Effects of cyanobacteria on quagga mussel (*Dreissena rostriformis bugensis*) reproduction

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Dreissenid - Cyanobacteria Interaction

- Alter nutrient and phytoplankton dynamics
- Dreissenid may enhance cyanobacteria blooms through selective feeding
- Cyanobacteria can produce harmful toxins

Toxic Algae Blooms Set Historic Records From Coast to Coast

Tap Water Ban for Toledo Residents
Dreissenids can persist in lakes with cyanobacteria blooms

Continuous exposure to *Microcystis* and toxins may physiologically impair mussels, potentially increasing the effectiveness of control methods
Dreissenid Background

- Are broadcast spawners
- Spawn from April-September
- May rely on phytoplankton cues for spawning
- Nutritious algae may stimulate while cyanobacteria could hinder reproduction

www.100thmeridian.org
Determine the effects of cyanobacteria on dreissenid reproduction

(spawning, fertilization, and sperm vitality)
- Mussels were collected from the Detroit River

- Tested 13 cyanobacteria cultures (8 species)
  - *Anabaena flos-aquae*
  - *Aphanizomenon flos-aquae*
  - *Dolichospermum lemmermanii*
  - *Gloeotrichia echinulata* (2 cultures)
  - *Lyngbya woolei*
  - *Microcystis aeruginosa* (5 cultures)
  - *M. wesenbergii*
  - *Planktothrix suspensa*
**Methods**

- **Spawning Assessment:** Individual mussels were placed into vials and $1 \times 10^{-3}$M 5-HT serotonin was added to induce spawning.

- **Fertilization Assessment:** After inducing spawning, sperm and eggs were collected and placed in well plates. Fertilization was monitored microscopically and quantified.

- **Sperm Vitality:** After inducing spawning, sperm was collected and placed in well plates where distance, velocity, and acceleration were quantified microscopically using image-tracking software.
Results – Spawning

Fisher’s Exact Test

Control
Aphanizomenon flos-aquae

% Spawned

Chlorophyll-a concentration (mg/L)
Results – Spawning

Fisher’s Exact Test; red circles = p<0.05
Results – Fertilization

Cyanobacteria

Control

% Fertilized Eggs

Anabaena

Dolichospermum

Gloeotrichia ASG

Gloeotrichia BQ

11-02

Gloeotrichia

M. aeruginosa LEMS

M. aeruginosa BQ

11

M. aeruginosa LSC

M. aeruginosa UTEX

M. aeruginosa ZUR

M. wesenbergii

P. subcapnica

T-test

* = p<0.05

% Fertilized eggs
Results – Fertilization

The bar graph shows the percentage of fertilized eggs for different species of Cyanobacteria and Control. The T-test indicates that the difference is statistically significant for some species, marked with an asterisk (*), where * = p<0.05.
Results – Sperm Distance

Distance Sperm Traveled (mm)

- Anabaena
- Aphanizomenon
- Dolichospermum
- Gloeotrichia
- Microcystis LSC
- Microcystis UTEX
- Microcystis GLERL
- Microcystis ZUR
- M. Wesenbergii

Cyanobacteria Control

MANOVA w/ multivariate ANOVA; p<0.05
Results – Sperm Distance

![Chart showing sperm distance traveled for various cyanobacteria and control conditions.](chart.png)

**Distance Sperm Traveled (mm)**

- **Cyanobacteria**
  - Anabaena
  - Aphanothece
  - Dolichospermum
  - Gloeotrichia
  - Microcystis LSC
  - Microcystis UTEX
  - Microcystis GLERL
  - Microcystis ZUR

- **Control**

**Significance:**
- * indicates MANOVA with multivariate ANOVA; p<0.05
Results – Sperm Acceleration

Cyanobacteria
Control

Sperm Acceleration (m/s²)

Manova w/ multivariate ANOVA; p<0.05
Results – Sperm Acceleration

MANOVA w/ multivariate ANOVA; p<0.05
Results Summary

- Fertilization – 7 cultures have an effect
- Spawning – *Aphanizomenon flos-aquae* inhibits at \( \geq 0.158 \text{ mg/L} \) chlor-a
- Sperm motility
  - Distance and velocity impacted by *Aphanizomenon flos-aquae* and two *Microcystis aeruginosa* cultures
  - Acceleration impacted by *M. wessenbergii*
Cyanobacteria impacts spawning and fertilization in lab studies.

Results can be used to enhance population model estimates.

A chemical tool for reducing dreissenid reproduction might be derived from cyanobacteria to be used in tandem with other control efforts.
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