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Photo: Reef photos and a map of sea surface temperature may be downloaded at http://www.unc.edu/~brunoj

Healthy reefs hit hardest by warmer temperatures

CHAPEL HILL – Coral disease outbreaks hit hardest in the healthiest sections of the Great Barrier Reef, where close living quarters among coral may make it easy for infection to spread, University of North Carolina at Chapel Hill researchers have found.

Despite a link to warmer ocean temperatures, coral disease defies predictability, with puzzling variations between years and locations. The international research team, led by UNC-Chapel Hill, tracked an infection called white syndrome in 48 reefs along more than 900 miles (1,500 kilometers) of Australia's coastline for six years. While higher temperatures drove the disease outbreaks, the team also discovered a strong connection between white syndrome and coral cover, a measure of reef health. The highest-cover reefs, which had living coral covering more than 50 percent of the ocean floor, had major outbreaks after warm years. Disease was usually absent on low-cover reefs.

Understanding the causes of disease outbreaks will help ecologists protect reef-building corals, which support commercial marine species and buffer low-lying coastal areas. "More diseases are infecting more coral species every year, leading to the global loss of reef-building corals and the decline of other important species dependent on reefs," said lead study author John Bruno, Ph.D., UNC assistant professor of marine ecology and conservation. "We've long suspected climate change is driving disease outbreaks. Out results suggest that warmer temperatures are increasing the severity of disease in the ocean," Bruno said.

The results were published May 8, 2007, in the online journal PLoS Biology. The study is one of the largest and longest surveys of ocean temperature and coral disease and is the first to conclusively demonstrate a link between disease severity and ocean temperature, Bruno said.

The colorful coral colonies that attract visitors to the Great Barrier Reef live atop a limestone scaffolding built from the calcium carbonate secretions of each tiny coral, or polyp. While polyps provide the framework, coral's vivid hues come from symbiotic single-celled algae that live within the polyp's cells. The algae supply much of the food coral need to survive. When disease or stressful environmental conditions strike a coral colony, the polyps expel their algae. This algae loss makes the coral appear pale.

During the study, the researcher monitored target reefs for white syndrome, which infects Pacific reef-building corals. The disease results in a white band of tissue or exposed coral skeleton that moves across as colony as infection progresses. (White isn't the only color of diseased coral – other syndromes include black band, yellow blotch and dark spots.)

Scientists from the Australian Institute for Marine Sciences made yearly visits to the same sites, applying epidemiological methods similar to those used for tracking human disease. They found white syndrome present on the reefs when the survey started in 1998. However, its frequency increased 20-fold in 2002 following a particularly warm summer. Sea surface temperature was monitored at each site using National Oceanic & Atmospheric Administration (NOAA) satellites.

Even during the peak of the 2002 outbreak, there was considerable variation in disease frequency among reefs, Bruno said. No white syndrome cases were recorded from 45 percent of the low cover reefs, while 88 percent of reefs above the high cover threshold at least one infected colony. Reefs with high coral cover and warm sea surface temperatures had the greatest white syndrome frequency. Most of the outbreaks occurred in the Cooktown/Lizard Island and Capricorn Bunkers sectors of the Great Barrier Reef, which are some of the healthiest reefs in the Pacific, Bruno said.

The study shows that stress caused by anomalously warm ocean temperatures is necessary, but not sufficient, for white syndrome outbreaks to occur, Bruno said. Coral cover must also be high. "There is a cover threshold of approximately 50 percent for white syndrome outbreaks," he said.

High coral cover could facilitate infection in several ways, Bruno explained. Abundance may increase disease vectors, such as fish, or lead to more competition – coral polyps compete with their neighbors via tentacles and digestive filaments that cause lesions and tissue damage, providing an inroad for infection. Close quarters among coral colonies could also make it easier to spread disease.

The research was funded in part by grants from the National Science Foundation; an Environmental Protection Agency STAR Fellowship; the NOAA Coral Reef Conservation Program; the Australian Institute of Marine Science; and UNC-Chapel Hill.

"This study developed valuable methods to pinpoint warm temperature as a partial driver of disease outbreaks. These methods will also be used to study climate drivers of disease outbreaks in other regions of the world," said Drew Harvell, Ph.D., Cornell University professor of ecology and evolutionary biology and a study co-author. Harvell's work was supported by the Global Environmental Fund's Coral Sustainability Program. The program is developing new scientific methods to improve study of climate and more local influences on coral sustainability.

Other co-authors include Elizabeth Selig, a graduate student in UNC's curriculum in ecology; Kenneth Casey, NOAA National Oceanographic Data Center; Cathie Page and Bette Willis, ARC Centre of Excellence in Coral Reef Studies and the School of Marine and Tropical Biology, James Cook University in Townsville, Australia; C. Drew Harvell, Cornell University; Hugh Sweatman, Australian Institute of Marine Science in Townsville, Australia; and Amy Melendy, UNC department of epidemiology.

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