Ocean acidification puts deep-sea coral reefs at risk of collapse

Press release: 17 September 2020

Deep-sea coral reefs face challenges as changes to ocean chemistry, triggered by climate change, cause their foundations to become brittle.

The underlying structures of the reefs – which are home to a multitude of aquatic life – could fracture as a result of increasing ocean acidity caused by rising levels of carbon dioxide.

Hundreds of metres below the surface of the ocean in Southern California, researchers measured the lowest – therefore the most acidic - pH level ever recorded on living coral reefs. Then they raised the corals in aquaria for one year at these levels.

Scientists observed that the skeletons of dead corals, which support and hold up living corals, had become porous due to ocean acidification, and rapidly become too fragile to bear the weight of the reef above them.

Previous research has shown that ocean acidification can impact coral growth, but the new study demonstrates that porosity in corals, known as "coralporosis", leads to weakening of their structure at critical locations.

This causes early breakage and crumbling that may cause whole coral ecosystems to shrink dramatically in the future, leaving them only able to support a small fraction of the marine life they are home to today.

The findings complement recent evidence of porosity in tropical corals, but demonstrate that the threat posed by ocean acidification is far greater for deep-sea coral reefs.

The study was led by University of Edinburgh scientists, together with researchers from Heriot-Watt University and the National Oceanic and Atmospheric Administration (NOAA), and was funded by the EU **ATLAS** and **iAtlantic** projects, the Natural Environment Research Council, and NOAA.

The team identified how reefs are becoming fractured by analysing corals from the longest-running laboratory studies, and by diving with submersibles off US Pacific shores to observe how coral habitat is lost as the water becomes more acidic.

Dr Sebastian Hennige, of the University of Edinburgh's School of GeoSciences, said: *"Corals don't just exist in the tropics. Deep-sea coral reefs are beautiful, fragile environments that play a vital role in the health and biodiversity of our oceans. This study highlights that a major threat to these wonderful ecosystems is structural weakening caused by ocean acidification, driven by the increasing amounts of carbon dioxide we produce. Our work highlights the vital importance of scientists from different disciplines and countries coming together to understand and tackle global challenges."*

The corals in Southern California – on the most acidified reefs studied to date – are already experiencing the effects of climate change and exist in conditions that most deep-sea reefs are expected to encounter by the end of the century.

Dr Peter Etnoyer, of NOAA's National Centers for Coastal Ocean Science, said: *"Deep-sea corals growing off Southern California are a window into the future ocean. The region is a natural laboratory to study the effects of ocean acidification."*

Submersibles were launched from NOAA ships off Southern California and were guided by Dr. Peter Etnoyer and graduate student Leslie Wickes.

The US team sampled live and dead corals and returned them to the laboratory for experiments. The UK team applied engineering principles to demonstrate the rapid weakening of the skeletons and discovered a striking similarity to the weakening observed in human bones from osteoporosis.

The team says that the link between osteoporosis and coralporosis opens up a range of methods and concepts that can be adapted in the challenge of monitoring and predicting the fate of such fragile deep-sea ecosystems and the life they support.

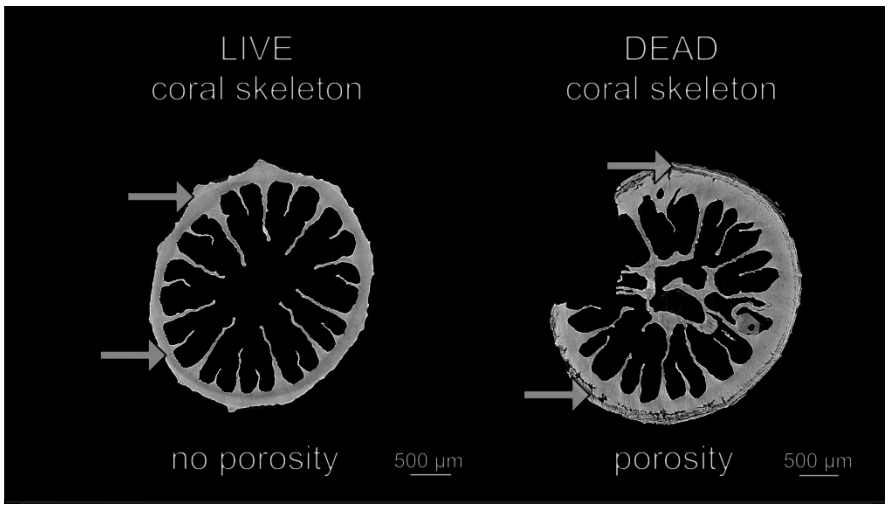
'By adapting strategies routinely used to monitor osteoporosis and assess bone fracture risk to instead understand coral reefs, we may have powerful non-invasive tools at our disposal to monitor these fragile ecosystems' said Dr Uwe Wolfram of Heriot-Watt University.

Tools developed as part of the project will aid understanding of when ocean ecosystems will change and how it will affect marine life.

