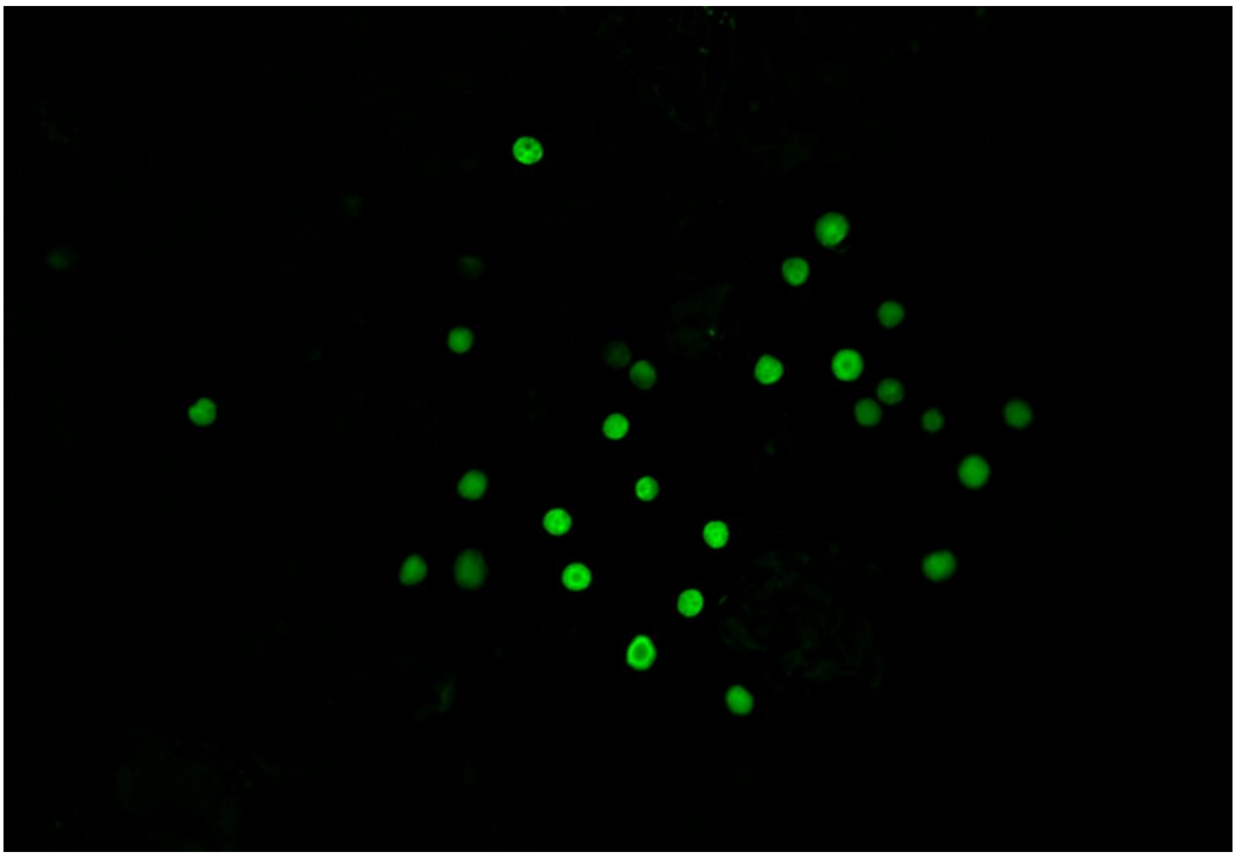
These tiny oceanic creatures are essential to tackling climate change

January 13 2021, by Mar Benavides



Fluorescence images of Crocosphaera. Credit: Mar Benavides, Author provided

The ocean withdraws about one third of the CO_2 in the atmosphere, mitigating climate change and making life possible on Earth. An important share of this CO_2 is removed thanks to phytoplankton, tiny marine creatures that use light to do photosynthesis, just as plants or trees on land. These cells fix CO_2 to build up biomass and multiply, and take it down to the deep ocean when they die and sink. Phytoplankton are thus the basis of the marine food chain, and their productivity not only affects CO_2 levels, but also fish catch and world economy.

So why does phytoplankton go unnoticed to most of us, if they are so important? Try to find them in your next visit to the aquarium, you may have a hard time. Most phytoplankton species are 100 times smaller than the ants in your garden, meaning you need a really powerful magnifying glass (a microscope!) to study them. From our coasts to the middle of the ocean, phytoplankton are widespread and getting to know them requires some seafaring.

