

Oldest DNA reveals life in Greenland two million years ago

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A two million-year-old trunk from a larch tree is stuck in the permafrost within the coastal deposits at Kap Kobenhavn, Greenland. The tree was carried to the sea by the rivers that eroded the former forested landscape. Scientists have analyzed 2-million-year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Svend

Funder via AP

Scientists discovered the oldest known DNA and used it to reveal what life was like 2 million years ago in the northern tip of Greenland. Today, it's a barren Arctic desert, but back then it was a lush landscape of trees and vegetation with an array of animals, even the now extinct mastodon.

"The study opens the door into a past that has basically been lost," said lead author Kurt Kjær, a geologist and glacier expert at the University of Copenhagen.

With animal fossils hard to come by, the researchers extracted environmental DNA, also known as eDNA, from [soil samples](#). This is the genetic material that organisms shed into their surroundings—for example, through hair, waste, spit or decomposing carcasses.

Studying really old DNA can be a challenge because the [genetic material](#) breaks down over time, leaving scientists with only tiny fragments.

But with the latest technology, researchers were able to get [genetic information](#) out of the small, damaged bits of DNA, explained senior author Eske Willerslev, a geneticist at the University of Cambridge. In their study, [published Wednesday in the journal Nature](#), they compared the DNA to that of different species, looking for matches.

The samples came from a sediment deposit called the Kap København formation in Peary Land. Today, the area is a polar desert, Kjær said.



This illustration provided by researchers depicts Kap Kobenhavn, Greenland, two million years ago, when the temperature was significantly warmer than northernmost Greenland today. Scientists have analyzed 2-million-year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Beth Zaiken via AP

But millions of years ago, this region was undergoing a period of intense climate change that sent temperatures up, Willerslev said. Sediment likely built up for tens of thousands of years at the site before the climate cooled and cemented the finds into permafrost.

The cold environment would help preserve the delicate bits of DNA—until scientists came along and drilled the samples out, beginning in 2006.

During the region's [warm period](#), when [average temperatures](#) were 20 to 34 degrees Fahrenheit (11 to 19 degrees Celsius) higher than today, the area was filled with an unusual array of plant and animal life, the researchers reported. The DNA fragments suggest a mix of Arctic plants, like birch trees and willow shrubs, with ones that usually prefer [warmer climates](#), like firs and cedars.

The DNA also showed traces of animals including geese, hares, reindeer and lemmings. Previously, a [dung beetle](#) and some hare remains had been the only signs of animal life at the site, Willerslev said.



Professors Eske Willerslev and Kurt H. Kjaer expose fresh layers for sampling of sediments at Kap Kobenhavn, Greenland. Scientists have analyzed 2-million-

year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Svend Funder via AP

One big surprise was finding DNA from the mastodon, an [extinct species](#) that looks like a mix between an elephant and a mammoth, Kjær said.

Many mastodon fossils have previously been found from temperate forests in North America. That's an ocean away from Greenland, and much farther south, Willerslev said.

"I wouldn't have, in a million years, expected to find mastodons in northern Greenland," said Love Dalen, a researcher in evolutionary genomics at Stockholm University who was not involved in the study.

Because the sediment built up in the mouth of a fjord, researchers were also able to get clues about marine life from this time period. The DNA suggests [horseshoe crabs](#) and green algae lived in the area—meaning the nearby waters were likely much warmer back then, Kjær said.

By pulling dozens of species out of just a few sediment samples, the study highlights some of eDNA's advantages, said Benjamin Vernot, an ancient DNA researcher at Germany's Max Planck Institute for Evolutionary Anthropology who was not involved in the study.



This 2006 photo provided by researchers shows a close-up of organic material in coastal deposits at Kap Kobenhavn, Greenland. The organic layers show traces of the rich plant flora and insect fauna that lived two million years ago. Scientists have analyzed 2-million-year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Svend Funder via AP

"You really get a broader picture of the ecosystem at a particular time," Vernot said. "You don't have to go and find this piece of wood to study this plant, and this bone to study this mammoth."

Based on the data available, it's hard to say for sure whether these species truly lived side by side, or if the DNA was mixed together from different parts of the landscape, said Laura Epp, an eDNA expert at Germany's University of Konstanz who was not involved in the study.



This 2006 photo provided by researchers shows geological formations at Kap Kobenhavn, Greenland. At the bottom of the section, the deep marine deposits are overlain by the coastal deposits of fine sandy material. The two people at the top are sampling for environmental DNA. Scientists have analyzed 2-million-year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Svend Funder via AP

But Epp said this kind of DNA research is valuable to show "hidden diversity" in ancient landscapes.

Willerslev believes that because these plants and animals survived during a time of dramatic climate change, their DNA could offer a "genetic roadmap" to help us adapt to current warming.

Stockholm University's Dalen expects ancient DNA research to keep pushing deeper into the past. He worked on the study that previously held the "oldest DNA" record, from a mammoth tooth around a million years old.



This 2006 photo provided by researchers shows the landscape at Kap Kobenhavn, Greenland. The many hills have been formed by rivers running towards the coast. Scientists have analyzed 2-million-year-old DNA extracted from dirt samples in the area, revealing an ancient ecosystem unlike anything seen on Earth today, including traces of mastodons and horseshoe crabs roaming the Arctic. Credit: Kurt H. Kjaer via AP

"I wouldn't be surprised if you can go at least one or perhaps a few million years further back, assuming you can find the right samples," Dalen said.

More information: Kurt H. Kjær et al, A 2-million-year-old ecosystem in Greenland uncovered by environmental DNA, *Nature* (2022). [DOI: 10.1038/s41586-022-05453-y](https://doi.org/10.1038/s41586-022-05453-y)

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