Ammonites' fate sealed by meteor strike that wiped out dinosaurs

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Ammonites basking under the Late Cretaceous sun. Credit: Artwork by Callum Pursall

Ammonites were not in decline before their extinction, scientists have found.

The marine mollusks with coiled shells, one of paleontology's great icons, flourished in Earth's oceans for more than 350 million years until they died out during the same chance event that wiped out the dinosaurs 66 million years ago.

Some paleontologists have argued that their demise was inevitable and that ammonite diversity was decreasing long before they went extinct at the end of the Cretaceous.

However, new research, published in *Nature Communications* and led by paleontologists at the University of Bristol, shows that their fate was not set in stone. Instead, the final chapter in ammonite evolutionary history is more complex.

"Understanding how and why biodiversity has changed through time is very challenging," said lead author Dr. Joseph Flannery-Sutherland. "The fossil record tells us some of the story, but it is often an unreliable narrator. Patterns of diversity can just reflect patterns of sampling, essentially where and when we have found new fossil species, rather than actual biological history.

"Analyzing the existing Late Cretaceous ammonite fossil record as though it were the complete, global story is probably why previous researchers have thought they were in long-term ecological decline."

To overcome this issue, the team assembled a new database of Late Cretaceous ammonite fossils to help fill in the sampling gaps in their record.

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"We drew on museum collections to provide new sources of specimens rather than just relying on what had already been published," said co-author Cameron Crossan, a 2023 graduate of the University of Bristol's Palaeobiology MSc program. "This way we could be sure that we were

getting a more accurate picture of their biodiversity prior to their total extinction."

Using their database, the team then analyzed how ammonite speciation and extinction rates varied in different parts of the globe. If ammonites were in decline through the Late Cretaceous, then their extinction rates would have been generally higher than their speciation rates wherever the team looked. What the team instead found was that the balance of speciation and extinction changed both through geological time and between different geographic regions.

"These differences in ammonoid diversification around the world are a crucial part of why their Late Cretaceous story has been misunderstood," said senior author Dr. James Witts of the Natural History Museum, London. "Their fossil record in parts of North America is very well sampled, but if you looked at this alone, then you might think that they were struggling, while they were actually flourishing in other regions. Their extinction really was a chance event and not an inevitable outcome."

To find out what was responsible for the continued success of ammonites through the Late Cretaceous, the team looked at potential factors that might have caused their diversity to change through time. They were particularly interested in whether their speciation and extinction rates were driven mainly by environmental conditions like ocean temperature and sea level (the Court Jester Hypothesis), or by biological processes like pressure from predators and competition between ammonites themselves (the Red Queen Hypothesis).

"What we found was that the causes of ammonite speciation and extinction were as geographically varied as the rates themselves," said co-author Dr. Corinne Myers of the University of New Mexico. "You couldn't just look at their total fossil record and say that their diversity

was driven entirely by changing temperature, for example. It was more complex than that and depended on where in the world they were living."

"Paleontologists are frequently fans of silver bullet narratives for what drove changes in a group's fossil diversity, but our work shows that things are not always so straightforward," Dr. Flannery Sutherland concluded. "We can't necessarily trust global fossil datasets and need to analyze them at regional scales. This way we can capture a much more nuanced picture of how diversity changed across space and through time, which also shows how variation in the balance of Red Queen versus Court Jester effects shaped these changes."

More information: Late Cretaceous ammonoids show that drivers of diversification are regionally heterogeneous, *Nature Communications* (2024). DOI: 10.1038/s41467-024-49462-z

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