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Shifts in bacterioplankton during cyanobacterial blooms reflect bloom toxicity and lake trophic state

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ABSTRACT

Harmful cyanobacterial blooms (cyanoHABs) typically occur in human-impacted eutrophic lakes suffering from nutrient pollution, but they also occur in pristine lakes spanning the trophic gradient. The drivers and dynamics of blooms in these oligotrophic lakes remain understudied. CyanoHABs alter the composition of bacterioplankton with increases in specific cyanobacteria strains, as well as shifts in heterotrophic taxa. Bacterioplankton community shifts during cyanoHABs can be somewhat predictable but have been only studied in a limited number of lakes, mostly eutrophic and impacted by development. The Cascade Mountains (USA) offer a novel setting to examine microcystin variation and shifts in bacterioplankton communities across trophic in relatively undeveloped lakes with documented cyanoHABs. Using physicochemical measurements, time-integrated toxin monitoring, and 16S rRNA gene sequencing, we explored associations of bacterioplankton communities with cyanoHABs and toxins within a season, as well as across lakes and years. In Cascade Mountain lakes, bacterioplankton communities and cyanoHABs varied spatially, reflecting differences in trophic state, among other factors. The cyanotoxin microcystin exceeded the drinking water chronic exposure level (1 ppb) in two lakes, during which cyanobacteria exceeded 20 % of the bacterioplankton community. Bacterioplankton composition changed notably during the cyanoHAB events, varying with bloom toxicity and lake trophic state. These compositional differences were not only driven by increases in cyanobacteria, specifically from the order Nostocales, but also heterotrophic bacteria such as from the orders Burkholderiales and Cytophagales. Therefore, bacterioplankton composition can potentially be consistent indicators of cyanoHABs and toxicity, more so than climatic factors across lakes that span substantial trophic gradients.