Study illuminates fate of marine carbon in last steps toward sequestration

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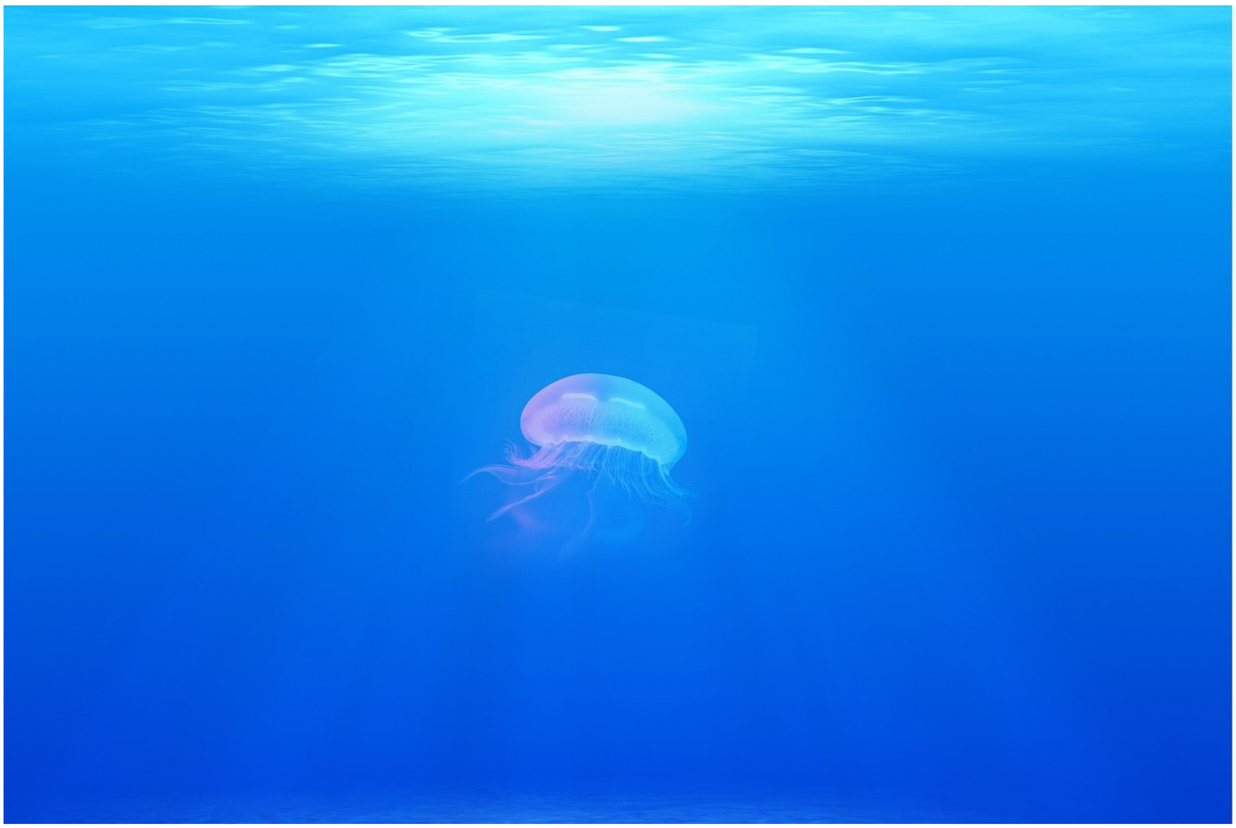

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The ocean sequesters massive amounts of carbon in the form of "dissolved organic matter," and new research explains how an ancient group of cells in the dark ocean wrings the last bit of energy from carbon molecules resistant to breakdown.

A look at genomes from SAR202 bacterioplankton found oxidative enzymes and other important families of enzymes that indicate SAR202 may facilitate the last stages of breakdown before the dissolved oxygen matter, or DOM, reaches a "refractory" state that fends off further decomposition.

Findings from the study by scientists at Oregon State University were recently published by the American Society for Microbiology.

The ocean sequesters nearly as much carbon as exists in the atmosphere as carbon dioxide (CO2) and the new research into deep-water bacteria's genomes sheds key new light on how the carbon storehouse operates.

Stephen Giovannoni, OSU distinguished professor of microbiology, said that near the ocean surface, the DOM carbon goes unconsumed because the cost of harvesting the resources is too high. Currents transport the "recalcitrant" forms of DOM that remain to the deep ocean, where they are slowly broken down to compounds that can persist for thousands of years.

Zach Landry, an OSU graduate student and first author of the study, named SAR202 "Monstromaria" from the Latin term for "sea monster."

"They're very abundant in the dark ocean where no photosynthesis is happening and planktonic cells are living off whatever rains down from surface," Giovannoni said. "The big carbon cycle unknown is why so much carbon accumulates as organic matter in the ocean. In principle, micro-organisms could use it as chow to make energy and build biomass - and return CO2 to the atmosphere, which would be a disaster.

"At the surface, where there's intense competition for nitrogen and phosphorus, and grazing by bigger plankton cells, Monstromaria's activities don't pay out well enough for them to make a living," Giovannoni said. "It's so difficult to break down the resistant compounds that it's not worth the cost. It's like trying to make a living farming in an urban area - it isn't going to work because the cost of living is too high.

"The resistant DOM carbon is like the last thing you'd want at a buffet, but the SAR202 consumes it in the deep ocean because it's all that is left."

The research was done in Giovannoni's lab by Landry, then a Ph.D. candidate at OSU and now a post-doctoral scholar, and collaborators at the Bigelow Laboratory for Ocean Sciences, the National Biodefense Analysis and Countermeasures Center, the University of Vienna, and Utrecht University.

"Since SAR202 are ancient and today dominate in the dark ocean realm, we speculate their arrival in ancient oceans may have impacted the early carbon cycle," Landry said.

More information: Zachary Landry et al, SAR202 Genomes from the Dark Ocean Predict Pathways for the Oxidation of Recalcitrant Dissolved Organic Matter, *mBio* (2017). DOI: 10.1128/mBio.00413-17

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