Fossil spines reveal deep sea's past

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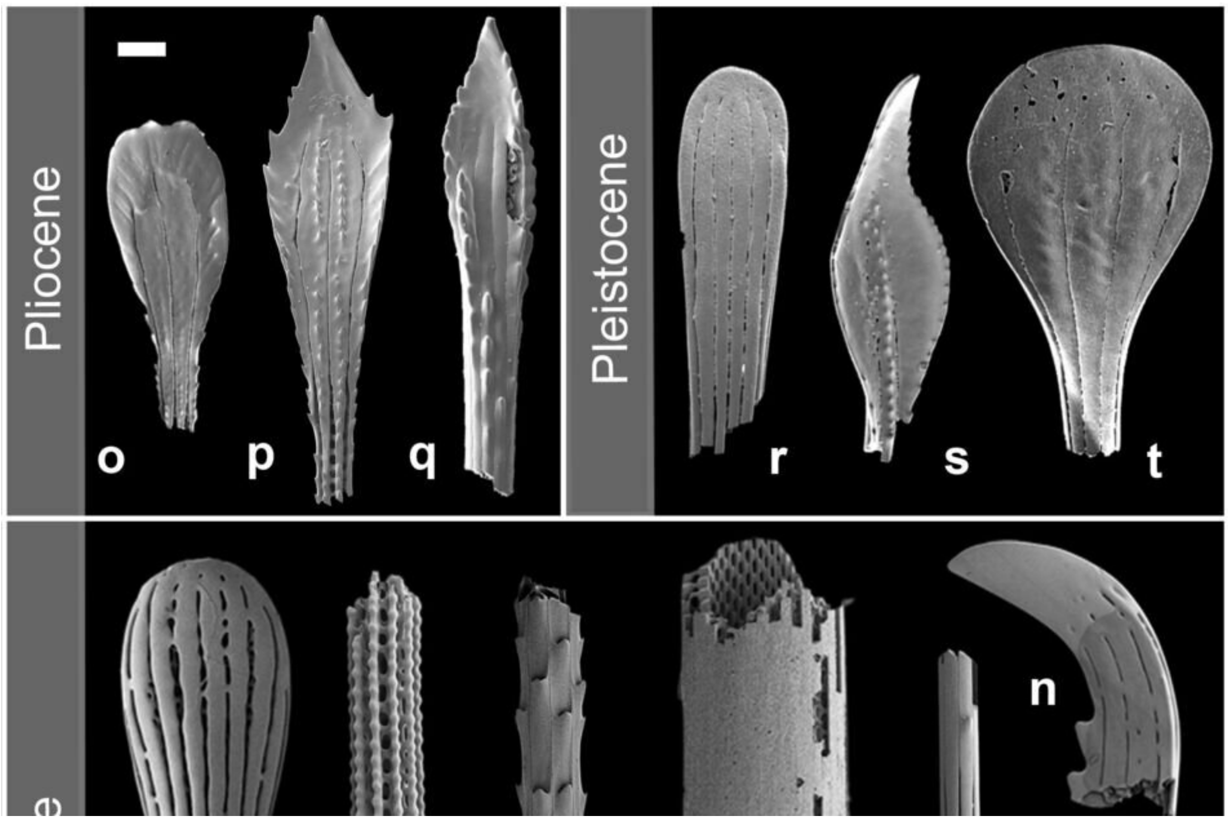

A range of sea urchin spines from different periods of the Earth's history illustrating the diversity of shapes. Credit: *PLOS ONE* (2023). DOI: 10.1371/journal.pone.0288046

Right at the bottom of the deep sea, the first very simple forms of life on Earth probably emerged a long time ago. Today, the deep sea is known for its bizarre fauna. Intensive research is being conducted into how the number of species living on the sea floor have changed in the meantime.

Some theories say that the ecosystems of the deep sea have emerged again and again after multiple mass extinctions and oceanic upheavals. Today's life in the deep sea would thus be comparatively young in the history of the Earth. But there is increasing evidence that parts of this world are much older than previously thought.

A research team led by the University of Göttingen has now provided the first fossil evidence for a stable colonization of the deep sea floor by higher invertebrates for at least 104 million years. Fossil spines of irregular echinoids (sea urchins) indicate their long-standing existence since the Cretaceous period, as well as their evolution under the influence of fluctuating environmental conditions. The results have been published in the journal *PLOS ONE.*

The researchers examined over 1,400 sediment samples from boreholes in the Pacific, Atlantic and Southern Ocean representing former water depths of 200 to 4,700 meters. They found more than 40,000 fragments of spines, which they assigned to a group called irregular echinoids, based on their structure and shape.

For comparison, the scientists recorded morphological characteristics of the spines, such as shape and length, and determined the thickness of around 170 spines from each of two time periods. As an indicator of the total mass of the sea urchins in the habitat—their biomass—they determined the amount of spiny material in the sediments.

What these fossil spines document is that the deep sea has been continuously populated by irregular echinoids since at least the early Cretaceous period about 104 million years ago. And they provide further exciting insights into the past: the devastating meteorite impact at the end of the Cretaceous period about 66 million years ago, which resulted in a worldwide mass extinction—with the dinosaurs as the most prominent victims—also caused considerable disturbances in the deep sea.

This is shown by the morphological changes in the spines: they were thinner and less diverse in shape after the event than before. The researchers interpret this as the "Lilliput Effect." This means that smaller species have a survival advantage after a mass extinction, leading to the smaller body size of a species. The cause could have been the lack of food at the bottom of the deep sea.

"We interpret the changes in the spines as an indication of the constant evolution and emergence of new species in the deep sea," explains Dr. Frank Wiese from the Department of Geobiology at the University of Göttingen, the lead author of the study. He emphasizes another finding: "About 70 million years ago, the biomass of sea urchins increased. We know that the water cooled down at the same time. This relationship between biomass in the deep sea and water temperature allows us to speculate how the deep sea will change due to human-induced global warming."

In addition to the University of Göttingen, the Universities of Heidelberg and Frankfurt as well as the Museum für Naturkunde Berlin were involved in the research project.

More information: Frank Wiese et al, A 104-Ma record of deep-sea Atelostomata (Holasterioda, Spatangoida, irregular echinoids)—a story of persistence, food availability and a big bang, *PLOS ONE* (2023). DOI: 10.1371/journal.pone.0288046

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