Coralporosis OCEAN ACIDIFICATION LEAVES DEEP-SEA CORAL REEFS AT RISK OF COLLAPSE

BY CHERYL LYN DYBAS

As we age, our skeletons often become riddled with osteoporosis, a disease in which the body loses too much bone. As a result, our hips and wrists become weak and may break. Could the same thing happen to the skeletons of coral reefs? Recent research says yes, and points to a weakening of deep-sea corals' "bones" from ocean acidification.

The study, which advances efforts to understand how reefs of the future will look and what we can do to preserve them and the life they support, was published in *Frontiers of Marine Science* in September 2020. It was led by University of Edinburgh scientists, along with researchers from Heriot-Watt University and the US National Oceanic and Atmospheric Administration (NOAA) and was supported by the European Union's Horizon 2020 Research and Innovation Programme and several other funders.

"Ocean acidification is a threat to the net growth of tropical and deep-sea coral reefs due to gradual changes in the balance between reef growth and loss processes," write lead author Sebastian Hennige of the University of Edinburgh's School of GeoSciences and his coauthors. "We go beyond identification of coral dissolution induced by ocean acidification to identify a mechanism that will lead to the loss of habitat in cold-water coral reef habitats on an ecosystem scale."

BRITTLE FOUNDATIONS

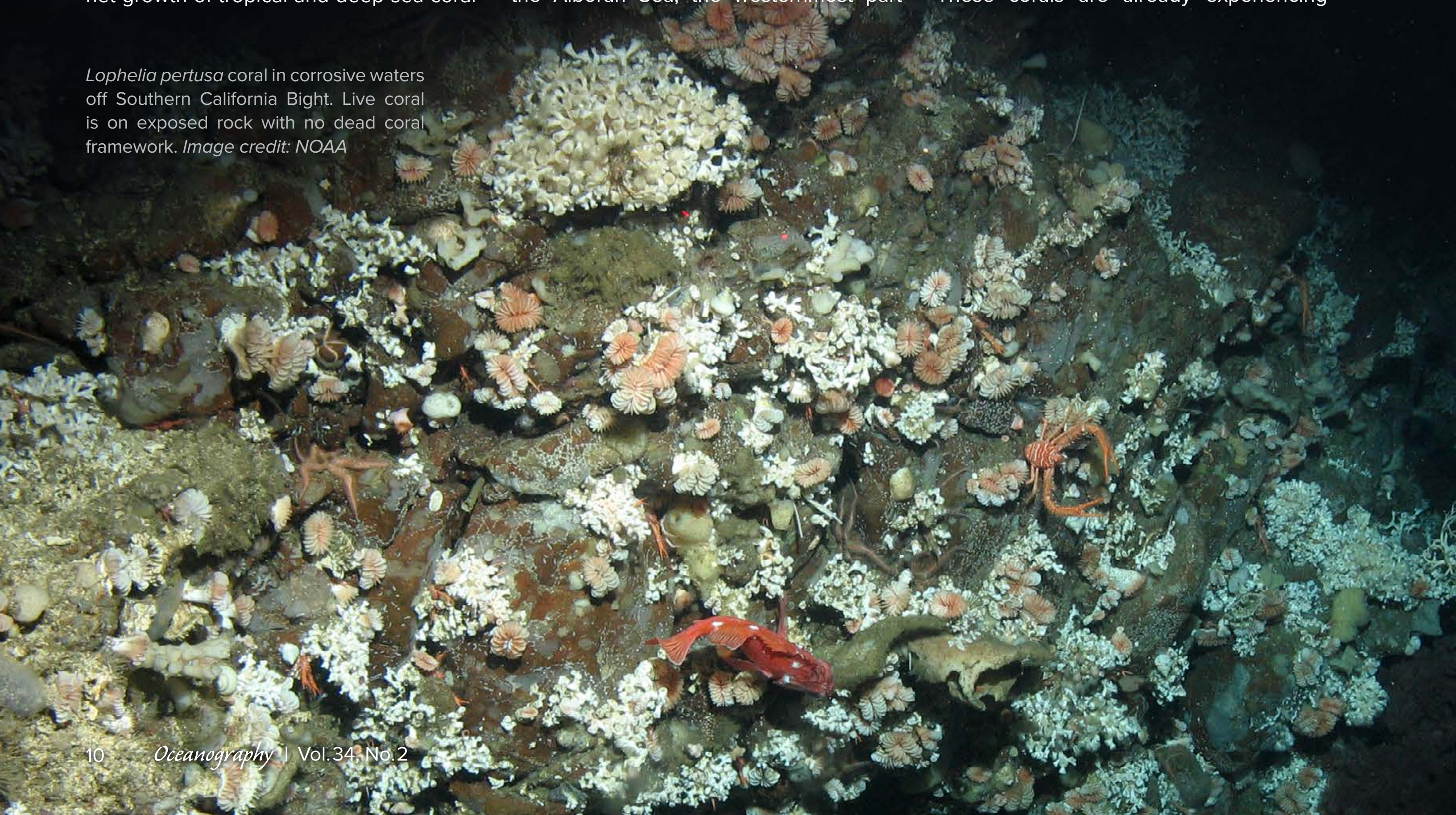
Deep-sea cold-water corals face challenges as declines in ocean pH, triggered by climate change, cause their foundations to become brittle. As a result, the underlying structures of the reefs—home to a multitude of marine species—may fracture.

