

Oldest-ever human genetic evidence clarifies dispute over our ancestors

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Skeletal remains of Homo antecessor. Credit: Prof. José María Bermúdez de Castro

Genetic information from an 800,000-year-old human fossil has been retrieved for the first time. The results from the University of Copenhagen shed light on one of the branching points in the human family tree, reaching much further back in time than previously possible.

An important advancement in [human evolution](#) studies has been achieved after scientists retrieved the oldest human genetic data set from an 800,000-year-old tooth belonging to the hominin species *Homo antecessor*.

The findings by scientists from the University of Copenhagen (Denmark), in collaboration with colleagues from the CENIEH (National Research Center on Human Evolution) in Burgos, Spain, and other institutions, are published April 1st in *Nature*.

"Ancient protein analysis provides evidence for a close relationship between *Homo antecessor*, us (*Homo sapiens*), Neanderthals, and Denisovans. Our results support the idea that *Homo antecessor* was a sister group to the group containing *Homo sapiens*, Neanderthals, and Denisovans," says Frido Welker, Postdoctoral Research Fellow at the Globe Institute, University of Copenhagen, and first author on the paper.

Reconstructing the human family tree

By using a technique called [mass spectrometry](#), researchers sequenced ancient proteins from dental enamel, and confidently determined the position of *Homo antecessor* in the [human family tree](#).



A tooth of Homo antecessor was studied using ancient protein analysis. Credit: Prof. José María Bermúdez de Castro

The new molecular method, palaeoproteomics, developed by researchers at the Faculty of Health and Medical Sciences, University of Copenhagen, enables scientists to retrieve molecular evidence to accurately reconstruct human evolution from further back in time than ever before.

The human and the chimpanzee lineages split from each other about 9-7 million years ago. Scientists have relentlessly aimed to better understand the evolutionary relations between our species and the others, all now extinct, in the human lineage.

"Much of what we know so far is based either on the results of ancient DNA analysis, or on observations of the shape and the physical structure of fossils. Because of the chemical degradation of DNA over time, the oldest human DNA retrieved so far is dated at no more than approximately 400.000 years," says Enrico Cappellini, Associate Professor at the Globe Institute, University of Copenhagen, and leading author on the paper.

"Now, the analysis of ancient proteins with mass spectrometry, an approach commonly known as palaeoproteomics, allow us to overcome these limits," he adds.



Digital reconstruction of specimen ATD6-69 from the Homo antecessor collection. Computerized microtomography (micro-CT) techniques were used to perform this reconstruction. Credit: Prof. Laura Martín-Francés.

Theories on human evolution

The fossils analyzed by the researchers were found by palaeoanthropologist José María Bermúdez de Castro and his team in 1994 in stratigraphic level TD6 from the Gran Dolina cave site, one of the archaeological and paleontological sites of the Sierra de Atapuerca, Spain.

Initial observations led researchers to conclude that Homo antecessor was the last common ancestor to [modern humans](#) and Neanderthals, a conclusion based on the physical shape and appearance of the fossils. In the following years, the exact relation between Homo antecessor and other human groups, like ourselves and Neanderthals, has been discussed intensely among anthropologists.

Although the hypothesis that Homo antecessor could be the common ancestor of Neanderthals and modern humans is very difficult to fit into the evolutionary scenario of the genus Homo, new findings in TD6 and subsequent studies revealed several characteristics shared among the human species found in Atapuerca and the Neanderthals. In addition, new studies confirmed that the facial features of Homo antecessor are very similar to those of Homo sapiens and very different from those of the Neanderthals and their more recent ancestors.

"I am happy that the protein study provides evidence that the Homo antecessor species may be closely related to the last common ancestor of

Homo sapiens, Neanderthals, and Denisovans. The features shared by Homo antecessor with these hominins clearly appeared much earlier than previously thought. Homo antecessor would therefore be a basal species of the emerging humanity formed by Neanderthals, Denisovans, and modern humans," adds José María Bermúdez de Castro, scientific co-director of the excavations in Atapuerca and co-corresponding author on the paper.



Gran Dolina preserves a long-term record of Pleistocene hominin populations.
Credit: Prof. José María Bermúdez de Castro.

Findings like these are made possible through an extensive collaboration between different research fields: from paleoanthropology to biochemistry, proteomics and population genomics.

Retrieval of ancient genetic material from the rarest fossil specimens requires top quality expertise and equipment. This is the reason behind the now 10-years-long strategic collaboration between Enrico Cappellini and Jesper Velgaard Olsen, Professor at the Novo Nordisk Foundation Center for Protein Research, University of Copenhagen and co-author on the paper.

"This study is an exciting milestone in palaeoproteomics. Using state-of-the-art mass spectrometry, we determined the sequence of amino acids within protein remains from Homo antecessor dental enamel. We could then compare the ancient protein sequences to those of other hominins, for example, Neanderthals and Homo sapiens, to determine how they are genetically related," says Jesper Velgaard Olsen.

"I really look forward to seeing what palaeoproteomics will reveal in the future," concludes Enrico Cappellini.

More information: The dental proteome of Homo antecessor, *Nature* (2020). [DOI: 10.1038/s41586-020-2153-8](https://doi.org/10.1038/s41586-020-2153-8) , [nature.com/articles/s41586-020-2153-8](https://www.nature.com/articles/s41586-020-2153-8)

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