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Deep-Sea Biodiversity Impacted by Climate Change's Triple Threat

Researchers find a key effect of oxygen loss and that climate change impacts vary by region

Scripps scientists Lisa Levin and Carlos Neira preparing a sediment coring instrument for deployment on the seafloor.

A new study found that vulnerability of deep-sea biodiversity to climate change's triple threat – rising water temperatures, and decreased oxygen, and pH levels – is not uniform across the world's oceans.

The analysis by researchers at Scripps Institution of Oceanography at University of California San Diego used responses to natural variation in temperature, oxygen, and pH to reveal that deep-sea biodiversity from Baja California to San Francisco may be highly susceptible to projected climate changes in the future.

Climate change is often thought of as a single environmental threat from increases in atmospheric CO_2. However, multiple climate stressors, from ocean warming and acidification to low oxygen levels, are expected to result in cumulative impacts on marine life. The deep ocean, which covers more than 60 percent of Earth's surface, is a biodiversity hotspot at increased risk from climate change.

The National Science Foundation-funded study, published in the April 27 issue of the journal *Proceedings of the Royal Society B*, looked at how marine communities change across natural gradients to better understand the influence of the three climate stressors.

"These stressors are often under-appreciated threats to diversity and ecosystem health," said Scripps biological oceanographer Lisa Levin, the senior author of the study. "Yet, they raise questions about whether, and how, populations will adapt and which stressors are the primary drivers."

To untangle the impacts that these three climate stressors will have on seafloor diversity in the future, the researchers examined existing published data and collected new data on organisms living in deep-sea sediments in upwelling regions along continental margins, where the ocean and continental crusts meet along the seafloor. The researchers found that organisms from each ocean basin had its own unique threshold for the level and type of stressor it could tolerate.

The researchers found that diversity of marine life in the eastern Pacific Ocean is highly sensitive to declining oxygen levels, while CO_2 levels were of importance to biodiversity in the Indian Ocean. Oxygen levels are falling throughout the world's oceans, and the decline is expected to have the greatest impact to biodiversity in the eastern Pacific Ocean.

"Global change affects so many different environmental aspects, and across such a range of conditions, that it can be difficult to study in the laboratory," said Erik Sperling, assistant professor of geological sciences at Stanford's School of Earth, Energy & Environmental Sciences, lead author of the study, which was conducted while he was a postdoctoral researcher at Scripps. "In some sense nature has already run these experiments on continental margins, where sharp natural environmental gradients exist."

Continental margins cover over 11 percent of the world's oceans. They are considered biodiversity hotspots and play a major role in supporting commercially important fisheries. They are also considered the largest "carbon sink" of atmospheric carbon dioxide on Earth.

The results from the study can help better identify areas under the most stress, and to predict the regions most susceptible to future climate change.

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