First ancient proteome revealed

Mammoth femur yields 126 prehistoric proteins.

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Mammoth bones have yielded proteins that could help to elucidate the animals' evolutionary history.

An international group of scientists has managed to identify 126 distinct protein sequences from a 43,000-year old bone from a woolly mammoth (*Mammuthus primigenius*).

The study, in the *Journal of Proteome Research*[1], unleashes the field of palaeoproteomics by identifying prehistoric protein sequences that could be used to help identify species, evolutionary relationships and even, perhaps, ancient diseases. Proteomic analysis could therefore be used as an alternative to DNA analysis in samples that are too degraded to contain any genetic material.

Protein sequences have previously been published for dinosaur fossils, including a 68-million-year-old *Tyrannosaurus rex*[2] and an 80-million-year-old hadrosaur[3], but the results have proved controversial (see Origin of '*T. rex*' protein questioned).

These and other ancient protein studies have identified "one or a few" of the most abundant proteins in bone, such as collagen, says Enrico Cappellini, a postdoc at the Centre for GeoGenetics at the Natural History Museum of Denmark in Copenhagen and lead author of the study.

Cappellini thought it was possible to do better, so he worked with researchers at the University of Copenhagen's Novo Nordisk Foundation Center for Protein Research and elsewhere, using state-of-the-art mass spectrometry to study samples from a mammoth femur found in permafrost in Yakutia, Russia in 1993.

He says that the team refined every stage of the technique — usually used for modern samples that have plenty of high-quality material — to maximize sensitivity to the trace amounts of protein, and developed strict controls to eliminate contamination. The researchers found, for instance, that they had to abandon the use of latex gloves after picking up peptides from the rubber tree (*Hevea brasiliensis*).

Previous analysis of the same mammoth's DNA had revealed that the animal probably had a dark-coloured coat[4]. Cappellini says he has no similar revelations. "We searched desperately for information relating to the biology of mammoths," he says, but to no avail.

Even so, Mary Schweitzer, a palaeontologist at North Carolina State University in Raleigh and part of the team that reported the dinosaur proteins, says that the study is “very exciting”, because it is the first to recover such a large number of ancient proteins. “This study holds hope for rigorous molecular testing of phylogenetic hypotheses using biomolecules other than DNA,” she says.

Prolific proteins

In addition to collagen, the team identified a range of proteins involved in the extracellular matrix of bone and several blood proteins, including albumin. The researchers are particularly excited about albumin because, unlike collagen, its amino-acid sequence varies quite a lot between species, so its sequence might be able to be used to identify species or to study phylogenetic relationships.

As expected, the mammoth’s protein sequences were most closely related to those of modern-day elephants, but the researchers did see some differences — mammoth albumin, for instance, had different amino acids in two places compared with today’s African and Asian elephants (*Loxodonta africana* and *Elephas maximus*, respectively).

Protein sequences don’t provide as much information as DNA, but they are more stable, so researchers hope that they might linger in ancient samples even after the DNA has degraded. Ancient proteomics could therefore provide information about the function of proteins that isn’t contained in an animal's DNA, and even in theory at least, be used to look for signs of mutations that could indicate the presence of ancient diseases.

But first, Cappellini wants to investigate how well proteins survive in different conditions and the mechanisms by which they degrade. He and his team was also able to identify 35 proteins in a mammoth found in the Dent excavation site in Colorado and 19 in a mammoth found in the La Sena site in Nebraska[1], both of which were found in much warmer climates in the United States. That shows that the technique can be used even in ancient samples that haven't been preserved through freezing.

“Now we can go back in time and see what we can detect in older samples,” Cappellini says. Next he plans to study remains that are hundreds of thousands of years old.

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References

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