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Siderophores: The special ingredient to cyanobacterial blooms

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Freshwater lakes provide a number of significant ecological services including clean drinking water, habitat for aquatic biota, and economic benefits. The provision of these ecological services, as well as the health of these aquatic systems, is threatened by the excessive growth of algae, specifically, cyanobacteria. Historically, blooms have been linked to eutrophication but recent occurrences indicate that there are less dramatic changes that induce these blooms. Iron is an essential micronutrient required for specific essential metabolic pathways; however, the amount of biologically available iron in naturally occurring lake ranges from saturation to much lower than cell transport affinities. To assist in the modulation of iron availabilities, cyanobacteria in culture produce low molecular weight compounds that function in an iron binding and acquisition system; nevertheless, this has yet to be confirmed in naturally occurring lakes. This project explored the relationship of P, N and in particular, Fe, in the promotion of cyanobacteria harmful algal blooms in 30 natural freshwater lakes located in and around the Elk Island National Park, Alberta. It is hypothesized that cyanobacteria produce and utilize iron chelators called siderophores in low Fe and nitrogen (N) conditions, creating a competitive advantage over other algae in freshwater lakes. Lakes were selected to represent a range of iron availability to explore the nutrient composition of lakes that propagated cyanobacteria harmful algal blooms (cHABs) compared to lakes that did not. Lake water was analyzed for nutrients, microbial composition, siderophore concentration, and toxin concentration. Modifications were made to optimize the Czaky and Arnow tests for hydroxamate- and catecholate-type siderophores, respectively, for field conditions. Preliminary results indicate the presence of iron-binding ligands (0.11-2.34 mg/L) in freshwater lakes characterized by widely ranging Fe regimes (0.04-2.74 mg/L). Furthermore, the concentration of iron-binding ligands was found to have a positive correlation to presence of cyanobacteria concentration, indicating a potential relationship between Fe, siderophores, and cyanobacteria. This project works to improve the understanding of freshwater cyanobacteria growth dynamics by investigating the physiological and biochemical processes leading to cHABs. The importance of this project lies in the understanding of elementary nutrient requirements in all algae and how cyanobacteria are able to access low concentration pools and subsequently bloom over other algal species. Investigating the nutrient regimes that stimulate siderophore production and the subsequent production of potentially toxic cyanobacteria blooms is important for lake management and preservation, specifically in the eutrophic and hypereutrophic freshwater lakes of Alberta.