Ocean acidification causes young corals to develop deformed skeletons

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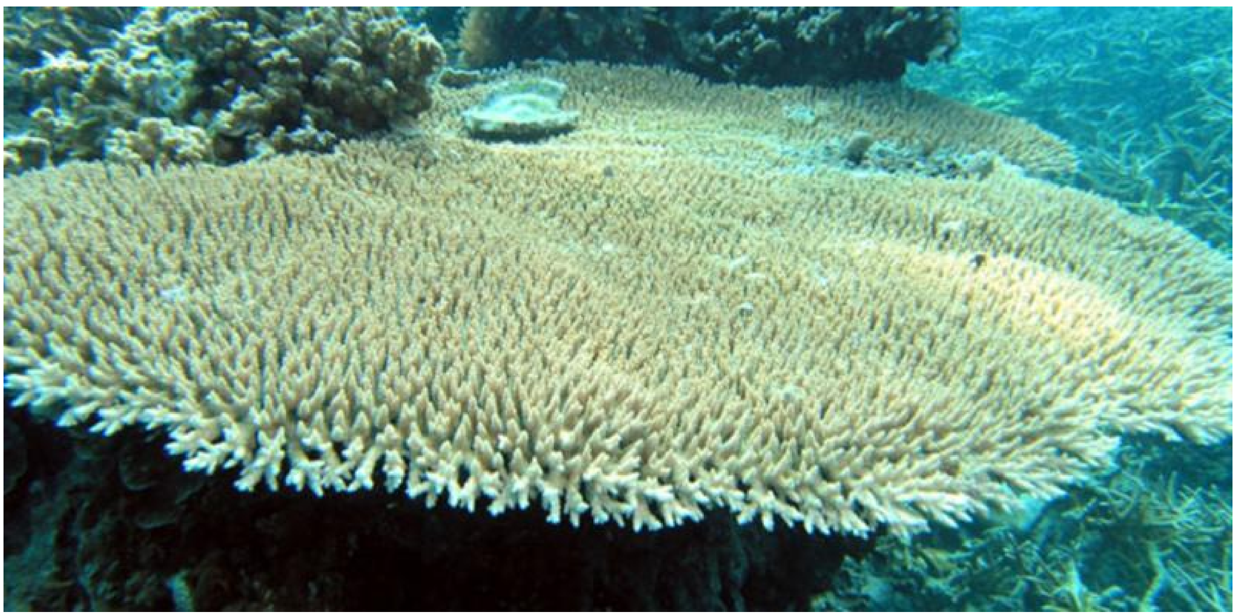


Adult corals need a good developmental start to establish themselves on the reef. Credit: Anders Poulsen/Wikimedia Commons, CC BY-SA

Coral reefs around the world are facing a whole spectrum of human-induced disturbances that are affecting their ability to grow, reproduce and survive. These range from local pressures such as overfishing and sedimentation, to global ones such as ocean acidification and warming. With the third global coral bleaching event underway, we now more than ever, need to understand how coral responds to these stressors.

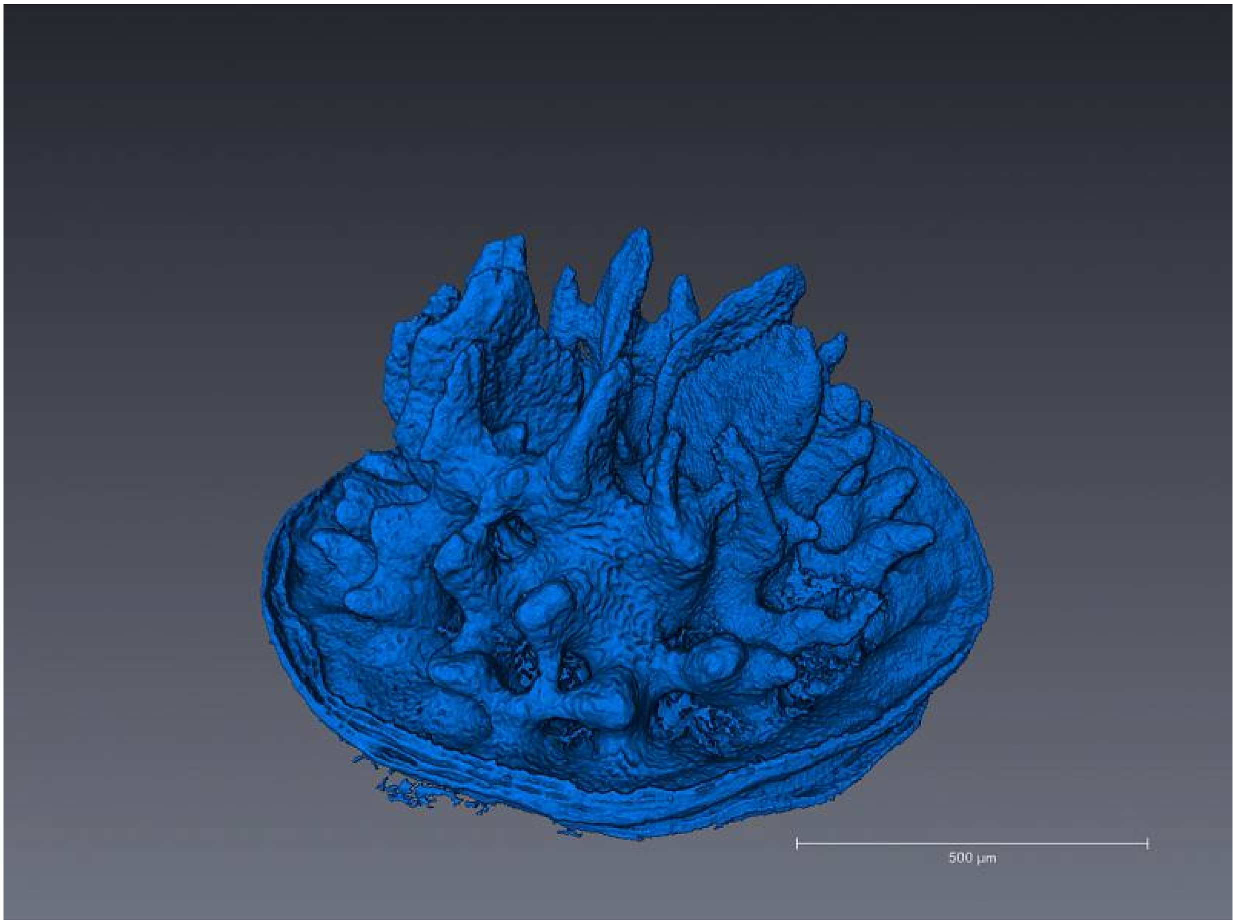
Our new research, published in *Science Advances*, now shows that young corals develop deformed and porous skeletons when they grow in more acidified waters, potentially making it more difficult for them to establish themselves on the reef and survive to adulthood.

