Effects of *Dreissena polymorpha* and *Pyganodon grandis* on Algal Density

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Abstract

Invasive species often compete with native species for various resources. This study investigated how an invasive species in Douglas Lake, the zebra mussel, and a native species, freshwater clams, would impact algal communities through their feeding habits. We set up aquaria with different treatments of clams and zebra mussels in the boatwell at the University of Michigan Biological Station (UMBS) and monitored algal populations through chlorophyll-a levels. The zebra mussel treatment had the highest chlorophyll-a levels and the zebra mussel and clams treatment had the lowest chlorophyll-a levels on Day 4. The higher levels of chlorophyll-a may be due to the selective feeding of zebra mussels while the lower levels of chlorophyll-a may be due to the non-selective feeding of native clams. Our findings may be useful to understand how zebra mussels are affecting algal populations and how that may in turn affect native clam populations.

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Introduction

Invasive species are organisms that are not native to an area and have the potential to negatively impact an environment. Invasive species compete with native species for resources such as nutrients and space. Michigan has a wide range of introduced, invasive species in terrestrial and aquatic environments from spotted knapweed to the sea lamprey. Perhaps the most widely known invasive species to the Great Lakes region is the zebra mussel. They were first discovered in the Great Lakes in 1988 and were discovered in Douglas Lake in 2001 (Hollandsworth et al. 2011). Here, we will look at the effect of zebra mussels on native clams in Douglas Lake at UMBS in northern Michigan.

Zebra mussels eat both phytoplankton and zooplankton by filtering the water column, reducing algal diversity throughout the Great Lakes (Lowe and Pillsbury 1995). They selectively feed on green algae and have been known to reject blue-green algae (Bierman et al. 2005). This can cause shifts in algal communities which can then lead to harmful algal blooms (Conroy and Culver 2005). Freshwater clams, such as *Pyganodon grandis*, are also filter feeders, however they consume blue-green algae and were present in Douglas Lake as recently as 2011 (Hollandsworth et al. 2011), but are now hard to find or perhaps have gone locally extinct due competition with zebra mussels (Nalepa 2011). The zebra mussels have also been shown to attach to the clams, impeding movement and affecting growth (Gillis and Mackie 1994). They still exist in Larks Lake, one of the few lakes in the region with no zebra mussels due to its alkalinity that makes it unfavorable for zebra mussels to survive (Hollandsworth et al. 2011).

In this study, we collected zebra mussels from Douglas Lake and freshwater clams from Larks Lake. We were looking to see if both species would have an effect on algal communities when both species are present in the same area. Over the course of a week, we measured the chlorophyll concentration and inferred the types of algae that are found over the course of the study. We predicted that the combination of zebra mussels and clams would have the lowest levels of chlorophyll, that zebra mussels and clams in isolation would have the higher levels of chlorophyll than the zebra mussels and clams treatment, and the control would have the highest levels of chlorophyll of all treatments. By monitoring feeding in competition and in isolation, we observed how invasive species might alter algal populations in ways that impact the feeding of native species.

Methods

We collected around 2,000 grams of clams from Larks Lake (approx. 50 clams) and around 500 grams of zebra mussels from Douglas Lake. We prepared 8, 10-gallon aquaria by adding one gallon of substrate (sand and stone) and two gallons of water from Douglas Lake. We had four treatments with two replicates of each (see below). Our experiment was set up in the boatwell of Lakeside Lab at UMBS and we included aerators for each tank (Aquaculture and Silent Giant) to facilitate atmospheric air exchange.

The first treatment was a control, which contained no zebra mussels or clams. The second treatment had only zebra mussels, with 125 grams of mussels in each tank. The third treatment had only clams, with 509 grams and 519 grams in two different tanks. The fourth treatment was both zebra mussels and clams (mixed species), with 125 grams of zebra mussels in each tank and 509 grams and 519 grams of clams in two different tanks.

Starting on Day 1, we collected 60 milliliters of water from each tank every day and filtered it through a Swann filter syringe. We folded the filters into aluminum foil, placed in a ziploc bag, and put in the freezer. After Day 5, we dissolved the filters in acetone overnight. We measured samples in a fluorometer to obtain the chlorophyll levels using a chlorophyll-a content equation (Lorenzen 1966). We ran an ANOVA test for each day to compare chlorophyll-a content over time.

Results

Day 4 contained the peak significance of difference in chlorophyll levels among treatments (Table 1, $p < 0.002$). The zebra mussel treatment had the highest level of chlorophyll-a while the mixed species treatment had the lowest level of chlorophyll-a. The control treatment had a higher chlorophyll level than the clams and the mixed species treatment but not the zebra mussel treatment (Figure 1). The clam treatment had a higher chlorophyll-a level than the mixed species and the control treatment (Figure 1).

