Local Adaptation Alters Population Dynamics in Experimental Plankton Systems

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Introduction

Harmful algal blooms are a growing concern in many Iowa lakes as these are impacted by agricultural nutrient runoff. One common management strategy to reduce algal blooms is to manage lake food webs for high population densities of the grazing zooplankter *Daphnia*. However, this management strategy produces inconsistent results, particularly in highly-impacted hypereutrophic lakes. This study was conducted to test the hypothesis that local adaptation of *Daphnia* to hypereutrophic conditions diminishes a lake's ability to control algal blooms using experimental mesocosms.

Materials and Methods

Mesocosms consisted of 20, 320-gallon stock tanks (Ace Roto-Mold) filled with filtered irrigation water from the Iowa State University Horticulture Research Station in May 2018. Mesocosms were seeded with phytoplankton from two lakes (Horticulture Research Station Lake and Swan Lake) and sat for approximately one week before zooplankton were added. Fifty adult *Daphnia pulicaria* were added to each mesocosm except for two *Daphnia*-free controls. Each mesocosm was stocked with individuals from one of six lakes, three of which were mildly eutrophic (low in total phosphorus) and three of which were hypereutrophic (high in total phosphorus). Mesocosms were fertilized at one of three total phosphorus (TP) concentrations: 20 μg/L, 65 μg/L, and 425 μg/L in a full factorial design. The team sampled chlorophyll-a (a proxy for phytoplankton biomass), *Daphnia* biomass, and water chemistry at weekly intervals until mid-September when the experiment concluded.

Results and Discussion

Population dynamics of phytoplankton and *Daphnia* varied substantially with both source lake and fertilization treatment. Analysis of these samples is ongoing, but preliminary results are presented here. *Daphnia* from hypereutrophic lakes reached substantially higher biomass when raised under high P conditions than *Daphnia* from lakes originally lower in P (Figure 1). In spite of this high biomass, however, *Daphnia* from hypereutrophic lakes failed to reduce algal biomass in this experiment. In contrast, tanks with higher *Daphnia* biomass from low-P lakes had reduced algal biomass (Figure 2).

These results suggest local adaptation in *Daphnia pulicaria* allow them to thrive in hypereutrophic conditions, which are becoming increasingly prevalent in Iowa. However, *Daphnia* evidently adapt to a P-rich diet by reducing feeding rate and decreasing P use efficiency, which together limit their ability to control algal populations. These results suggest management of lake food webs for high *Daphnia* biomass can reduce algal blooms in low-P lakes, but this strategy will be ineffective in high-P lakes.

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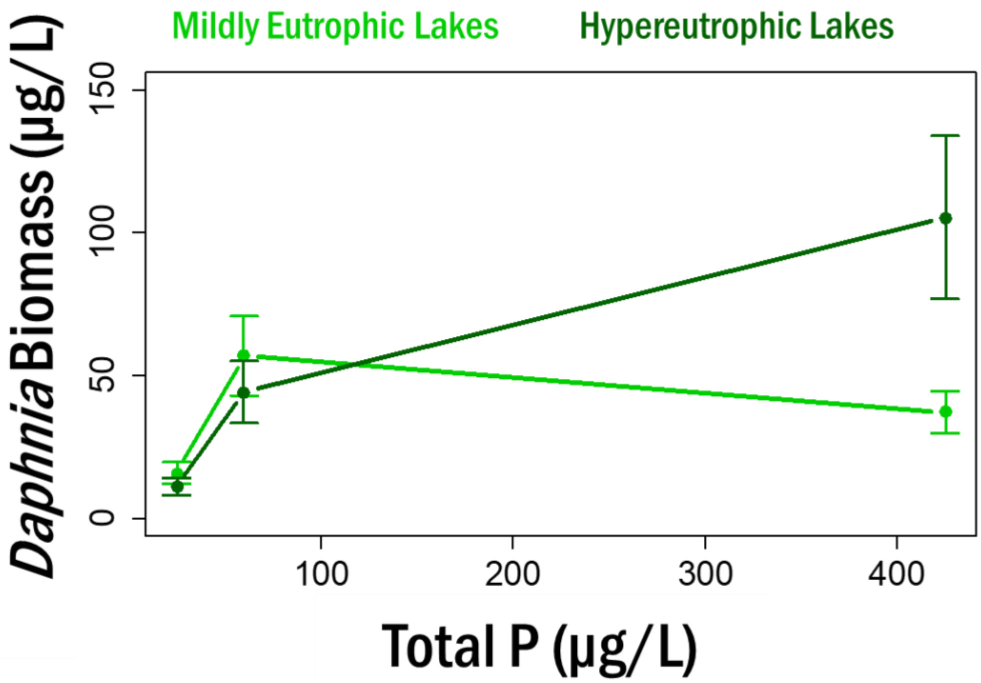

Figure 1. *Daphnia* biomass in experimental mesocosms averaged over May-July samples. Light points are *Daphnia* from low-P lakes and dark points are *Daphnia* from high-P lakes.

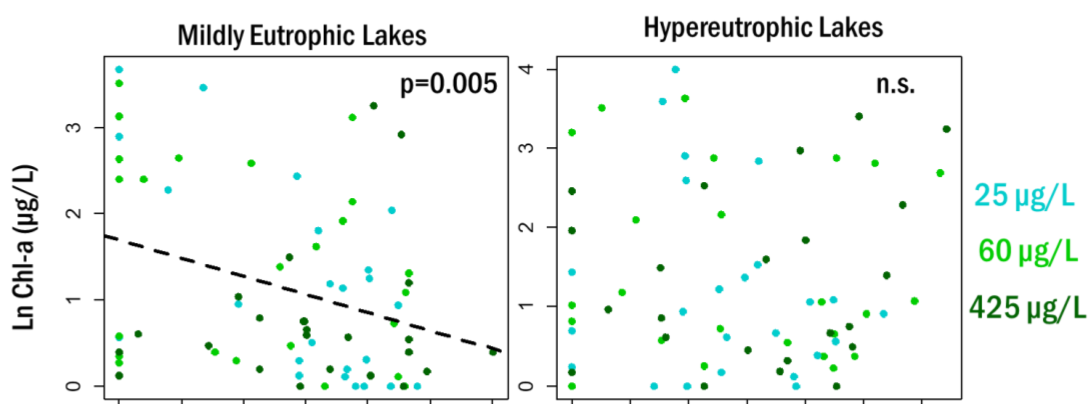

Figure 2. Chlorophyll-a (a proxy of phytoplankton biomass) vs. *Daphnia* biomass in experimental mesocosms averaged over May-July samples. High *Daphnia* biomass significantly reduced phytoplankton biomass in mesocosms stocked with low-P lake *Daphnia* (left panel) but not those stocked with high-P lake *Daphnia* (right panel). Points represent each individual weekly mesocosm sample and are color-coded by P fertilization treatment.