Ocean acidification means major changes for California mussels, researcher says

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McCoy and her team found that ocean acidification has begun to change California mussel shells on a basic structural level. Credit: Sophie McCoy

Accelerating ocean acidification could be transforming the fundamental structure of California mussel shells, according to a new report from a

Florida State University-led team of scientists.

For thousands of years, California mussel shells have shared a relatively uniform mineralogical makeup—long, cylindrical calcite crystals ordered in neat vertical rows with crisp, geometric regularity. But in a study published this week in the journal *Global Change Biology*, researchers suggest that escalating rates of ocean acidification are shaking up that shell mineralogy on its most basic structural levels.

"What we've seen in more recent shells is that the crystals are small and disoriented," said Assistant Professor of Biological Science Sophie McCoy, who led the study. "These are significant changes in how these animals produce their shells that can be tied to a shifting ocean chemistry."

To document these changes, the research team studied an archival record of natural California mussel specimens collected from Tatoosh Island off the northwestern tip of Washington. Modern mussel shells were compared to shells from the 1970s as well as shells provided by the local Makah Cultural and Research Center dating back thousands of years.

Researchers found that while shell mineralogy had remained consistent for centuries, shell specimens collected within the past 15 years had experienced dramatic structural changes.

"When the mussels are ready to build their shells, they first lay down an amorphous soup of calcium carbonate, which they later order and organize," McCoy said. "More recent shells have just started heaping that calcium carbonate soup where it needs to go and then leaving it there disordered."

The team also found that recent shells exhibited elevated levels of magnesium—a sign that the process of shell formation has been disrupted.

Typically, healthy shells are composed primarily of calcium carbonate, and any magnesium incorporated in a shell is a product of trace amounts of ambient magnesium present in the environment.

"When more magnesium is found in the skeleton, it signals that the organism has less control over what it's making," McCoy said.

Increased skeletal magnesium also causes changes in the strength of important magnesium-oxygen bonds. The robustness of these bonds is an instructive proxy for the level of organization in a shell.

"When there's not a clear geometric pattern in the skeleton, the bond strengths become more variable, and that's what we're seeing in modern shells," McCoy said. "They're not being organized."

This trend toward disorganized, variable shell structures over the past decade corresponds with the rapidly increasing rate of climate change-related ocean acidification. But while these environmental stressors have rendered the California mussel particularly vulnerable, McCoy said that the same variation that stems from disordered skeletons could also offer the species a glimmer of hope.

"An important theme of climate change science is that increased variability might be the new rule," she said. "We know that climate change right now is happening faster than what the Earth has experienced before, but we also see that over these long timescales, things tend to plateau and stabilize. Variability is the basis of natural selection, and the fact that we now see so much variability in the mussels' individual traits means there is potential for natural selection to act."

McCoy first began investigating California mussel shell structure in 2009 when, soon after she began working toward her doctorate, she noticed stark visual differences between older and more recent shells.

"My job was to slice mussels in half and drill out the shell for isotope measurements, and by chance I noticed that older shells looked completely different," she said. "They were twice as thick, massive and took twice as long to cut. Eventually, we found that this was true for other older shells found at various sites throughout the region. It was sort of by accident. We could see the shells were changing, but we weren't exactly sure what was going on."

Now, years after those initial observations, McCoy and her team have found the culprit: global climate change and its destabilizing effects on our oceans.

But according to McCoy, this is no cause for outright pessimism.

"I don't know if this species will succeed in the future, but I have too much confidence in the natural processes of ecology and evolution to think that we'll have barren oceans," she said. "It's true that we might not have as many mussel species, or that their populations might be smaller and have a more restricted range, but I don't think that we'll have an ocean with no mussels."

More information: Sophie J. McCoy et al, A mineralogical record of ocean change: Decadal and centennial patterns in the California mussel, *Global Change Biology* (2018). DOI: 10.1111/gcb.14013

Provided by Florida State University

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