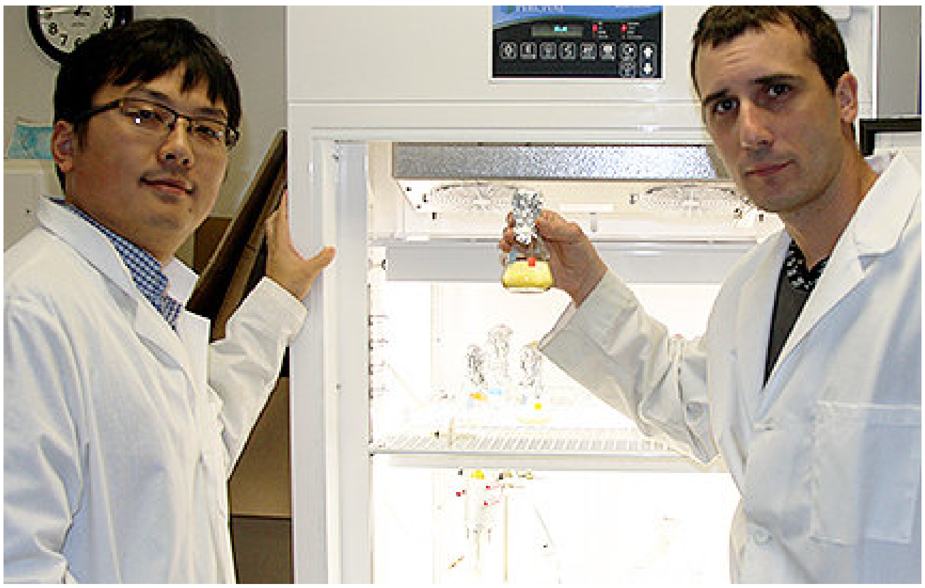
Venus flytrap of the sea

June 20 2014, by Richard Hoops



The Moore Foundation study includes computational expert Zhenfeng "Jay" Liu (left), who joined the project after earning his Ph.D. from Penn State, and USC Dornsife postdoctoral researcher Ramon Terrado, a Ph.D. from Université Laval (Québec, Canada). Credit: Richard Hoops

A team of USC Dornsife biologists affiliated with the USC Wrigley Institute for Environmental Studies is working on a $1.2 million study of marine organisms that are the microscopic equivalent of the Venus flytrap.

They're one-celled microbes that employ photosynthesis and predatory behavior to acquire nutrition, and the USC Dornsife research team is exploring this hybrid approach to microbial nutrition with the help of advanced gene sequencing and computational analysis.

The study is led by David Caron, professor of biological sciences, and Karla Heidelberg, assistant professor of biological sciences.

"This is really fundamental research," Caron said. "We're trying to understand fundamental principles behind the way these organisms 'make a living' and how different nutritional strategies contribute to their existence and their evolution."

Many marine microbes get their nutrition from photosynthesis, the use of sunlight to extract nutrients from the water. Other microbes consume microscopic plant and animal matter floating in the water. The microbes that are the focus of the study have meal plans that fall in between.

"They're basically algae that can still eat things," Caron said.

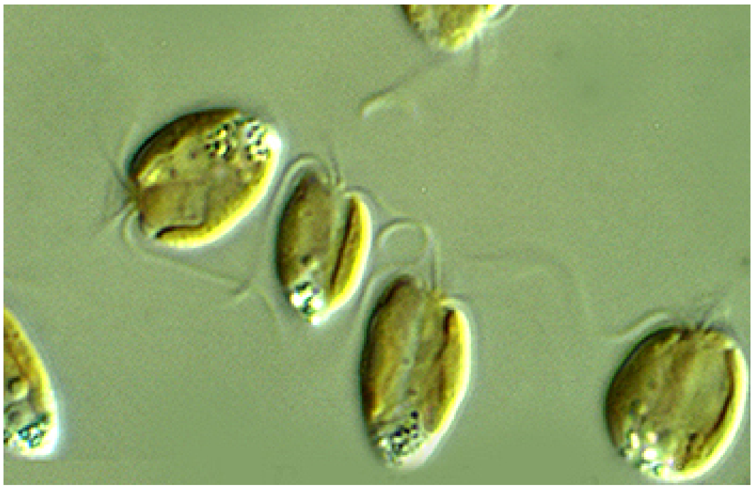
These organisms are called mixotrophs, and the research project is titled "Comparative Functional Analyses of Mixotrophy among Microbial Eukaryotes." The project is funded by the Gordon and Betty Moore Foundation through its Marine Microbiology Initiative.

