Megafaunal extinctions driven by too much moisture

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Studies of bones from Ice Age megafaunal animals across Eurasia and the Americas have revealed that major increases in environmental moisture occurred just before many species suddenly became extinct

around 11-15,000 years ago. The persistent moisture resulting from melting permafrost and glaciers caused widespread glacial-age grasslands to be rapidly replaced by peatlands and bogs, fragmenting populations of large herbivore grazers.

Research led by the Australian Centre for Ancient DNA (ACAD) at the University of Adelaide, published today in *Nature Ecology and Evolution*, has revealed that the ancient bones preserve direct biochemical evidence of the environmental upheavals, which can be traced through time.

Using 511 radiocarbon dated bones from animals such as bison, horse, and llamas the team was able to investigate the role of environmental change in the mysterious megafaunal extinctions, which claimed the vast majority of existing large land animals such as giant sloths and sabre-toothed cats.

"We didn't expect to find such clear signals of moisture increases occurring so widely across all of Europe, Siberia and the Americas," says study leader Professor Alan Cooper, ACAD Director. "The timing varied between regions, but matches the collapse of glaciers and permafrost and occurs just before most species go extinct.

The international team of researchers, including the University of Alaska Fairbanks, University of Oslo, the Yukon Government, and palaeontologists across Russia and Canada, measured nitrogen isotopes preserved in dated ancient animal bones and teeth recovered from permafrost areas and caves across Europe, Siberia, North and South America. They found distinctive biochemical signals reflecting massive increases of moisture on the landscape.

"Grassland megafauna were critical to the food chains. They acted like giant pumps that shifted nutrients around the landscape", says lead

author Dr Tim Rabanus-Wallace, from the University of Adelaide. "When the moisture influx pushed forests and tundras to replace the grasslands, the ecosystem collapsed and took many of the megafauna with it."

The head of Blue Babe, a mummified ice age bison, rests recently in a lab at the University of Alaska Museum of the North. The bison, uncovered near Fairbanks in 1979, was first described by Dale Guthrie, now professor emeritus. Most of Blue Babe's skin was preserved and is now publicly displayed on a model at the museum, but the head and horns were kept frozen. Professor Matthew Wooller and others are now analyzing them to improve our understanding of Blue Babe's environment. The work includes extraction of collagen from the bones for nitrogen isotope analysis. Credit: Photo by Matthew Wooller

"The idea of moisture-driven extinctions is really exciting because it can also explain why Africa is so different, with a much lower rate of megafaunal extinctions and many species surviving to this day,, says Professor Cooper. "Africa's position across the equator means that grassland zones have always surrounded the central monsoon region. The stable grasslands are what has allowed large herbivores to persist - rather than any special wariness of hunters learned from humans evolving there."

Professor Matthew Wooller, of the University of Alaska Fairbanks, says: "We find that on different continents the climate changes happened at different times, but they all showed that moisture increased massively just prior to extinction. The really elegant feature of this study is that it produces direct evidence from the fossils themselves - these extinct creatures are informing us about the climate they experienced leading up to their own extinctions."

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