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MYSTERIOUS EXTINCT GLYPTODONTS ARE ACTUALLY GIGANTIC ARMADILLOS, SAYS THEIR DNA

STUDY OF ANCIENT DNA REVEALS THAT THE HUGE ARMORED MAMMALS ORIGINATED LATER THAN PREVIOUSLY THOUGHT

New research reveals that the evolutionary history of glyptodonts—huge, armored mammals that went extinct in the Americas at the end of the last ice age—is unexpectedly brief. The work, published this week in the journal *Current Biology* by an international team of researchers, confirms that glyptodonts likely originated less than 35 million years ago from ancestors within lineages leading directly to one of the modern armadillo families. More surprising still, the study finds that the closest relatives of glyptodonts—some species of which may have weighed two tons or more—include not only the giant armadillo (*Priodontes maximus*), which can weigh up to 25 pounds, but also the four-ounce pink fairy armadillo, or pichiciego (*Chlamyphorus truncatus*).

Although scientists like Charles Darwin collected partial remains of glyptodonts in the early 19th century, at first nobody knew what kind of mammal they represented. It was eventually accepted that glyptodonts must be related in some way to armadillos, the only other New World mammals to develop a protective bony shell. However, because of the many physical differences between these two groups, most paleontologists have held the view that they must have separated very early in their evolutionary history.

This might have remained the final word on glyptodont relationships had it not been for two molecular phylogeneticists—Frédéric Delsuc of the French National Center for Scientific Research (CNRS) at the University of Montpellier (France) and Hendrik Poinar of McMaster University (Canada)—who were interested in studying the relationships of living xenarthrans, a group of placental mammals that includes anteaters and tree sloths as well as armadillos. To make their study as comprehensive as possible, they wanted to include genomic evidence from extinct species using so-called "ancient" DNA techniques. They contacted Ross MacPhee, a curator in the American Museum of Natural History's Department of Mammalogy who studies recent extinctions, for help in acquiring suitable material. With the assistance of South American colleagues at the Argentinian Museum of Natural Sciences in Buenos Aires and the Museum of La Plata, MacPhee presented them with a wide range of specimens. As is often the case in ancient DNA investigations, fossil genomic material is poorly preserved, and only one sample worked—a carapace fragment of an undetermined species of *Doedicurus*, a gigantic glyptodont that lived until about 10,000 years ago. Using a novel approach to recover genetic information from ancient specimens, the team successfully assembled the complete mitochondrial genome of *Doedicurus* and compared it to that of all modern xenarthrans.

"Ancient DNA has the potential to solve a number of evolutionary questions, but it is often extremely difficult to obtain endogenous DNA, that is, DNA actually belonging to the animal being sampled, rather than some contaminant," Poinar said. "In this particular case, we used a technical trick that allowed us to selectively enrich our *Doedicurus* DNA extract so that we had enough endogenous genetic material to work with."

Together, Delsuc and Poinar developed a set of computer-reconstructed ancestral sequences to design probes used for fishing *Doedicurus* mitochondrial fragments out of the complex ancient DNA extract in order to be able to reconstruct the complete mitogenome of this glyptodont.

The researchers found that instead of representing a very early, independent branch of armored xenarthrans, glyptodonts likely had a much later origin, from ancestors within lineages leading to the modern armadillo family Chlamyphoridae.

"Contrary to what is generally assumed about the distinctiveness of glyptodonts, our analyses indicate that they originated only some 35 million years ago, well within the armadillo radiation," Delsuc said. "Taxonomically, they should be regarded as no more than another subfamily of armadillos, which we can call Glyptodontinae."

Although the relationships of *Doedicurus* and its relatives are now more fully resolved, puzzles remain. Why did supersized armadillos evolve in the first place? Glyptodonts were not the only evolutionary experiment of this sort. Pampatheres, another group of extinct armadillos, also attained large sizes, but only up to about 440 pounds. Unfortunately, none of the pampathere specimens sampled for ancient DNA have yielded any genetic information so far.

The authors also point out that they were unable to identify any morphological features that confirm the close relationship of relatively enormous glyptodonts and much smaller living armadillos. This might be partly due to the limitations of fossil evidence. However, with the new genomic evidence challenging existing concepts of glyptodont evolution, paleontologists will be eager to test the molecular evidence with additional physical traits.

Finally, the researchers note that glyptodonts were a very successful group for most of their history and that the cause of their disappearance remains a major scientific question.

"Despite their ungainly appearance, different species of glyptodonts occupied habitats as distinct as open grassland and dense woodland, all the way from Patagonia to the southern parts of the continental United States," MacPhee said. "Although their disappearance has been blamed on human depredation as well as climate change, some species persisted into the early part of the modern or Holocene epoch, long after the disappearance of mammoths and saber-toothed cats. Like the loss of giant ground sloths, mastodons, and dozens of other remarkable mammalian species, the precise cause of the New World megafaunal extinctions remains uncertain."

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