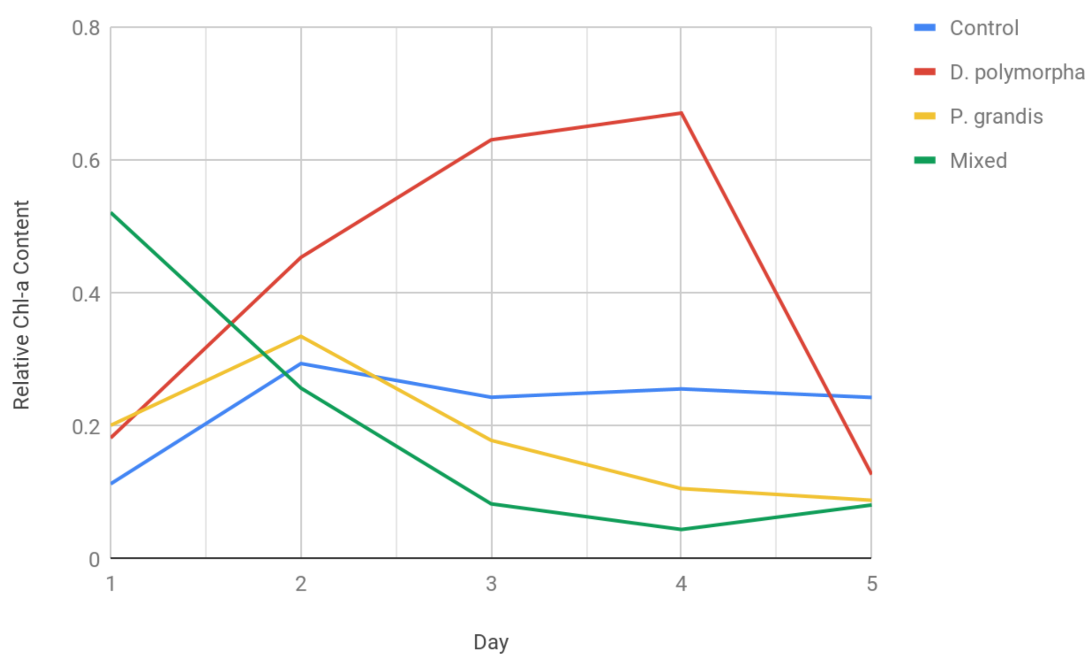

Figure 1- Relative chlorophyll-a readings of all treatments for Days 1-5. Relative reading were found by dividing each day's readings by day 0 readings.

Table 1- ANOVA table for Day 4 chlorophyll-a readings.

Source of Variation	SS	df	MS	F	P-value	F-crit

Between Groups	0.01247221486	3	0.004157404	43.38993329	0.001649869	6.591382125
Within Groups	0.0003832598614	4	0.000095814			

Table 2- P-values from ANOVA for the chlorophyll-a readings for Days 1-5.

Day	Test Statistic	P-value
1	14.17748918	0.01345145131
2	1.897637795	0.2712650273
3	2.613168724	0.1881385561
4	43.38993329	0.001649869
5	10.93797625	0.02131707898

Discussion

We chose to only include an ANOVA table Day 4 for our analysis because it was the only day that the chlorophyll-a levels were significantly different than each other. The chlorophyll-a levels in Day 1 are statistically significant (Table 2), however, we excluded this due to this occuring at the beginning of the experiment because the organisms were placed in a new environment and perhaps needed to habituate to the aquaria.

We had hypothesized that the control treatment would have the highest levels of chlorophyll-a, however, this was disproved by the zebra mussel treatment (Figure 1). The zebra mussel treatment had the highest level of chlorophyll-a which may be due to the selectivity of zebra mussels for green algae. The blue-green algae and diatoms could then proliferate due to lack of competition with green algae for resources (Lowe and Pillsbury 1995). Intraspecies competition may have increased due to the low abundance of non blue-green algae. However, the high chlorophyll-a level may also be due to numerous zebra mussels dying and ejecting their contents, which contain pseudofeces (Walz 1978). Pseudofeces are undigested algae which could have caused the trend in the zebra mussel treatment shown in Figure 1 (Berg 1996).

The clam treatment had a higher level of chlorophyll-a than the mixed treatment but not the zebra mussel treatment. The level of chlorophyll-a in this treatment was also lower then the level of chlorophyll-a in the control treatment (Figure 1). Since the clams were in isolation, they were able to feed without competition from zebra mussels (Gillis and Mackie 1994) and the algae populations can remain diverse (Conroy and Culver 2005). This could help with conservation efforts of native clams where zebra mussels are present (Hollandsworth et al. 2011).

