NEWS

In Search of the First Europeans

Who were the first people to set foot in Europe—and why did it take them so long to get there?

Spreading out. Archaeological sites record human expansion into Asia, then Europe.

SIERRA DE ATAPUERCA, SPAIN—Paleoanthropologist Juan Luis Arsuaga of the University of Madrid stands at the bottom of a towering limestone cliff just outside Burgos in northern Spain. Soaring above him, a meshwork of metal scaffolding blankets the 18-meter-high Gran Dolina, one of several hidden caves that were exposed in the late 19th century when a deep trench was dug through the hill for a mining railway.

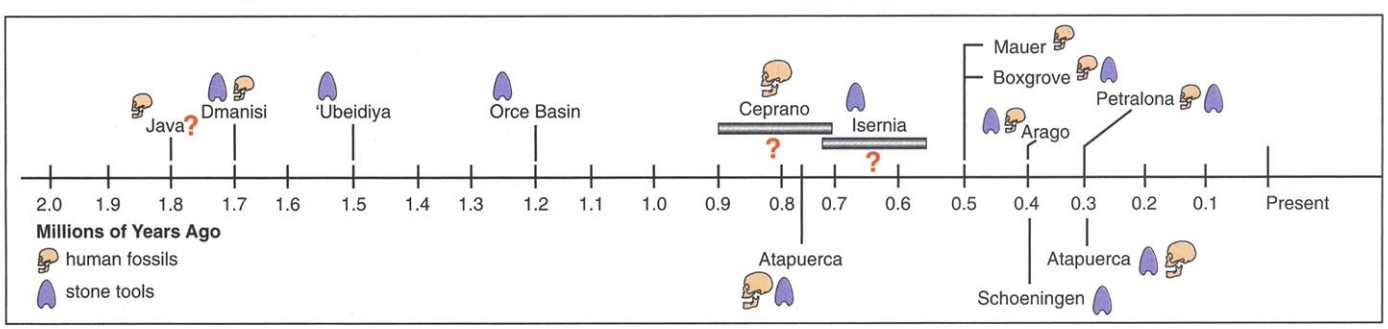
Here, in 1990, Arsuaga and his co-workers found five pieces of quartzite that appeared to be primitive stone tools—in stratigraphic levels thought to be close to 1 million years old. But at the time, many researchers believed there were no humans in Europe before about 500,000 years ago. So in June 1994, a small squad of excavators led by Arsuaga's colleague Eudald Carbonell of the University of Tarragona set out to dig in the Gran Dolina and prove the conventional wisdom wrong.

One day in early July, they struck pay dirt in a stratigraphic layer called TD6. First came some human teeth, then a fragment of a lower jaw, followed by pieces of limb bones, and finally, part of a skull. Just a few days earlier, paleomagnetics experts had reported their first results from TD6: The layer was nearly 800,000 years old, the oldest uncontested date for hominid fossils in Europe. The common wisdom was shattered. In these caves, said Arsuaga, looking up at the Gran Dolina, there were people as long as 1 million years ago.

And in another cave just a stone's throw away, called the Sima de los Huesos—the "Pit of the Bones"—the team has uncovered the remains of some 30 individuals whose bodies were apparently thrown there about 300,000 years ago. The amazing collection of hominid fossils in the Sima, the largest anywhere, may represent the ancestors of the Neandertals, who later lived throughout Europe and the Middle East. These fossils were found entirely by chance, says Arsuaga: "If the railroad had not been built here, we may never have found these caves." He adds that hominid bones rarely survive the elements to be preserved as fossils. Arsuaga believes that cannibalistic practices at Gran Dolina and early burial practices at Sima de los Huesos helped create this treasure trove of ancient human bones.

Atapuerca's riches are all the more prized because they are so rare. The region we now call Europe is only a short distance from Africa, the acknowledged birthplace of humans. Yet the archaeological and fossil record of the most ancient Europeans is frustratingly sparse. Although there are signs of early wanderers in Asia at least 1.7 million years ago and in the Middle East at 1.5 million years ago, early human colonizers seemed to have largely bypassed Europe. Only after 500,000 years ago—the age of an explosion of archaeological sites across Europe—did early humans take up residence on the continent, researchers thought (see timeline). Before that time, "there [was] so little data to go on," says archaeologist Mark Roberts of University College London (UCL), leader of recent excavations at Boxgrove in southern England, where early humans appear to have butchered horses 500,000 years ago.

