Finally, a Denisovan specimen from somewhere beyond Denisova Cave

Enlarge / The entrance of the cave is relatively flat with a gentle slope up to the inside, where two small trenches were plotted in 2018.
Dongju Zhang, Lanzhou University

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Denisovans, an extinct group of hominins that once walked alongside (and had sex with) Neanderthals and modern humans, are an enigmatic branch of our family tree. They left fragments of their DNA behind in modern human genomes across Asia, Australia, and Melanesia. But their only physical remains seem have been left in Denisova Cave in Siberia: just a finger, a few molars, a fragment of arm or leg bone, and a small chunk of skull.

But we're starting to piece together a little more of our mysterious cousins' story. A team of paleoanthropologists recently identified a new Denisovan fossil—half of an entire jaw. And it comes from the high altitude of the Tibetan Plateau in northern China, nearly 2,000km (1,200 miles) from Denisova Cave.

An accidental find

Half a lower jaw and a few teeth may not sound like much, but it's one of the largest pieces of a Denisovan skeleton that we know of so far. Its owner died at least 160,000 years ago, according to uranium-series dating of a thin crust of carbonate on the fossil, so the Denisovan from Tibet is about the same age as the oldest Denisovan unearthed so far at Denisova Cave.

Archaeologists weren't able to recover any DNA from the Tibetan fossil, but they did find ancient proteins preserved in the dentin (the layers below the hard outer enamel) of a tooth. DNA's code spells out instructions for making proteins, so the archaeologists compared the proteins from the jawbone with the proteomes (all the proteins a particular organism's DNA codes form) of modern humans, Neanderthals, and Denisovans. It most closely matched the Denisovan genome sequenced from a fossil at Denisova Cave. They also created a virtual model of the fossil with micro-CT scans in order to digitally "excavate" away the carbonate crust and get a better look at the jawbone's features.

A monk stumbled across the fossil in 1980, but it took several years to find its way to archaeologists. "We were all too busy to start the work on this mandible until 2010," anthropologist Dongju Zhang of Lanzhou University told Ars. No one was sure exactly where the specimen had come from, and without that information, it became a low priority. When Zhang and his colleagues started surveying the region in 2010 and eventually traced the mandible back to Baishya Karst Cave in 2016, they finally started work on the fossil.

- Xiahe mandible, only represented by the right half, was found in 1980 in Baishiya Karst Cave.
  Dongju Zhang, Lanzhou University
- The cave is facing southeast and about 40 meters above

the modern Jiangla riverbed in front of it. It is both a locally famous Buddhist cave and a famous tourist place.
Dongju Zhang, Lanzhou University

- The opening of the cave is about 5m-high and 7m-wide. Various Buddhist sacrifices were placed in the immediate entrance of the cave.
  Dongju Zhang, Lanzhou University
- The entrance of the cave is relatively flat with a gentle slope up to the inside, where two small trenches were plotted in 2018.
  Dongju Zhang, Lanzhou University
- A team led by Dongju Zhang (top right in the trench) were excavating in one of the two 2m trenches in Baishiya Karst Cave in 2018.
  Dongju Zhang, Lanzhou University
- Views of the virtual reconstruction of the Xiahe mandible after digital removal of the adhering carbonate crust.
  Jean-Jacques Hublin, MPI-EVA, Leipzig
- The mandible is so well preserved that it allows for a virtual reconstruction of the two sides of the mandible. Mirrored parts are in gray.
  Jean-Jacques Hublin, MPI-EVA, Leipzig
- Looking through the entire Jiangla River Valley at the upper reach of the valley. Ganjia Basin could be seen in the end of the valley.
  Dongju Zhang, Lanzhou University
- The autumn view of Jiangla River Valley where Baishiya Karst Cave is located.
  Dongju Zhang, Lanzhou University

Pleistocene encounters

The find means Denisovans had been living on the Tibetan Plateau at least 120,000 years before Homo sapiens arrived in the neighborhood. Surviving on the Tibetan Plateau, typically

about 3,280m (10,000 feet) above sea level, meant adapting to scarce resources, a chilly climate, and the thin air of higher altitudes. Those challenges selected for genetic traits that would help, and some of those traits got shared with the strange new species that moved into the area sometime between 30,000 and 40,000 years ago.

