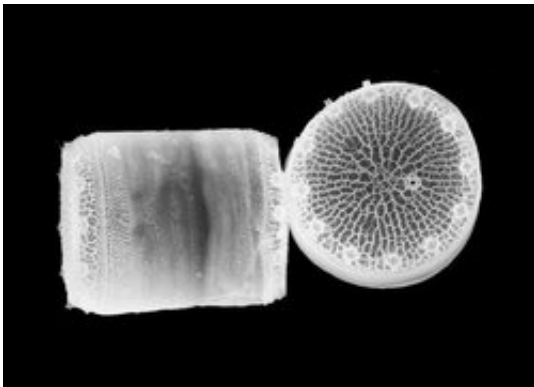


Scientists sequence genome of kind of organism central to biosphere's carbon cycle

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The first ever genomic map of a diatom, part of a family of microscopic ocean algae that are among the Earth's most important inhabitants, has yielded surprising insights about the way they may be using nitrogen, fats and silica in order to thrive.

Diatoms, most of which are far too tiny to see without magnification, are nevertheless thought to **absorb carbon dioxide, a major greenhouse gas, in amounts comparable to all the world's tropical rain forests combined.**

"These organisms are incredibly important in the global carbon cycle," says Virginia Armbrust, a University of Washington associate professor of oceanography and lead author of a research article in the Oct. 1 issue of Science.

*Image: The diatom species *Thalassiosira pseudonana*, with a hard outer shell of silica shaped like a hatbox and delicately marked with pores, is 3 to 4 microns in size. Nils Kröger, Universität Regensburg/Science*

Together, these single-celled organisms generate as much as 40 percent of the 50 billion to 55 billion tons of organic carbon produced each year in the sea, and in the process use carbon dioxide and produce oxygen. And they are an important food source for many other marine organisms.

The genome work, funded by the Department of Energy and conducted at its Joint Genome Institute in California, gives insight into how the diatom species *Thalassiosira pseudonana* prospers in the marine environment, Armbrust says. It's important to understand because diatoms like *Thalassiosira pseudonana* and other phytoplankton are vital components of the biosphere's role in mediating global warming.

"Now that we have a glimpse at the inner workings of diatoms, we're better positioned to understand how changes in the environment will translate into increases or decreases in diatom abundance," says Dan Rokhsar, who heads computational genomics at the Joint Genome Institute and one of the co-authors on the article.

Scientists would like to better understand how these organisms react to changes in sea temperatures, the amount of light penetrating the oceans and nutrients.

"Oceanographers thought we understood how diatoms use nitrogen, but we discovered they have a urea cycle, something no one ever suspected," Armbrust says. A urea cycle is a nitrogen waste pathway found in animals and has never before been seen in a photosynthetic eukaryote like a diatom, she says. Nitrogen is crucial for diatom growth and is often in short supply in sea water, depending on ocean conditions. The

genome work revealed that diatom *Thalassiosira pseudonana* has the genes to produce urea-cycle enzymes that may help to reduce its dependence on nitrogen from the surrounding waters.

The genome work also shed additional light on how this diatom species uses fats, or lipids, that it is known to store in huge amounts.

"Learning the actual pathways they use to metabolize their fats helps explain the ability of diatoms to withstand long periods with little sunlight -- even to overwinter -- and then start growing really rapidly once they return to sunlight," she says.

Three or four microns in width -- as many as 70 could fit in the width of a human hair -- *Thalassiosira pseudonana* is among the smallest diatoms. Like its brethren, it is encased by a frustule, a rigid cell wall delicately marked with pores in patterns distinctive enough for scientists to tell the species apart. Another new finding reported in *Science* concerns the unusual way the diatom metabolizes silicon to form its characteristically ornate silica frustule.

"Diatoms can manipulate silica in ways that nanotechnologists can only dream about. If we understood how they can design and build their patterned frustule as part of their biology, perhaps this could be adapted by humans," Rokhsar says.

Scientists on the project, which includes 46 researchers from 26 institutions, also considered the evolutionary implications revealed by the genomic work. The research provided direct genetic confirmation of a hypothesis that diatoms evolved when a heterotroph, a single-cell microbe, engulfed what scientists say was likely a kind of red alga. The two became one organism, an arrangement called endosymbiosis, and swapped some genetic material to create a new hybrid genome.

"This project helps illustrate the amazing diversity of life on our planet," Armbrust says. "Diatoms display features traditionally thought to be restricted to animals and other features thought to be restricted to plants. Diatoms, with complete disregard for these presumed boundaries, have mixed and matched different attributes to create an incredibly successful microorganism. It's exciting to imagine the novelty in the oceans that still await our discovery."

Other co-authors were Winnie Lau, Micaela Schnitzler Parker and Tatiana Rynearson, University of Washington; John Berges, University of Wisconsin-Milwaukee; Chris Bowler, Anton Montsant and Assaf Vardi, Centre National de la Recherche Scientifique, France; Beverley Green, Balbir Chahal and Miroslav Obornik, University of British Columbia, Canada (Obornik now at Academy of Sciences of the Czech Republic); Diego Martinez, Nicholas Putnam, J. Chris Detter, Tijana Glavina, David Goodstein, Uffe Hellsten, Susan Lucas, Mónica Medina and Paul Richardson, Department of Energy Joint Genome Institute; Shiguo Zhou, Michael Bechner and David Schwartz, University of Wisconsin-Madison; Andrew Allen, Princeton University; Kirk Apt and J. Casey Lippmeier, Martek Biosciences Corp.; Mark Brzezinski and Mark Demarest, University of California Santa Barbara; Anthony Chiovitti, University of Melbourne, Australia; Aubrey Davis, Mark Hildebrand, Brian Palenik and Kimberlee Thamatrakoln, Scripps Institution of Oceanography; Masood Hadi and Todd Lane, Sandia National Laboratory; Bethany Jenkins, University of California Santa Cruz; Jerzy Jurka and Vladimir Kapitonov, Genetic Information Research Institute; Nils Kröger, Universität Regensburg; Frank Larimer, Oak Ridge National Laboratory; Gregory Pazour, University of Massachusetts Medical School; Mak Saito, Woods Hole Oceanographic Institution; Klaus Valentin, Alfred Wegener Institute, Germany; Frances Wilkerson, San Francisco State University.

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