But discoveries over the past decade have brought new insight into the waves of migration into Europe and Asia. Now most anthropologists agree that early humans frequented southern Europe beginning perhaps 1.2 million years ago. But there are only a handful of these most ancient sites, and many researchers aren't sure just what species name to give to the first Europeans, or how many species were here. There is even less agreement on where the first settlers came from and whether they gave rise to later Europeans. And yet the recent discoveries at Atapuerca and other sites in Spain and Italy indicate that Europe was more than just a neglected backwater during the early days of human evolution. "After Atapuerca, we have to rethink everything," says Roberts.



Short chronology goes long. An explosion of hominid remains appears in Europe about 500,000 years ago, but a handful of accepted European sites now date back as far as 1.2 million years ago.

A "short chronology"?

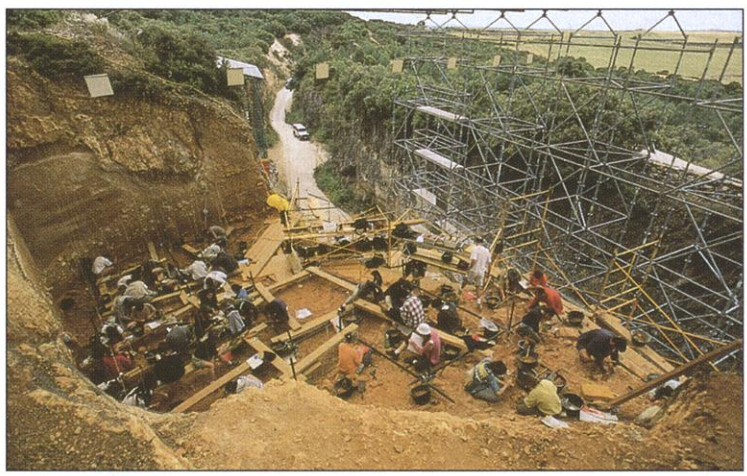
The migration story begins in Africa, where the human lineage was born some 2.5 million years ago. But just how many waves of migration left that continent, which species they

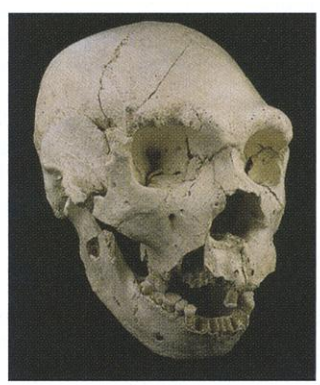
were, and where they went remains the subject of much speculation. There are a few solid data points, and the earliest suggest a very ancient migration out of Africa about 1.7 million or 1.8 million years ago. Most scientists now agree that simple stone tools and human bones discovered at Dmanisi, Georgia, indicate that humans were there at least 1.7 million years ago (*Science*, 12 May 2000, p. 948). The German-Georgian team that made the discovery believes that the remains belong to a tall, fully erect species called *Homo ergaster*, previously found only in Africa (see diagram on p. 1724) starting about 1.9 million years ago. Other researchers prefer to use the name *H. erectus* for these fossils as well as for many other human fossils found across Asia.

Many researchers believe *H. ergaster/H. erectus*, carrying simple Oldowan stone tools—named after the Olduvai Gorge where they were first found—left Africa early and spread widely. Signs of this early diaspora include Dmanisi as well as other, more contested finds. Hominid remains often attributed to *H. erectus* on the island of Java in Indonesia have been dated to 1.8 million years ago, for example. And hominid jaw and tooth fragments as well as stone tools dated to 1.9 million years ago have been found at Longgupo Cave in Sichuan province, China, although both claims have drawn varying degrees of skepticism. There are persistent, if not fully accepted, claims for even earlier sites in Pakistan and China, too. Later, beginning about 1.1 million years ago, there are many widely accepted human sites across Asia.

To researchers working in Europe, such ancient dates can only give rise to envy. Over the years there have been a smattering of widely disbelieved claims for stone tools and hominid fossils in France and Spain dating as far back as 2.5 million years ago, and somewhat stronger arguments for hominid activity between 700,000 and 1 million years ago at sites in France, Spain, and Italy. But in the early 1990s, many scientists questioned whether humans were in Europe before 500,000 years ago, when uncontested hominid remains and advanced stone tools begin to show up at far-flung sites such as Boxgrove, Tautavel in France, and Mauer in Germany.

