OCEAN SCIENCE

DNA map for marine algae could decode climate change

By JOHN C. CANNON

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MOSS LANDING — Scientists now have a new set of tools to better understand the tiny plants known as phytoplankton and the critical role they play in our changing climate, thanks to the work of Alexandra Worden, a microbial oceanographer at the Monterey Bay Aquarium Research Institute in Moss Landing, and her colleagues.

Worden and her team, including a UC Santa Cruz graduate student in ocean sciences and representatives from institutions around the world, spent four years mapping out the genes in t wo species of microscopic algae from the genus Micromonas. Before the group's paper was published in the journal Science on April 10, only five other complete genomes of singlecelled, marine organisms with a nucleus were known. With these new genome sequences, scientists could begin to uncover clues about how climate change might affect the oceans and ultimately humans.

But having the location of each gene within the millions of building blocks that make up each alga's DNA is only the beginning. Uncovering their functions pres ents a different challenge — and one Worden relishes.

Genomic research on marine algae has long been "lagging behind" research into the genetics of other organisms, such as bacteria, she said. Bacteria are often more attractive research subjects because they have smaller genomes, and many grow more readily in the laboratory.

"We're really hoping to jump-start more research by making these [genome sequences] available," said Worden, who is also an adjunct professor in ocean sciences at UC Santa Cruz.

Though more obscure than their terrestrial cousins, phytoplankton pump a lot of oxygen into our atmosphere — by some estimates, around 80 percent of it, dwarfing the contribu tions of the Amazon rain forest or any other ecosystem on land. And they're an important link in the cycling of carbon through the environment, grabbing carbon dioxide from the atmosphere as they use the sun's energy to make food.

Studies shedding light on the function of algal genes have often been guided by known genes in bacteria and land plants. But it's possible that scientists are missing valuable information by ignoring the bits of the genome in the shadows.

"Many of the genes we know a lot about are held in common with better studied organisms that live on land, but it is the genes of unknown function that might really give us new insights to how these organ isms interact with the environment," Worden said. "They may reveal aspects of that interaction that we don't even know we should be thinking about." The team also discovered that the Micromonas spe cies have genes that could allow them to reproduce sexually. But in the lab, scientists have only ever seen them reproducing asexually — that is, where a single cell splits into two cells, then four, and so on. Right now, Worden doesn't know what conditions might trigger that switch in strategy from asexual to sexual reproduction. But just knowing about the sex-related genes now makes investigation possible — as it turns out, right offshore in Monterey Bay.

The bay is home to both species of Micromonas, making it an ideal setting to learn more about how they use their genes to adapt to different situations, Worden said.

"We can say, 'Wow, [a particular gene] is 'on' at this site. What's different about this site compared with other locations in Monterey Bay?'" As global temperatures rise, the role of Micromonas and other phytoplankton in the carbon cycle will likely change, Worden said. Sci-entists predict that warmer oceans will lead to less turbulence in the water and fewer nutrients — prime conditions for tiny, singlecelled organisms to flourish — but the consequences of population shifts for the food web and carbon cycling are still a mystery.

KIM FULTON-BENNETT /MBARI

Microbial oceanographer Alexandra Worden, left, sequenced the genomes of two marine algae in her MBARI lab, with the help of colleagues from around the world, including graduate students Melinda Simmons, center, of UC Santa Cruz and Marie Cuvelier of the University of Miami.

MBARI

Microbial oceanographer Alexandra Worden and her colleagues studied microscopic, single-celled algae of the genus Micromonas that live in the ocean, pictured here.