Combining DNA and fossil evidence to understand how pine martens evolved through the Ice Age

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For this study, Dr. Leigha Lynch extracted DNA from pine marten specimens preserved in natural history museum collections. Credit: OSU Vert Paleo

The Pleistocene Epoch, often called the Ice Age, was a dynamic time of

fluctuating environmental conditions, but understanding exactly how animals evolved throughout this time can be challenging. New research by Dr. Leigha Lynch brings together DNA and fossil data to re-assess what scientists know about the evolution of North American pine martens.

Pine martens are small mammals closely related to weasels and badgers, and today they are widespread across North America. For this new study, published in the *Journal of Mammalian Evolution*, Lynch, an alumnus of East Tennessee State University and postdoctoral research associate at Washington University in St. Louis, was particularly interested in the story of two living species of American marten: Martes americana and Martes caurina.

"I chose martens for this study because I was really interested in understanding the environmental context under which these species evolved," Lynch says. She explains that most small carnivores have a very patchy fossil record, making it difficult to understand their history, but that "this isn't the case with martens and so it was really a great system to test this question in."

These two marten species both evolved from a shared ancestor during the Late Pleistocene. By comparing DNA between them and estimating rates of genetic change, researchers can calculate how long ago that evolutionary split occurred, and how the different species evolved from there. Previous research using these methods have estimated that this split happened right at the end of the Ice Age, less than 20,000 years ago.

But fossil data can help anchor these estimates by providing precise information on where and when these species lived throughout the Ice Age. In this new study, Lynch used data on marten fossils from all over the continent, from the Appalachians to California to Canada. With DNA and fossil evidence combined, she was able to estimate a much

earlier date for the two species' split, between 230,000 and 540,000 years ago. As glaciers waxed and waned, the species appear to have repeatedly separated, expanded, and reconnected over tens of thousands of years.

Lynch says this research suggests the martens were experiencing fluctuating habitats and climates throughout their evolution. "Today we know the species are fairly behaviorally plastic, meaning they can modify hunting, nesting, and locomotor behaviors easily depending on their habitat and prey density," she says. "I think this knowledge coupled with their evolution through fluctuating climates really suggests that being flexible was advantageous through the Pleistocene."

Understanding how species have been shaped by environmental changes in the past helps researchers to infer how they'll continue to react to future change. Scientists are continuously refining how best to use genetic and fossil data to interpret evolutionary history. "I think recent research is really showing that the combination of these forms of data is the way to go," Lynch says. "The difficulty is finding appropriate fossils to use as calibration points. So, the limiting factor here unfortunately is the fossil record itself."

More information: Leigha M. Lynch. Fossil Calibration of Mitochondrial Phylogenetic Relationships of North American Pine Martens, Martes, Suggests an Older Divergence of M. americana and M. caurina than Previously Hypothesized, *Journal of Mammalian Evolution* (2019). DOI: 10.1007/s10914-019-09476-7

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