by the astonishingly complete 1.6-million-year-old skeleton known as the Turkana Boy, discovered in 1984, these humans possessed an essentially modern body structure, indicative of modern gait, combined with moderately large-faced skulls that contained brains double the size of those of apes (though not much above half the modern human average). The Boy himself had died as an adolescent, but it is estimated that had he lived to maturity he would have attained a height of six feet, and his limbs were long and slender, like those of people who live today in hot, arid African climates, although this common adaptation does not, of course, indicate any special relationship. Here at last we have early hominids who were clearly at home on the open savanna.

A long-standing paleoanthropological tradition seeks to minimize the number of species in the human fossil record and to trace a linear, progressive pattern of descent among those few that are recognized. In keeping with this practice, the Boy and his relatives were originally assigned to the species *H. erectus*. This species was first described from a skullcap and thighbone found in Java a century ago. Fossils later found in China—notably the now lost 500,000-year-old "Peking Man"—and elsewhere in Java were soon added to the species, and eventually *H. erectus* came to embrace a wide variety of hominid fossils, including a massive braincase from Olduvai Gorge known as OH9. The latter has been redated to about 1.4 million years, although it was originally thought to have been a lot younger. All these fossil forms possessed brains of moderate size (about 900 to 1,200 milliliters in volume, compared with an average of around 1,400 milliliters for modern humans and about 400 milliliters for apes), housed in long, low skull vaults with sharp angles at the back and heavy brow ridges in front. The few limb bones known were robust but essentially like our own.

Whether *H. erectus* had ever occupied Europe was vigorously debated, the alternative being to view all early human fossils from that region (the earliest of them being no more than about 500,000 years old) as representatives of archaic *H. sapiens*. Given that the Javan fossils were conventionally dated in the range of one million to 700,000 years and younger and that the earliest Chinese fossils were reckoned to be no more than one million years old, the conclusion appeared clear: *H. erectus* (as exemplified by OH9 and also by the earlier Turkana Boy and associated fossils) had evolved in Africa and had exited that continent not much more than one million years ago, rapidly spreading to eastern Asia and spawning all subsequent developments in human evolution, including those in Europe.

Yet on closer examination the specimens from Kenya turned out to be distinctively different in braincase construction from those of classic eastern Asian *H. erectus*. In particular, certain anatomical features that appear specialized in the eastern Asian. *H erectus* look ancestral in the African fossils of comparable age. Many researchers began to realize that we are dealing with two kinds of early human here, and the earlier Kenyan form is now increasingly placed in its own species, *H. ergaster*. This species makes a plausible ancestor for all subsequent humans, whereas the cranial specializations of *H. erectus* suggest that this species, for so long regarded as the standard-issue hominid of the 1- to 0.5-million-year period, was in fact a local (and, as I shall explain below, ultimately terminal) eastern Asian development.

An Eastern Asian Cul-de-Sac

THE PLOT THICKENED in early 1994, when Carl C. Swisher of the Berkeley Geochronology Center and his colleagues applied the newish argon/argon dating method to volcanic rock samples taken from two hominid sites in Java. The results were 1.81 and 1.66 million years: far older than anyone had really expected, although the earlier date did confirm one made many years before. Unfortunately, the fossils from these two sites are rather undiagnostic as to species: the first is a braincase of an infant (juveniles never show all the adult characteristics on which species are defined), and the second is a horrendously crushed and distorted cranium that has never been satisfactorily reconstructed. Both specimens have been regarded by most as *H. erectus*,

more for reasons of convenience than anything else. Over the decades, sporadic debate has continued regarding whether the Javan record contains one or more species of early hominid. Further, major doubt has been cast on whether the samples that yielded the older date were actually obtained from the same spot as the infant specimen. Still, these dates do fit with other evidence pointing to the probability that hominids of some kind were around in eastern Asia much earlier than anyone had thought.

Independent corroboration of this scenario comes, for instance, from the Dmanisi site in the former Soviet republic of Georgia, where in 1991 a hominid lower jaw that its describers allocated to *H. erectus* was found. Three different methods indicated that this jaw was as old as 1.8 million years, and with four crania from the site now in hand, there is ample evidence of an unexpectedly early hominid exodus from Africa. Even the most parsimonious reading of the admittedly imperfect record suggests that these pioneering emigrants must have been *H. ergaster* or something very much like it.

