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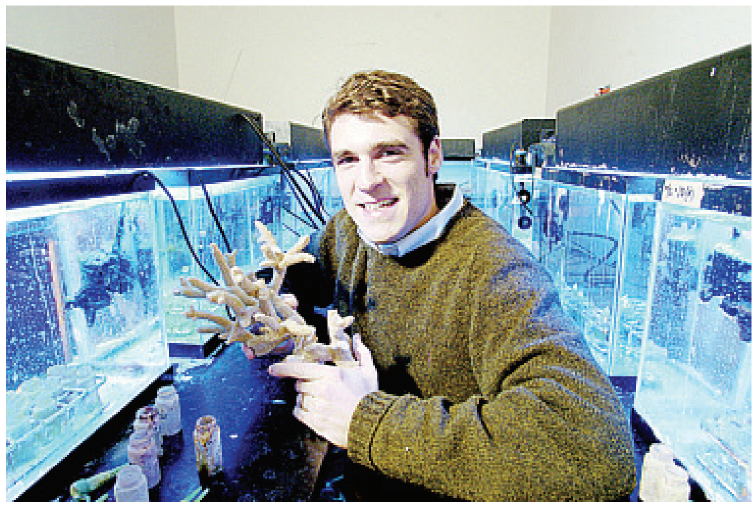
Sea Change: Skeletons of Ancient Corals Different From Today's

By Lisa De Nike
Homewood



By growing coral in tanks under various chemical conditions, Justin Ries may have solved a problem baffling marine biologists and paleontologists for years.
PHOTO BY HPS/WILL KIRK

A Johns Hopkins doctoral student may have solved a problem that has been baffling marine biologists and paleontologists for years: Why did coral reefs disappear from the fossil record during the beginning of the Cretaceous period — 120 million years ago — only to reappear after its end 35 million years ago?

The possible answer: Ancient seawater's low magnesium-to-calcium ratio during this interval made it difficult for the marine animals — which build their skeletons from a mineral called aragonite calcium carbonate — to grow and flourish into vast reefs. That left few to end up in the fossil record, posits doctoral candidate Justin Ries and his adviser, Steven Stanley, professor in the Morton K. Blaustein Department of Earth and Planetary Sciences in the Zanvyl Krieger School of Arts and Sciences.

"Scientists have grappled with this question for years, and my research shows that the answer is that the chemistry of Cretaceous seawater did not support the secretion of the aragonite mineral from which corals construct their skeleton," said Ries, who presented his research on Nov. 10 at the 116th annual meeting of the Geological Society in Denver. "What's more, my experiments suggest that corals from the Cretaceous period almost certainly built at least part of their skeletons from calcite. This is groundbreaking because it was previously believed that organisms do not generally change their skeletal mineralogy over time. Now we know that they do."

Ries spent two months growing three species of modern Scleractinian corals (the major reef-building corals in today's seas) in seawater formulated at six different chemical ratios that have existed throughout the geologic history of corals. He created this seawater "from scratch" according to recipes provided by Earth and planetary sciences Professor Lawrence Hardie, who recently discovered that the magnesium-to-calcium molecular ratio of seawater has oscillated between 1-to-0 and 5-to-2 over the past 540 million years due to chemical reaction between rising magma and seawater brine along various parts of the ocean floor.

"The artificial seawaters were created by adding different concentrations of salts as calculated by

Lawrence Hardie," Ries said. "I specifically wanted to test how modern corals respond to the ancient levels of magnesium and calcium because these chemicals, along with carbon and oxygen, are the building blocks of their skeletons. More important, however, is that the ratio of these two chemicals determines whether the aragonite or calcite mineral will form."

Into 10-gallon tanks filled with these mixtures went coral fragments replete with colonies of polyps — tiny animals, a few millimeters in size, from which larger corals and, eventually, reefs grow. Ries prepared the polyps for the experiment by having them spend a one-month "adjustment period" in tanks filled with modern seawater. Gradually, Ries adjusted the tanks' chemistry until their contents were in line with the prescribed "ancient" seawater chemistries.

"To prevent the corals from experiencing chemical shock in the unfamiliar seawaters, I learned that they must be acclimated gradually, in stages," Ries said. "This was actually one of the most challenging aspects of the project. There were many failed attempts before I was able to keep the corals alive so that I could observe their growth and calcification in the ancient seawaters."

The corals were grown under special lights called PowerCompacts, which simulated true daylight by emitting a wavelength commensurate to sunrise and sunset, as well as normal sunlight during the rest of the day. Ries fed the growing corals with plankton particles and monitored each tank's pH level — and level of chemicals such as strontium, iodine and manganese, as well as vitamins — several times a week.

Ries credits his experiments with leading to "two very important discoveries about corals."

First, the skeletons of the corals cultivated in the ancient seawaters had a different mineral composition from those grown in modern seawater. Those in the so-called Cretaceous seawater began building skeletons of 35 percent calcite mineral, as opposed to modern corals, which built them from 100 percent aragonite. This suggests that the skeletons of corals have been changing along with seawater throughout the geologic past.

"This is astounding, given that most scientists have long believed that the mineral composition of a group of organisms' skeletons is fixed over time," Ries said.

Secondly, the experiment was important because it proved corals cultivated in Cretaceous seawater grew more slowly than their counterparts raised in modern seawater.

"This solves, experimentally, the long-standing question of why the Scleratinian corals stopped making reefs during the Cretaceous period — because the low magnesium/calcium ratios in the oceans at that time inhibited the growth of the aragonite mineral that they used to build their skeletons," Ries said.

Ries' research was funded by the National Science Foundation, the Petroleum Research Fund and a J. Brien Key Grant. Moody Gardens Aquarium in Galveston, Texas, provided coral fragments for the study.

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