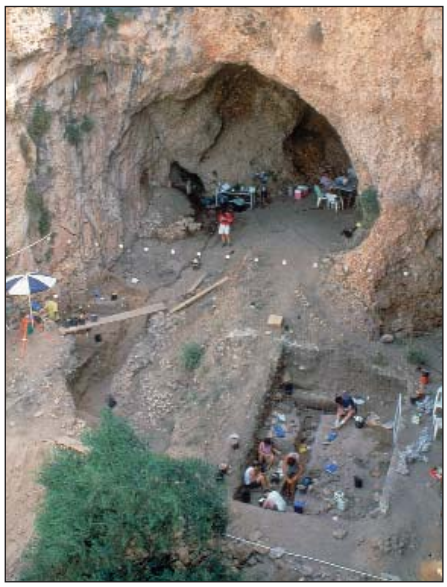


Ice age shelter. Neandertals lived in this cave in Amud, Israel, when the climate was cool and wet.

able to trace the plants the animals ate. They reconstructed climate so precisely that they could detect even seasonal differences in the climate experienced by Neandertals and early modern humans, say graduate student Kris Hallin of the University of Wisconsin, Madison, and her adviser Margaret Schoeninger of the University of California, San Diego.

"This is great work," says Stanley Ambrose of the University of Illinois, Urbana-Champaign. "It shows something very important about variation in climate at the annual scale." It also suggests how the two species adapted to different habitats and why they thrived at different times in Israel.

The first fossils of early modern humans and Neandertals were found in the region in the early 1930s, but for many years anthropologists thought Neandertals were ancestral to modern humans and so assumed that their fossils were older. Then in the 1980s, modern radiometric dating methods revealed that modern humans had occupied the caves of Qafzeh and Skhul as early as 110,000 to 92,000 years ago. The Neandertals inhabited the caves of Amud and Kebara considerably later, from about 70,000 to 50,000 years ago.

Harvard paleoanthropologist Ofer Bar-Yosef, noting that a 1980s study found that modern humans coexisted with African mammals and Neandertals with European ones, proposed that modern humans moved north into the region during the interglacial period 128,000 to 71,000 years ago. Then the cold-adapted Neandertals moved south to the same places during the last ice age, 70,000 years to 45,000 years ago. But uncertainties about the dating raised the possibility that the two types of humans could have met, since all the caves are within 100 kilometers of each other and often closer.

To explore whether the Neandertals and moderns took shelter in the caves under different climatic conditions, Hallin analyzed isotopes in fossil animal teeth. During the year or two that a tooth develops and erupts, it accumulates isotopes of carbon and oxygen. The ratio of carbon-13 to carbon-12 reflects whether an animal ate grasses in dry, open landscapes or plants in a more forested landscape. The variation of oxygen-18 to oxygen-16 reveals the season in which an animal consumed water, thus reflecting seasonal rainfall.

Hallin applied the method to the fossil teeth of goats and gazelles found in the hearths and garbage of the ancient humans. She found that those eaten by the modern humans at Qafzeh and Skhul grazed in dry grasslands and consumed little water except during winter rains—a climate similar to that of Israel today. Conversely, the animals eaten by Neandertals at Amud lived in a cooler climate in which it rained year-round. (The Neandertals ate more gazelles; the moderns, more goats.) "There was a major change in climate in Israel between the time that it was occupied by modern humans and the time when Neandertals were present," says co-author and geochemist Henry Schwarcz of McMaster University in Hamilton, Ontario.

To Bar-Yosef, the isotope work chiefly confirms the evidence from animal fossils. But Hallin's precise climatic reconstructions use animals that were apparently served up as ancient meals rather than simply found in the same layer as the humans. Thus the work adds new evidence to the idea that this region was an important crossroads, with moderns and Neandertals moving in and out as climatic conditions changed. And it shores up the case against coexistence, adds Tel Aviv University paleoanthropologist Yoel Rak. Neandertals and our ancestors, he says, "were not sitting in the caves playing cards together."

First Modern Remains in Europe

Three Romanian spelunkers were exploring the Transylvanian Alps last year when they came across a jawbone lying in the middle of a newfound cave. They took one look at the robust bone and knew it was very old, so they quickly contacted Romanian Academy scientist Oana Moldovan, who in turn called paleoanthropologist Erik Trinkaus of Washington University in St. Louis, Missouri. Trinkaus examined the bone last May and sawed off a sliver for radiocarbon dating. At the meetings he announced his results: The jaw is at least 35,000 years old—which makes it "the first modern human found in Europe."

Modern humans are thought to have swept into Europe about 40,000 to 35,000 years ago, swamping or replacing the Neandertals who had evolved there during the previous 400,000 years (*Science*, 7 March, p. 1525). Archaeologists have detected the moderns' entrance not by fossils but by the art and tools left behind, including blades, beads, and bone tools more sophisticated than those used by Neandertals. But although modern tools begin to appear in eastern Europe 40,000 years ago, only poorly dated scraps of modern human bones older than 32,000 years have been found.

"The jawbone is the earliest well-dated and identifiably modern human fossil in Europe so far, and that is important," says paleoanthropologist Chris Stringer of the British Museum of Natural History in London. The date, which is a minimum age, is unusually reliable because it was done on the human bone itself rather than associated animals, notes Robert Franciscus of the University of Iowa in Iowa City. A second lab is now confirming the results, says Trinkaus.



Chin up. This jawbone is the oldest in Europe with a modern chin.

Trinkaus reported at the meeting that the lower jaw has distinctly modern features such as a chin and a wide piece of bone in the back. But it also has some archaic traits, such as "huge" wisdom teeth, which he thinks link it with earlier archaic humans. Thus, although their tools may have been sophisticated, modern humans were still evolving anatomically as late as 35,000 years ago. Or, as Trinkaus says: "Early modern humans were not particularly modern."

–ANN GIBBONS

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