A very early hominid departure from Africa has the advantage of explaining an apparent anomaly in the archaeological record. The stone tools found in sediments coeval with the earliest *H. ergaster* (just under two million years ago) are essentially identical with those made by the first stone toolmakers many hundreds of thousands of years before. These crude tools consisted principally of sharp flakes struck with a stone "hammer" from small cobbles. Effective cutting tools though these may have been (experimental archaeologists have shown that even elephants can be quite efficiently butchered using them), they were not made to a standard form but were apparently produced simply to obtain a sharp cutting edge. Following about 1.5 million years ago, however, standardized stone tools began to be made in Africa, typified by the hand axes and cleavers of the Acheulean industry (first identified in the mid-19th century from St. Acheul in France). These were larger implements, carefully shaped on both sides to a teardrop form. Oddly, stone tool industries in eastern Asia lacked such utensils, which led many to wonder why the first human immigrants to the region had not brought this technology with them, if their ancestors had already wielded it for half a million years. The new dates suggest, however, that the first emigrants had left Africa before the invention of the Acheulean technology, in which case there is no reason why we should expect to find this technology in eastern Asia. Interestingly, in 1989 Robin W. Dennell of the University of Sheffield in England caused quite a stir by reporting very crude stone tools from Riwat in Pakistan that are older than 1.6 million years. Their great age is now looking decreasingly anomalous.

Of course, every discovery raises new questions, and in this case the problem is to explain what it was that enabled human populations to expand beyond Africa for the first time. Most scholars had felt that it was technological advances that allowed the penetration of the cooler continental areas to the north. If, however, the first emigrants left Africa equipped with only the crudest of stone-working technologies, we have to look to something other than technological prowess for the magic ingredient. And because the first human diaspora apparently followed hard on the heels of the acquisition of more or less modern body form, it seems reasonable to conclude that the typically human wanderlust emerged in concert with the emancipation of hominids from the forest edges that had been their preferred habitat, Of course, the fact that the Turkana Boy and his kin were adapted in their body proportions to hot, dry environments does nothing to explain why *H. ergaster* was able to spread rapidly into the cooler temperate zones beyond the Mediterranean; evidently the new body form that made possible remarkable endurance in open habitats was in itself enough to make the difference.

The failure of the Acheulean ever to diffuse as far as eastern Asia reinforces the notion, consistent with the cranial specializations of *H. erectus*, that this part of the world was a kind of paleoanthropological cul-de-sac. In this region, ancient human populations largely followed their own course, independent of what was going on elsewhere in the world. Further datings tend to confirm this view. Swisher and his colleagues reported in 1996 dates for the Ngandong *H. erectus* site in Java that center on only about 40,000 years ago. These dates, though very carefully obtained, have aroused considerable skepticism; but, it accurate, they have considerable implications for the overall pattern of human evolution. For they are so recent as to suggest that the long-lived *H. erectus* might even have suffered a fate similar to that experienced by the Neandertals in Europe: extinction at the hands of late-arriving *H. sapiens*. Here we find reinforcement of the gradually emerging picture of human evolution as one of repeated experimentation, with regionally differentiated species, in this case on opposite sides of the

Eurasian continent, being ultimately replaced by other hominid lineages that had evolved elsewhere.

At the other end of the scale, in 1996 an international group led by Huang Wanpo of Academia Sinica in Beijing reported a remarkably ancient date for Longgupo Cave in China's Sichuan Province. This site had previously yielded an incisor tooth and a tiny lower jaw fragment with two teeth that were initially attributed to *H. erectus*, plus a few very crude stone artifacts. Huang and his colleagues concluded that the fossils and tools might be as many as 1.9 million years old, and their reanalysis of the fossils suggested to them a closer resemblance to the earliest African *Homo* species than to *H. erectus*.

This latter claim has not gone unexamined. As my colleague Jeffrey H. Schwartz of the University of Pittsburgh and I pointed out, for instance, the teeth in the jaw fragment resemble African *Homo* in primitive features rather than in the specialized ones that indicate a special relationship. What is more, they bear a striking resemblance to the teeth of an orangutan-related hominoid known from a much later site in Vietnam. And although the incisor appears hominid, it is fairly generic, and there is nothing about it that aligns it with any particular human species. Future fossil finds from Longgupo will, with luck, clarify the situation; meanwhile the incisor and stone tools are clear evidence of the presence of humans in China at what may be a very early date indeed. These ancient eastern Asians were the descendants of the first emigrants from Africa, and, whatever the hominids of Longgupo eventually turn out to have been, it is a good bet that Huang and his colleagues are right in guessing that they represent a precursor form to *H. erectus* rather than that species itself.

All this makes sense, but one anomaly remains. If *H. erectus* was an indigenous eastern Asian development, then we have to consider whether we have correctly identified the Olduvai OH9 braincase as belonging to this species. If we have, then *H. erectus* evolved in eastern Asia at quite an early date (remember, OH9 is now thought to be almost 1.4 million years old), and one branch of the species migrated back to Olduvai in Africa. But if these new Asian dates are accurate, it seems more probable that as we come to know more about OH9 and its kind we will find that they belonged to a different species of hominid altogether.

