Long-term study finds nitrogen fixation hot spots in Atlantic seaweed

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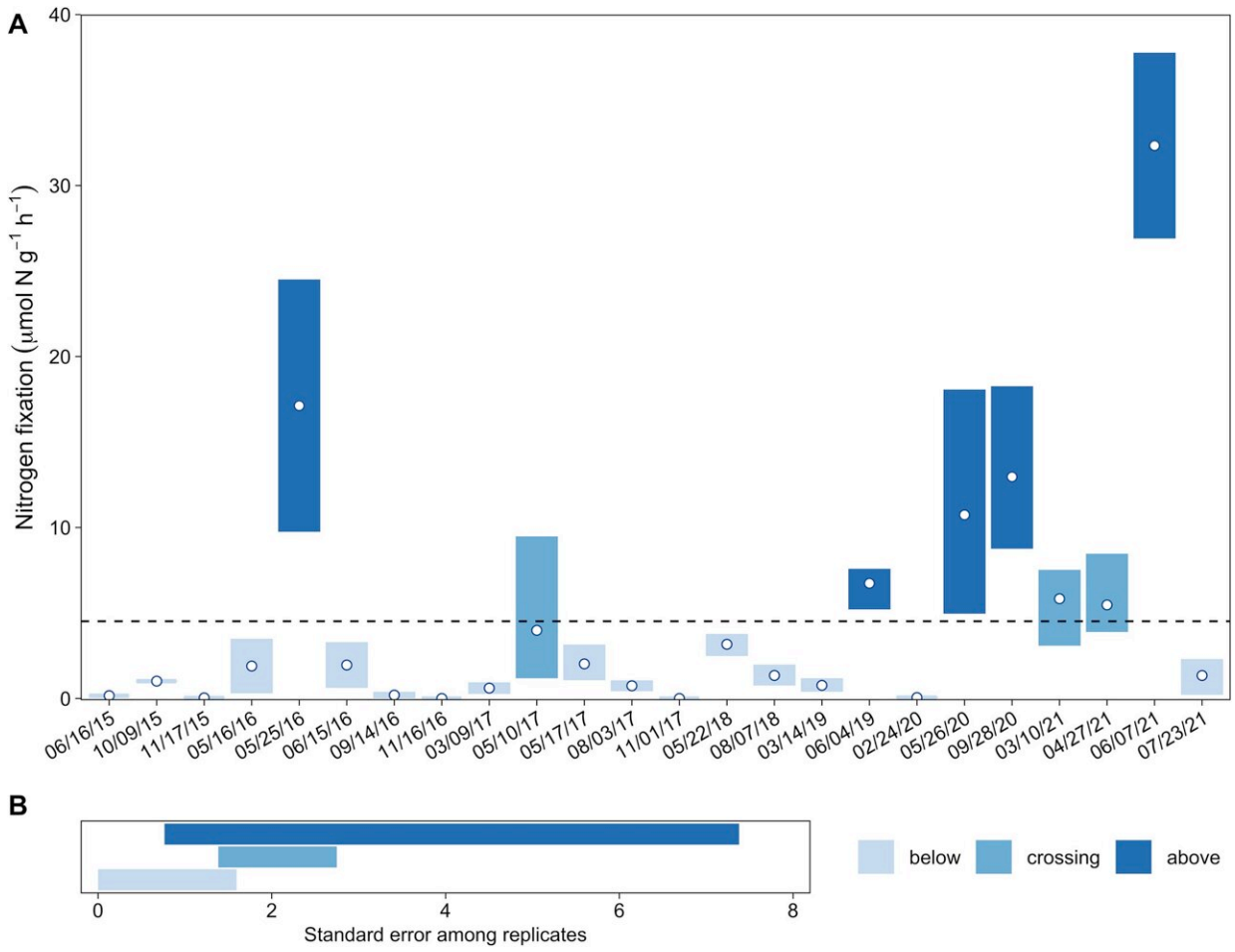