The mixed species treatment had the lowest levels of chlorophyll-a. This may be due to the combination of selective and non-selective feeding of both species where all types of algae were consumed, but zebra mussels continued to ignore blue-green algae (Bierman et al. 2005). There was increased interspecies competition for non blue-green algae and this may lead to a less diverse diet for native species (Bell-Dereske et al. 2007). There are extreme implications when zebra mussels and clams occur together in nature because the zebra mussels can affect the growth and mobility of clams by attaching to their shells (Schloesser et al. 1996).

Limitations in our study include having only one duplicate tank per treatment. This affected how confident we were in our results due to having a small sample size. In our lab analysis, we wanted to test for other kinds of chlorophyll (types b, c, and d), but were unable to due to time constraints. The other concentrations of chlorophyll would have allowed us to be more confident in trying to identify which types of algae were consumed since all algae contain chlorophyll-a (Li et al. 2002). Human error may have been a factor when collecting samples because near the end of the week, there was an increase of algae present with the zebra mussel treatment (Figure 1) and not all of the sample could be filtered due to the filter becoming saturated with algae. Instead of replacing the saturated filter, we wrote down the milliliters of water we were able to sample and this could have affected the fluorometry readings.

Future studies could look further into the feeding habits of zebra mussels and clams to see which types of algae each species prefer. They could also test for the other types of chlorophyll in order to see how algae species and type diversity changes over time in the presence of zebra mussels. More work can always be done to understand how zebra mussels and other aquatic invasive species continue to affect native species in the Great Lakes region.

Works Cited

Bell-Dereske, L., Detjen, C., and Kappler, K. (2007). Zebra mussel feeding relationships and their implications for native unionids. Deep Blue, University of Michigan, Ann Arbor, Michigan.

Berg, D. J., Fisher, S. W., & Landrum, P. F. (1996). Clearance and Processing of Algal Particles by Zebra Mussels (Dreissena polymorpha). *Journal of Great Lakes Research*,*22*(3), 779-788. doi:10.1016/s0380-1330(96)70996-6

Bierman, V. J., Kaur, J., Depinto, J. V., Feist, T. J., & Dilks, D. W. (2005). Modeling the Role of Zebra Mussels in the Proliferation of Blue-green Algae in Saginaw Bay, Lake Huron. *Journal of Great Lakes Research,31*(1), 32-55. doi:10.1016/s0380-1330(05)70236-7

Conroy, J. D., & Culver, D. A. (2005). Do Dreissenid Mussels Affect Lake Erie Ecosystem Stability Processes? *The American Midland Naturalist,153*(1), 20-32. doi:10.1674/0003-0031(2005)153[0020:ddmale]2.0.co;2

Gillis, P. L. and G. L. Mackie. (1994). Impact of zebra mussels, Dreissena polymorpha, on populations of Unionidae (Bivalvia) in Lake St. Clair. Canad. J. Zool. 72:1260-1271.

Hollandsworth, D., Lowe, R., and Badra, P. (2011). Indigenous unionid clam refugia from zebra mussels in Michigan inland lakes. *Am. Midl. Nat.* 166:369-378.

Li, H., Gong, G., & Hsiung, T. (2002). Phytoplankton pigment analysis by HPLC and its application in algal community investigations. *Botanical Bulletin of Academia Sinica,43*(4), 283-290. doi:0006-8063

Lorenzen, C. J. (1966). A method for the continuous measurement of in vivo chlorophyll concentration. *Deep Sea Research and Oceanographic Abstracts,13*(2), 223-227. doi:10.1016/0011-7471(66)91102-8

Lowe, R. L. and Pillsbury, R. W. (1995). Shifts in benthic algal community structure and function following the appearance of zebra mussels (*Dreissena polymorpha*). *J. Great Lakes Res.* 21:558-566.

Nalepa T.F. 4 994. (2011). Decline of native unionid bivalves in Lake St. Clair after infestation by the zebra mussel, Dreissena polymorpha. Can. J. Fish. Aquat. Sci. 51: 2227-2233.

Schloesser, D. W., Nalepa, T. F., & Mackie, G. L. (1996). Zebra Mussel Infestation of Unionid Bivalves (Unionidae) in North America. *American Zoologist,36*(3), 300-310. doi:10.1093/icb/36.3.300

Walz N. (1978) The energy balance of the freshwater mussel Dreissena polymorpha Pallas in laboratory experiments and in Lake Constance. I. Pattern of activity, feeding and assimilation efficiency. Archiv für Hydrobiologie, 55: pp83-105.