Fossil snail shells offer new tool for analyzing ancient ocean chemistry

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A 250-million-year-old fossil of a marine snail shell in pristine condition. The shell was one of the thousands examined in the study. Scale bar = 100 μm. Credit: William Foster et al.

A collection of fossil shells from marine snails and clams is challenging a theory that says the world's deadliest mass extinction was accompanied by severe ocean acidification.

Instead of showing damage or signs of repair—which would be expected if the mollusk was surviving in acidic conditions—the shells were in excellent shape, according to a study that was published on Jan. 24, 2022, in *Scientific Reports*.

William Foster, a scientist at the University of Hamburg and former postdoctoral researcher at The University of Texas at Austin Jackson School of Geosciences, led the research.

The study is the first to use shells from fossilized mollusks to investigate ocean chemistry, demonstrating a new tool that scientists can use to study the conditions of the planet's deep past.

"For events that occurred millions of years ago, we have to rely on evidence such as the chemistry of marine rocks and fossils," said co-author Rowan Martindale, an associate professor at the Jackson School. "Sometimes these proxies give conflicting results, so we need multiple, independent measures of ocean conditions."

The world's deadliest mass extinction wiped out about 90% of living species about 252 million years ago at the end of Permian Period. The extinction was triggered by huge volcanic eruptions in present-day Siberia, which released large amounts of carbon dioxide into the atmosphere in relatively short amount of time, causing rapid global warming.

When atmospheric carbon dioxide is high, the ocean can absorb some of the gas and become more acidic. However, the geologic record is inconclusive about whether this occurred during the end Permian

extinction event.

"Some previous studies based on chemical analyses of rocks had suggested that the world's seas were acidic at that time, but other geochemical evidence suggested the opposite," said Foster.

A fossilized shell belonging to the extinct snail species Sinuarbullina yangouensis that was examined by researchers. The shell is in pristine condition. Credit: William Foster et al.

The analysis of the mollusk shells offers a more thorough perspective, Foster said, because they capture the chemical state of the ocean shortly after the extinction event from top to bottom, not just where sediment settled. The s tested for acidification in surface waters by analyzing larval shells and tested for seafloor acidification by analyzing adult shells.

The research entailed examining more than 2,300 fossil shells from marine snails and bivalves from under a microscope. And although a handful of shells record some growth impairment, there were no signs of patched holes, a tell-tale sign of mollusks living in an acidic environment .

"None show repair marks that would indicate severe acidification in surface waters or on the seafloor," Foster said.

The fossils were collected from a site in what is now Svalbard, Sweden. When the animals were alive, the site was covered by a shallow sea and the Earth contained just a single massive continent.

"It was really exciting to study organisms that lived when Pangea was a supercontinent," said co-author Jaime Hirtz, who recently earned a master's degree from the Jackson School but started working on these fossils when she was an undergraduate student.

Marine animals with shells made of aragonite (a type of calcium carbonate mineral) are particularly susceptible to ocean acidification. Scientists use shells from "sea butterflies," a type of swimming sea snail, to study ocean acidification in the present and recent past. This study shows that shells from fossilized mollusk species can be analyzed in a similar manner, opening the door to more extensive research on ocean chemistry in Earth's past and its connection to climatic events.

"One of the exciting aspects of this research is that we now know we can use fossil shells of aragonitic marine animals from millions of years ago as bioindicators of past ocean acidification," said co-author Richard Twitchett, a professor at the Natural History Museum, London.

The study's additional co-authors are Maria Reistroffer, who conducted the research while earning a bachelor's degree from the Jackson School, and Conor Farrell, an undergraduate student at University College Dublin.

More information: William J. Foster et al, Bioindicators of severe ocean acidification are absent from the end-Permian mass extinction, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-04991-9

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