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[web story]

STUDIES IN REEF HEALTH

RESEARCH BY THE CENTER FOR BIODIVERSITY AND CONSERVATION DURING 2008, THE INTERNATIONAL YEAR OF THE REEF

Bursts of bubbles stream from his SCUBA regulator while Dan Brumbaugh carefully installs unglazed terracotta tiles among living coral. Using simple tools familiar to anyone handy with home repairs, he kicks against the current and surge while maneuvering an underwater drill, epoxy, PVC pipe, and vinyl and stainless steel hardware.

Brumbaugh, Senior Conservation Scientist at the Center for Biodiversity and Conservation at the American Museum of Natural History, teams with the CBC's Kate Holmes and other colleagues to investigate the health of the coral reef of Palmyra Atoll. Reef health is gauged, in part, from the tiny clues that attach themselves to the tiles: the number and kind of baby corals and other species of marine organisms able to colonize new surfaces, the variation of colonization at different locations within the reef, and the survival of corals from year to year. Preliminary coral recruitment results, presented this summer at the 11th International Coral Reef Symposium in Ft. Lauderdale, Florida, show that baby corals are ready and waiting to latch onto the new substrate but that their survivorship is low.

"Understanding the ecology of coral recruitment is really important, since the ability of a reef to bounce back after disturbance is tied in part to these recruitment processes. Being able to conduct these studies in a place like Palmyra gives us a window into how coral maintenance and recovery can work on more pristine reefs," says Brumbaugh. "Despite its apparent health, and perhaps even because of the extra dynamism of Palmyra's reef community—especially the large numbers of predatory and grazing fishes—the reef on Palmyra actually appears to be a tough place for a coral to get started."

Palmyra Atoll lies in the remote Northern Line Islands of the Pacific Ocean. Although the islands were heavily modified during World War II, the atoll has never been permanently settled. As a result, the surrounding coral reefs—and the reef-fish community that is dominated by sharks, large snappers, and jacks—are more intact than most coral reefs found throughout the

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world. For their coral recruitment experiment, Brumbaugh and colleagues secured a total of 180 tiles at three locations and three depths in 2006. During repeat surveys over the next two years, they carefully brought each tile back to the lab, where the crusty growths were examined and photographed before the tiles were returned to their original reef locations. The last survey is set for 2010.

So far, the team has found little variation in the overall number of baby corals that took up residence on the tiles from year to year, although different locations in the reef system had variable numbers of settlers (the more remote eastern side of the atoll has higher numbers, while the fore reefs have more recruits than the back reefs). The survivorship of these recruits, though, was low between 2007 and 2008 compared to other reef systems studied: only 4.1% survived. Palmyra recruits also seemed to prefer the top of tiles when compared to other similar studies throughout the world (only 21% of the total corals were found on the lower sides of the tile, in comparison to about 85% reported in the Caribbean). As Brumbaugh sums it up, "There are some things going on at Palmyra that we don't yet understand, but we're working to tease apart the dynamics here since we think they'll have broad relevance to coral reefs elsewhere."

One potential explanation for Palmyra's unusual pattern of coral colonization and survivorship is that new corals face heavy grazing from herbivorous fish. To test this idea, Brumbaugh and colleagues placed cages around some tiles to exclude large grazing fish. The team found that coral recruitment was temporarily higher when protected from larger fish, a result supported by observations of Palmyra's marine assemblage, where the dominant species is an encrusting coralline algae species that is very tolerant to heavy grazing. On more pristine reefs, therefore, removal of larger fishes may have a short-term positive effect on coral recruitment, as both grazers and possibly planktivores may have a role in controlling coral settlement and survival.

Brumbaugh and Holmes, though, realize that long-term removal of large fish could have different results elsewhere, and results from their research on Caribbean reef systems lend some support to this prediction. Teaming with Alastair Harborne and Peter Mumby from the Marine Spatial Ecology Lab at the University of Exeter and other members of the Bahamas Biocomplexity Project, Brumbaugh and Holmes compared reef communities inside marine reserves to those in the surrounding, fished waters. The results, recently published in the *Journal of Applied Ecology,* were clear: in the reserve, where fishing is prohibited, the mean number of fish species per site was 15% greater—an increase driven in part by higher diversity and biomass of large groupers, fish prized by the fishing industry. Another observation—an increase in the size of parrotfishes in the marine reserve assemblage—means that seaweed cover decreased and the number of coral recruits increased. Fish grazing is essential for keeping seaweeds at bay so

that baby corals can gain a foothold on the reefs. “There is a surprising complexity of ecological interactions on coral reefs, and our Bahamas research is showing that by protecting fish, reserves can allow for more successful coral recovery,” says Holmes.

Holmes and Brumbaugh are continuing their research in both The Bahamas and Palmyra Atoll to provide lessons for global coral conservation and recovery. Learning more is especially important since coral recruitment appears to be influenced by several different factors, including the make-up of current coral communities, the history of storms and other disturbances, and the abundance of predators, herbivores, and seaweeds.

Learn more about the International Year of the Reef online, and read further about the CBC’s research among coral reefs in the AMNH Science Bulletin “Our Oceans, Ourselves.” Other researchers from the Palmyra study include Douglas McCauley and Hillary Young of Stanford University and Robert Steneck and Suzanne Arnold of the University of Maine. Funding for this research is from the National Science Foundation, the National Oceanic and Atmospheric Administration, and the Jaffe Family Foundation. Additional researchers in the Bahamian Project include Carrie Kappel and Fiorenza Micheli of Stanford University, Craig Dahlgren of the Perry Institute for Marine Science, James Sanchirico of the University of California at Davis, and Kenneth Broad of the Rosenstiel School of Marine and Atmospheric Science in Miami.

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