PALEOANTHROPOLOGY

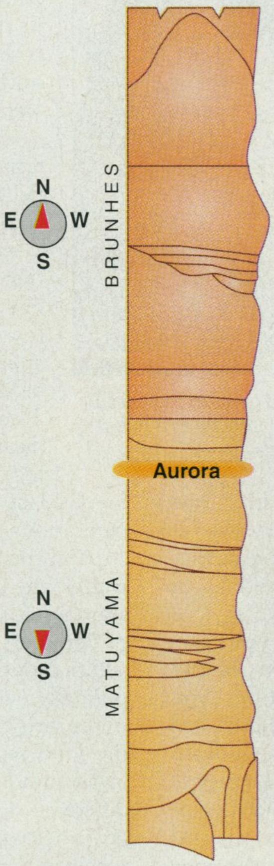
Remains in Spain Now Reign As Oldest Europeans

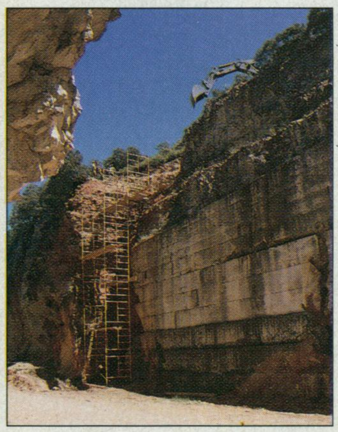
Although it's crowded with visitors this time of year, Europe hasn't always been a popular travel destination. For much of prehistory, human forerunners on the move gave the continent a wide berth. Protohumans began hoofing it out of Africa about 1.5 million years ago, but fossils show they went to Asia and the Middle East. Not a single bone—or undisputed stone tool site—occurs in Europe until about 500,000 years ago. Observes University of Michigan anthropologist Milford Wolpoff: "Europe has always stuck out like a sore thumb."

Now it appears that a thumblike protuberance from the continent—the Iberian peninsula—could plug this million-year-gap. On pages 826 and 830 of this issue, two teams of researchers report they have discovered fossil hominids (human precursors) and stone tools from caves in Atapuerca, in northeast Spain, that are at least 780,000 years old, and possibly older. The date makes these the oldest hominids, and the oldest stone tools that can confidently be attributed to them, in Europe.

These dates, derived from a magnetic "calendar" etched into the rocks of Atapuerca by periodic shifts in Earth's magnetic field, seem solid to researchers familiar with the work, such as dating expert Carl Swisher of the Berkeley Geochronology Center in California. Swisher calls the measurements "A-1 work," adding that "of all the European sites, this Atapuerca project is one of the best." Some skeptics, however, point out that earlier published dates for Atapuerca were much younger, and are adopting a wait-and-see attitude.

If the dates indeed hold up, the impact of the finds is "vast, simply vast," says anthropologist F. Clark Howell of the University of California at Berkeley. "We now have good dates, hominids, tools, and fauna where we had nothing before. We've gone from zero to 100%." The discoveries will allow researchers to investigate who the first Europeans were, he says, when they arrived from Africa, and how they lived. The hominids are quite primitive in appearance, says archaeologist Eudald Carbonell of the University of Tarragona, one of the team leaders, and could possibly be a new species of distant ancestors to better-known European descendants, the Neandertals, who appeared in Europe hundreds of thousands of years later.





XOSÉ PEDRO RODRIGUEZ

Pre-flip fossils. Rocks from Gran Dolina *(photo)* record a flip in Earth's magnetic field at 780,000 years ago, and new fossils from the "Aurora" level may predate it.

The finds, which include the fragmented remains of at least four hominids, including an adolescent and a child, come from a site called Gran Dolina. It is one of nearly two dozen sites dotting the honeycomb of limestone caverns in Atapuerca Hill. The area has been a treasure trove of fossils since the late 19th century, when a mining company blasted a railroad through the hill, exposing cross-sections of caverns crammed with bones and sediment.

The section encompassing Gran Dolina consists of 11 distinct rock layers. Carbonell and his colleagues found the bones in 1994, in a level called TD-6 that falls roughly in the middle of the sequence. That level had traditionally been thought to be about 500,000 years old, based on its paleomagnetic signature.

Magnetic minerals in sediments have their own tiny magnetic fields that, when the sediments are formed by heat and compression, swing like compass needles to point in the same direction as Earth's stronger field. But Earth's field periodically flip-flops, pointing sometimes at geographic north and sometimes south. So the tiny fields imprinted in sedimentary rocks that were formed during each flip provide a record of these changes. The timing of the flips has been well established, so tracking them through a stack of sediments allows researchers to deduce the age of the rocks.