In a widely debated article in the September 1994 issue of *Antiquity*, prehistorians Wil Roebroeks and Thijs van Kolfschoten at Leiden University in the Netherlands threw down the gauntlet by arguing for a "short chronology" of human occupation in Europe—no more than 500,000 years. They reviewed a number of southern European sites where claims had been made for stone tools dated at 700,000 years or earlier, including Le Vallonet in France, Isernia and Monte Poggiolo in Italy, and the Orce Basin in Spain. The pair argued that in nearly every case the dates were unreliable or the "tools" were more likely to have been created by natural erosion. They concluded that their theory would be very easy to falsify: "The finding of only one [earlier] site … would disprove it," they wrote. Ironically, while the *Antiquity* article was still in press, two hominid fossil discoveries were made that would do just that.





Atapuerca's riches. The Gran Dolina *(above)* yielded a 780,000-year-old partial skull *(left)*, while a nearby cave held an amazingly complete 300,000-year-old skull.

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Atapuerca and Ceprano

In March 1994, Italian scientists discovered a hominid skull—fragmented by the bulldozer that uncovered it—near the town of Ceprano, about 80 kilometers southeast of Rome. Dating of the clay layer in which the skull was found suggests that it might be 800,000 to 900,000 years old, although some experts prefer a safer age of about 700,000 years. Then in 1994 and 1995, the Spanish team found skull fragments in the Gran Dolina beds at Atapuerca. The paleomagnetic dates of about 780,000 years were later verified by electron spin resonance and radiometric methods on animal teeth from the same layers. Suddenly there were two very early sites—and they even seemed to represent different species.

The Ceprano skull resembles *H. erectus*, the only apparent sighting of this species in Europe, according to reconstructions by anthropologist Ron Clarke of the University of Witwatersrand in Johannesburg, South Africa, and by the Italian team, both published in the October 2000 *Journal of Human Evolution*. With features such as a massive browridge and a sharply angled occipital bone at the back of the skull, "to me the cranium appears very *erectus*-like," agrees paleoanthropologist Philip Rightmire of the State University of New York (SUNY), Binghamton.

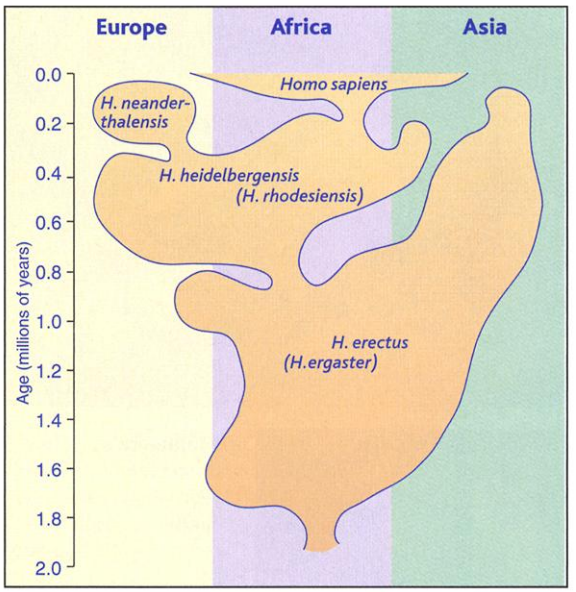
And a fragment of the Gran Dolina frontal bone and parts of an upper jaw and midface from a juvenile bear an eerie resemblance to modern humans. That was a shock, because the Gran Dolina people lived at least 600,000 years before most researchers believe modern humans evolved. The Spaniards concluded that the Gran Dolina skull represents a new human ancestor, which they call *Homo antecessor*. They argue that this hominid gave rise both to our own species—*H. sapiens*—and the Neandertals, although many of their colleagues are reluctant to accept that conclusion, given that the skull is fragmentary and comes from a juvenile (*Science*, 30 May 1997, p. 1331).

In any case, these finds put an end to the short chronology theory, at least for the whole of Europe. Roebroeks now concedes that the Gran Dolina skulls—as well as Oldowan-like stone tools from Orce, near Granada, which may be as old as 1.2 million years—do indeed disprove the theory. "The short chronology has been falsified for the Mediterranean," he says.

