New imaging technique reveals vulnerability of coral reefs

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Researcher, Nyssa Silbiger, retrieving an experimental block from the reef. Credit: NOAA

Corals, the primary reef builders on coral reefs, are often the star player in research studies addressing the impacts of climate change on coral reefs because they are the foundation of coral reef ecosystems. However, the breakdown of coral reefs from borers (such as bivalves, sponges, and marine worms) and grazers (such as parrotfish and urchins)—called bioerosion—and growth from encrusting algae and invertebrates (for example, oysters and barnacles) - called secondary accretion—are critical processes for reef sustainability.

In a study published today in *PLOS ONE*, Nyssa Silbiger and colleagues created a novel method to expose how these underdogs of coral reef science respond to varying environmental conditions, including changing ocean acidity. Using µCT (micro-computed tomography) scans, Silbiger and colleagues were able to calculate detailed bioerosion and secondary accretion rates on coral reefs—work she performed as a graduate student at the University of Hawai'i—Mānoa's (UHM) Hawai'i Institute of Marine Biology (HIMB).

Silbiger, now a post-doctoral scholar at the University of California - Irvine, and colleagues used fine-scale µCT scans—a technique that is commonly used in the medical field to image internal organs and bones in 3D—to create 3-dimentional images inside and outside of calcium carbonate blocks constructed from dead pieces of the coral skeleton. Silbiger and colleagues applied this non-destructive µCT technology to reveal the impacts of changing climate conditions on reef bioerosion and secondary accretion.

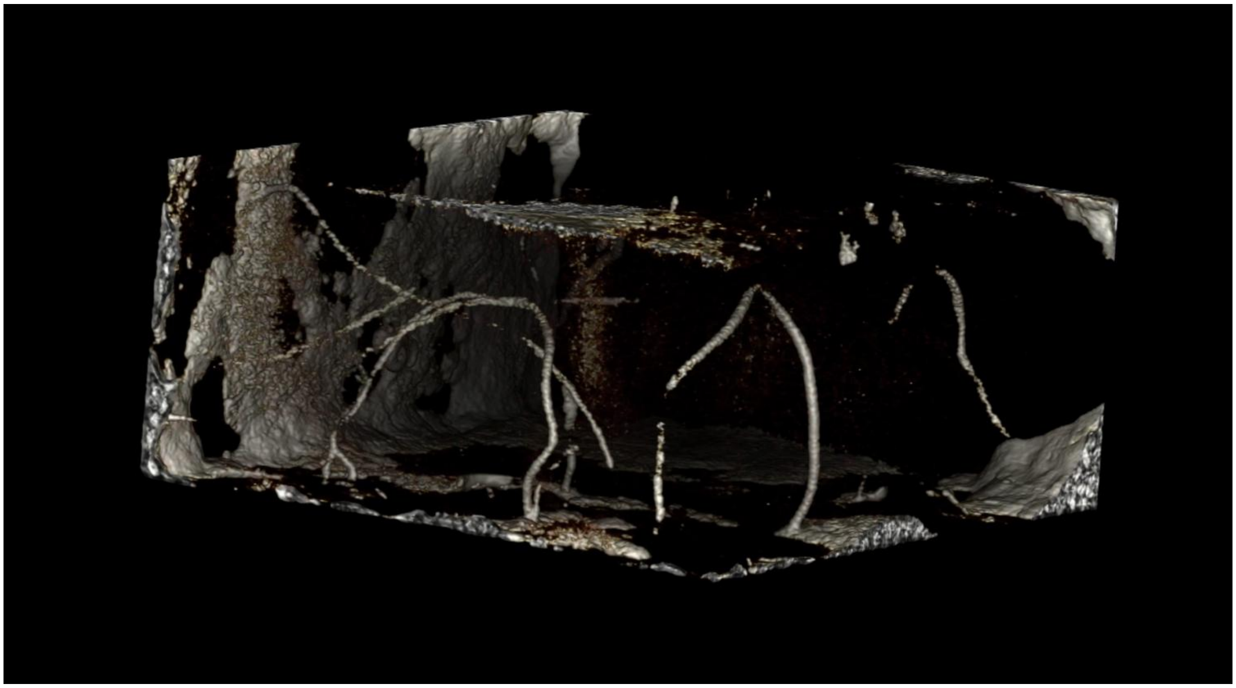

Image from µCT scan highlighting bioerosion in a coral block. Credit: Nyssa Silbiger and Mark Riccio

"While there are several methods currently being used to test how bioerosion responds to environmental variability, our study provides the first method to accurately separate bioerosion and secondary accretion on the same time-scale and determine how these processes individually respond to different environmental parameters," said Silbiger.

The team of researchers constructed blocks from dead pieces of coral and performed µCT scans on the samples before and after a one-year deployment period on a coral reef in Kāne`ohe Bay, Hawai`i to determine how much new growth had settled onto the block and how much of the block had been eroded from bioeroding organisms. By comparing pre- and post-deployment µCT scans, Silbiger and colleagues were able to separate secondary accretion and bioerosion from the same experimental substrate exposed to the same environmental variation over the same time-scale. Because the blocks were placed along an environmental gradient with naturally varying pH conditions (acidity), the researchers could assess how pH and other environmental parameters impact secondary accretion and bioerosion.

In a previously published dataset (Silbiger et al. 2014 Marine Ecology Progress Series), Silbiger and colleagues showed that reefs shifted from net growth to net erosion along this natural pH gradient. However, with this new analysis the scientists were able to uncover results that were unattainable with prior methods. They demonstrated that secondary accretion and bioerosion are driven by different environmental parameters—bioerosion is more sensitive to changing ocean pH than secondary accretion, and the net change in reef growth is driven more by changes in bioerosion than secondary accretion.

"We were surprised that bioerosion was so much more sensitive to ocean acidification than growth processes on the reef," said Silbiger, "This key finding could change our perspective on how coral reefs are predicted to respond to ocean acidification."

In order for coral reefs to persist, the rate of reef growth must be higher than the rate of reef breakdown. If reef breakdown continues to increase because of ocean acidification there could be a deadly shift from net growth to net breakdown of coral reefs in the future.

"The results of our study are sobering because it seems that even if corals can adapt, acclimatize or withstand changing ocean pH, bioerosion of the reef framework will still continue to increase," according to Silbiger.

In order to predict how reefs will change in the future, it is critical to understand how environmental variability impacts individual reef processes. Without this information, researchers could over- or under-estimate how coral reefs will actually respond to future ocean conditions. Silbiger and colleagues are excited by the discoveries that await using μCT technology.

"We are able to assess the addition or removal of calcium carbonate (the skeletal make-up of coral reefs) at a resolution of 100μm [micrometers]—approximately the thickness of a human hair," said Silbiger. "There is so much that we can learn about coral reefs using μCT scans. My colleagues and I are mining all the information we can from this exciting technology."

More information: Silbiger NJ, Guadayol Ó, Thomas FIM, Donahue MJ (2016) A novel μCT analysis reveals different responses of bioerosion and secondary accretion to environmental variability. *PLOS ONE*: DOI: 10.1371/journal.pone.0153058

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