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Priming of microbial microcystin degradation in biomass-fed gravity driven membrane filtration biofilms

Running title: Microcystin degradation in membrane filtration biofilms

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Abstract

Gravity-driven membrane (GDM) filtration is a promising tool for low-cost decentralized drinking water production. The biofilms in GDM systems are able of removing harmful chemical components, particularly toxic cyanobacterial metabolites such as microcystins (MCs). This is relevant for the application of GDM filtration because anthropogenic nutrient input and climate change have led to an increase of toxic cyanobacterial blooms. However, removal of MCs in newly developing GDM biofilms is only established after a prolonged period of time. Since cyanobacterial blooms are transient phenomena, it is important to understand MC removal in mature biofilms with or without prior toxin exposure. In this study, the microbial community composition of GDM biofilms was investigated in systems fed with water from a lake with periodic blooms of MC-producing cyanobacteria. Two out of three experimental treatments were supplemented with dead biomass of an MC-containing cyanobacterial strain, or of a non-toxic mutant, respectively. Analysis of bacterial rRNA genes revealed that both biomass-amended treatments were significantly more similar to each other than to a non-supplemented control. Therefore, it was hypothesized that biofilms could potentially be 'primed' for rapid MC removal by prior addition of non-toxic biomass. A subsequent experiment showed that MC removal developed significantly faster in mature biofilms that were pre-fed with biomass from the mutant strain than in unamended controls, indicating that MC degradation was a facultative trait of bacterial populations in GDM biofilms. The significant enrichment of bacteria related to both aerobic and anaerobic MC degraders suggested that this process might have occurred in parallel in different microniches.