Zooplankton Community Composition Across an Ion Gradient

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Microscopic zooplankton play a central role in lake food webs. 'Zooplankton' refers to the animal-like members of the planktonic community, as opposed to plant-like phytoplankton or other bacterial, fungal, and viral types (Waervagen et al., 2002). Zooplankton consume large amounts of algae and they in turn are eaten by fish and larger invertebrates. Within this food web, the population of zooplankton is controlled by both predation (in what is known as top-down control, because predators exist in the trophic levels above zooplankton in the web) and the availability of food and other resources (bottom-up control).

A great deal of ecological study has focused on how macronutrients like nitrogen and phosphorus drive bottom-up ecological dynamics in lakes, but emerging research points to the importance of *micronutrient* availability in shaping these systems (Kaspari, 2021). Concentrations of relatively rare elements like dissolved salts and trace metals can have important effects at the individual, population, and community scales. For zooplankton living in lakes, it is essential that there is a sufficient availability of ions in the water, which they can take up to use for bodily functions. As lakes and their surrounding watersheds change over time, the availability of ions in a given lake can change, as can the ratio of ions in comparison to each other. This can stress organisms, and zooplankton have been found to decline both in number of individuals and size of individuals in ion-depleted conditions (Jeziorski et al., 2012).

In order to better grasp the effect that one singular micronutrient might have on a lake's zooplankton population, we examined samples from 20 Maine lakes with varying calcium levels (previously collected by Elizabeth Baker '22). We chose calcium because its importance to zooplankton is well-known: it is used in the construction of bodies. Species vary in how much calcium they have in their exoskeleton, how often they molt this outer shell, and how often they reproduce, so some need much more calcium than others. We'd expect this to affect population-level and community-level dynamics (number of individuals of a given species, competition between species, etc.) as the amount of calcium in the lakes changes.

In order to test our predictions, we determined the species composition of each lakewater sample. We looked through each sample under a microscope, picking out individuals that looked different from one another, and then used a dichotomous key to correctly identify them to the species level. Knowing which species we should expect to see, we then did a 'count' where we recorded every species that we saw until we reached at least 250 individuals (Jeziorski et al., 2014).

As calcium concentration in the lakes increased, we expected to see higher densities of *Daphnia* - a specific zooplankton Genera known for its high calcium needs - as well as more *Daphnia* relative to the other zooplankton in the lake (because more calcium would allow *Daphnia* to reproduce as fast as possible and outcompete their peers), but we surprisingly saw the exact opposite of this: as calcium concentration increased, the *Daphnia* seemed to become less dominant and their populations shrunk (Figure 2).

Because we know that calcium is an essential micronutrient for *Daphnia*, these findings indicate that its effect might be more indirect than previously thought. While we originally thought calcium levels would control zooplankton in a direct bottom-up manner, we now think they might have a more intense effect on the predatory fish, resulting in a top-down pressure (Figure 3). If the fish are benefitted by higher levels of calcium, then their predation might increase as the calcium does. This is also supported by Elizabeth Baker's previous findings in which she saw *Daphnia* body size decline with increasing calcium (smaller *Daphnia* would be more undetectable by predatory fish) (Figure 4).

Looking forward, we would like to investigate this possibility via collaboration with environmental agencies or additional data collection. We would also like to continue our analysis for all the species of zooplankton that we counted, not just the *Daphnia* species.