The last major geomagnetic reversal occurred about 780,000 years ago, when a flip, known to geomagnetists as the Brunhes/Matuyama boundary, swung Earth's field from south to north. A decade ago, paleomagnetic work on the sedimentary rocks at Gran Dolina found a reversal that appeared to be the Brunhes/Matuyama boundary toward the bottom of the Gran Dolina sequence, which made TD-6, up above it, considerably younger, possibly in the neighborhood of 500,000 years old.

But geomagnetist Josep Pares of the Institute of Earth Sciences in Barcelona and his colleague A. Perez-Gonzalez suspected the location of the flip in the sediments might have been disguised by "overprints" of the subsequent Brunhes "normal" orientation, which made the boundary zone—the site and time of the flip—appear to be lower down in the sequence. When they heated the rocks to remove any such misleading overprints, they realized the major Brunhes/Matuyama boundary occurred not toward the bottom of the whole sequence, but above TD-6. Suddenly, everything in level TD-6 was older than 780,000 years, and its hominids were the oldest in Europe.

Although dating specialists such as Swisher believe this work to be accurate, some archaeologists are slightly skeptical. Wil Roebroeks, an archaeologist at the University of Leiden in the Netherlands, notes that while the site has "enormous importance independent of 200,000 years more or less," the re-evaluation seems to fit a pattern: "In general, sites seem to get older once hominids turn up." The type of mammals at this site, when found elsewhere in Europe, are often assigned younger ages, he argues, along with his colleague, Leiden paleomammalogist Thijs van Kolfschoten. But Carbonell responds that the mammals from TD-6 on which previous faunal dating estimates were based came from a small—and possibly misleading—sample.

No matter which date is finally assigned to them, the tools from TD-6 deepen an archaeological mystery. Although the African contemporaries of the Atapuercans, even at the older date, were making tools such as elaborate hand axes, those tools were conspicuously absent from Europe. The Atapuercans were using nothing fancier than rock flakes with a little retrimming around the edges. The same simplicity is seen in Asian tools from this period. Since Europeans and Asians presumably came from African roots, researchers wonder why the hand axe technology didn't travel. "Was it just a question of losing old habits on the road?" asks anthropologist Eric Delson of the American Museum of Natural History in New York City.

But the rudimentary toolkit prompts other paleoanthropologists to wonder about that road trip itself, and how such ill-equipped Atapuercan ancestors could have ventured so far in the world. "I fail to see how tools like that could give anyone an edge over a sabertooth!" says Clive Gamble of the University of Southampton, U.K.

The tools are not the only Atapuercan puzzle: the affinities of the hominids themselves are somewhat murky. Carbonell says anatomical details of the face suggest that the fossils are distinct from their only known non-African contemporaries, Asian hominids of the species *Homo erectus*. Instead, the researchers say, the fossils appear closer kin to finds from East Africa sometimes called *Homo ergaster*, although the Atapuercans had larger brains. Their teeth, however, share primitive traits with both the African and Asian forms. It may be necessary, Carbonell suggests, to name an entirely new species when more complete material emerges.

The bones also show some connection to later European fossils, although probably not to modern Europeans. Speaking from the field in July, Carbonell noted that while the Gran Dolina fossils are "very primitive, we think they are possibly related to later Europeans such as *H. heidelbergensis*." This is a group, about 400,000 years old, commonly thought to be ancestral to the better-known Neandertals, who appeared in Europe about 160,000 years ago and disappeared about 35,000 years ago, coincident with the advent of fully anatomically modern humans.

Howell, however, suggests it may be a bit early to place the Gran Dolina hominds in the Neandertal family album. If they are "somewhere between 700,000 and 1 million years old, and the next oldest humans in Europe are at 500,000," says Howell, "an awful lot can happen in half a million years." Early local populations such as the Atapuercans can go extinct, to name just one possibility, he notes.

More light on these relationships may be forthcoming, if omens are to be believed. Carbonell's team called the hominid-bearing stratum "Aurora" in honor of the name of the archaeology student who found the fossils. "But this word also means 'dawn' in Spanish," says Carbonell. "Perhaps these fossils represent a new dawn in the Paleolithic archaeology of Europe."