But Roebroeks argues that these few certified early sites in southern Europe represent an initial incursion into the continent that did not take permanent hold. He now proposes a "two-phase model" for the colonization of Europe: an early "intermittent occupation of the Mediterranean … followed by a substantial occupation of the Mediterranean and a significant, virtually continuous occupation

of the areas north of the Alps and Pyrenees mountains from about 500,000 to 600,000 years onward." This picture sounds right to many other scientists. "The hominid occupation ebbed and flowed with the changes in climate," says paleoanthropologist Russell Ciochon of the University of Iowa in Iowa City, with most occupations taking place during interglacial periods.

But Atapuerca may tell a somewhat different tale, UCL's Roberts says. The stratigraphic levels at the cave complex span several hundred thousand years of occupation, from the earliest levels to the most recent, estimated at about 250,000 years. "There are people there over a hell of a long time period," Roberts says. They held on "through a number of interglacial cycles and [were] able to survive quite extreme climates." Atapuerca team member Antonio Rosas of the National Museum of Natural Sciences in Madrid agrees that early humans probably began frequenting the area on a steady basis "beginning about 900,000 years ago."



Go with the flow. One view of how various human species might have dispersed in space and time.

The long journey

Even if people lived at Atapuerca for that long, anthropologists are left puzzling over the lack of evidence for an even earlier European occupation. If humans were already at Dmanisi, on the cusp between Europe and Asia, at least 1.7 million years ago, why did it take them so long to get to Europe proper? "The apparent time lag between Dmanisi and the first European traces is puzzling, but probably also very informative," says Roebroeks.

One possible answer is that the first migrants out of Africa turned east rather than west, perhaps steered by geology and climate. During the late Pliocene epoch, some 1.8 million to 2 million years ago, conditions might have been more favorable for sorties out of Africa than during the period of frequent glaciations that followed. And during the Late Pliocene there was a land bridge between Africa and Arabia at the southern end of the Red Sea. But that route led to Asia, not Europe. And although it's clear that humans reached the Middle East by 1.5 million years ago, because stone tools dating to this time have been found at 'Ubeidiya in Israel, the Taurus and Zagros mountains in Turkey and Iran present a "major barrier" to moving north and west into Europe, notes biologist Alan Turner of the University of Liverpool, U.K., in the September 1999 issue of *Antiquity*.

Some researchers see support for this scenario in the kinds of stone tools early humans left behind. The first wave out of Africa apparently used Oldowan tools, which show up in Africa about 2.6 million years ago. About a million years later, a more advanced toolmaking technology, called the Acheulean and consisting of hand axes and other carefully crafted symmetrical tools, apparently arose in Africa (see Review on p. 1748).

But Acheulean tools are rarely found in Asia beyond 'Ubeidiya, even in more recent sites, nor in any of the early European sites dating before 500,000 years ago. To explain this, in the early 1990s paleoanthropologist Nicholas Rolland of the University of Victoria in Canada proposed the "long journey" hypothesis. According to Rolland, early humans left Africa and colonized Asia before the Acheulean technology was invented. But the mountains prevented them from turning west. Much later, taking a more northern route through central Asia that avoided the most formidable ranges, these Oldowan-bearing hominids dispersed west into Europe, eventually showing up at sites such as Atapuerca and Orce. "The fact that hand axes do not appear in Europe until about 500,000 years ago suggests that hominids were trapped in the Levant and could not move north," says archaeologist Sarah Milliken of the University of Cork in Ireland. Adds paleoanthropologist Chris Stringer of the Natural History Museum in London, "We might have had a very complex situation in Europe, with people coming into the continent from different directions, including *Homo erectus* coming over all the way from the Far East."

But there are other possible explanations for the perplexing pattern of stone tool use. For example, Tarragona's Carbonell notes that Oldowan and Acheulean tool users overlapped in time in Africa, and he suggests that early humans there were split into two cultural groups. Competition between them may have driven the Oldowan users to migrate, leaving the Acheulean group to venture out later in an independent movement.

Another possible route for the first settlers of southern Europe, including the Atapuercans, would have been the most direct: directly across the Mediterranean from North Africa. The rise and fall of sea levels during the Pleistocene sometimes narrowed the Straits of Gibraltar to as little as six or seven kilometers, compared with its current width of 13 kilometers. And the straits between modern-day Tunisia and Sicily were at times dotted with islands. "Judging from the distributions of archaeological material, and the early dates in the south but not the north of Europe, early humans must have crossed the Straits of Gibraltar and very probably also the route into Sicily in the Early and Middle Pleistocene," says University of Oxford archaeologist Derek Roe. (The fossils on the island of Java suggest that humans may have had boats very early, but there is no direct evidence of such ancient seafaring.)