Mixotrophy is widespread in marine microbial ecosystems, and Heidelberg said the project fits into a larger effort by the Moore Foundation to bring advanced genomic sequencing and computational analysis to the study of marine microbes.

"The Moore Foundation Initiative is completely changing our field," Heidelberg said, adding that it is supporting the study of microbial transcriptomes—the evaluation of expressed genes under various environmental conditions.

The Moore Foundation has funded the sequencing and analysis of nearly

700 transcriptomes, in particular for many ecologically important species that have been understudied, Heidelberg said.



Prymnesium parvum, an example of the mixotrophs under study by USC Dornsife biologists. Credit: Karla Heidelberg.

"In our case, we're not just looking at gene expression and how microbial organisms are functioning; we're looking at a specific example of that in the process of mixotrophy," she said.

Prymnesium parvum, an example of the mixotrophs under study by USC Dornsife biologists. Photo courtesy of Karla Heidelberg.

Among larger organisms, this hybrid process of obtaining nutrition is rare. Plants, for example, are considered "phototrophs" and synthesize their own food. Animals are considered "heterotrophs"— they cannot synthesize their own nutrition and depend on other organic substances for food.

"We human beings, and all of our animal friends, are mostly heterotrophic with a few exceptions," Caron said. "Plants are mostly photosynthetic with some exceptions. Microbes have more of a continuum between heterotrophic and phototrophic behaviors."

That continuum is where mixotrophs find their meals.

"In a sense, this sounds like a perfect combination," Caron said. "When they have prey, they can eat them. When they don't have prey but they do have light, they can use photosynthesis. Our project is trying to figure out what they get out of these two types of nutrition, and why and when they favor one behavior over the other."

The research team includes four graduate students in the Caron and Heidelberg labs, a postdoctoral researcher and a staff computational analyst.

The graduate students are Jennifer Cardell, Sarah Hu, Amy Koid and Alle Lie and all are enrolled in the USC Dornsife Ph.D. Program in Marine Biology and Biological Oceanography. Last summer, as part of this research project, Hu served as a mentor to one of the graduate students who participated in the NSF-funded USC WIES Summer Research Experiences for Undergraduates Program at the Wrigley Marine Science Center on Catalina Island.

The postdoctoral researcher is Ramon Terrado, an expert in marine microbial communities, who recently joined the USC Dornsife group after completing a Ph.D. in biology and oceanography at the Université Laval (Québec, Canada).

The computational expert working with Caron and Heidelberg is Zhenfeng "Jay" Liu. He joined the project in 2012 after receiving his Ph.D. in biochemistry and molecular biology from Pennsylvania State University. Liu said the application of computational analysis to marine organisms is still in its early stages.

"Oceanography has been overlooked—we don't have much knowledge compared to other fields," he said. "The Moore Foundation is generously investing a lot of money to do sequences for several hundred marine microorganisms, including many mixtrophic species, so we will eventually get a lot of data back and have a much better understanding of this particular group of organisms."

Caron emphasized the basic nature of this research.

"We're trying to understand how photosynthetic organisms such as algae and plants evolved," he said. "We're also trying to understand how heterotrophy and phagotrophy—the engulfment and ingestion of prey—has played a role in the development of those photosynthetic organisms. Conventional wisdom indicates that higher forms of photosynthetic organisms—algae and plants—evolved from heterotrophic species that ingested and retained simpler, photosynthetic forms of life such as photosynthetic bacteria."

This study of marine microbes might someday reveal information about the species that form harmful algal blooms.

"Many mixotrophs are bloom-forming organisms," Heidelberg said. "Maybe this strategy allows them to dominate and out-compete other organisms under certain conditions. Our research will provide insights into the advantages of being a mixotroph. Any application of that would be a ways off, but you need this solid basic research as a foundation for moving forward."

Provided by University of Southern California

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