How mass extinctions drove the evolution of dinosaurs

January 3 2014

For 20 privileged Victorians, Benjamin Waterhouse Hawkins held a lavish New Year's dinner party in 1853 inside a model of a dinosaur that was created for the Great Exhibition held two years earlier. Hawkins's models, which still stand in Crystal Palace Park in London, were the first life reconstructions of dinosaurs. They gripped the public imagination, and dinosaurs have never left it since.

Yet today, dinosaurs are stereotypical symbols of failure, because, apart from birds, none of their lineage have survived. A massive meteorite strike caused their mass extinction about 65 million years ago. But this

event negatively skews our perception of the dinosaur story. In fact, far from failures, dinosaurs were highly successful.

Dinosaurs reigned as the dominant large vertebrates on land for 135 million years, twice the length of time of mammal dominance which followed the dinosaur extinction. During this time dinosaurs diversified into more than 1,000 ecologically and morphologically diverse species. They lived on all continents including Antarctica and ranged in size from pigeon-sized species weighing less than 1 kg up to 70 tonne herbivorous giants that were the largest animals to ever walk on land. While most attention has been on their extinction, a more interesting question is: how and why did the dinosaurs become so successful?

Our research team at the University of Birmingham and the Lapworth Museum are hoping to unravel the story of dinosaur origins in the Triassic period. Now is an exciting time to research dinosaurs. In the last two decades the rate of discovery of new dinosaur fossils and species has rapidly increased – a new dinosaur species is now named every 1.5 weeks. Our research team alone has described 11 new species since 2005.

The first dinosaurs appear in the fossil record around 240 million years ago, in the Middle Triassic. Growing evidence suggests that dinosaur origins may have formed part of the long-term recovery of ecosystems from the Permo-Triassic (PT) mass extinction. The PT extinction was the most severe in the history of Earth, and was probably driven by intense volcanic eruptions and associated rapid climate change. This extinction decimated many of the earlier reptile and amphibian groups, and may have created environmental space for dinosaurs and other new groups to evolve.

For the first 40 million years of their evolution dinosaurs remained the minority in a world ruled by other reptile groups – those with obscure

names such as therapsids, aetosaurs and rauisuchians. Our research is focused on understanding this "long fuse" in dinosaur evolution. By combining evolutionary trees with data such as body size, we are able to quantitatively and explicitly test hypotheses about the timing, rate and processes of the dinosaur radiation.

At the end of the Triassic, 200 million years ago, many of the other reptile groups died out in the Triassic-Jurassic mass extinction, again linked to massive volcanic activity and climate change. Dinosaurs survived, and rapidly increased in diversity and underwent dramatic size increases, marking the onset of the age of dinosaurs.

Why dinosaurs survived this extinction, but other groups of reptiles did not, is still poorly understood. However, as palaeontologists understand more about dinosaur biology, we are beginning to recognise that unique features such as rapid growth rates or highly efficient bird-like lungs may have helped dinosaurs prosper as others died out.

The story of dinosaur evolution appears, therefore, to have been driven by three enormous extinctions caused by rapid, traumatic and massive environmental change. The first, at the end of the Permian, created environmental space for dinosaurs to evolve. The second, at the end of the Triassic, allowed dinosaurs to rise to dominance and evolve seemingly unfeasible body sizes. And the third, at the end of the Cretaceous, brought the dinosaurs their doom.

As we head into another mass extinction, this time driven by humans, the fossil record, including that of dinosaurs, provides unique insights into the role of mass extinction in shaping and altering the course of evolutionary history.

Provided by The Conversation