Juvenile corals

Corals vary in their responses to stress, not only between species and location, but also among different stages of their life cycle. Juvenile corals are extremely important to the health of a reef, as they help to replenish the reef's coral population and also help it recover from severe disturbances such as bleaching and storms.

However, newly settled young corals are small (typically about 1 mm across) and therefore very vulnerable to things like overgrowth and predation. To survive into adulthood they need to grow quickly out of this vulnerable size class. To do that they need to build a robust skeleton that can maintain its structural integrity during growth.

Two major factors that affect coral skeletal growth are ocean temperature and carbon dioxide concentration. Both are on the rise as we continue to emit huge amounts of CO_2 into the atmosphere. Generally with adult corals, increased temperature and CO_2 both reduce growth rates. But this varies considerably depending on the species and the environmental conditions to which the coral has been exposed.



A 3D X-ray microscopy image of a one-month-old coral skeleton. Credit: Taryn Foster/Science Advances, Author provided

Much less is known about the impacts of these factors on juvenile corals. This is mainly because their small size makes them more difficult to study, and they are only usually around once a year during the annual coral spawn. The corals we studied spawn for just a couple of hours, on one night of the year, meaning that our study hinged on taking samples during a crucial one-hour window.

When collecting the samples, at Western Australia's Basile Island in the Houtman Abrolhos archipelago in March 2013, we watched the adult spawners each night waiting to see if they would spawn and, when they did, we worked all night fertilising the eggs to collect our juvenile samples.

Having collected our elusive coral samples, we cultured and grew newly settled coral recruits under temperature and CO_2 conditions that are expected to occur by the end of the century if no action is taken to curb the current trajectory of CO_2 emissions.

We then used three-dimensional X-ray microscopy to look at how these conditions affect the structure of the skeleton. This technique involves taking many X-ray projection images of the sample (in this case around 3,200) and then reconstructing them into a 3D image.

Deformed and porous skeletons

Corals grown under high-CO_2 conditions not only showed reduced skeletal growth overall, but developed a range of skeletal deformities.

These included reduced overall size, gaps, over- and under-sized structures, and in some cases, large sections of skeleton completely missing. We also saw deep pitting and fractures in the skeletons of corals grown under high CO_2, typical of skeletal dissolution and structural fragility.

Surprisingly, increased temperature did not have a negative impact on skeletal growth and for some measures even appeared to help to offset the negative impacts of high CO_2 – a response we think may be unique to sub-tropical juveniles.

Nevertheless, our study highlights the vulnerability of juvenile corals to ocean acidification.

Under the current CO_2 emissions trajectory, our findings indicate that young corals will not be able to effectively build their skeletons. This could have wider implications for coral reef health, because without healthy new recruits, reefs will not replenish and will be less able to bounce back from disturbances.

The effect of temperature in this study however, was both a surprising and welcome finding. There is a lot of variation even between species, but it is possible that subtropical organisms have more plasticity due to their natural exposure to a wider range of conditions. This could indicate that subtropical juveniles may have an unexpected edge when it comes to ocean warming.

More information: T. Foster et al. Ocean acidification causes structural deformities in juvenile coral skeletons, *Science Advances* (2016). DOI: 10.1126/sciadv.1501130

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