

# The rise of the mammals

An asteroid strike put an end to the dinosaurs 66 million years ago, making way for mammals to thrive – that much we know. But how exactly did our ancestors go about their march to dominance? Stephen Brusatte and Sarah Shelley introduce an unassuming fossil that holds some of the answers.

Edward Drinker Cope named more than 1,000 species and published nearly 1,500 papers during his long career in vertebrate palaeontology. He worked on everything, from fish and frogs to sea-living reptiles and dinosaurs. But in 1881 he announced a discovery that stood above the rest. In the characteristic understatement of a 19th-century gentleman scientist, Cope boasted that the new fossil would be remembered as 'an important event in the history of palaeontological science'. He wasn't referring to a charismatic dinosaur of colossal size or an early branch of the human family tree. Instead, he was talking about an unassuming little mammal called *Periptychus*, just about the size of a dog, found in the dusty badlands of the American Southwest.

Cope's excitement was prophetic. *Periptychus* may look like nothing more than a cute pet, but it and a growing number of other mammal fossils are now helping us better understand one of the pivotal moments of Earth history. At the end of the Cretaceous, about 66 million years ago, a 10-kilometre-wide asteroid slammed into what is now Mexico. It rudely interrupted a world

in which dinosaurs were dominant, and had been for more than 100 million years. The asteroid hit with the force of several million nuclear bombs, unleashing a torrent of tsunamis and wildfires and sending dust into the stratosphere, blocking out the sun and poisoning the atmosphere. Ecosystems were devastated and many plants and animals went extinct. When things eventually settled down and the Earth recovered, dinosaurs were nowhere to be found

primates and, later, to us. But surprisingly we still know little about when and how mammals started their march to dominance. Why did some mammals survive the extinction but not dinosaurs? How quickly did mammals diversify after the asteroid? When did the major groups of living mammals like rodents, elephants and primates originate?

*Periptychus* and its kin seem to hold the key. These so-called 'archaic' mammals thrived during the first few million years

“When rapid environmental change occurs, animals and ecosystems that have been successful for millions of years can suddenly disappear.”

and mammals were everywhere.

This is one of the classic stories in Earth science, repeated to every first-year geology student. The asteroid knocked out the dinosaurs making way for mammals, which had been living in the shadows for tens of millions of years, to prosper, eventually leading to

after the dinosaurs died out, during a time called the Paleocene (66-56 million years ago). They were the very mammals that took the reins from *Tyrannosaurus* and *Triceratops*, establishing a new world in which mammals invaded nearly every conceivable environment across the globe and ascended to the top of

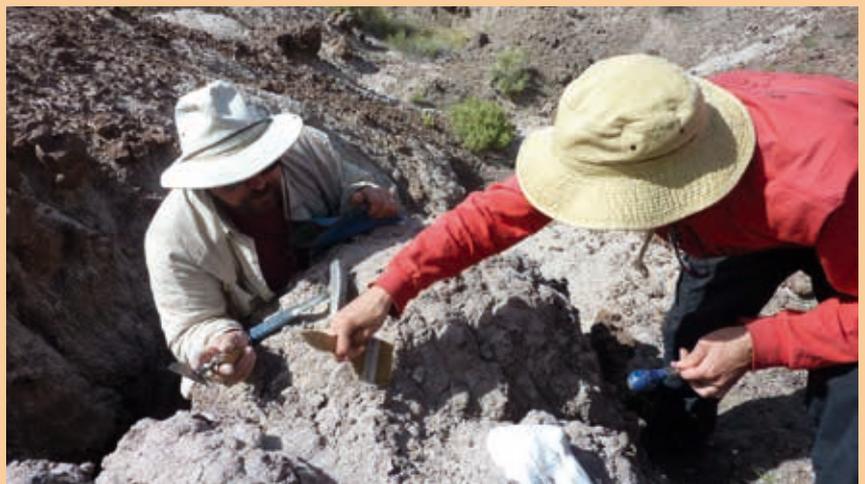


the food chain in many ecosystems. But surprisingly, after the initial fossil discoveries by Cope and other 19th- and early-20th-century palaeontologists, research on these archaic Paleocene species nearly died out itself. As dinosaurs and fossil hominids grabbed the headlines and research funds, *Priptychus* and other Paleocene mammals became an afterthought.

But now a new generation of scientists is returning to these Paleocene fossils because of their obvious importance in understanding a major interval of environmental change. We have been working in New Mexico (USA), one of the best places in the world to find both the latest Cretaceous dinosaurs and the Paleocene mammals that replaced them. We are doing fieldwork with our colleague Thomas Williamson, who for more than two decades has been scouring the San Juan Basin area of north-western New Mexico in the hunt for new fossils. Our joint work in the Paleocene-aged Nacimiento Formation is aimed at finding new Paleocene mammals, tracking the diversity of mammals across this interval, and better understanding the environments they lived in.

Working in New Mexico harkens back to the early days of palaeontology, when explorers would fan out to remote corners of the globe in search of the unknown. Fieldwork in the San Juan Basin probably hasn't changed much since Cope's day. Although New Mexico is within the borders of one of the most economically developed countries in the world, a lot of unexplored territory and many undiscovered fossils remain. Most of the state is vast, empty desert: it is a third larger than the UK in land area, but has only 3 per cent of the population. When we're out prospecting in the barren, candy-striped hills it isn't uncommon to go entire days without seeing other people.

Our field expeditions over the past five years have produced many new fossils and an emerging picture of what happened to mammals before, during, and after the end-Cretaceous mass extinction. We've discovered spectacular new specimens of big plant-eating mammals like *Pantolambda* and *Ectoconus* (a close cousin of *Priptychus*), fast-running species like *Tetraclaenodon*, weird burrowers like *Wortmania*, and bizarre rodent-like mammals called multituberculates. Our team has also



used radiometric dating to place these fossils in time, analysed sediments and isotopes to reconstruct the environments they lived in, and used diversity analysis to look at broad evolutionary trends during this dynamic period of mammal evolution.

There's still plenty to do but an evolutionary picture is coming into focus. Mammals did not pass through the mass extinction unscathed; the close relatives of modern marsupials were decimated but the hitherto unspectacular placentals (mammals that give live birth to well-developed young) weathered the storm and radiated in the aftermath. This radiation was rapid: within a few hundred thousand years at most there were complex ecosystems with mammals of many sizes, up to about cow size, filling many niches, eating different types of

food, and living in the ground, on the land and in the trees.

So it looks like the end-Cretaceous extinction was a knife-edge moment in evolution. Right up until the asteroid impact dinosaurs prospered, then the environment rapidly changed and very quickly entirely new animals – placental mammals – moved in and took over. There is surely a lesson here: when rapid environmental change occurs, animals and ecosystems that have been successful for millions of years can suddenly disappear and the world changes in an instant. When this happened at the end of the Cretaceous it set in motion a chain of events which led, eventually, to humans. If it happens again, who knows where that unpredictable chain could lead.

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