Grazing Impacts of Rotifer Zooplankton in a Seasonally Cyanobacteria-Dominated Lake

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Background

Harmful cyanobacterial blooms are a detriment to freshwater ecosystems, as they can produce irritating or illness-inducing toxins, decrease biodiversity, and alter food webs (Paerl et al. 2001). Temperature and nutrients are important bottom-up influences on cyanobacterial blooms worldwide (Paerl et al. 2011, Kosten et al. 2012), but equally important are simultaneous top-down influences like zooplankton grazers. However, the effects of microzooplankton grazing on cyanobacteria are not certain. One group, rotifers, is particularly understudied (Agasild et al. 2007, Thomas et al. 2017).

Previous studies of cyanobacteria blooms at Vancouver Lake (WA) show grazing by other zooplankton to influence blooms (Boyer et al. 2011, Rollwagen-Bollens et al. 2013, Rose et al. 2017). However we don't yet understand the role of rotifers in Vancouver Lake.

Methods

We conducted feeding incubations (Incubation Experiments) to quantify rotifer grazing rates at different stages of the 2019 cyanobacterial bloom in Vancouver Lake (July 16th, Aug. 7th, Sept. 18th, and Oct. 23rd). Each experiment featured an initial control, final control, and treatment of rotifers. Treatment vials contained 5 rotifers/mL. All vials contained a lake water suspension that had been pre-filtered over a 75µm sieve. Vials were incubated at ambient lake temperature and light/dark cycles for 12 hours on a rotating plankton wheel. Concurrently, ambient Vancouver Lake water was diluted by particle-free lake water into 3 dilution treatments (100%, 50%, and 10% ambient lake water). One liter bottles were incubated as above for 24 hours. These Dilution Experiments aimed to quantify phytoplankton community growth and microzooplankton community grazing rates. Chlorophyll concentration was measured from each sample. Microscopical analyses to elucidate grazing perferences will occur in 2020.

Research Questions

1. What are rotifer grazing rates in Vancouver Lake?
2. What food preferences do rotifers have?
3. How do these patterns compare to other temperate lake systems?

Results

Chlorophyll and phycocyanin measurements of Vancouver Lake show the peak of the 2019 bloom occurred at the end of July. Phytoplankton community growth rates were variable throughout the season with microzooplankton grazing rates loosely matching this trend, except just after the peak of the bloom where grazing rates were very high. Rotifer grazing was not significant in any experiment except just after the bloom peak in August, when the rate of ingestion was the greatest.

