We are all Africans

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Nice hypothesis, you may say, but is it true? The heart of the scientific method lies in that skeptic’s simple question. A merely plausible explanation of what we observe will not suffice, nor will a hypothesis bolstered only by some expert’s endorsement. Modern science is wonderfully egalitarian, and it demands proof that all can see: measurements, objects or evidence of some kind. Scientific hypotheses must be both well-defined and firmly supported, preferably by several different types of data.

If a hypothesis meets these requirements, does this mean it is true? No, according to the philosopher Karl Popper, who believed that hypotheses could never be proven true—only false. Frederick Nietzsche claimed that the great charm of hypotheses was that they were refutable. While Nietzsche may be correct in the abstract, my experience suggests that scientists do not gleefully bury hypotheses in which they have invested many years of research.

In the study of human evolution, dueling hypotheses are commonplace because of long-standing, frequently erupting feuds about the interpretation of the fossil record. The field is so argumentative, in part, because the theories reflect directly on the nature and origin of humans. There is immense room for giving and taking offense when the subject is oneself. Too, the primary data of paleoanthropology—fossilized remains of our ancestors and near-relatives—are rare and difficult to obtain. Hence, it is not a simple matter to collect more evidence to clarify or support hypotheses. Fossil hunting requires tremendous knowledge and effort, good organizational skills, substantial grants, and a huge dollop of luck. New theories are, sadly, easier to come by than new primary evidence.

Thus it is a joyous occasion when my paleoanthropologist colleagues appear to resolve one of the most bitterly debated questions in the discipline: the issue of when, where and how modern humans evolved. For simplicity, I use “modern humans” or “recent humans” to denote the species to which I (and all the readers of this magazine) belong, but the formal term is either “anatomically modern Homo sapiens” or “Homo sapiens sapiens.” Humans who lived in the past and did not have modern anatomy are often referred to as archaic or primitive.

Opposable Theories

For decades, paleoanthropologists have argued over two competing theories about the origin of our kind. The older notion, which owes its crude beginnings to Charles Darwin, is the Out of Africa hypothesis. This theory maintains that modern humans evolved in Africa and then spread around the world. Boiled down to its essence, the hypothesis states that modern humans are both relatively recent (100,000 to 200,000 years old) and African in origin. A major prediction of this hypothesis is that the earliest remains of modern humans will be found in Africa, dated to an appropriate time period.

The rival Multiregional hypothesis argues that modern humans evolved in many locations around the world from a precursor species, Homo erectus, approximately one to two million years ago. According to this school of thought, these regional populations evolved along parallel paths and reached modernity at roughly the same time. Because the populations were largely isolated from one another, they developed distinctive regional features, which people recognize today as “racial” differences. The Multiregional hypothesis predicts that the fossilized remains of the earliest modern humans will be found all over the Old World and that these scattered fossils will all date from about the same time. Furthermore, the theory requires these early populations to show anatomical and genetic continuity with the current inhabitants of the same region. For example, Multiregionalists believe that Neandertals, an archaic human form, are most closely related to modern indigenous Europeans.

Unfortunately for adherents of the Multiregional hypothesis, recent results are weighing heavily against them. Three very different strains of evidence have converged to offer convincing support for the rival theory.
Evidence for “Eve”
In April of this year, Sarah Tishkoff of the University of Maryland and a team of coworkers reported genetic analyses of more than 600 living Tanzanians from 14 different tribes and four linguistic groups. They analyzed mitochondrial DNA (mtDNA)—the tool of choice for tracing ancestry because it is inherited only through the mother as part of the ovum. The number of mutations that have accumulated in mtDNA is a rough measure of the time that has passed since that lineage first appeared. The owner of the first modern human mtDNA (by definition, a woman) is often referred to as “Eve,” although many women of that time are likely to have shared similar mtDNA.

Tishkoff and her colleagues chose to investigate East African peoples for specific reasons. The number of linguistic and cultural differences is unusually high in the region, as is the variation in physical appearance—East Africans are tall or short, darker-skinned or lighter-skinned, round-faced or narrow-faced, and so on. This observation suggested that the genetic composition of the population is highly diverse, and as expected, the team found substantial variation in the mtDNA. In fact, members of five of the lineages showed an exceptionally high number of mutations compared with other populations, indicating that these East African lineages are of great antiquity. Identified by tribal affiliation, these are: the Sandawe, who speak a “click” language related to that of the Bushmen of the Kalahari desert; the Burunge and Gorowaa, who migrated to Tanzania from Ethiopia within the last five thousand years; and the Maasai and the Datog, who probably originated in the Sudan. The efforts of the University of Maryland group reflect a substantially larger database and more certain geographic origins for its subjects than earlier mtDNA studies. Further, the work by Tishkoff’s team reveals that these five East African populations have even older origins than the Kung San of southern Africa, who previously had the oldest known mtDNA.

