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Pole-to-pole study of ocean life identifies nearly 200,000 marine viruses

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VIDEO: THIS VIDEO SHOWS THE ROUTE TAKEN BY THE TARA ON ITS POLAR CIRCLE EXPEDITION IN 2013. **view more** ›

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An international team has conducted the first-ever global survey of the ecological diversity of viruses in the oceans during expeditions aboard a single sailboat, the Tara. They identified nearly 200,000 marine viral species, which vastly exceeds the 15,000 known from prior ocean surveys of these waters and the approximately 2,000 genomes available from cultured viruses of microbes. Their findings, appearing April 25 in the journal *Cell*, have implications for understanding issues ranging from evolution to climate change, because they help create a new picture of our planet and how it may be impacted by interactions among organisms.

"Viruses are these tiny things that you can't even see, but because they're present in such huge numbers, they really matter," says senior author Matthew Sullivan (@Lab_Sullivan), a microbiologist at the Ohio State University. "We've developed a distribution map that is foundational for anyone who wants to study how viruses manipulate the ecosystem. There were many things that surprised us about our findings."

Among the surprises was the existence of these nearly 200,000 marine viral species. Additionally, meta-community analysis showed that the viruses were organized into five distinct ecological zones throughout the entire ocean, which was unexpected given the fluid nature of the oceans and the complexity of many of the marine regions. Also, despite the paradigm from larger organisms that species diversity is highest near the equator and lowest near the poles, the researchers collected an extensive number of samples in the Arctic compared to previous studies of ocean life and found a biodiversity hotspot in the Arctic Ocean.

The samples were collected between 2009 and 2013 on the Tara as part of the Tara Oceans effort. Begun in 2006, the Tara project aims to conduct unique and innovative ocean science with the goal of predicting and better anticipating the impacts of climate change. In the current effort, a rotating team of scientists spent time on the boat collecting ocean water samples from different depths across many geographical regions. After being collected, the samples for this study were filtered and shipped back to about a dozen different labs for analysis.

The investigators studied not only the water samples for viruses, but also other microbes and other living creatures. "We filtered the samples to analyze organisms ranging in size from viruses to fish eggs," Sullivan says. He adds that papers reporting some of the other microbial components from the samples are forthcoming.

Another noteworthy aspect of the project was the extensive number of samples collected in the Arctic, a highlight that has not been part of earlier studies of ocean life.

This research has significant implications for understanding how ocean microorganisms affect the earth's atmosphere. "In the last 20 years or so, we've learned that half of the oxygen that we breathe comes from marine organisms," Sullivan notes. "Additionally, the oceans soak up half of the carbon dioxide from the atmosphere."

"Because of complex chemistry, increased levels of carbon dioxide at the surface acidify the oceans," Sullivan adds. "However, if carbon dioxide instead is converted to organic carbon and biomass, then it can become particulate and sink into the deep oceans. That's a good result for helping mitigate human-induced climate change--and we're learning that viruses can help facilitate this sinking. Having a new map of where these viruses are located can help us understand this ocean carbon "pump" and, more broadly, biogeochemistry that impacts the planet."

The investigators say that having a more complete picture of marine viral distribution and abundance will help them to determine which viruses they should be focusing on for further studies. Additionally, the maps based on this research establish a baseline for other collection efforts going forward, which can help to answer questions about how levels of microorganisms change over time, in response to both seasonal variation and climate change.

"Previous ocean ecosystem models have commonly ignored microbes, and rarely included viruses, but we now know they are a vital component to include," Sullivan concludes.

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