Cyanobacterial Mats of the Earth: Spotlight on Lake Huron's Sinkholes

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Abstract

Recent underwater explorations in the Great Lakes reveal the presence of hotspots of biogeochemistry where a variety of microbial mats cover the lake floor bathed by high sulfate and low oxygen groundwater. While not hospitable to the fish and invertebrates that are typically found in Great Lakes, these habitats are a haven for specialized microbes. Here diverse and abundant microbial cells and some specialized invertebrate micrometazoa appear to be living in symbiosis with the microbes. These filamentous cyanobacteria can form brilliant purple, green or whitish mats, and perform different kinds of metabolism: oxygenic/anoxygenic photosynthesis or chemosynthesis. In sulfate-rich lakes of Yellow Stone, Mexico, Switzerland, and Antarctica, cyanobacteria form similar structures on the sediment surfaces. In this study, we compare the taxonomy, behavior, and community composition of the microbial mat communities in Lake Huron to microbial mats found in different parts of the world.

Introduction

The Laurentian Great Lakes make up the largest body of freshwater on Earth. They are commonly referred to as North American's inlands seas (Hough, 1958). The lakes currently contain roughly 19% of the Earth's surface freshwater (Beeton, 1954) . According to Black (1983), in the Lake Huron basin, Paleozoic carbonate bedrock has dissolved over the millennia to produce numerous karst formations such as sinkholes and caves through which groundwater flows. This groundwater can then emerge from the sinkholes beneath the lake surface onto the lake floor at various depths creating submerged sinkholes. As this environment is not suitable for fish and phytoplankton, it is instead dominated by communities of bacteria and archaea. These underwater ecosystems, fueled by venting groundwater that contains high sulfate and low dissolved oxygen, are characterized by physical and chemical gradients and colorful benthic microbial mats, covering carbon-rich sediments (Biddanda *et al*., 2009). Because of the physical and chemical conditions of the Lake Huron sinkholes, a unique habitat for diverse microorganisms exists.

Literature Cited

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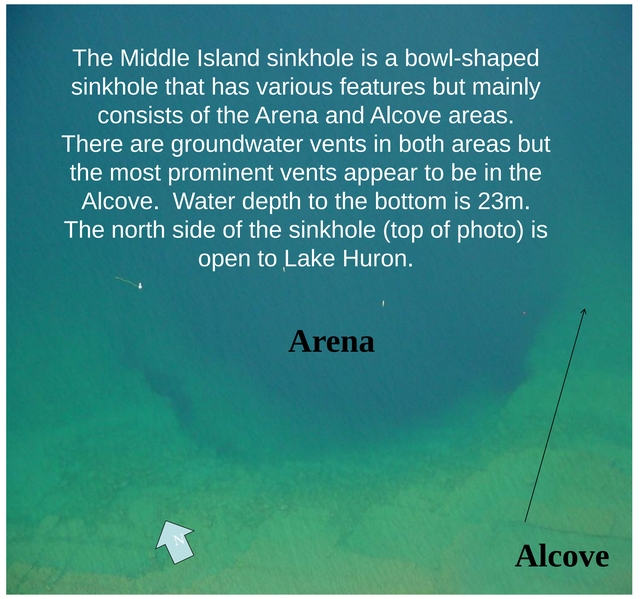
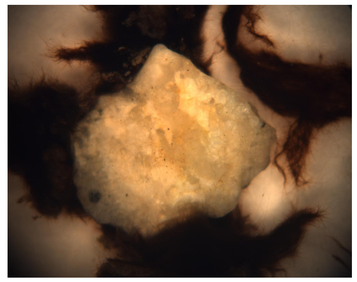
Black, T. J. (1983), Selected views of the tectonics, structure, and karst in northern Lower Michigan, in *Michigan Basin Geological Society Field Conference Proceedings*, edited by R.E. Kimmel, pp.11-35, Mich. Basin Geol. Soc., Lansing.

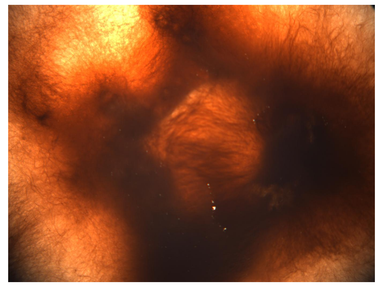


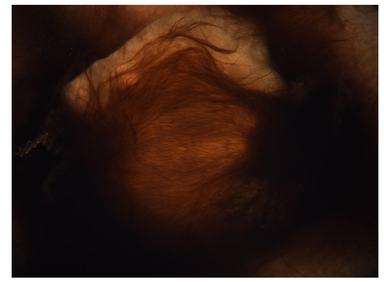
In the arena, the landscape is more flat with groundwater flowing along the bottom on its way out to Lake Huron. Purple mates thrive along the patches of white mats. The groundwater layer has about 2-4 mg/L dissolved oxygen after picking some up from the overlying lake water.

Behavioral Experiment

The purple filaments that comprise the microbial mats exhibited the ability to "crawl" over obstructions in their path, such as pebbles. The following pictures show their "preferred" movement over time: 0 hour, 2 hours, & 26 hours respectively.

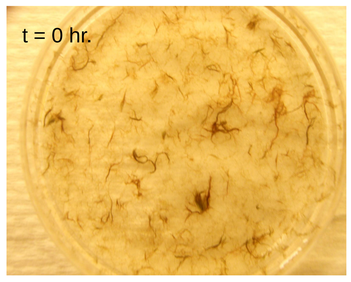


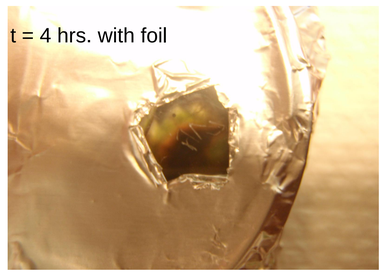


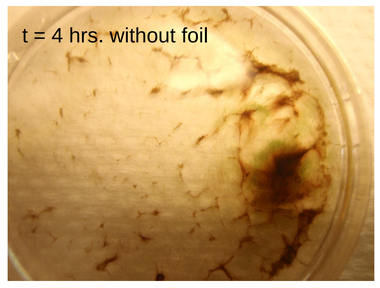


Phototaxis Experiment

The purple filaments that comprise microbial mats also exhibited the ability to move toward light and reassemble themselves as a microbial mat. The following pictures show phototaxis occurring over a four hour period.







Filaments Under the Microscope (40X)