“‘Eve’ was an East or Northeast African. My guess is that the region of Ethiopia or the Sudan is where modern humans originated.”

By assuming that mtDNA mutates at a constant rate, Tishkoff’s team estimated that the oldest lineages in their study originated 170,000 years ago, although she cautions that the method only gives an approximate date. Nonetheless, this finding is neatly congruent with new fossil evidence.

Idaltu Means “Elder”
This past June, an international team headed by Tim White and F. Clark Howell of the University of California at Berkeley, and Berhane Asfaw of the Rift Valley Research Service in Addis Ababa announced the discovery of three fossilized human skulls in the Herto Bouri area of Ethiopia. Volcanic layers immediately above and below the layer were dated to 154,000 and 160,000 years using radiocarbon methods, meaning that the owners of the skulls lived sometime between those dates. The most remarkable of the three specimens is an adult male cranium: With the exception of a few missing teeth and some damage on the left side of the skull, the fossil is complete. There is also part of another male skull and an immature cranium from a six- or seven-year-old child.

Once these specimens were cleaned and pieced together, the team was able to make some telling observations. Like modern humans, the owners of these skulls had small faces tucked under capacious braincases, making the facial profile vertical. The cranial volume of the most complete specimen, designated BOU-VP-16/1, is 1,450 cubic centimeters—large even for modern humans. The braincase of the other adult skull may have been even bigger. Although the African Herto skulls are longer and more robust than those of recent humans, the team considers the Herto specimens to be the earliest modern Homo sapiens yet found—direct ancestors of people living today. In an unknowing echo of Tishkoff’s genetic findings, Tim White concludes, “We are all, in this sense, Africans.”

Because the discoverers of the Herto skulls were unable to find convincing links between these fossils and archaic humans from any single geographic region, they put the three specimens...
into a new subspecies, *Homo sapiens idaltu*. The subspecies name *idaltu* comes from the Afar language of Ethiopia. It means "elder."

Even paleoanthropologists who were not associated with the finds overwhelmingly agree that the Herto skulls are the earliest securely dated modern humans yet found, meshing with the Out of Africa hypothesis. The Herto fossils also fit neatly into an African succession: Older skulls from the region include *Homo erectus* fossils from Daka, dated to about 1 million years ago, and the archaic Bodo skull, estimated to be about 500,000 years old. Meanwhile, fossils from Omo Kibish, also in Ethiopia, are more recent than the Herto skulls, according to a reanalysis of those remains. For a long time, the Omo Kibish specimens were regarded as ambiguous: They were fragmentary, making their anatomy less clear, and the site was originally dated using older, less reliable methods. However, a recent relocation of the site turned up new pieces that glued onto specimens found in 1967, and the site was re-dated to about 125,000 years using modern techniques. Further evidence comes from the Quaish site in Israel—on a plausible route from Africa—where there is a 92,000-year-old modern human skull.

These findings establish the earliest modern humans in Africa, but they do not exclude the simultaneous evolution of modern man in other parts of the world, as suggested by the Multiregional hypothesis. The most pertinent test of Multiregionalism focuses on Neandertals, which are a uniquely European form of primitive humans. According to Multiregionalists, Neandertals (which lived between about 200,000 and 27,000 years ago) are a transitional form that connects European *Homo erectus* to modern *Homo sapiens sapiens*. Could the Herto skulls simply be the regional, African equivalent of Neandertals?

"No," says co-leader Berhane Asfaw definitively. "The Herto skulls show that people in Africa had already developed the anatomy of modern humans while European Neandertals were still quite different." Indeed, the Herto skulls, though robust, lack many of the diagnostic anatomical features of Neandertal skulls. Asfaw states, "We can conclusively say that Neandertals had nothing to do with modern humans based on these skulls and on the genetic evidence."

