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Prehistoric animals offer new evolutionary hints as riddles persist

Remnants of ancient bears and other mammals in Europe reveal the challenges and potential rewards of understanding why species went extinct.

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In the prehistoric times of Neanderthals and early modern humans, one of Europe's largest-ever bear species roamed the land and inhabited its caves.

But the cave bear, weighing up to one tonne, died out some 25 000 years ago. Its bones have been found in caves located from England to Russia.

Competing views

Possible reasons for this case of animal extinction include human exploitation and climate change, with the demise coinciding with the coldest part of the last Ice Age. At this time, the cave bear may have been vulnerable as a result of an inflexible diet that excluded meat.

Another mystery is why today's brown bears, which are closely related to cave bears and diverged from their lineage about 1.5 million years ago, survived the same conditions.

'One explanation is that the cave bear maybe lacked flexibility in its food resources, which made it vulnerable to ecosystem changes caused by climate modifications,' said Dr Ioana Meleg, a palaeogeneticist at Babes-Bolyai University in Cluj-Napoca, Romania.

The work of Meleg and other scientists highlights the extraordinary difficulties involved in seeking both to explain key evolutionary moments and to draw contemporary lessons for animal survival and protection.

Herbivores and omnivores

While the brown bear is omnivorous, earlier studies of the protein collagen in bones indicated the cave bear was herbivorous. As a result, it may have been unable to adapt to eating meat in cold spells when plants were scarcer.

The hope of researchers is that more insight into the extinction of such species will expand knowledge about how animals as a whole adapt to environmental change.

‘Those types of investigations are time machines that offer the opportunity to access snapshots of deep-time dynamics via ancient biomolecules,’ said Meleg, who studied ecology in subterranean environments for her doctorate.

While at the Swedish Museum of Natural History in Stockholm, she led a European team that received EU funding to carry out genetic sequencing of cave-bear populations with varying diets, creating the most comprehensive genomic data set for the animals to date.

Called Evolution, the project ran for two years until the end of September 2022. Meleg and her colleagues are still analysing the results, some of which may be announced later this year.

Carpathian conundrum

One conundrum related to the cave bear’s diet persists. It’s unusual for such a large terrestrial animal with carnivorous relatives to have become completely herbivorous.

Present-day bears such as giant pandas that have largely or partly herbivorous diets are much smaller.

Some answers may lie in cave bears that lived in Romania’s Carpathian Mountains and that Meleg’s team has focused on.

Unusual ratios of two forms of nitrogen previously found in their fossils had suggested that these animals, unlike cave bears elsewhere in Europe, may have eaten meat as well as plants.

But in a more recent analysis, Meleg and other researchers concluded that the finding was instead evidence of a wider plant diet than that of other cave bears. Meleg said even this would normally have been a survival advantage for the Carpathian bears.

‘When there seems to be ecological flexibility, you would think that would allow you to cope with whatever happens in the environment,’ she said.

Her team is still assessing why Romanian cave bears had a wider plant diet and why it didn’t spare them from extinction.

Meleg thinks it may ultimately boil down to a lack of meat in the diet even when food became scarcer, creating a greater vulnerability to extreme shifts in climate. Natural disasters such as volcanic eruptions could have compounded the plight.

‘Strict herbivory might have made the cave bear more vulnerable to decreases in plant biomass and quality related to colder climates,’ Meleg said.

A cave bear skeleton exhibited in Meziadului Cave, Apuseni Mountains, North-western Romania. © Viorel-Traian Lascu, 2022

Teeth samples

Fossils from the prey of extinct humans also dangle the promise for scientists of shedding light on the effects of past climate change.

In the EU-funded EnvINExt project, Dr Emilie Berlioz is analysing samples of ancient animal teeth from both sides of the Pyrenees, starting at Isturitz in France and La Viña in Spain.

The specimens, from herbivores including red deer, reindeer, ibexes and horses, date from between 35 000 and 57 000 years ago, according to Berlioz, a palaeontologist at the University of Cantabria in the Spanish city of Santander.

During the period in question, anatomically modern humans – Homo sapiens – emerged from Africa and replaced the Neanderthals after the two species briefly coexisted.

EnvINExt runs for two years until the end of August 2024. Over the course of the project, Berlioz aims to study specimens from eight more locations, mainly in northern Spain.

She is the project's principal investigator and expects preliminary results later this year.

A key method being used by Berlioz is 3D dental microwear analysis, which examines microscopic features that form on teeth and that provide information about diet in the days leading up to death.

Hunting grounds

Knowing where animals were pursued and killed gives a clearer picture of how Neanderthals lived, hunted and ate and how these activities evolved in response to climate developments.

Aside from climate factors, there are competing theories about why the Neanderthals disappeared around 40 000 years ago. These include interbreeding with Homo sapiens, competition for resources and disease.

'It's probably a composite answer,' said Berlioz.

She believes that understanding how climate change affected Neanderthals' prey, which made up more than half their daily food intake, will help provide an explanation.

Teeth capture physiological, ecological and climatic information and, as a result, mirror past environments.

Earlier studies in which Berlioz participated – in the Dordogne region of France, for example – suggest that the Neanderthals continued to hunt in open, tundra-like grassland amid various climatic fluctuations that caused forests to expand and shrink, altering their value as food sources at different times.

In EnvINExt, she's seeking to build on this analysis to provide a fresh perspective on the environmental conditions faced by Neanderthals and their prey in this part of Europe.

By evaluating dental evidence from 10 archaeological sites, including information on feeding behaviour over seasons and years and in different habitats, the project will attempt to reveal links between local environmental conditions and global climate changes.

Research resolve

The fundamental question is whether climate played a major role in the Neanderthals' disappearance or was just one factor among many.

'If you take a wider look at environmental variations through time during the Neanderthals' existence, they had already previously experienced tough climatic situations that they survived,' she said.

As EnvINExt seeks elusive answers to such tricky questions, Berlioz expresses no doubt about the potential value of such research for considerations about climate adaptation today.

'Palaeontologists and archaeologists can provide a long-term perspective of relationships among humans, animals and the environment that is complementary to the short-term approach of biologists,' Berlioz said.

Meleg in Romania echoed the point with regard to her project.

'The overarching aim is to find sustainable approaches for ecosystem resilience to help counteract biodiversity decline related to increasing anthropogenic impacts and climate change,' she said.

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