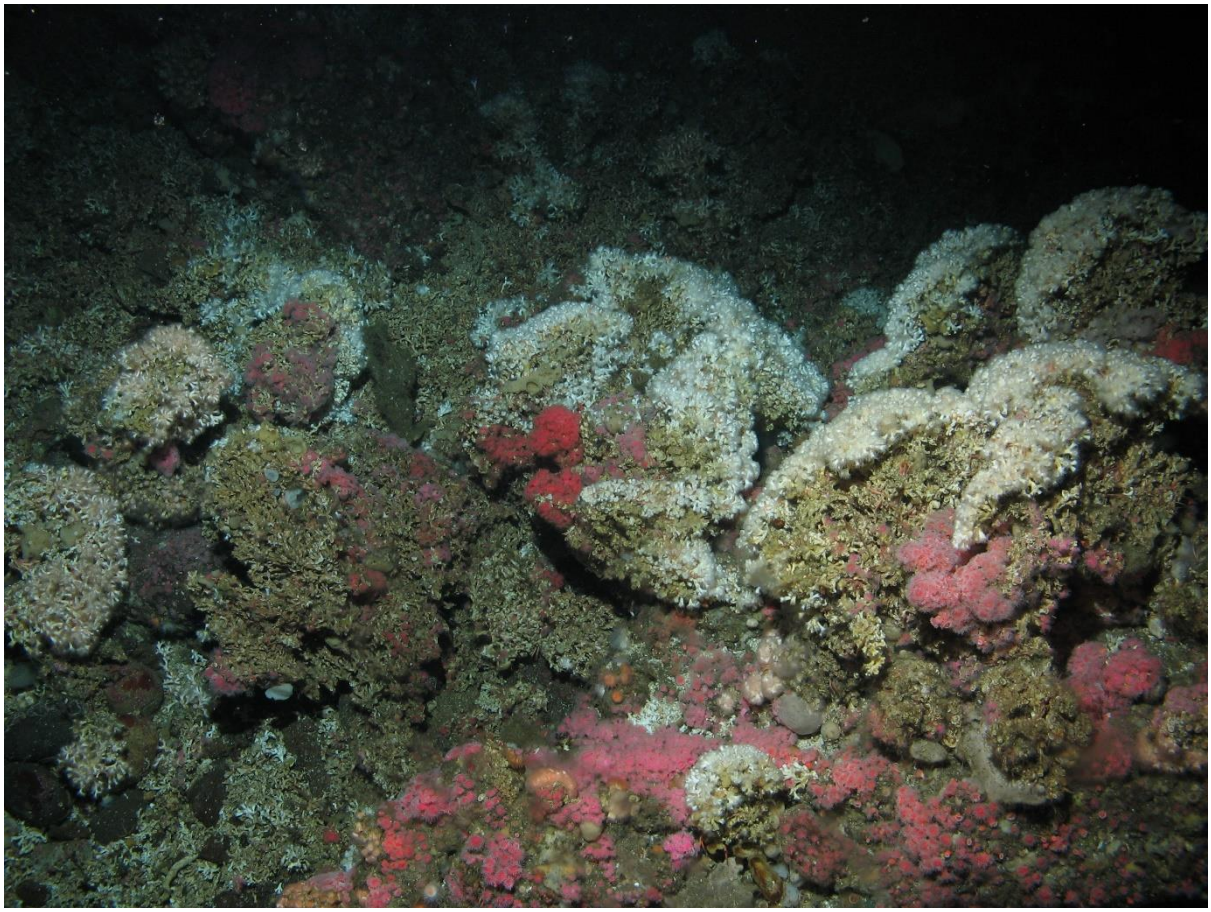
This will better equip society to deal with how these vulnerable ecosystems can be protected in the future, and will support the UN Decade of Ocean Science – which starts in 2021 – to deliver the science we need, for the ocean we want, the team says.

Prof J Murray Roberts at the University of Edinburgh, who leads the **ATLAS** and **iAtlantic** programmes, said *"Cold-water corals are truly the cities of the deep-sea, providing homes to countless other animals. If we lose the corals the city crumbles. This study is a great example of how we can work across the Atlantic and Pacific Oceans to understand the impacts of rapidly changing ocean conditions."*

The research, published in the journal *Frontiers of Marine Science*, was funded by the Natural Environment Research Council, the European Union's Horizon 2020 Research and Innovation Programme (Grant agreements 678760 (**ATLAS**) and 818123 (**iAtlantic**)) and NOAA, and supports increasing efforts to understand how reefs of the future will look, and what we can do to preserve them and the life they support.



Picture showing live and dead coral skeletons in acidified water. Once the coral dies, the skeleton can be corroded by the acidified water. See also supplementary video clip here © Sebastian Hennige



Coral in non-corrosive water off Southern California Bight © NOAA

Notes to Editors

Publication Reference: Hennige *et al* (2000). Crumbling Reefs and Cold-Water Coral Habitat Loss in a Future Ocean: Evidence of "Coralporosis" as an Indicator of Habitat Integrity. *Frontiers in Marine Science.* doi: 10.3389/fmars.2020.00668

Additional images and videos for use by the media are available here

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This story was also publicised by University of Edinburgh on 17 September 2020.

ATLAS ("A Trans-Atlantic Assessment and deep-water ecosystem-based spatial management for Europe") is a research and innovation action funded under the European Union's Framework Programme for Research and Innovation, Horizon 2020, Grant No 678760. It is the largest integrated study of deep Atlantic ecosystems ever undertaken. The four-year project was launched in May 2016

and has a total budget of €9.4 million. Led by the University of Edinburgh (Scotland, UK) **ATLAS** brings together 25 partners (and one linked third party) from 10 European countries, the USA and Canada. For more information on the **ATLAS** project, please visit www.eu-atlas.org.

For more information on the ATLAS project, please visit www.eu-atlas.org, follow @eu_atlas on Twitter and LinkedIn (https://www.linkedin.com/groups/7063683/) or contact Prof J Murray Roberts (Murray.Roberts@ed.ac.uk).

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