The Samaritans of the ocean

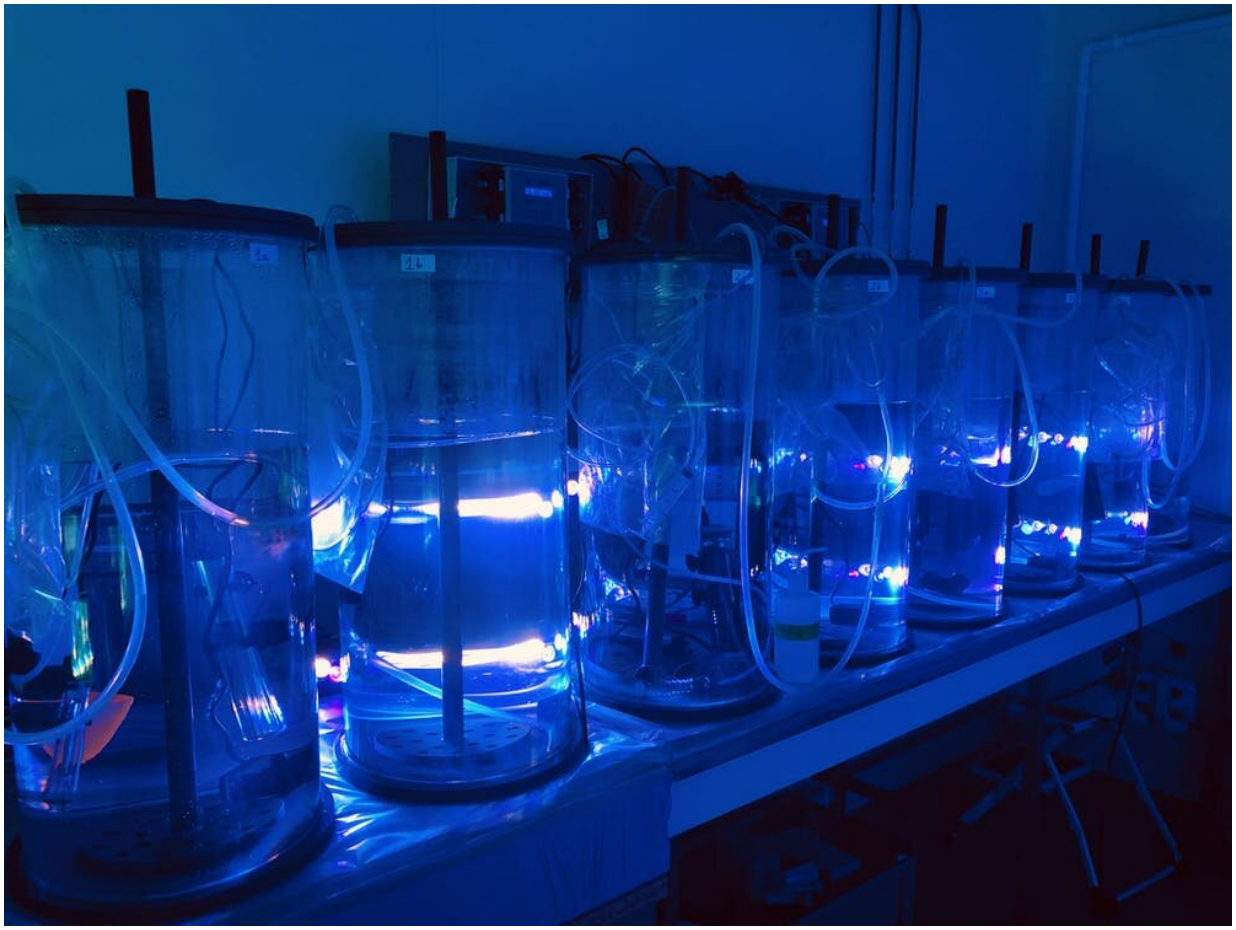
Phytoplankton however need a key ingredient to be active : nitrogen. Just as fertilizers or legume plants are necessary to grow crops on land, nitrogen provides the nutrient value that phytoplankton need to grow in the ocean. Getting enough nitrogen in the ocean can be cumbersome. Coasts receive nitrogen through rivers or upwelling of deep waters rich in nitrogen, but most of the ocean is too remote to benefit from these sources.

To make matters worse, the surface tropical ocean is warm, making mixing with deep and nutrient rich waters very difficult. These "oceanic deserts" are great extensions of clear blue water which altogether make about 60% of the global ocean surface. How is life possible there without nitrogen? Luckily, other tiny creatures, diazotrophs, exist in these deserts

> Tropical ocean bacteria help pump CO_2 out of the atmosphere—new study.@PearseJBuchanan @zanna_chase

https://t.co/6JVG2IGMWM

— The Conversation (@ConversationUK) October 24, 2019



Experiments testing the response of diazotroph cells to simulated climate change scenarios expected until 2100, as part of the NOTION project. Credit: Mar Benavides

Diazotrophs come to the rescue performing a Herculean service : transforming inert nitrogen from the air into juicy nitrogenous forms available to phytoplankton. This transformation involves a great energy investment for the diazotrophs, to end up giving that nitrogen away to the community. Diazotrophs are the true Samaritans of the ocean.

Their crucial mission is likely to be impacted by climate change. Pollution, acidification, loss of oxygen and warming are among the negative effects of our economic development and ever-increasing population growth. Climate change is already impacting how much nitrogen reaches the ocean through changes in currents circulation, increased agricultural nitrogen loading through rivers, or atmospheric inputs through industrial activities.

But, how will climate change affect the activity and diversity of diazotrophs? It is hard to say when we even don't know how many are out there and how diverse they are. Only about five species of diazotrophs have been studied in the ocean, and climate change simulation experiments have been only tested on two. Global circumnavigation expeditions have found that diazotrophs are much more diverse than we thought. Constraining their responses to the changing climate is crucial for predicting the ocean's future productivity. The much larger diversity of diazotrophs implies not only overall higher provision of nitrogen to the oceans, but also higher efficiency and perhaps greater resilience to change, which awaits to be verified.

A lens into the future

The project Notion will look into the future of phytoplankton via a diazotroph lens. In the lab, we will recreate climate change conditions and observe how diazotrophs respond to them.

We will answer questions such as : does the extra CO_2 in the water affect their growth? Do diazotrophs give even more of the "fertilizer" nitrogen away to other organisms in a high CO_2 world? Global models of ocean circulation and phytoplankton species distribution already exist, but they need to be improved with experimental data to predict how our ocean will look like in the future. NOTION will integrate new global datasets and new experimental data to integrate the lacking information in models. We will thus transform biology into mathematics, using the response behavior of diazotrophs as trends projectable to different future climate change scenarios.

With these tools, we aim at providing a better understanding of the ocean's response to climate change, which will be critical for a sustainable use of the ocean and its resources, and essential to evaluate its capacity to act as a sink of CO_2 in our near future.

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