Extreme environmental conditions can lead to a massive global reshuffling of biodiversity

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Around 252 million years ago, the world experienced a mass extinction, killing ninety percent of all animal and plant species in the world's oceans. This event, called the Permian-Triassic mass extinction, at the end of the Permian Age had consequences beyond simple loss of species: In the following five million years, the pattern of the global distribution of biodiversity appeared to be very different from those before and after this time period.

"Today, and many times during the earth's history, we see that species diversity peaks in the tropics and decreases towards the poles. This is known as the latitudinal gradient of biodiversity. During the Early Triassic (about 252 to 247 million years before today), however, this was not the case. Instead, in the world's oceans, there were roughly the same number of species from the tropics to the poles—the latitudinal diversity gradient was almost flat," explains Dr. Shan Huang, a scientist at the Senckenberg Biodiversity and Climate Research Centre.

Huang investigates how climate, earth surface processes and biodiversity interact on different time scales, which is known as geobiodiversity. In the current study, she and her collaborators analyzed 52,000 fossils of marine organisms from the late Permian to Triassic period (254 million years to 201 million years ago). Among them are algae, unicellular organisms, invertebrates and vertebrates from all oceans.

Huang and her team have an idea what might have leveled the field of global biodiversity—the extreme global environmental conditions during the Early Triassic. Features include an ocean warm-up by ten degrees and a lack of oxygen in the world's oceans which lead to a collapse of tropical ecosystems. The fossil record also shows that biodiversity became more evenly distributed because species that survived the mass extinction tended to be widespread and the extreme environmental condition hindered accumulation of endemic species like today's tropical biota.

Once the environmental turmoil was over, the biodiversity switched back to its 'usual' pattern in which species diversity was highest in the tropics. "We see that in this case environmental change was the driving force beyond the shifts in biodiversity distribution. This is in contrast to previous work which identified temperature as the main driver of biodiversity distribution," says Huang. All in all, the fossil record indicates that environmental stability is crucial for maintaining a rich tropical marine fauna while dramatic climate changes may damage tropical ecosystems in particular.

"If we were to make a projection about the future based on this past, the take-home-message is: Tropical marine ecosystems which includes coral reefs will be the first major victims of rapid global change. The evidence that this process of destruction has already begun has been documented. Our study provides further evidence from the past about how this might play out. Also, modern climate change might demand a substantial reconfiguration of how global biodiversity is distributed around the world, and species that cannot change their ranges accordingly will go extinct," Huang says.

More information: Haijun Song et al. Flat latitudinal diversity gradient caused by the Permian–Triassic mass extinction, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1918953117

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