The scientists studied *Lophelia pertusa*, the only species in the genus *Lophelia*, a cold-water coral that lives in the depths throughout the North Atlantic Ocean and in parts of the Caribbean Sea and the Alboran Sea, the westernmost part of the Mediterranean Sea. Small, patchy *L. pertusa* reefs also exist in the North Pacific. The coral lives between 80 m and more than 3,000 m depth but is most commonly found at 200–1,000 m in a temperature range from about 4°C to 12°C. *Lophelia pertusa* is extremely slow-growing.

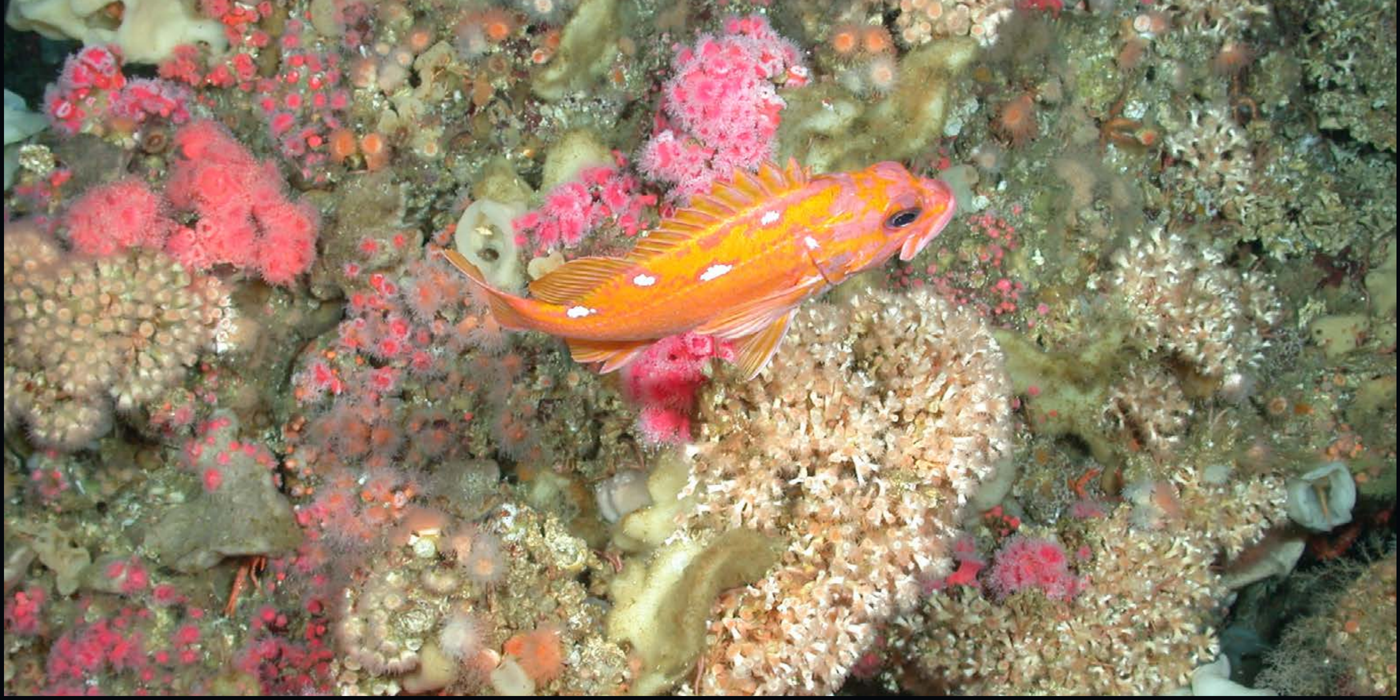
The reefs create a specialized habitat frequented by several species of deep-water fish, including conger eels, sharks, groupers and hake. Myriad invertebrates—brittle stars, mollusks, amphipods, and crabs—also live in these reefs. High densities of smaller fish such as hatchetfish and lanternfish have been documented in the waters above; the fish may be important prey for larger fish below.