One of those alleles codes for a specific protein in the cells lining blood vessels, which helps a person function in hypoxic conditions at high altitude. The Denisovan version of that gene is still found in the genomes of modern Tibetans, Sherpas, and neighboring peoples. It's been a bit of a puzzle, given the low altitude of Denisova Cave (about 800m above sea level) and the fact that modern humans didn't arrive on the Tibetan Plateau until well after the latest fossil evidence we have of Denisovans.

But this find, and its date, suggest that modern humans had plenty of time to commingle with Denisovans in Tibet and that natural selection would have favored keeping that chunk of the Denisovan genome even when most of the rest of the genome got discarded.

The Xiahe mandible is also concrete evidence of how widespread Denisovan populations once were. The presence of fragments of Denisovan DNA in modern human genomes suggests that the species once had an extensive range, but the only physical traces we've found so far have come from a single site in Siberia, so we don't know much about their actual range. A 2018 study suggested that those traces actually came from at least two populations of Denisovans who had been separated for long enough to have genetic differences. That means humans encountered and mingled with Denisovans at least twice—and at a large enough scale to leave genetic traces behind 30,000 years later.

A comparison between the Denisovan genome recovered from a fossil fragment at Denisova Cave and fragments of Denisovan

DNA in modern human genomes suggests that both populations were recognizably Denisovan, but they'd split apart around 300,000 years ago. That find raises questions about how genetically diverse the Denisovans were and how many groups they branched into (and when) as they spread through their slice of the world.

"These two groups split more than 300,000 years ago and therefore could be almost as different, one from the other, as Neanderthals from Denisovans," anthropologist Jean-Jacques Hublin of the Max Planck Institute for Evolutionary Anthropology told Ars. (Analysis of Neanderthal and Denisovan genomes suggest that the two sister species diverged between 445,000 and 473,000 years ago.)

More Denisovans out there?

As usual, we still need more data to answer some burning questions about our past; the question of Denisovan diversity is just one among many. Paleoanthropologists also need more fossils from other areas to fully understand how much of the world the Denisovans once called home. At the moment, all we can definitely say about Denisovans' geographic reach is that they lived in Siberia and Tibet. "We need more fossil material outside of China, in particular in southeast Asia," Hublin told Ars.

But it's possible that some of those fossils have already been found and, like the Xiahe jawbone, are just waiting to be identified. For example, the molars in the lower jaw from Xiahe have some important features in common with molars from hominin lower jaws from Taiwan and north China. That's not enough to prove those hominins are Denisovans, of course, but ancient DNA or ancient protein analysis could test the idea if they've been preserved well enough. University of Copenhagen anthropologist Fredo Welker is optimistic. "I would have to say that although the Tibetan Plateau is colder, the proteome

recovered from the Xiahe mandible is not particularly rich (in other words, there are not many proteins preserved in the mandible),” he told Ars. Yet the team still managed to identify the fossil’s species based on those few preserved proteins.

“I therefore think it is reasonable to expect that other fossils can be identified as Denisovans or Denisovan-related hominins based on ancient protein analysis in the future,” said Welker.

Meanwhile, the search for new sites and new fossils continues. Zhang and his colleagues started excavations in Baishiya Karst Cave in 2018, and they plan to spend the next few years continuing that excavation and analyzing fossils and artifacts from the site. “And at the same time, we plan to do archaeological surveys in a much wider region on the Tibetan Plateau, hoping that we could find more good Paleolithic sites,” Zhang told Ars Technica.

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