Ripple Marks

The Story Behind the Story BY CHERYL LYN DYBAS

Is Getting Older Truly Getting Better?

Yes, If You're a Coral Reef

You're not getting older, you're getting better, the saying goes. Does that also apply to marine species like corals?

The answer is yes, discovered scientist Laura Mydlarz of the University of Texas at Arlington. Older species of corals indeed have more of what it takes to survive in today's world.

Corals are threatened by pollution, overfishing, and climate change. These stressors have weakened their defenses and left some reefs more susceptible to diseases such as white plague.

"Scientists once thought that ocean species had huge geographic ranges, and that that insured them against extinction," says conservation biologist Stuart Pimm of Duke University. Pimm is also founder and chair of the conservation organization Saving Species. "We now know that many coral reef species have very small ranges, so are in extreme danger when local reefs are destroyed."

Current species extinction rates worldwide are 1,000 times higher than natural background rates, Pimm and co-authors report in a paper in the September 2014 issue of the journal *Conservation Biology*.

Future rates, they found, are likely to be 10,000 times higher.

EXTINCTION BY DISEASE?

Diseases significantly contribute to that threat, states Mydlarz in a paper published in August 2014 in the journal *PLOS ONE*. "The increase in frequency and severity of disease outbreaks has made evaluating and determining coral reef resistance a priority."

She and co-authors looked at 14 species of corals, tracking the number of diseases affecting each one.

For the study, samples were collected from several Caribbean reefs, including those off St. Croix, Lee Stocking Island in the Bahamas, the Yucatán Peninsula in Mexico, and Los Roques in Venezuela. The corals represent some 20 percent of the total number of scleractinian species—stony corals that generate hard skeletons—in the Caribbean.

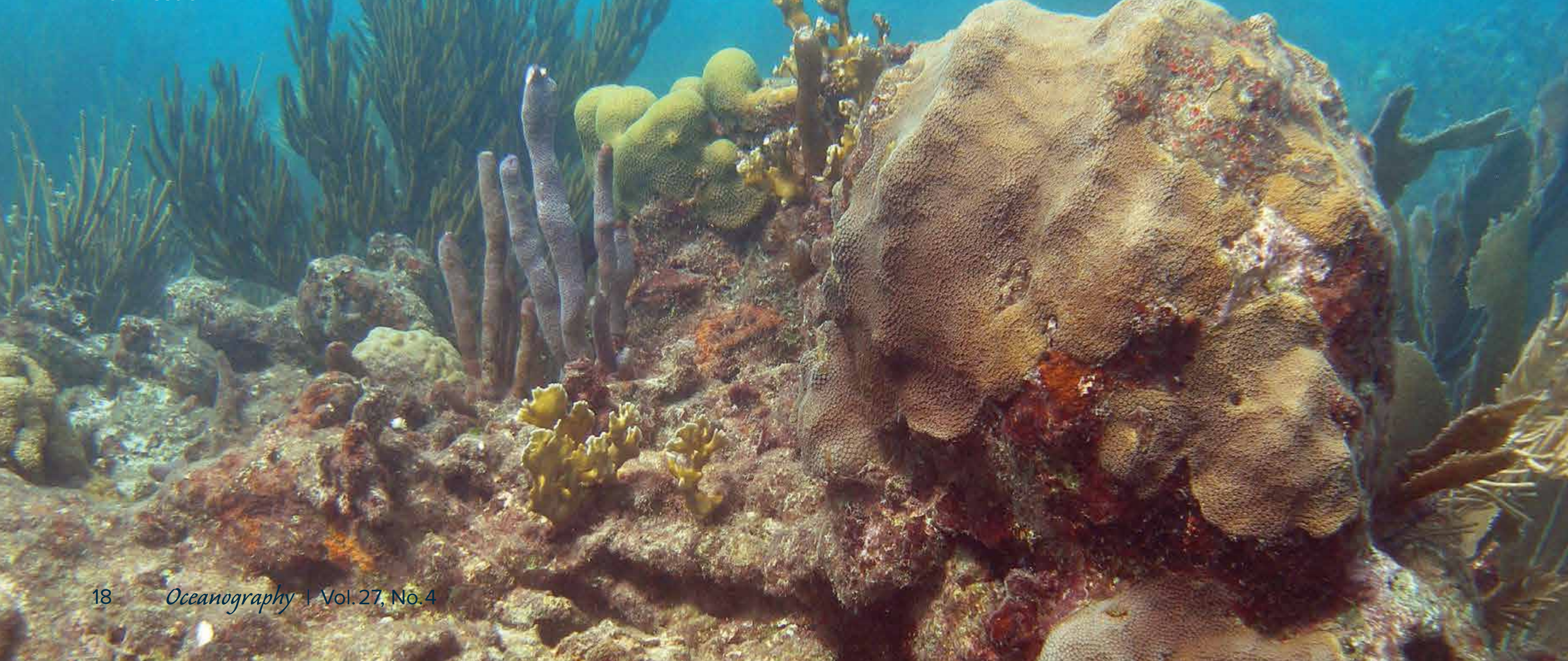
Many of the species, such as *Montastraea cavernosa*, are common and widely distributed throughout the region. Others, like *Madracis spp*., were not collected due to strict limits on research on these besieged corals.

Small fragments of apparently healthy corals—with no signs of disease or bleaching—were retrieved. A chip measuring five square centimeters was carefully removed with a hammer and chisel from the top of each colony. In free-living species such as *Siderastrea radians*, four centimeter "rolling stones" were collected in shallow seagrass beds next to coral reefs.

The biologists then tested the corals' immunity in the lab to determine whether there was a "phylogenetic signal": organisms in closely related species have characteristics that are more similar to each other than to distantly related species.

