Gas-passing plankton illuminate another piece of the carbon cycle puzzle

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Credit: Luis Bolaños, OSU

The ocean's most abundant life form, a type of bacteria discovered by Oregon State University, consumes an organic compound commonly found in solvents like paint remover, a new study by OSU shows.

Finding that SAR11 bacteria use acetone adds to evidence suggesting that aspects of the marine carbon cycle, which pulls atmospheric carbon into the sea, are not being considered in the study of the cycle and its ability to buffer climate change, scientists say.

The research led by Oregon State microbiologist Kimberly Halsey and then-OSU Ph.D. student Eric Moore revealed not only that the bacteria consume acetone but another volatile organic compound, isoprene, as well.

Isoprene, chemically expressed as C_5H_8 and the key component of natural rubber, is a gaseous product of plant metabolism. Isoprene and acetone (C_3H_6O) are produced by phytoplankton, microscopic marine algae, and are abundant in the surface ocean, from which these gases can move into the atmosphere and influence climate.

"Isoprene is often associated with the famous haze of the Blue Ridge Mountains," said Halsey, the Excellence in Microbiology Faculty Scholar in the OSU College of Science. "How acetone is produced biologically is not well understood, but both isoprene and acetone interest atmospheric scientists because if they escape the surface ocean, they can react chemically with other compounds in the atmosphere, potentially forming aerosol particles that can precipitate rain, ice and snow formation."

SAR11, discovered in 1990 by Oregon State's Stephen Giovannoni, is the smallest free-living cell known and also has the smallest genome of any independent cell. But the bacteria thrive where most other cells would perish—SAR11's combined weight exceeds that of all the ocean's fish—and through their sheer numbers play a huge role in carbon cycling.

A single milliliter of ocean water might contain a half-million SAR11 cells, said Giovannoni, distinguished professor of microbiology, and 25% of all ocean plankton are SAR11.

"That SAR11 cells can use isoprene adds further weight to a new theory that some plankton cells specialize in very low molecular weight—very light—molecules that for the most part are missed by the common methods to study the carbon cycle," said Giovannoni, who took part in the acetone and isoprene research. "SAR11 have the surprising metabolic ability to both oxidize and produce a variety of volatile organic compounds, or VOCs, that can diffuse into the atmosphere."

VOCs are any of a number of carbon-containing chemicals with high vapor pressure and low water solubility, some of which can cause adverse health effects to humans.

"We don't really have a clear picture yet of the cycling of acetone and isoprene but we know there are hidden aspects of the carbon cycle that need further study before we can fully understand the movement of carbon through biological systems in the ocean," Halsey said. "It's important to understand SAR11 and other bacteria's potential to control the emission of climate-active gases because it helps our overall understanding of climate change and stability."

The scientists say next steps include dissecting the biochemical mechanisms underlying the cycling of volatile organic compounds and trying to link marine microbial processes to gas emissions and the transport of chemicals in the atmosphere.

"Plankton exchanging gases in the surface ocean is far more common than once thought," Halsey said.

Findings were published in *Environmental Microbiology*.

More information: Eric R. Moore et al, Metabolism of key atmospheric volatile organic compounds by the marine heterotrophic bacterium Pelagibacter HTCC1062 (SAR11), *Environmental Microbiology* (2021). DOI: 10.1111/1462-2920.15837

Provided by Oregon State University

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