Salty water causes some freshwater harmful algae to release toxins

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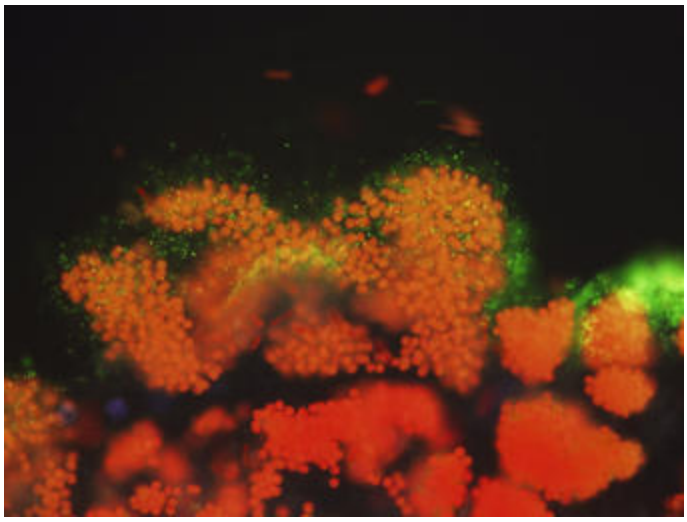
USGS study of Lake Okeechobee algae gives new insight on South Florida coastal blooms

A new U.S. Geological Survey laboratory study of two potentially toxic types of freshwater cyanobacteria, or blue-green algae, found that exposure to salty water can damage the cyanobacteria cells' walls, causing them to release their toxins into the water. The finding suggests that understanding the mixing of fresh and salt water, which takes place in many coastal water bodies around the world, will help researchers understand the toxic effects of these harmful algal blooms.

"Our findings open up the possibility that water managers may eventually be able to help reduce the algal toxins reaching coastal waters by manipulating water salinity," said USGS biologist Barry H. Rosen, an expert on freshwater algae and the lead author of the study. "This is especially true in places where freshwater flows are managed by a network of pumps and canals. In Holland, for example, water managers are using impoundments as a way to control salinity levels and manage harmful algal blooms."



In this microscopic image the potentially toxic cyanobacteria *Microcystis aeruginosa* have been exposed to a green stain in fresh water (0 practical salinity units). The green stain doesn't enter the cells, which show up in red. Credit: Barry H. Rosen, USGS. Public domain.

The cyanobacteria tested came from Florida's Lake Okeechobee, where freshwater cyanobacteria have been linked to harmful algal blooms occurring at least as far back as 1986. The naturally-occurring algae can develop into large blooms, fueled by phosphorus and other nutrients from farms and developed lands, and can release toxins that harm wildlife and humans.

The lake is connected by canals to downstream brackish- and saltwater estuaries, such as the Indian River Lagoon on Florida's southeast coast. A persistent freshwater harmful algal bloom occurred on Lake Okeechobee and the Indian River in 2016, and another one is taking place this year.

"When these freshwater algae get exposed to certain levels of salinity, their cell walls weaken, and the toxin they contain leaks out," said Rosen. "The point where the mixing of fresh and

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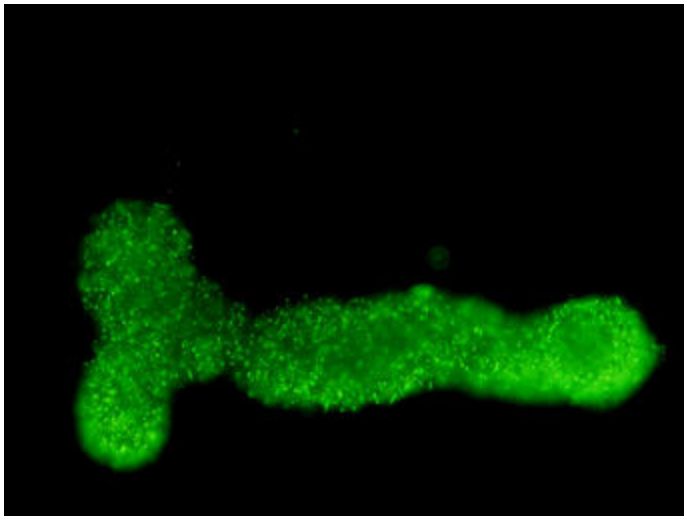
saltwater reaches that critical level where damage begins to occur will vary, depending on factors like the tides and the freshwater flow in the canals."

After state water quality samples taken in 2016 showed that cyanobacteria from Lake Okeechobee or the canals connected to it were probably being transported downstream to the St. Lucie Estuary and the Indian River Lagoon, USGS experts decided to investigate how contact with brackish water affects two cyanobacteria species commonly found in those blooms. Scientists have long suspected that saltwater kills freshwater cyanobacteria. Rosen wanted to find out how quickly these particular toxic cyanobacteria died, what level of salinity killed them, and what happened to the cells -- and the toxins they contain -- before they di



In this image the same potentially toxic cyanobacteria, *Microcystis aeruginosa,* have been exposed to the same stain, but this time in water half as salty as seawater (18 practical salinity units). The cell walls are breaking down and the stain has penetrated them, turning the colony green. Credit: Barry H. Rosen, USGS. Public domain.

In July 2017, the USGS scientists collected water samples from Eagle Bay on Lake Okeechobee's north shore. In the laboratory, the researchers found the Lake Okeechobee water had plentiful amounts of a common toxin-producing cyanobacteria called *Microcystis aeruginosa*. The samples contained smaller amounts of another potentially harmful species, *Dolichospermum circinale.* The researchers split the water samples into batches and exposed them to different levels of salinity for at least four days.

The team found that at levels about one-half as salty as seawater, *Microcystis aeruginosa* cell walls began to weaken and leak their toxin, called microcystin. The cell walls of *Dolichospermum circinale* began to leak at levels about one-fourth the salinity of seawater. Most *Microcystis aeruginosa* died after four days' exposure to high levels of salinity.

The red tide along the Southwest Florida coast is dominated by a salt-tolerant harmful algal species that was not examined in this study. A USGS Scientific Investigations Report on the study is available at https://doi.org/10.3133/sir20185092

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