The results indicate that the corals' immune-related processes do show such signs. "Both the number of diseases affecting each species and disease prevalence show a significant phylogenetic signal," the scientists state in *PLOS ONE*. "Immunity plays an important role in the success of a species and likely evolves as species diverge, conserving beneficial mechanisms from ancestral species."

Immune defenses are critical for species'



success on both ecological and evolutionary time scales. As species diverge, new sets of genetic, biological, and/or environmental conditions take place, so emerging species trade off costs and benefits within and between traits, including those related to immunity, says Mydlarz.

ANCIENT IMMUNE DEFENSES TO THE RESCUE

Corals' immune systems develop new strategies and diversify during speciation, favoring individuals that survive diseases and other stressful events.

"Species that have been around for longer periods have been exposed to more environmental and biological stressors, and they've survived, so it seems logical that they would have better base-level immunity—or be better adapted to respond to new stresses," says Ernesto Weil, a marine scientist at the University of Puerto Rico-Mayaguez and co-author of the *PLOS ONE* paper.

"In general, older coral species are doing far better than younger ones," confirms Mydlarz.

Some of the oldest corals in the study, such as *Porites astreoides*, have been reef members for more than 200 million years, while others diverged and became new species "recently"—seven million years ago.

As tested in the lab, older corals can kill 41 percent of bacterial growth, vs. 14.6 percent in newer species.

The results have given the scientists a starting point for predicting which corals might be most susceptible to diseases.

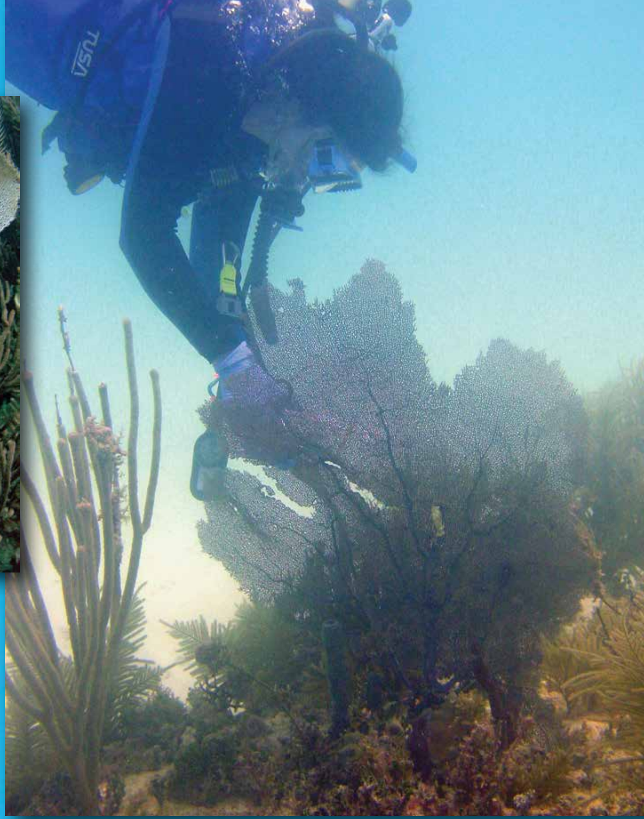
Factors such as the inhibition of bacterial growth, and melanin, or pigment, concentration were higher in older corals. They may play an important part in disease resistance.

Newer species had higher amounts of antioxidants. But high antioxidant levels may indicate that the newer corals are under constant stress that compromises their immune systems and other functions.

Similar patterns to those detected in the Caribbean have been reported for Indo-Pacific corals, where melanin markers were related to disease prevalence. Corals with higher melanin concentrations may be able to prevent infections by "deploying a melanin barrier before the need to engage in additional, more costly responses," the scientists state.

The team plans to continue to look for similarities in coral diseases and for their explanations. The answers could be a crystal ball for determining reefs' futures.

Photos courtesy of Laura Mydlarz



"The increasingly stressful conditions on corals in the Caribbean," says Mydlarz, "suggest that future reefs in the region will likely be dominated by older lineages while modern species may face local population declines and/or geographic extinction.

"Coral species with advantageous life history traits will be more likely to dominate, with the immune capacity of individuals and/or populations a critical piece of the puzzle."

UNDERSEA CORAL WARFARE

Another clue may lie in the delicate branches of a coral named the purple sea fan, *Gorgonia ventalina*. Mydlarz and colleagues studied the sea fan in the Florida Keys and near La Parguera, Puerto Rico.

Why purple sea fans? "We were looking for other ways to assess how corals might be affected by pathogens," says Mydlarz, "and purple sea fans are extremely susceptible to a fungal pathogen called *Aspergillus*."

Aspergillus infects purple sea fans with the help of proteases. These enzymes are manufactured by pathogens to break down proteins in their hosts and allow infections. "How macabre!" Mydlarz observes.

Proteases are found in plants, animals, bacteria, archaea, and viruses.

Mydlarz decided to find out how proteases work in *Aspergillus*-infected sea fans. As she and other researchers report in the July 2014 issue of the journal *Marine Biology*, "we were surprised to discover that warmer waters make *Aspergillus* proteases more virulent."

Healthy sea fans were able to resist *Aspergillus* proteases by increasing their levels of protease inhibitors, but diseased sea fans could not keep pace. In the undersea arms race of *Aspergillus* proteases and purple sea fans' protease inhibitors, warmer waters may tip the balance toward *Aspergillus*.

The finding is also important to life on land.

Diseases of purple sea fans and of terrestrial animals have something in common: the research may someday lead to new protease inhibitors for treating human illnesses such as HIV. If, Mydlarz says, we can conserve corals in time.

"We don't think coral reefs will go away completely, but that their species composition will change. That change, however, could affect everything that depends on the reef ecosystem."

Including us.

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