And however narrow these sea passages were, they do seem to have blocked the migrations of other large mammals, faunal experts note. "No large mammals from the Lower Pleistocene, nor fauna of an African origin, have been found" in Sicily, notes independent Spanish faunal expert Bienvenido Martinez-Navarro. Likewise, few claims for African mammals—with the exception of one giant baboon—showing up only in Europe are widely accepted, casting at least a shadow of a doubt on the Sicilian route. "Most of these dispersals can be explained as migrations from the Near East," says Jordi Agusti, a faunal expert at the Paleontological Institute in Sabadell, Spain.

A big bang

Whatever routes the first immigrants took into Europe, about 500,000 years ago a new species suddenly appeared, leaving substantial traces of its presence across the continent. At Mauer, near Heidelberg, Germany, where this hominid was first found in 1907, it left a massive mandible later dated to about 500,000 years ago. At Arago Cave, outside the town of Tautavel in southeastern France, its calling card was a partial skull some 400,000 years old and some substantial Acheulean stone tools. A similar skull, beautifully preserved and at least 300,000 years old, was found in the Petralona Cave in northeast Greece. And researchers at Boxgrove, on the Sussex coast of southern England, unearthed a 500,000-year-old hominid tibia and a cache of spectacular Acheulean hand axes. "Something happens at about 500,000 years ago," says Roberts. "You get a big bang [of hominid occupation], and

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the geographical area covered is much greater." After many millennia of sparse occupation, suddenly, "it's as though [early humans] said, 'OK, now let's do things properly,' " says archaeologist Clive Gamble of Southampton University in the United Kingdom.

Most researchers believe that this human was a different species from the more ancient Europeans. Its brain cavity ranged from about 1100 to 1300 cubic centimeters, compared to 1000 cubic centimeters or less for Asian *Homo erectus*, and it carried not simple Oldowan tools but Acheulean hand axes. Although opinions are divided as to what to call this European hominid, with some favoring *H. heidelbergensis* after its discovery in Germany and others simply calling it "archaic *Homo sapiens*," many researchers believe that it represents an intermediate step between *H. erectus* and full-fledged modern humans.

These new immigrants were able to firmly establish themselves in Europe where perhaps less hardy hominids had failed. "It seems that *Homo heidelbergensis* was better able to cope with fluctuations in climate," says Gamble. One possible reason is that its Acheulean tool kit allowed it to be a better hunter than earlier humans, who may have survived primarily by scavenging. At Boxgrove, for example, hominid remains are associated with animal bones bearing cut marks and other signs of butchering. Spectacular support for this view may come from Schoeningen, Germany, where 400,000-year-old wooden spears—the oldest uncontested hunting weapons—were found together with the skeletons of more than a dozen horses. "This is *Homo heidelbergensis* at its best!" enthuses Iowa's Ciochon. "It had superb hunting skills far outpacing [those of] any hominid that had come before."

The Atapuerca team believes that *H. antecessor* gave rise to *H. heidelbergensis*, but other researchers are not so sure. Instead, the origins of *H. heidelbergensis* might be traced to similar-looking hominid fossils in Africa, including skulls found at Bodo, Ethiopia, dated to at least 600,000 years ago, notes Ciochon. If the African origin is correct, a possible route for the migration of *H. heidelbergensis* out of the continent may be suggested at the site of Gesher Benot Ya'aqov, on the banks of the Jordan River in Israel (*Science*, 14 January 2000, p. 205; 11 August 2000, p. 944). Although there are no human bones at Gesher, Acheulean hand axes and cleavers closely resembling those found in Africa clock in at 780,000 years old. "One can argue that this species evolved [in Africa] ... and then spread quickly to western Eurasia" with the Acheulean tools, says SUNY's Rightmire.