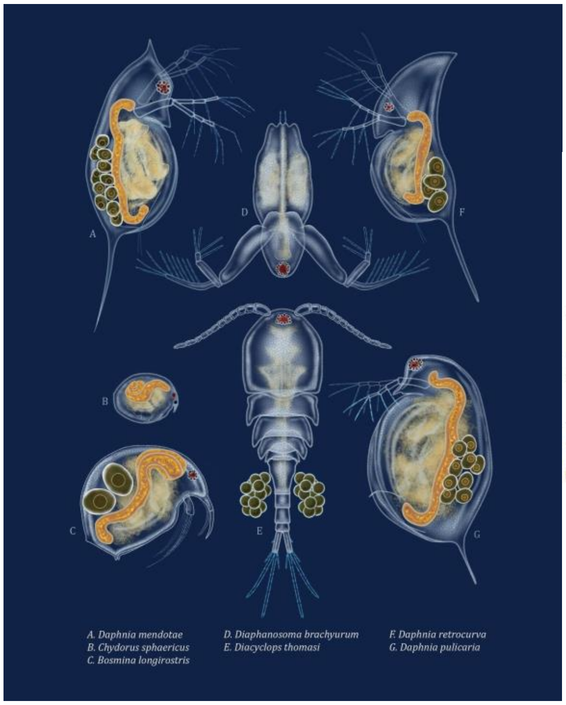

Figure 1: Drawing of zooplankton species commonly found in Maine lakes. The top left, top right, and bottom right drawings are different *Daphnia* species (from Rebecca Jabs).

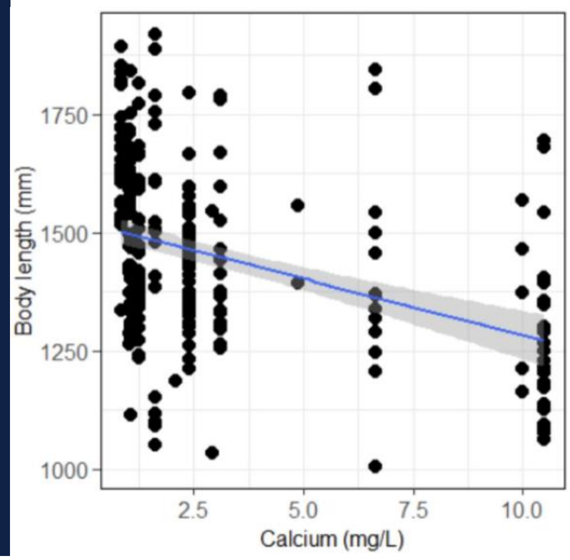

Figure 3: One of the graphs resulting from Elizabeth Baker '22's research; shows increasing calcium concentrations on the x-axis and decreasing *Daphnia* body size on the y-axis.

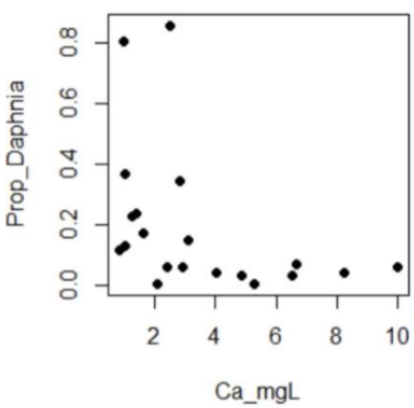

Figure 3: One of the graphs resulting from our data analysis; shows increasing Calcium concentrations on the x-axis and decreasing proportions of *Daphnia* on the y-axis.

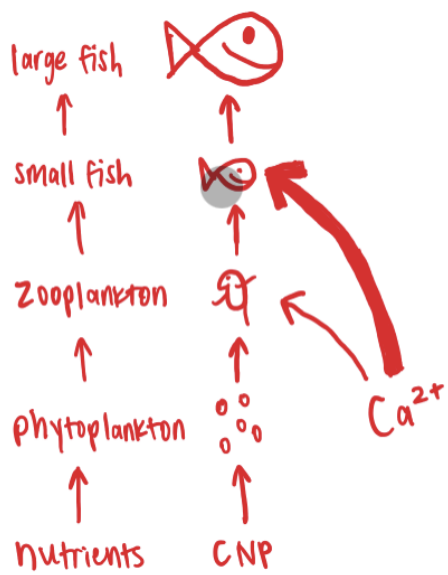

Figure 4: Diagram of a simplified lake food web. Our new prediction as to the effect of calcium is drawn in, with thickness of line representing intensity of effect.

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