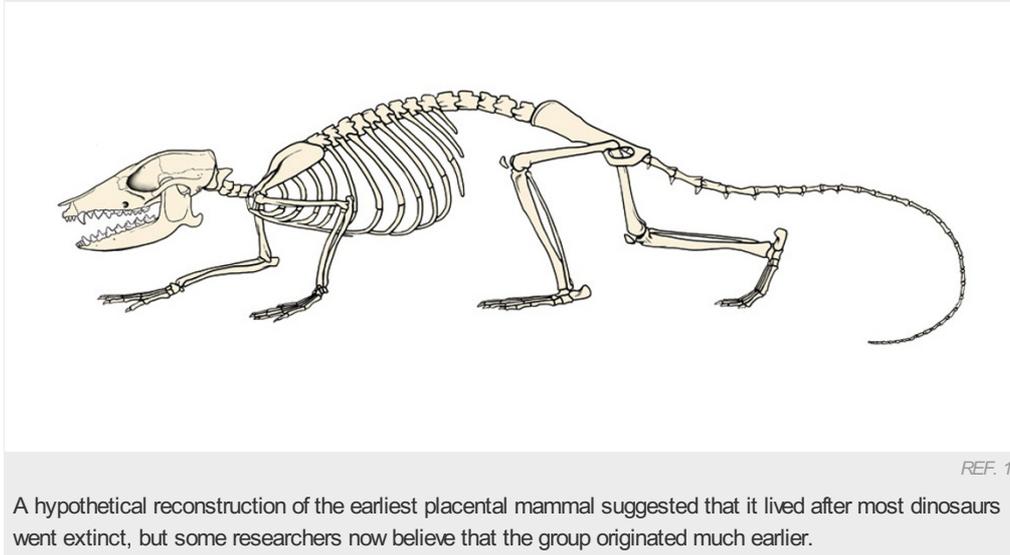


Debate over which mammals roamed with the dinosaurs

Genetic tree challenges fossil-based conclusion that placental mammals emerged only after mass extinction.

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15 January 2014



Did the first mammal with a placenta live alongside the dinosaurs — or did it emerge after a gigantic asteroid wiped them out? This is the subject of a heated debate that pits scientists who contend that fossils are the ultimate timekeeper of life's history against researchers who say that genetics offers more reliable dates.

Such disputes have been waging for decades, since researchers first began gleaning evolutionary detail from proteins and DNA. But the skirmish over placental mammals — animals that give birth to live offspring that are in late stages of development, including whales, mice and humans — began with a paper¹ published early last year, arguing that the group diversified **only after those dinosaurs that did not evolve into birds went extinct**, 65 million years ago.

For that study, Maureen O'Leary, an evolutionary biologist at Stony Brook University in New York, and her team spent several years characterizing and analyzing thousands of traits in dozens of living and fossil mammals. The team combined those characteristics with genetic data to build a giant tree of life, showing how different placental mammals related to one another.

But to establish when the different creatures evolved, the researchers looked only at the fossil record. They concluded that the earliest placental mammals appeared only after the asteroid impact that killed the dinosaurs and marked the end of the Cretaceous period and the beginning of the Palaeogene. After this, the team said, the placentals quickly diversified, and a menagerie of mammals filled the habitat niches left by the dinosaurs.

Phil Donoghue, a palaeobiologist at the University of Bristol, UK, and his collaborators were not convinced. O'Leary's work was "an incredibly impressive study in all aspects — except the timescale in evolutionary history", he says. "What we were really concerned about is that this stuff was going to end up in textbooks."

Fossil boundary

Now, Donoghue and evolutionary geneticists Mario dos Reis and Ziheng Yang of University College London publish a study in *Biology Letters*², saying that O'Leary's team made a fatal error in assuming that lineages of species date back no further than their oldest fossils. The fossils should instead mark the minimum age for a lineage, says Donoghue, because it is likely that animals existed before that, but were not preserved as fossils or their remains have yet to be discovered.

Using a mathematical elaboration of this concept and genome data from dozens of mammals, Donoghue's team calculated new dates for the placental-mammal family tree. The researchers conclude that placental mammals first emerged between 108 million and 72

million years ago — well before the (non-avian) dinosaurs disappeared.

The critique follows an August 2013 technical comment³ on O'Leary's paper, in which an independent group also took umbrage with the suggested Palaeogene origin, because, they said, it requires a dramatic increase in the rate of evolution to explain the early diversity of placental mammals.

Hard evidence

O'Leary says that her team wanted to avoid introducing a bias by assuming that placental mammals are older than suggested by the fossil evidence. But Anne Yoder, an evolutionary geneticist at Duke University in Durham, North Carolina, prefers Donoghue, dos Reis and Yang's approach. "It's hard to say who's right and who's wrong, but the weight of the data support the dos Reis conclusion," she says.

Yoder adds that discoveries have the potential to harmonize molecular and fossil dates. A decade ago she concluded, using genetic data, that the common ancestor of bush babies and lorises lived around 40 million years ago⁴, even though the oldest fossil was less than 20 million years old. While her paper was in press, a team reported a more than 40-million-year-old fossil that matched her predictions⁵.

As for the current debate, "early placental mammals found in the Cretaceous will settle this once and for all", says Yoder. O'Leary agrees that the question will be decided by fossil evidence, not mathematical models. "I don't see this as a problem that's going to be solved by a computer," she says.

Nature | doi:10.1038/nature.2014.14522

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