Many researchers also think that *H. heidelbergensis* later gave rise to the Neandertals, who first appeared in Europe about 250,000 years ago and whose ability to survive in the cold climates of the Pleistocene was unequaled. Indeed, the Atapuerca team believes that the Sima de los Huesos skeletons are a transitional form between *H. heidelbergensis* and the Neandertals. For example, Atapuerca team member Rosas compared more than 30 of the 300,000-year-old mandibles found at Sima with those from Neandertals and other earlier species of *Homo*, including *H. erectus* and *H. heidelbergensis*, and concluded in the January 2001 *American Journal of Physical Anthropology* that a number of their features—such as the shape of the chin and the arrangement of the back molars—are ancestral to the Neandertal fossils.

But according to one leading theory of modern human origins, while this transition was taking place in Europe, the ancestors of modern humans—whatever species they were—remained in Africa. In this "Out of Africa" view, about 100,000 years ago, in one final explosion of migrations, modern humans began moving out of Africa, ultimately pushing the Neandertals and any other remaining hominids in the world aside. Some researchers strongly disagree with this scenario (see sidebar on p. 1728). But if it is true, the nearly 2 million years of hominid wanderings across Europe and Asia that preceded it merely set the stage for events to come. **–MICHAEL BALTER**

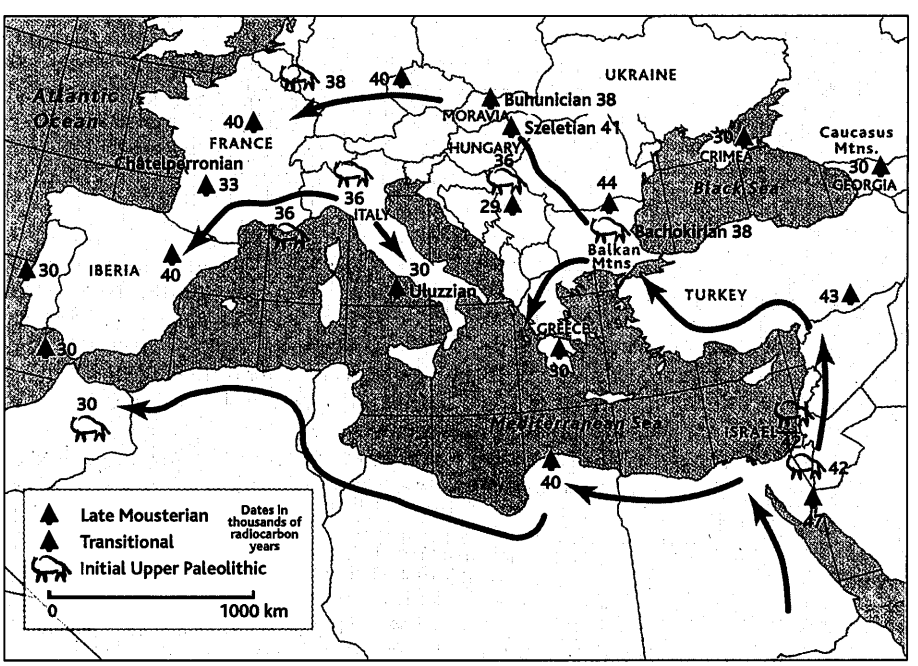
NEWS

The Riddle of Coexistence

Neandertals and modern humans lived side by side for thousands of years in Europe—with apparently dramatic consequences for each group

Forget first contact with aliens. For real drama, consider close encounters of the human kind. Forty thousand years ago, for example, our ancestors wandered into Europe and met another type of human already living there, the brawny, big-brained Neandertals. Such a collision between groups of humans must have happened many times. Several early human species coexisted in Africa, and when our ancestors left Africa and spread around the globe, they probably came across other kinds of humans, such as *Homo erectus*, who had left Africa in a previous migration. But the European encounter with Neandertals was probably the last such meeting. And so it has proven to be irresistible terrain for anthropologists and novelists alike, who often explore the same themes, including the question of sex (see sidebar on p. 1726), and come up with similar endings to the story: Anatomically modern Cro-Magnons arrive, prevail, and abruptly wipe out the brute Neandertals.

The real story from the archaeological and fossil records, however, is far more interesting. It suggests that Neandertals were neither stupid nor easily driven to extinction. They vanished about 25,000 to 30,000 years ago, and many researchers think that they were indeed replaced, with little or no interbreeding, by modern humans—although



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Cultural diversity. As modern humans and their sophisticated tools arrive from Asia (red), Late Mousterian tools made by Neandertals (black) persist in refugia in Europe and Asia. "Transitional" tools, perhaps made by both kinds of people (purple), also appear at this time.