The opposite end of the Eurasian continent was, as I have hinted, also isolated from the human evolutionary mainstream. As we saw, humans seem to have arrived in Europe fairly late. In this region, the first convincing archaeological sites, with rather crude tools, show up at about 800,000 years ago or thereabouts (although in the Levant, within hailing distance of Africa, the site of 'Ubeidiya has yielded Acheulean tools dated to around 1.4 million years ago, just about as early as any found to the south). The problem has been the lack of a sign of the toolmakers themselves.

This gap began to be filled by finds made by Eudald Carbonell of the University of Tarragona in Spain and his coworkers at the Gran Dolina Cave site in the Atapuerca Hills of northern Spain.

In 1994 excavations at that site produced numerous simple stone tools, plus quite a few human fossil fragments, the most complete of which is a partial upper face of an immature individual. All came from a level that was dated to more than 780,000 years ago. No traces of Acheulean technology were found among the tools, and the investigators noted various primitive traits in the fossils, which they provisionally attributed to *H. heidelbergensis*. This is the species into which specimens formerly classified as archaic *H. sapiens* are increasingly being placed. Carbonell and his colleagues see their fossils as the starting point of an indigenous European lineage that gradually evolved into the Neandertals. These latter, large-brained hominids are known only from Europe and western Asia, where they flourished in the period between about 200,000 years and 30,000 years ago, when they were extinguished in some way by invading *H. sapiens*.

This is not the only possibility, however. With only a preliminary description of the very fragmentary Gran Dolina fossils available, it is hard to be sure, but it seems at least equally possible that they are the remains of hominids who made an initial foray out of Africa into Europe but failed to establish themselves there over the long term. Representatives of *H. heidelbergensis* are known in Africa as well, as long ago as 600,000 years ago, and this species quite likely recolonized Europe later on. There it would have given rise to the Neandertals, whereas a less specialized African population founded the lineage that ultimately produced *H. sapiens*.

At another site, just a kilometer from Gran Dolina, Juan-Luis Arsuaga of Complutense University in Madrid and his colleagues have discovered a huge cache of exquisitely preserved human fossils, about 400,000 years old. These are said to anticipate the Neandertals in certain respects, but they are not fully Neandertal by any means. And although they emphasize that the Neandertals (and possibly other related species) were an indigenous European development, these fossils from Sima de los Huesos ("Pit of the Bones") do not establish an unequivocal backward connection to their Gran Dolina neighbors.

Born in Africa

EVERY LONGTIME READER of *Scientific American* will be familiar with the competing models of "regional continuity" and "single African origin" for the emergence of our own species, *H. sapiens*. The first of these models holds that the highly archaic *H. erectus* (including *H. ergaster*) is nothing more than an ancient variant of *H. sapiens* and that for the past two million years the history of our lineage has been one of a braided stream of evolving populations of this species in all areas of the Old World, each adapting to local conditions, yet all consistently linked by gene exchange. The variation we see today among the major geographical populations of humans is, by this reckoning, simply the latest permutation of this lengthy process.

The other notion, which happens to coincide much better with what we know of evolutionary processes in general, proposes that all modern human populations are descended from a single ancestral population that emerged in one place at some time between about 150,000 and 100,000 years ago. The fossil evidence, thin as it is, suggests that this place of origin was somewhere in Africa (although the neighboring Levant is an alternative possibility); proponents of this scenario point to the support afforded by comparative molecular studies for the notion that all living humans are descended from an African population.

In view of what I have already said about the peripheral roles played in human evolution by early populations both in eastern Asia and Europe, it should come as no surprise that between these two possibilities my strong preference is for a single and comparatively recent origin for *H. sapiens*, very likely in Africa—the continent that, from the beginning, has been the engine of mainstream innovation in human evolution. The rise of modern humans is a recent drama that played out against a long and complex backdrop of evolutionary diversification among hominids, but the fossil record shows that from the earliest times, Africa was consistently the center from which new lineages of hominids sprang. Clearly, interesting evolutionary developments occurred in both Europe and eastern Asia, but they involved populations that were not only derived from but also eventually supplanted by emigrants from Africa. In Africa our lineage was born, and ever since its hominids were first emancipated from the forest edges, that continent has pumped out successive waves of emigrants to all parts of the Old World. What we see in the human fossil record as it stands today is without doubt a shadowy reflection at best of what must have been a complex sequence of events.

Most important, the new dates from eastern Asia show that human-population mobility dates right back to the origins of effectively modern bodily form. Finds from Europe demonstrate that although distinctive regional variants evolved there, the history of occupation of that region may itself not have been at all a simple one. As ever, though, new evidence of the remote human past has served principally to underline the complexity of events in our evolution. We can only hope that an improving fossil record will flesh out the details of what was evidently a richly intricate process of hominid speciation and population movement over the past two million years.

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