Fighting climate change with deep-sea water

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Marine biologists have long known the power of microbes to transform carbon released by surface phytoplankton—algae on the surface of the sea—into more stable molecules. But what happens when that carbon reaches deep parts of the ocean, thousands of meters down?

According to new research at Université de Montréal, the answer could provide one more arsenal in the global fight against climate change: the deep-sea microbes could be a great tool to neutralize carbon molecules and store them—for millennia—where they can't do any damage.

"The microbial communities living in deeper layers of the ocean might actually be better equipped to transform surface carbon into unique and more stable molecules," said Richard LaBrie, an UdeM graduate student who made the finding in a series of shipboard lab experiments.

"Why? Because these unique microbes are used to live in harsh conditions. The question then becomes whether they could be sequestering carbon in the deep ocean for centuries, helping in the fight against climate change. And the answer is yes."

In a study co-authored with his thesis advisor, UdeM biology professor Roxane Maranger, LaBrie's results were published last month in the journal *Science Advances*. The co-authors are also members of the Interuniversity Group in Limnology.

A natural phenomenon

Can surface carbon reach microbes in the deep ocean? It turns out they can, through a natural phenomenon occurring right here in Canadian waters. Off the Atlantic coast in the Labrador Sea, this type of mixing is routine in winter.

Year after year, surface water typically mixes down to between 500 and 1,500 meters, in some cases going as deep as 2,500 meters. And when it does, it carries carbon from the surface to these different layers to meet with the microbes floating below.

Like peatlands on the Earth's surface, the result is a fertile environment with huge potential to turn carbon into something far less problematic, the UdeM researchers say. And the mixing can happen in much smaller, routine ways, they add: through physical phenomena called eddies.

"Eddies are like tornadoes in the ocean, and they can occur on the surface as well as in deep ocean, connecting different ocean layers," explained Maranger, who with LaBrie observed firsthand in the Labrador Sea a number of deep eddies mixing waters from around 2,000 to 1,500 meters. When these events happen, microbes encounter different carbon and start feeding on it.

Carbon consumed faster

LaBrie tested whether deeper microbes were better at creating more stable carbon by exposing filtered surface water to microbes from water collect from three different depths in the Labrador Sea: the surface, 500 meters deep, and a deep-water eddy sampled at 1,500 meters. Sure enough, what he and his co-authors found was that the surface carbon was consumed faster and was transformed into much more stable molecules when exposed to the deeper microbes.

Why were deeper microbes better at converting this carbon into more stable molecules?

"We found that there was a greater diversity of unique microbes living in the deeper ocean, and we suspect that these microbes were creating these more stable molecules" said LaBrie. "The molecules can remain untouched for decades and even centuries in the deep waters."

Added Maranger: "We still don't know whether there would be a way to use these deep microbes as a nature-based solution to help counter climate change more actively. It's possible, and that's promising."

At the very least, "we know that the deep ocean holds a diverse community of microbes," she concluded, "and those microbes are able to go through a number of unique metabolic transformations. That's pretty amazing in itself."

More information: Richard LaBrie et al, Deep ocean microbial communities produce more stable dissolved organic matter through the succession of rare prokaryotes, *Science Advances* (2022). DOI: 10.1126/sciadv.abn0035

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