

Histories of cyanobacteria from a northern country: redefining limnological “nordicity”

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Increased nutrient loading and warmer waters are thought to be the main reasons cyanobacterial blooms have become more frequent and intense in temperate lakes. Of particular concern is the potential increase in toxic cyanobacteria because of their impacts on wildlife and human health. Over the past few decades, substantial warming in Northern Canada and the Arctic has been reported, along with sporadic reports of cyanobacterial blooms in lakes further north than previously found. Overall the North is considered highly sensitive to climate change, yet there is little limnological monitoring of any of the hundreds of thousands of lakes in this vast region. Given the present warming trend, we predicted that the sediment record in northern lakes would show a concomitant rise in cyanobacteria, perhaps even in the absence of changes in trophic state. To test this hypothesis we conducted a small survey of lakes along a latitudinal gradient from the sub-Arctic to Arctic Canada. Using a top/bottom approach to analyze sediment cores, we extracted and analyzed cyanobacterial DNA abundance (by quantifying copy numbers of cyanobacterial 16S rRNA genes) and composition (high throughput sequencing). Along with more detailed sediment DNA analyses through time of dated cores from oligotrophic Great Slave Lake (~ lat. 60° N and the tenth largest lake in the world), we found an overall trend of more cyanobacteria at the top of cores as well as shifts towards planktonic bloom-forming and potentially toxic genera coupled with decreases in diversity at some sites. Some northern lakes have also experienced an increase in toxin genes (for the hepatotoxic microcystins). Sediment DNA combined with more traditional proxies of lake histories are redefining our understanding of northern limnology. These results and empirical models linking cyanobacterial biomass to surface water temperatures provide an additional argument for global action on reducing anthropogenic carbon dioxide emissions.

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