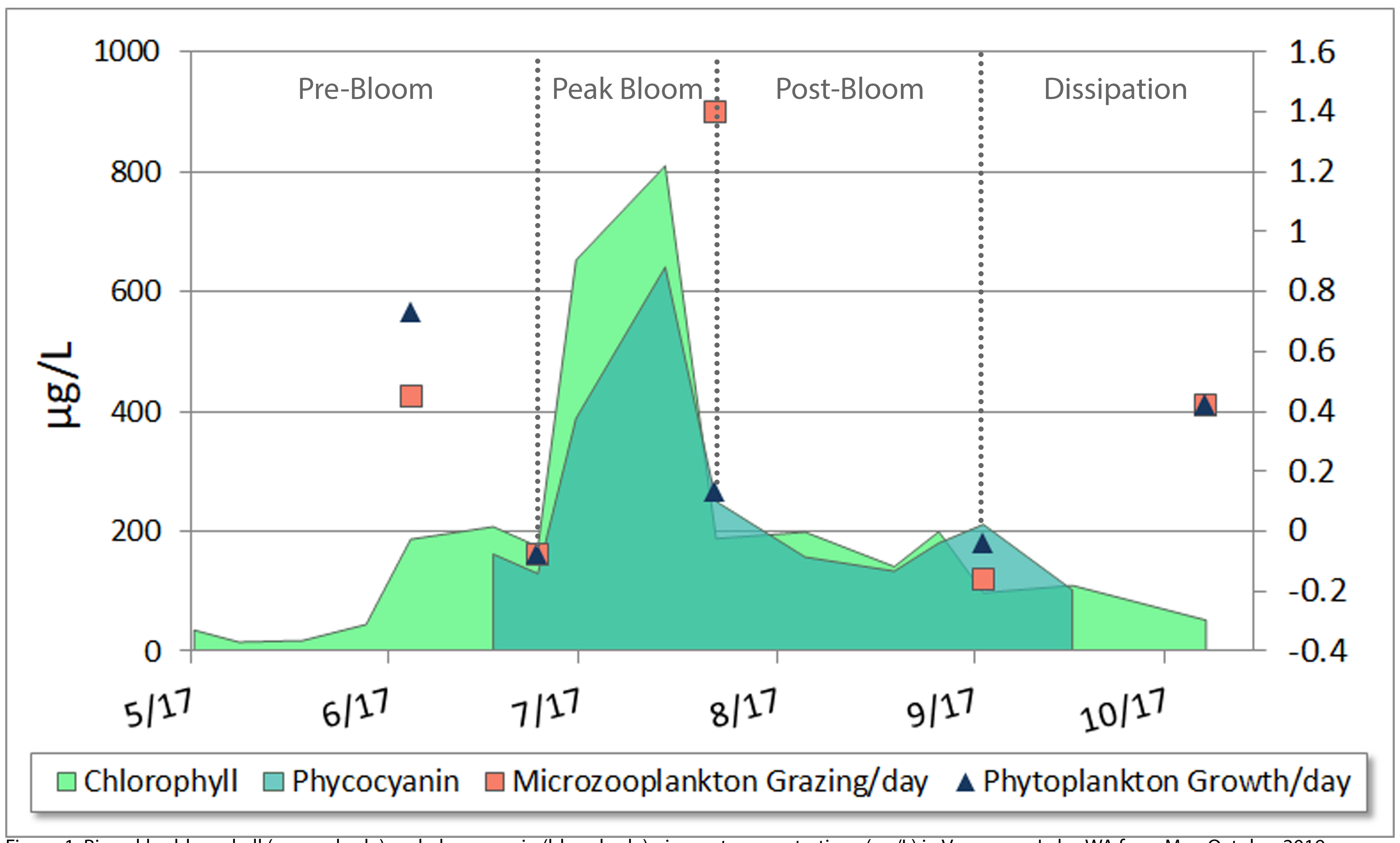

Figure 1: Biweekly chlorophyll (green shade) and phycocyanin (blue shade) pigment concentrations (µg/L) in Vancouver Lake, WA from May-October 2019, representing total phytoplankton (i.e. diatoms, algae, cyanobacteria, etc.) biomass and cyanobacteria only biomass, respectively. Pink squares indicate daily microzooplankton community (i.e. both rotifers and heterotrophic protists) grazing rates. Daily phytoplankton community growth rates are indicated by blue triangles. Growth and grazing rates were determined from dilution experiment regressions and are plotted via the right y-axis. Bloom phases are labelled at top.

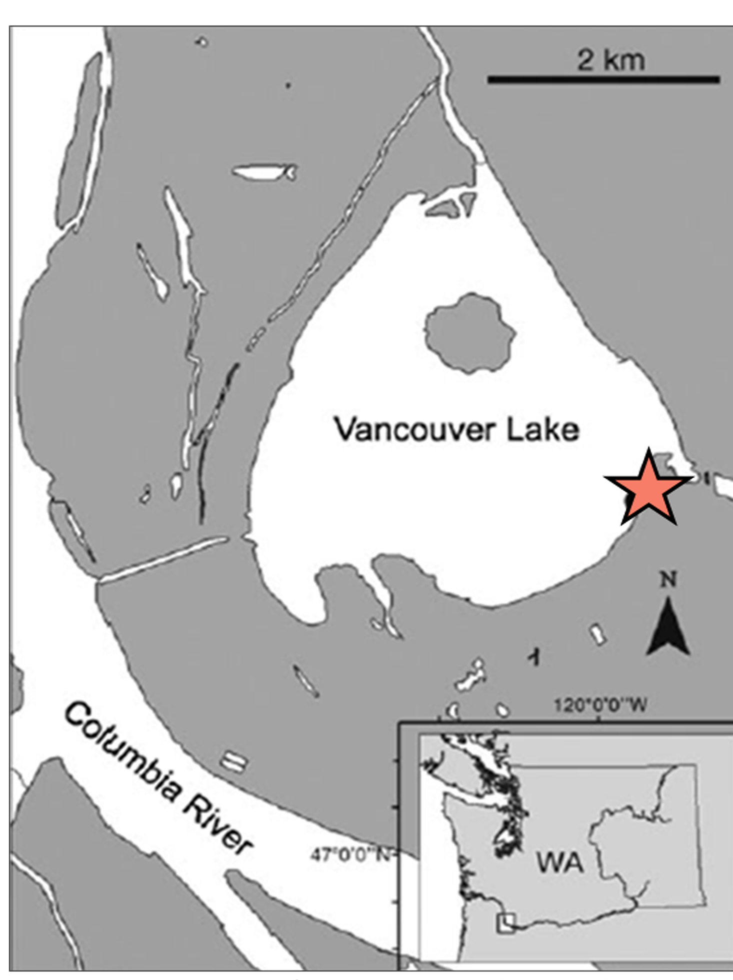

Figure 2: Location of Vancouver Lake, Washington, USA, indicating the point of previous and future sampling (from Rollwagen-Bollens et al. 2013).

