Temperature Controls on Microcystin Degradation

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Introduction

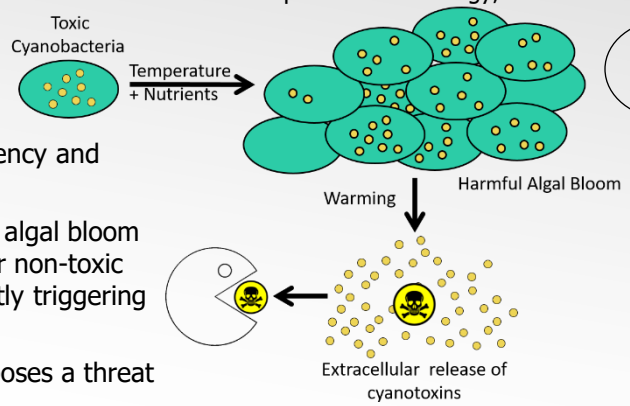

Figure 1. Conceptual diagram.

- Toxic cyanobacteria blooms are increasing in frequency and severity with rising surface-water temperatures.
- Warming generates a positive feedback on harmful algal bloom development by promoting toxic cyanobacteria over non-toxic strains, stimulating toxin synthesis, and subsequently triggering toxin release (Figure 1).
- The release of cyanotoxins into the water column poses a threat to water quality and human health.
- Yet, cyanotoxins rarely accumulate in the water column long-term, suggesting that biodegradation by heterotrophic bacteria may play a role in the removal process (Figure 1).
- Owing to increased metabolic rates at higher temperatures, microbial-mediated degradation of cyanotoxins may be influenced by warming.
- However, the effect of warming on the uptake and subsequent biodegradation of cyanotoxins has not yet been evaluated.

Methods

- We evaluated the ability for heterotrophic bacteria to degrade microcystin produced by a common cyanobacterium, *Planktothrix agardhii*, across a natural temperature gradient during a laboratory incubation experiment.
- Water temperature was manipulated at 5, 10, 15, and 20°C using recirculating water baths plumbed to jacketed beakers (Figure 2).

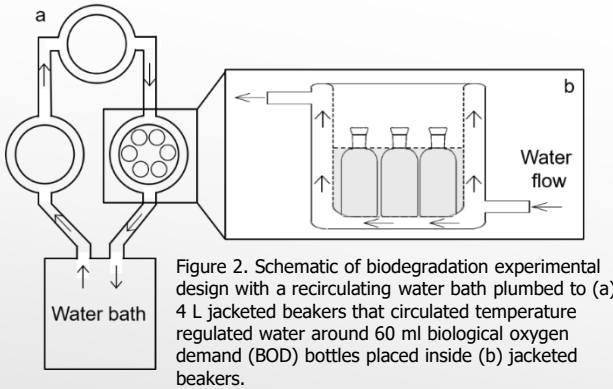

Figure 2. Schematic of biodegradation experimental design with a recirculating water bath plumbed to (a) 4 L jacketed beakers that circulated temperature regulated water around 60 ml biological oxygen demand (BOD) bottles placed inside (b) jacketed beakers.

- Water and the bacterial inoculum for the bioassay were collected from Grand Lake St. Marys located in western OH, USA.
- *Planktothrix agardhii* were lyophilized to produce a concentrated solution of microcystin.
- Microcystin concentration and bacterial abundance were determined at 0, 6, 12, 24, 48, 96, and 192 hours using high sensitively enzyme-linked immunosorbent assay (ELISA) and direct counts.

Results

- Microcystin concentration declined over time in all temperature treatments and degradation increased with warming (Figure 3).
- Patterns of microcystin degradation corresponded with increases in bacterial cell density over time that were enhanced by warming (Figure 4).

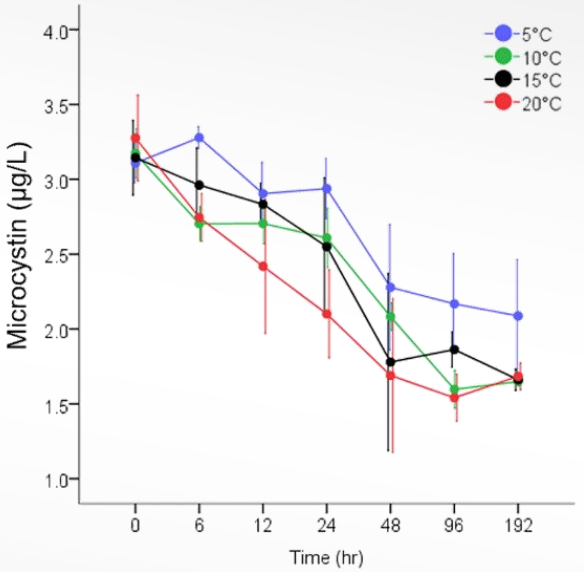

Figure 3. Mean (± 1 SE; n= 3) microcystin concentration among temperature treatments over time.

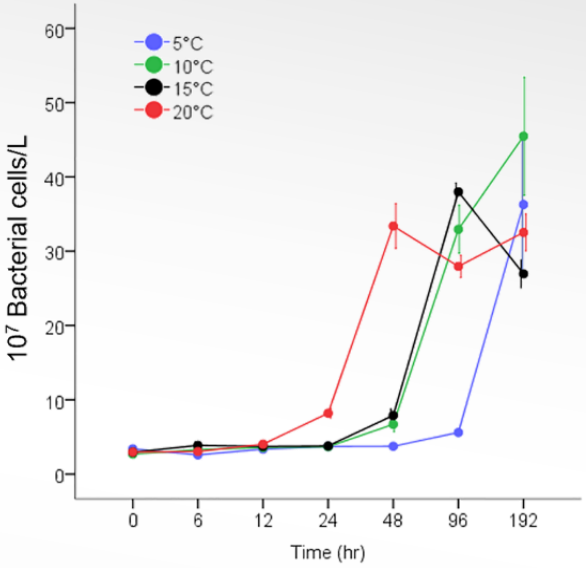

Figure 4. Mean (± 1 SE; n= 3) bacterial cell density among temperature treatments over time.

Conclusions

- The results of this study suggest that cyanotoxins can be reduced by microbial-mediated degradation and the rate of cyanotoxin degradation increases with water temperature.
- Understanding the effects of temperature on the degradation of cyanotoxins is necessary because of the increasing prevalence of toxic algal blooms in freshwater ecosystems and their influence on water quality and human health.