TROUBLE IN THE DEPTHS

Hennige and his colleagues measured very low pH levels in living *L. pertusa* reefs hundreds of meters below the surface of the Pacific Ocean off Southern California. These corals are already experiencing



Lophelia pertusa coral in corrosive waters off Southern California Bight. Live coral is on exposed rock with no dead coral framework. *Image credit: NOAA*



Lophelia pertusa with strawberry anemones (*Corynactis californica*) and a rosy rockfish (*Sebastes rosaceus*) at 93 m depth on Cherry Bank, offshore Southern California. *Image credit: NOAA Southwest Fisheries Science Center, Advanced Survey Technologies Group*

the effects of climate change; they exist in the acidified conditions most deep-sea reefs are expected to face by the end of the century.

The *L. pertusa* corals are a window into the future ocean, according to Peter Etnoyer of NOAA. The region is a natural laboratory for studying the effects of ocean acidification, he says.

The team analyzed corals collected via submersible dives and from long-running laboratory studies to find out how habitat is lost as the water becomes more acidic. The scientists also raised *L. pertusa corals* in aquaria for a year at very low pH levels.

They found a rapid degradation of the "building blocks" of the coral framework, such as individual coral branches. They also noted significant porosity; the change happened in just 12 months in laboratory conditions. "On the scale of a colony, which supports the complex reef structure, loss of structural integrity could contribute to a crumbling of the larger habitat," the scientists write. "The result is smaller aggregations of live coral with less three-dimensional complexity and massively reduced reef/mound-building potential."

Previous research showed that ocean acidification can affect coral growth, but the new study demonstrates that porosity in corals, or "coralporosis," leads to a weakening of their structures at critical locations.

In next steps, the scientists are starting long-term coral experiments with triple stressors (low oxygen, low pH, and increasing temperature). "Combined with new work on how the changing reef structure will impact biodiversity, we will get a very useful prediction tool for management and conservation," says Hennige.

The findings complement recent evidence of porosity in tropical corals and show that the threat posed by ocean acidification also exists in deep-sea coral reefs. "Corals don't just exist in the tropics," says Hennige. "Deep-sea coral reefs are beautiful, fragile environments that play a vital role in the health and biodiversity of the ocean. This study highlights a major threat to these wonderful ecosystems: weakening caused by ocean acidification, driven by the increasing amounts of carbon dioxide we produce."

A CASE OF CORALPOROSIS

The team applied engineering principles to demonstrate the rapid dissolution of the corals' skeletons—and discovered a striking similarity to the disintegration observed in human bones from osteoporosis.

The researchers found that the link between osteoporosis and coralporosis opens a range of methods and concepts that can help monitor and predict the fate of deep-sea ecosystems and the life they support. "By adapting strategies used to monitor osteoporosis in coral reefs, we now have powerful tools to track these fragile ecosystems," says Uwe Wolfram of Heriot-Watt University. Wolfram is a mechanical engineer who specializes in musculoskeletal diseases such as osteoporosis.

"Because the osteoporosis field is advanced, we were able to directly adapt some of the techniques, such as CT analysis, for use in coral," he says. "We want to arrive at a model where we can say exactly when the risk of critical fracture will be."

The work, Hennige says, highlights the importance of scientists from different disciplines and countries coming together to understand and tackle global challenges.

The results will better equip researchers to understand how vulnerable ecosystems can be protected in the future, he says.

Cold-water corals are the cities of the deep sea, according to J. Murray Roberts of the University of Edinburgh. If we lose these corals, Roberts says, the entire city will crumble.

In humans, osteoporosis can lead to fractured hips and other bones, which may spiral into long-term ill health and eventually death. For *Lophelia pertusa* reefs, the outcome may be the same.

ABOUT THE AUTHOR

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