**Neandertals as European Ancestors?**

The genetic evidence to which he refers has accumulated over the last six years, but the most dramatic advance came in 1999, when a team led by Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, became the first to extract mtDNA from the original Neandertal specimen. His group's success was a spectacular tour de force of meticulous technique and solid research design. The ancient mtDNA was compared with mtDNA from more than 2,000 people living in various regions around the world and differed from each of the modern regional groups by an average of 27 mutations (out of a possible 379 that were examined). Contrary to the expectations of the Multiregional hypothesis, the mtDNA of Neandertals was not closer to that of the modern Europeans. The work was a strong blow to the theory that humans evolved in several places simultaneously.

Multiregionalists Milford Wolpoff of the University of Michigan and Alan Thorne, then of Australian National University in Canberra, challenged the conclusions. They urged an investigation of mtDNA from additional Neandertals, in case the single individual used by Pääbo's team was particularly unusual. They also suggested that Neandertal mtDNA might be closer to samples from the fossilized remains of early modern humans in Europe than from living Europeans.

Since these criticisms were levied, several teams have carried out additional studies of mtDNA from Neandertals and fossilized modern humans. All have shown that Neandertal samples differ significantly from modern mtDNA, which is indistinguishable from fos-
silized modern human mtDNA. Giorgio Bertorelle of the University of Ferrara in Italy led one of these teams, which published important results last May. Bertorelle’s team compared mtDNA from two early modern humans (Cro-Magnons) from Italy, dated to 23,000 and 24,720 years old, with four mtDNA sequences of Neandertals from 42,000 to 29,000 years ago. The chronological proximity of the Neandertal and modern fossils was key because it increased the likelihood that Neandertal mtDNA would strongly resemble the early modern human mtDNA—if the former evolved into the latter, as the Multiregional hypothesis states.

Bertorelle and colleagues found that the Cro-Magnon mtDNA was unlike the Neandertal samples, differing from them at 22 and 28 sites out of 360. Instead, the Cro-Magnon mtDNA sequences fell squarely within the range of variation of living humans. One of the Italian Cro-Magnons had a sequence shared by 359 (14 percent) of 2,566 modern samples in Europe and the Near East, and the other differs by only one mutation.

“The early modern humans had sequences that living individuals still have,” concluded Bertorelle, “they [have] ... nothing to do with Neandertal sequences.” He and Asfaw might chime in unison that Neandertals cannot represent a regional European transition from *Homo erectus* to modern *Homo sapiens*.

The identity between Cro-Magnon and modern human mtDNA sequences in this study and others is striking, and it has caused some researchers to worry about the possibility of mtDNA contamination from researchers or others who have handled the fossils. Although contamination is a major problem in such studies, Bertorelle asserts spiritedly that his data are clean, stating that his group performed nine different tests to check for contamination and followed the most stringent procedures and methodology. He also points out the irony of questioning the validity of the mtDNA of a prehistoric human only because it is identical to that of modern humans.

**Compelling Congruity**

The Out of Africa hypothesis has become compelling because these different studies have all yielded congruent answers. Tishkoff’s work points to East Africa in general, and Ethiopia/Sudan in particular, as the region where the oldest modern human lineages are found—and probably evolved. Studies of ancient mtDNA by groups led by Paabo, Bertorelle and others emphasize the genetic discrepancies between Neandertals and modern humans and demonstrate that some early anatomically modern fossils were also genetically modern—undermining the Multiregional hypothesis.

Despite the power of these genetic studies, only the fossils can tell us what our ancestors ac-

Figure 3. 23,000-year-old remains of a woman from Paglicci, Italy were used for a comparative mtDNA study at the University of Ferrara. (Courtesy of Rignano Garganico.)

...tually looked like, what they actually did and where they actually lived. It is singularly satisfying that the White-Howell-Asfaw team has discovered fossilized human remains from the right place (Ethiopia) and time (about 160,000 years ago) that also have the right (modern human) anatomy. The authors of the Out of Africa hypothesis are celebrating.

I don’t expect that the subscribers of the Multiregional hypothesis will be waving a white flag of surrender, although they have lost the great majority of their supporters. At least one of the theory’s most ardent proponents, Wolpoff, is still steadfast in defense of the hypothesis he has so long espoused. While it remains possible that new findings will shift the balance in favor of the Multiregional viewpoint, the consilience of such evidence creates a powerful testament. It would take many new fossils and new genetic studies to recut this intellectual landscape.

**Bibliography**