Range (colored bars) and mean (open circles) nitrogen fixation rates by cruise date (A) and standard error range among replicates by category (B). Bar color in panel A indicates whether a cruise date's range of rates falls entirely below, crosses, or entirely above the overall mean rate (dashed line). Panel B illustrates the range of standard error among replicates from a single cruise date according

to these same mean rate categories. Credit: *PLOS ONE* (2023). DOI: 10.1371/journal.pone.0289485

A new study by researchers at the University of North Carolina at Chapel Hill examined nitrogen fixation among diazotrophs—microorganisms that can convert nitrogen into usable form for other plants and animals—living among sargassum. Sargassum, a brown macroalgae in the seaweed family, floats on the surface of the open ocean and provides habitat for a colorful array of marine life such as small fish, brine shrimp and other microorganisms.

Previous studies have overlooked diazotrophs associated with sargassum, which could mean a historical underestimation of nitrogen fixation in the Atlantic nitrogen budget. The study, published today in *PLOS ONE*, found that nitrogen fixation in sargassum communities was significant.

"The findings of this study are exciting, especially given much of the recent news regarding sargassum is about the negative effects of its overgrowth in Florida and the Caribbean," said Lindsay Dubbs, a research associate professor and director of the Outer Banks Field Site at the UNC Institute for the Environment and research associate at East Carolina University's Coastal Studies Institute. "We were able to show sargassum's role in nitrogen fixation as meaningful in supporting marine productivity."

Nitrogen is critical for life. Plants and animals need it for growth. More nitrogen in the ocean means greater biological productivity and growth. Sargassum mats provide an important habitat for organisms to perform nitrogen fixation, but few studies have measured it in sargassum communities.

"Only four studies have been published detailing rates of nitrogen fixation by epiphytes on pelagic sargassum and none in over 30 years," said Claire Johnson, a Ph.D. student in the Department of Earth, Marine, and Environmental Sciences in the UNC College of Arts and Sciences and a graduate research assistant at the Coastal Studies Institute.

"It's really exciting for us to be able to contribute this long-term dataset which provides an updated view of this process and, in doing so, will hopefully bring attention to something which has been overlooked for decades."

The team compared the nitrogen fixation rate with other marine sources, including commonly studied nitrogen fixing organisms such as planktonic diazotrophs and coastal epiphytes—plants that grow on other plants—and found the sargassum communities outpaced them—contributing significantly to the marine nitrogen cycle and potentially to sargassum blooms.

Collecting this type of data can be difficult, but the team's proximity to the Gulf Stream from their lab at the Coastal Studies Institute on East Carolina University's Outer Banks campus on Roanoke Island made it possible for them to make day-long trips to collect samples seasonally and process them quickly.

The team was able to collect whole fronds of the seaweed and process them with minimal handling, better keeping the microorganisms intact for the study. Each piece was carefully managed in large tubs at the laboratory, where they collected data on nitrogen fixation rates. The team collected samples over a six-year period.

Sargassum is typically abundant in the Caribbean Sea, Gulf of Mexico, Gulf Stream and Sargasso Sea. The team's work in North Carolina provides a comprehensive view of how nitrogen fixation rates vary over

time, but understanding how they could vary across a wider geographic range could be a next step for further research.

"This research is even more critical now given the sargassum blooms in the South Atlantic," said Johnson. "If nitrogen is being fixed by epiphytes on sargassum in this population on a scale anywhere near what we are seeing here, it would almost certainly have a significant impact on the Atlantic marine nitrogen budget."

"There is so much to be learned about this plant, the other life that it supports, and the factors that contribute to it becoming a nuisance in some places. I am optimistic that our long-term dataset will continue to reveal new insights about its importance and complexity," Dubbs added.

More information: Claire Johnson et al, Reframing the contribution of pelagic Sargassum epiphytic N_2 fixation, *PLOS ONE* (2023). DOI: 10.1371/journal.pone.0289485

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