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Mighty diatoms: Global climate feedback from microscopic algae

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Tiny creatures at the bottom of the food chain called diatoms suck up nearly a quarter of the atmosphere's carbon dioxide, yet research by Michigan State University scientists suggests they could become less able to "sequester" that greenhouse gas as the climate warms. The microscopic algae are a major component of plankton living in puddles, lakes and oceans.

Zoology professor Elena Litchman, with MSU colleague Christopher Klausmeier and Kohei Yoshiyama of the University of Tokyo, explored how nutrient limitation affects the evolution of the size of diatoms in different environments. Their findings underscore potential consequences for aquatic food webs and climate shifts.

"They are globally important since they 'fix' a significant amount of carbon," Litchman explained of the single-cell diatoms. "When they die in the ocean, they sink to the bottom carrying the carbon from the atmosphere with them. They perform a tremendous service to the environment."

Carbon dioxide buildup, due to a significant extent to burning fossil fuels and deforestation, is identified as the leading cause of climate change. Carbon dioxide is at its highest level in at least 650,000 years and rising, according to The National Academies, and only half of the CO_2 produced now can be absorbed by plant life.

Litchman analyzed data from lakes and oceans across the United States, Europe and Asia and found a striking difference between the size of diatoms in freshwater and in marine environments. In oceans, diatoms grow to be 10 times larger on average than in freshwater and have a wider range of sizes.

One factor that affects growth is nutrient availability, Litchman said. The research shows that limitations by nitrogen and phosphorus exert different selective pressures on cell size. The availability of these nutrients depends on the mixing of water from greater depths. Using a mathematical model, Litchman and her colleagues found that when those nutrients are constantly limited and mixing is shallow, smaller diatoms thrive.

But when nitrate comes and goes, as often happens in roiling oceans, diatoms evolve larger to store nutrients for lean times. Deep mixing also benefits large diatoms. Depending on how intermittent the nitrate supply is and how deep the ocean mixes, there can be a wide range of diatom sizes. Size matters for the creatures that eat them and also for carbon sequestration, as large diatoms are more likely to sink when they die.

Changing climate could alter the mixing depths and delivery of nutrients to diatoms and their subsequent sizes with a cascade of consequences, Litchman said.

"On a global scale, increased ocean temperatures could make the ocean more stratified," she explained. "This would cause less mixing and create stronger nutrient limitation and less frequent nutrient pulses. A change like this would select for different sizes of diatoms. If smaller sized diatoms dominate, then carbon sequestration becomes less efficient and there may be more CO_2 remaining in the atmosphere, which would exacerbate global warming."

More information: Their findings were published recently in the

Proceedings of the National Academy of Sciences.

Source: Michigan State University (news : web)