–JoAnn C. Gutin

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MALARIA

How the Parasite Disguises Itself

Like any protracted battle, the fight between the human immune system and the parasites that trigger malaria is fraught with sneak attacks and counterattacks. Sometimes, the immune system wins out. All too often, however, the malaria parasites sneak past the immune defenses and reach the blood vessels in the brain, where they kill their victim by blockading the brain's oxygen supply. Now, new intelligence from the trenches has uncovered the genes responsible for a key strategy that enables the malaria parasite to outsmart the immune system.

Work by three independent teams, one led by Russell Howard of the Santa Clara biotech company Affymax Research Institute, another by Thomas Wellems of the National Institute of Allergy and Infectious Diseases (NIAID), and the third by NIAID's Louis Miller, shows that the malaria parasite avoids detection by the immune system by switching between as many as 150 genes, each encoding a different version of a protein known as EMP-1 (for erythrocyte membrane protein 1). EMP-1, which is made by the parasite after it infects red blood cells, ends up on the surfaces of the cells, and anchors them to blood vessels in the brain and elsewhere. But the EMP-1's surface location also signals the parasite's presence to the immune system, so synthesizing new variants should help the parasite avoid detection. (The results appear in the 14 July issue of *Cell*.)

"Genetic, immunological, and biological data from three different labs have converged on the same group of proteins," says parasitologist Victor Nussenzweig of the New York University Medical Center in New York City. "It's important," he says, because "if you understand the mechanisms that cause cerebral malaria, perhaps you can find a way of preventing it." Such treatments are urgently needed; malaria kills more than two million people each year, often as a result of brain complications. And in many parts of the world, *Plasmodium falciparum*—the parasite that causes the most deadly form of malaria—is resistant to chloroquine, once the mainstay of malarial drug therapy.

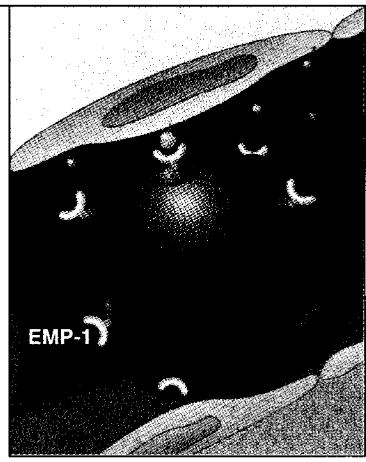

ILLUSTRATION: K. SUTLIFF

Blocking agent. EMP-1 anchors red blood cells to vessel wall.

In fact, the Wellems team originally stumbled on the new genes several years ago while searching for a gene responsible for chloroquine resistance. Three of their candidate genes turned out to be structurally similar, and further work showed they are members of a superfamily of up to 150 related genes scattered across the *P. falciparum* genome. While it soon became obvious that the genes had nothing to do with chloroquine resistance, they nonetheless piqued the Wellems team's interest, in part because they were peculiarly variable—so much so that Wellems and his colleagues dubbed the family the *var* (for variation) family.

The mystery of the *var* genes' function was eventually solved, in part, by Howard and his colleagues at Affymax. Howard has spent 10 years searching for the *P. falciparum* EMP-1 genes under the conviction that EMP-1 proteins—which have yet to be fully characterized—are central to the malaria parasite's disease-causing capabilities. By last August, the Affymax workers had finally identified two candidate genes and shown that, when inserted into bacteria, they synthesized EMP-1 as expected. When the Affymax and Wellems teams compared their genes' sequences, they found that they were looking at the same ones.

"We showed that the genes correspond to the EMP-1 proteins," says Howard, "and [Wellems] provides very nice evidence of a large family of genes, which means that the parasite has a great capacity for variation to evade the immune response." Other evidence that the *P. falciparum var* genes encode the EMP proteins came when Miller and Chris Newbold of the University of Oxford, U.K., showed that different *var* genes are turned on in malaria parasites that synthesize different types of EMP-1.

Indeed, earlier work from the Newbold laboratory had shown that about one in every 50 of a new generation of parasites secretes a different EMP-1 protein, although at that time the genes responsible for the changes were unknown. As a result, these altered parasites can dodge the immune responses that had been mounted against the original parasites, allowing them to set off a new wave of infection, and to lodge in the blood vessels of the brain and other organs.

Now that the genes responsible for that variation have been found, it's back to "the trenches," says Howard. The hope is that the *var* genes and the EMP-1 proteins they encode will eventually lead to some much-needed new anti-malarial drugs that can keep EMP-1 from attaching red blood cells to blood vessels.

–Rachel Nowak