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Community Science Institute
Partnering with Communities to Protect Water

CLUMPS OF BENTHIC CYANOBACTERIA:

Observations from the Cayuga Lake Watershed

Introduction

Community Science Institute (CSI) volunteers are trained to identify, report and sample surface blooms of cyanobacteria in Cayuga Lake through the Cayuga Lake Harmful Algal Bloom (HAB) Monitoring Program. Since the program started in 2018, samples collected from these planktonic blooms have been dominated by cyanobacteria in the genera *Microcystis* and *Dolichospermum*.

In recent years, some CSI volunteers have been reporting the presence of clumps of material floating on the surface of the water that don't match the typical bloom patterns that they have historically been trained to report, that is those associated with planktonic blooms (e.g exhibiting streakiness or somewhat resembling spilled paint or pea soup). Some samples of these clumps have been collected and through microscopy appear to be dominated by the filamentous cyanobacteria *Oscillatoria spp.* and/or other members of the *Oscillatoriales* order which are benthic cyanobacteria known to form mats on submerged substrates. These mats sometimes dislodge from substrates as clumps that float to the surface, perhaps due to the accumulation of oxygen bubbles from photosynthesis[1]. Since some *Oscillatoriales* genera have been known to produce potent cyanotoxins and have been associated with animal poisonings [1,2,3,4], their presence may present health risks to recreational users of waterbodies and their pets, as well as threaten drinking water sources.

The Project

The Community Science Institute (CSI) has been exploring the phenomenon of floating clumps of benthic cyanobacteria since the summer of 2022. Samples have been collected and microscopy has shown all of the sampled clumps to be dominated by benthic cyanobacteria in the order *Oscillatoriales* and likely the genus *Oscillatoria*. One sample collected in the summer of 2023 was analyzed for a suite of cyanotoxins (see methods) and no cyanotoxins were detected. Moving forward, CSI intends to engage their existing volunteer HABs monitoring network and to work with the Chemistry Department at SUNY-ESF in order to try to better understand the frequency, geographical distribution and toxicity of floating clumps of benthic cyanobacteria in the Cayuga Lake watershed.

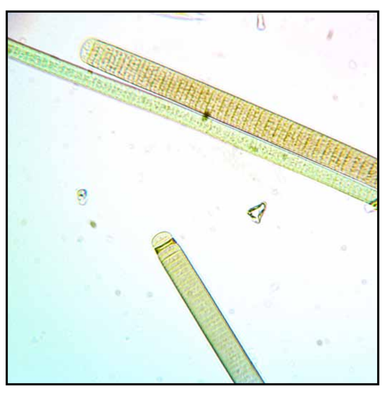
Clumps of benthic cyanobacteria at the Ithaca Farmer's Market Dock on Cayuga Inlet in June 2023

Methods

The Community Science Institute HABs monitoring network of over 80 volunteers will be engaged to help document and better understand the geographic distribution and toxicity of floating clumps of benthic cyanobacteria on Cayuga Lake. Toxin analysis will be conducted by the chemistry department at SUNY-ESF for the following cyanotoxins:

- **Microcystins**
  RR, dRR, mRR, H4YR, hYR, YR, dLR, LR, mLR, hiLR, meLR, AR, FR, WR, dLA, LA, mLA, LL, LY, LW, LF and zLR
- **Anatoxins**
  ATX, homoATX (=HTX), dihydro ATX (alpha and beta), and dihydro HTX (alpha and beta)
- **Nodularins**
  Nod-z
- **Cylindrospermopsins**
  CYL, deoxyCYL and 7 epi-CYL
- **PSP toxins**
  analyses are done by ELISA, which cross reacts with all 52 congeners in varying efficiency ranging from 2-120%. They are reported in STX eq
- **BMAAs**
  BMAA, DAB, AEG (and phenyl alanine)

Benthic Cyanobacteria
in the Cayuga Lake Watershed



Oscillatoriales

is an order of filamentous cyanobacteria that have dominated floating clumps of material collected by CSI from the south end of Cayuga Lake in 2022 and 2023. Some *Oscillatoriales* genera and species are capable of independent movement. Their bodies are made up of coin or barrel-shaped cells that are stacked together into long, unbranching filaments. Through gliding and oscillating movements, such as exhibited by species in the genus *Oscillatoria*, some of these filaments are able to weave themselves into mats that coat surfaces on the bottom of shallow water bodies such as mud, plants, stones or sand. Parts of the mats often separate and float to the surface. While *Oscillatoriales* are a natural part of freshwater ecosystems, heavier densities of them are sometimes associated with elevated nutrient levels[5], though other environmental factors such as warming water temperatures are likely also contributing factors to all cyanoHABs.

A big THANK YOU to all of the CSI volunteers who pay close attention to our local water bodies and who have been noticing this particular phenomenon and reporting it. And another big THANK YOU to Greg Boyer and Bofan Wei at SUNY-ESF for their generous work on the toxin analysis of samples.

References

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Toxins Associated with Benthic Cyanobacteria

Most of the known cyanotoxins have been identified from samples of benthic cyanobacteria, including Microcystins, Nodularians, Cylindrospermopsins and Saxitoxins[4].

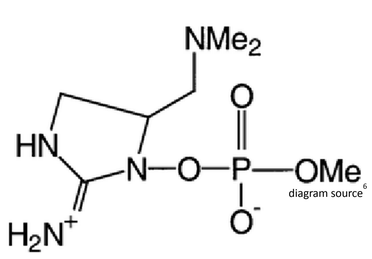

diagram source[6]

Anatoxins

are the most common cyanotoxins associated with benthic cyanobacteria[2,4] and anatoxins are also the most commonly reported cyanotoxins linked to animal deaths[1]. Anatoxins are produced by numerous genera in the order *Oscillatoriales* including *Oscillatoria*, *Planktothrix*, and *Phormidium*.

Toxin production varies with growth stage and nutrient availability and some studies have shown significant variability in toxin production throughout benthic cyanobacterial mats to be connected with relative abundance of toxic genotypes[1].

Current Worldwide, National and State Efforts
to Address Potenial Threats of Benthic CyanoHABs

As of 2020, only New Zealand and Cuba had established national recreational guidelines to address human health risks of benthic cyanoHABs. New Zealand guidelines include a 3-tier alert level framework based mostly on percent coverage of substrate. **Detached mats automatically trigger the highest alert level status[1].**

The US Environmental Protection Agency (EPA) is in the process of developing standardized methods for sampling, analyzing and assessing benthic harmful algal blooms. Pilot studies of benthic mats in streams and rivers across the United States which have recently experienced benthic cyanoHABs are being conducted in the summers of 2023 and 2024[7].

The New York State Department of Environmental Conservation (NYSDEC) is "starting to work towards a more deliberate understanding of statewide benthic HAB distribution and potential risk to human, animal, and ecological health[8]." They have updated their online HABs identification materials to include floating "clumps" or "globs" in their descriptions of possible appearances of cyanoHABs and their recommendation is to avoid and report them just as any other HAB.