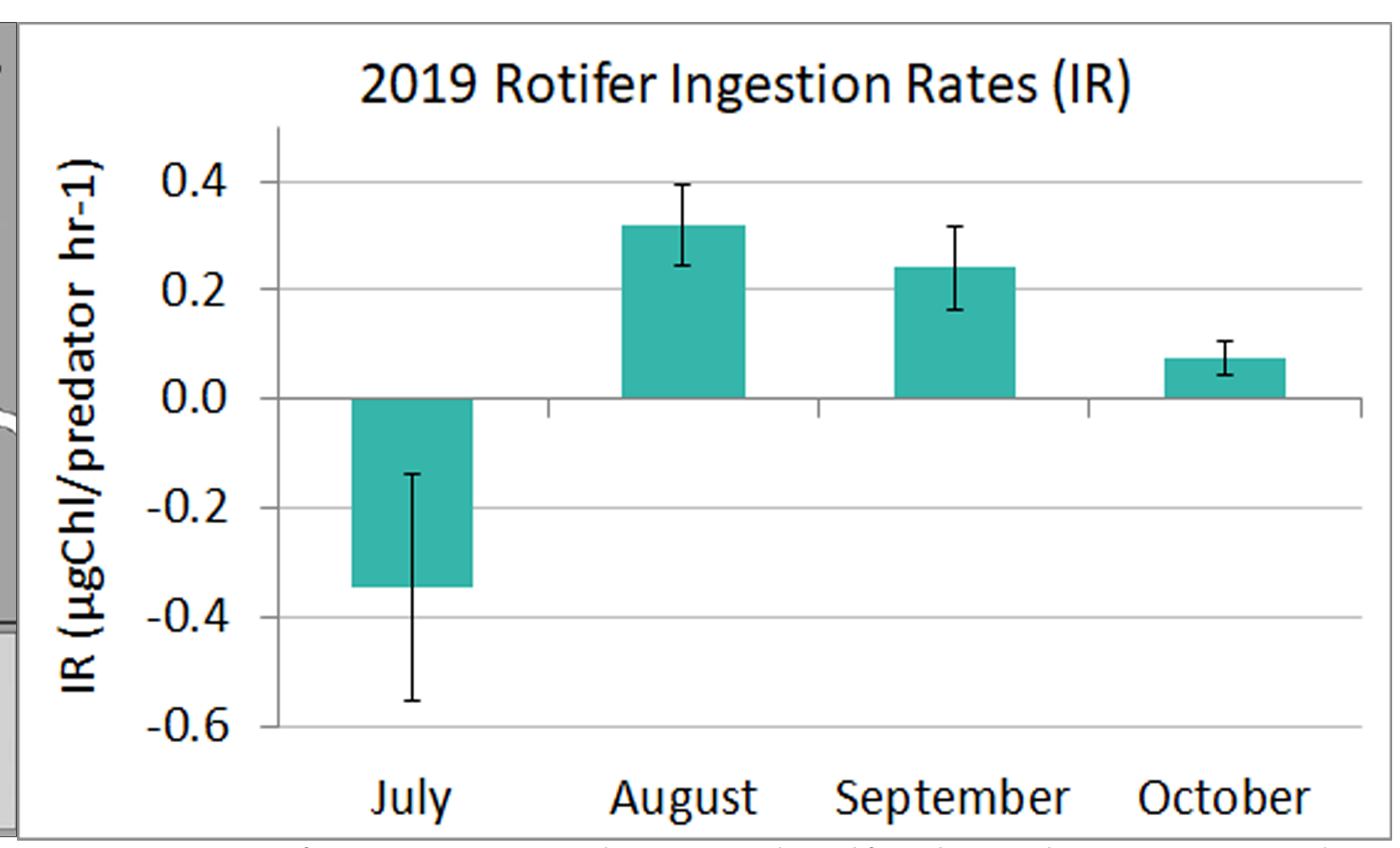

Figure 3: Mean rotifer ingestion rates (IR) with SE (n=3), as derived from the 4 incubation experiments (July 16, Aug. 7, Sept. 18, Oct. 23). TIngestion rate portrays grazing success, or actual prey biomass (represented by chlorophyll) ingested per rotifer individual per hour. Statistically significant (p=0.04) rotifer grazing on the phytoplankton comunity only occurred in the Aug. 7 experiment, just after the peak of the 2019 bloom.

Conclusions

A negative rotifer ingestion rate early in the season indicates that the addition of rotifers at this time increases the amount of phytoplankton, contrary to expectations. This may occur through trophic cascade where the added rotifers perhaps consumed other microzooplankton which were in turn grazing on phytoplankton. Furthermore, actual microzooplankton grazing was high in the early pre-bloom period, only dropping just before the bloom, which may have alleviated grazing pressure on phytoplankton, allowing the bloom to occur. These results provide evidence that phytoplankton biomass is at least partially limited by microzooplankton grazing in this pre-bloom period.

Additionally, both rotifer ingestion and microzooplankton grazing rates were greatest just after the bloom peak. This indicates that bloom suppression may be initially driven by both groups. Rotifer grazing quickly decreases, but phytoplankton biomass still does not recover through the fall. However, microzooplankton community grazing remains high. These trends present evidence that non-rotifer microzooplankton are likely responsible for the continued maintenance of low phytoplankton and cyanobacteria biomass through the fall post-bloom and dissipation stages.

Ecological mechanisms, such as plankton grazing, are important in understanding lake dynamics. Understanding the lake system is critical for making decisions about resource management, recreation, and public health, especially with respect to treating and preventing harmful cyanobacteria blooms. This research contributes to the wealth of information about Vancouver Lake, as a model eutrophic system and provides basis for further research.

References

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