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Good Things Come in Small Packages: Tiny Plankton Producing Oxygen Near Dead Zone

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Good Things Come in Small Packages

Tiny plankton producing oxygen near Dead Zone

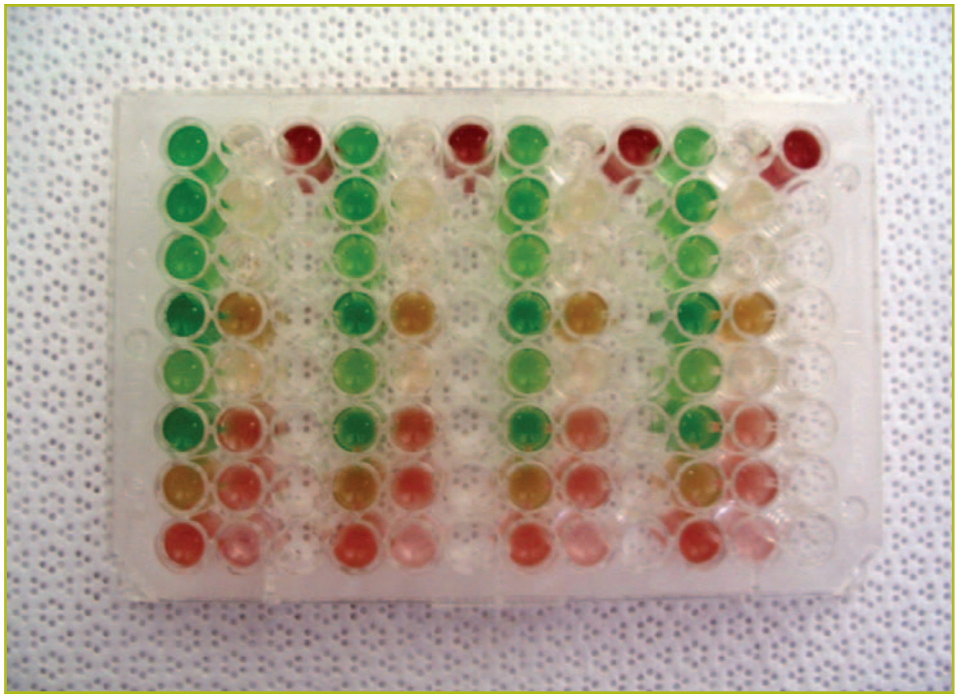
by Abbie Basile, Ohio Sea Grant Communications

For many, the words "Lake Erie" bring to mind large things: big sport fish, sprawling waterfront homes, and an enormous body of water bordering four states and two countries. Similarly, much of the Lake Erie research of which the public is aware deals with larger biological organisms—larger algae and zooplankton, the small fish that eat the zooplankton, and the large fish that feed on those smaller fish. Over the years, the smaller lake life have been somewhat overlooked.

However, for two Ohio Sea Grant researchers, the Lake is all about a community of tiny bacteria living in the Central Basin's Dead Zone. Drs. George Bullerjahn and Michael McKay, both biologists at Bowling Green State University, have found microscopic plankton that not only thrive in the low-oxygen environment of the Dead Zone, but actually contribute oxygen to the watery world in which they live.

Picoplankton are minute, less than two millionths of a meter, or two microns, in size; 100 could easily fit across the width of a human hair. The specific types of plankton the researchers are studying are referred to as picocyanobacteria, a subset of what is commonly known as blue-green algae.

In August 2002, Bullerjahn and Dr. Steve Wilhelm, a biologist at the University of Tennessee, were on Lake Erie gathering water samples in the Central Basin, north of Cleveland, to take chlorophyll measurements. When they pulled up their sample from 16 meters down, they were surprised to see that their filter had turned bright red. "Usually, the filter is green and brown. To find a sample that is pink or red was strange and very unexpected," recalls Bullerjahn. The pair took similar samples in 2004 and 2005, both before the seasonal Dead Zone established itself and in late-summer, when it was in full swing.

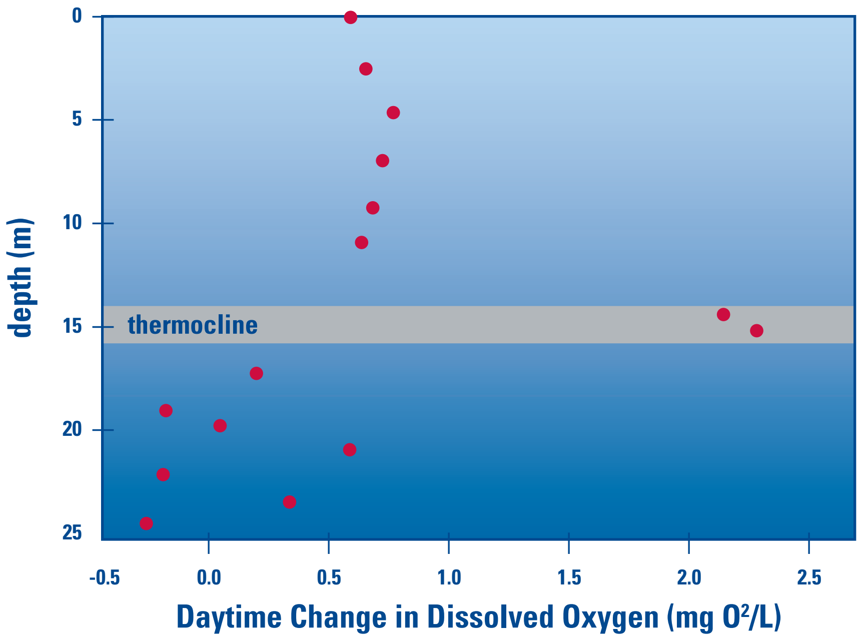


Shown above are various *Synechococcus* strains. The tray's red picocyanobacteria are from a deep-water chlorophyll layer, while the blue-green samples were taken from near-shore surface waters.

