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Rich Coral Reefs in Nutrient-Poor Water: Paradox Explained?

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Coral reefs are the rain forests of the oceans, teeming with a biological diversity that boggles the mind. Just how did such profusion of life come to thrive in crystal-clear—and thus nutrient poor—water? The question has eluded scientists since Charles Darwin took his famous voyage on the H.M.S. *Beagle* in the 1830s.

Now, a team of German and Jordanian researchers may have the answer to this so-called coral reef paradox: an abundance of sponges that dwell inside the nooks and crannies of reef interiors.

"In the Red Sea, what you see are stony and soft corals—a profusion of life," said Claudio Richter of the Center for Tropical Marine Ecology in Bremen, Germany. But this lush canopy has distracted attention from the understory of the reef, he added.

Richter and his colleagues used a modified endoscope—a surgical tool commonly used by doctors to look at the insides of their patients' lungs and colons—to look inside the small holes and crevices on five reefs in the Red Sea. What they found was a diversity of sponges as rich as the range of corals on the reef surface.

The sponges act as filter feeders, consuming more than 60 percent of the available phytoplankton as it passes through the reef cavities. The nutrients excreted by these sponges in turn serve as sustenance for coral organisms.

Inside Look

Mark Wunsch, a colleague of Richter's at the Center for Tropical Marine Ecology and co-author of a paper on the sponges published in the October 18 *Nature,* developed the underwater endoscopic video camera that allowed the scientists to peer inside the reef cavities.

The system, called the CaveCam, is essentially a video camera and light enclosed in a watertight housing at the end of a cable. It allows the researchers to probe reef crevices to a depth of 13 feet (4 meters). The CaveCam images are analyzed by a computer program, which creates an image of the crevice insides.

The images from the Red Sea reefs show that delicate, sheet-like sponges dominate the crevice areas beyond the reach of sunlight. Richter suggested that the sponges have adapted to the dark, narrow habitat to avoid predation by parrot fish and sea urchins.

"A sponge has two choices," he said. "Either it lives close to food on top of the reef, where it is exposed to predators, or it goes inside the framework, where it is further from the food source but protected from predators. Then they have to adapt sophisticated filtering systems to get food out."

The researchers compared samples of water before and after the current flowed over the sponges in the crevices. The samples showed that concentrations of micron-sized organisms called picoplankton decreased while nutrients increased.

This suggests, said Richter, that the sponges are eating the picoplankton and excreting nutrients that the reef coral

and algae need to survive.

"Our findings may therefore provide a general answer to Darwin's question of how coral reefs manage to thrive in oligotrophic [nutrient-poor] waters," the researchers conclude in their scientific paper in *Nature*.

Claims Challenged

John Ogden, director of the Florida Institute of Oceanography in St. Petersburg, agrees that the cavity-dwelling sponges are a source of nutrients for the reef coral and algae, but he says Richter and his colleagues are overstating Darwin's paradox to make their point.

"This is a false conundrum," he said.

Researchers have known for a long time that a variety of processes, such as nitrogen fixation, groundwater seepage, and the influx of nutrients from the oceans, enable reefs to thrive in nutrient-poor water.

Nutrients are also thought to come from within the cracks and crevices that riddle the reef framework, and the main value of the CaveCam research is that it has revealed more detailed information on this source, Ogden said.

"They elaborated on one of the mechanisms in which nitrogen is contributed to reefs," he said.