Marine fossils show location as important as area for biodiversity

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(Phys.org)—Science has charted a close relationship between the number of species in a given region and the area of the region. This relationship has been documented for many present-day environments, where it can be used to estimate the number of species that will be lost if an area of a given size is eradicated through human actions.

A new paper by University of Cincinnati master's graduate Anne J. Lagomarcino and UC geology professor Arnold I. Miller, published in *PLOS ONE*, extends this concept into ancient marine environments, and shows that some environments support more biodiversity than others, even if they areas are equal.

Lagomarcino and Miller used large databases of paleontological information, notably the Paleobiology Database with sophisticated mapping tools and analytical methods to define diversity in two different types of marine environments in the late Cretaceous period (around 65 million to 100 million years ago).

"Today," Miller said, "it is easier to sample diversity on land. In the fossil record, it is easier to find marine fossils, so it is easier to study marine environments."

One of the two major environments the co-authors studied cannot be found among today's marine regions – "epicontinental" seas, large, shallow bodies of water atop continental plates that were widespread in the past and harbored substantial reservoirs of biodiversity. The second environment is open-ocean-facing marine settings that were also present in the past and persist today along the edges of modern continents.

In an earlier paper published in *Science*, Miller compared extinction rates between these environments throughout the late Paleozoic and Mesozoic Eras, which including a widespread extinction at the end of the Cretaceous period. He found that open-ocean-facing environments suffered higher extinction rates than epicontinental sea environments during three major extinction events that occurred during the study interval. The evidence suggested that poor circulation in the epicontinental seas may have impeded the spread of the environmental catastrophes that caused the extinctions.

The new research shows that these distinct environments also exhibit different levels of diversity per unit area. In general, Lagomarcino and Miller found that, for an area of a given size, there was greater diversity in the epicontinental seas than in the open-ocean-facing environments. Again, the evidence suggests that water circulation may have a significant role.

"Differences in physical properties between the two environments are likely associated with the biological differences we observe," Miller said. "There was a relative lack of circulation in these very broad, shallow seas, like the one that covered Cincinnati and much of the rest of North America at the time when its famous Ordovician rocks and fossils were deposited."

In general, Lagomarcino and Miller found that epicontinental seas contained greater biological diversity than open-sea-facing environments when comparing areas of the same size. It is possible that the low levels of circulation in these shallow seas promoted greater diversity by allowing for more distinct habitats over a given area with species from different regions remaining fairly isolated from one another.

The methodology used to analyze the large amount of data needed for this study was developed by Lagomarcino for her master's degree. Because the quality of fossil data can be patchy and uneven, her mathematical model strengthens the signal from large data sets.

"She has developed a really innovative method for attacking the data," Miller said. "It is a new protocol that shows a lot of promise for future studies."

Provided by University of Cincinnati

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