To identify what they had in their sample, the researchers analyzed DNA sequences of the ribosomal RNA genes present. Bullerjahn and McKay, working with Wilhelm, found the bacteria were oxygen-producing *Synechococcus*. These organisms appear to have a close evolutionary relationship to cyanobacterial communities in European and Japanese lakes, earning them the label of "cosmopolitan," a term scientists use to denote relationships between far-flung organisms from around the world. At the same time, they were performing ground-breaking identification work on Lake Superior's cyanobacteria community. McKay notes, "We found there was no close evolutionary relationship between the picoplankton in Lake Superior and that in Lake Erie. In fact, the picoplankton community in Lake Superior is found nowhere else in the world."

Beyond the genetic analysis of the Lake Erie picocyanobacteria community, these researchers wanted to know what relationship existed between the miniscule plankton and their Dead Zone environment. This specific region in the Central Basin is so named because of its extremely low oxygen levels, also known as hypoxia, in mid-to-late summer. As oxygen is depleted, the presence of organisms, such as fish, that require oxygen to exist dramatically decreases. This lack of visible life makes the area appear to be dead.

However, Wilhelm, Bullerjahn, and McKay have found something in their pre- and post-Dead Zone sampling that is in sharp contrast to the dreary portrayal of the region. "The picocyanobacterial population size and its genetic diversity increase during the Dead



Water samples taken from the Dead Zone show that oxygen concentration directly below the thermocline was significantly higher during the daytime, indicating a rapidly photosynthesizing population.

Zone period," states Bullerjahn. "Our work has revealed that factors like hypoxia may actually stimulate the abundance and genetic diversity of the cyanobacterial community."

This large population of microscopic bacteria that is producing oxygen thrives in one specific place in the Dead Zone. In the summer, the upper water in the Central Basin is heated while the lower water remains cold and dense, with little oxygen. The water layer between these two temperatures is known as the thermocline and this is where the blue-green algae reside.

The algae's descriptive name provides a clue for another part of its life story, with the green coming from the chlorophyll it contains. Chlorophyll plays a key role in photosynthesis, the process where sunlight is used to produce nutrition and oxygen is generated as an important by-product. "These small organisms conducting plant-like photosynthesis comprise upwards of 50% of the total chlorophyll in the Great Lakes." notes McKay. "This community can also be performing up to half of the photosynthesis that occurs off-shore."

The researchers feel this new information can play a key role in developing more accurate ecosystem models. "This *Synechococcus* community is highly active in photosynthesis in a part of Lake Erie that is typically not considered very productive," explains Bullerjahn. "There may be more nutrient recycling to other organisms going on in the Central Basin than we previously believed." Their research has the potential to revolutionize science's thinking regarding productivity of large lakes, including everything from oxygen sources to human use of the fisheries.

With the support of Ohio Sea Grant funding, these scientists will be carrying out a far more detailed examination of the Lake's picoplankton. Bullerjahn states, "Until 20 years ago, these cyanobacteria hadn't even been documented. When you generally think of blue-green algae, you tend to think of the bad guys, such as poisonous *Microcystis*. What we've discovered are the good guys who are doing a great deal of photosynthesis in the Lake." Future research will tell us just how large the positive impact is of these, the tiniest of Erie's inhabitants. TL

For more information about this Ohio Sea Grant funded project, contact Dr. George Bullerjahn at ***bullerj@bgnet.bgsu.edu*** *or Dr. Mike McKay at* ***rmmckay@bgnet.bgsu.edu****.*

The Lake Erie Discussion Board

Ohio Sea Grant Extension developed a Lake Erie Discussion Board in 2002 to provide an online venue for questions about Lake Erie and its resources. Over the years, Extension agents have fielded questions about such topics as the dead zone, current fishing techniques and regulations, and Lake Erie water levels.

The online discussion board has proven to be very popular, averaging 60,000 hits per month. To celebrate its success as one of the top Ohio Sea Grant web pages, Extension would like to share questions posed and their answers.

Question

Some maps of Lake Erie's Western Basin include submerged well heads and net stakes. What are they and do they present hazards? Are they found in U.S. waters?

Answer from Fred Snyder

Submerged well heads generally refer to gas wells and should be on the Canadian side. For shallow-draft sport boats, these should not present navigational hazards.

Net stakes are used to set pound nets, which might be thought of as "fish corrals." These nets have not been used for several decades in Ohio waters, although Ontario may still have some in use. Most pound net stakes in Ohio waters have probably decomposed or been torn out by ice, but some may still exist. In 25 years, I've never heard of a boat hitting one.

Question

What has the state done to control or eliminate lampreys in Lake Erie?

Answer from John Hageman

The Great Lakes Fishery Commission controls sea lampreys with a piscicide, TFM, in Lake Erie streams containing spawning populations. Since larval sea lampreys take 4-17 years to metamorphose into the parasitic adult, the streams only require the poison treatment about every five years. In other Great Lakes, additional control measures are used, such as other chemicals, low head dams, and sterile male releases. Pheromone attractors may be used in the future to lure sexually mature lampreys into traps before they can spawn. Overall, these programs, costing millions of dollars a year, control lampreys to the extent they no longer impact our sport fish significantly.