The effect of polypropylene on the formation of byssal threads produced by zebra mussels (*Dreissena polymorpha*)

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Introduction

As a result of human activity and reliance on plastic products, microplastics and fibers are becoming a major ecological problem in both terrestrial and aquatic environments. These particles - which are less than 5 millimeters large - become ingested by organisms and pose a risk to them as well as others along the food chain (Galloway and Lewis 2016). Previous studies of microplastic effects have been conducted on bivalves; oysters experience decreased reproduction and larval development (Susarellu et al. 2016). However, the behavioral effects of plastic and fiber uptake are relatively unknown. The zebra mussel (Dreissena polymorphia) is a possible indicator of microplastics' effect in water systems; it is an invasive bivalve found in many water systems including the Great Lakes and can filter large quantities of water in a short period of time (Figure 1). In order to anchor themselves to substrates, zebra mussels produce byssal threads which have adhesive flared ends called "plaques" (Figure 2). The plaques and threads together anchor the mussel in place (Farsad N. and Sone ED, 2012) and may be important in predator avoidance (Krobak and Karkareko 2009). The objective of this study was to examine how the amount of byssal threads produced by zebra mussels would change in response to microplastics in the mussels' environment. This experiment can show if microplastics significantly change zebra mussel behavior, which could open up possibilities for further research and understandings of the larger ecological effects and implications of such pollutants.

Figure 1: *Dreissena polymorpha* extending muscular foot for movement. Filter-feeding "siphon" is also visible.

Figure 2: Byssal threads produced by zebra mussel. The flared ends are the "plaques" which are quantified in the study.

Methods

- The mussels were retrieved from Stone Lake, Indiana, in September and October, 2019 (Figure 3).
- Seven trials were conducted between October 25, 2019 and January 30, 2020.
- For each trial, we set up 10 fingers bowls of 200 mL of experimental water (~ 400 microfibers per liter of aged polypropylene rope fiber) and 10 fingers bowls of 200 mL of control water. Each finger bowl contained one zebra mussel (Figure 4).
- Water came directly from the stock mussel tanks and was originally from their source lake.
- We allowed the mussels 24 hours to attach to the fingerbowls before detaching the mussels with a sharp blade and examining the bowls under a microscope to record the number of plaques left behind.

Figure 3: Collecting zebra mussels at Stone Lake, Indiana

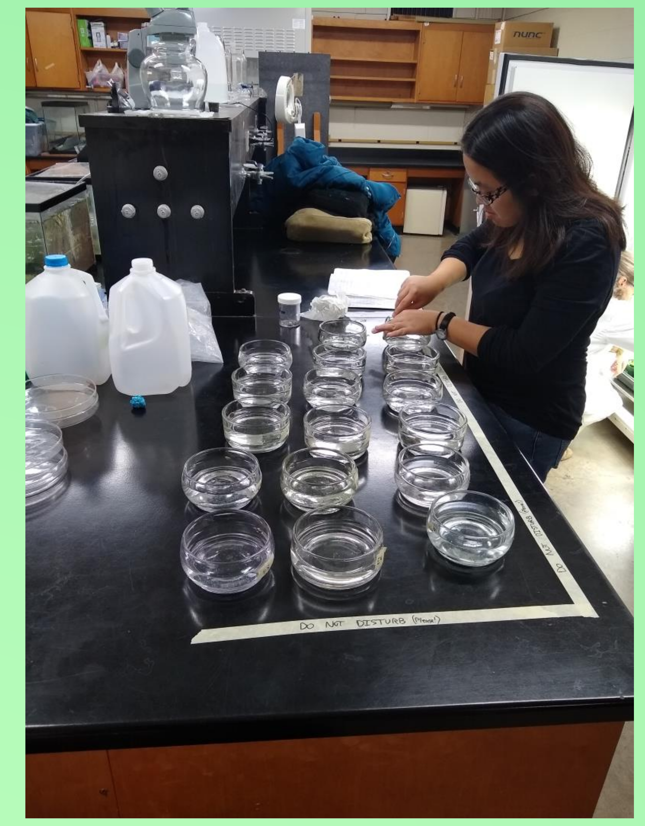

Figure 4: Setting up a trial. Each fingerbowl contained a zebra mussel

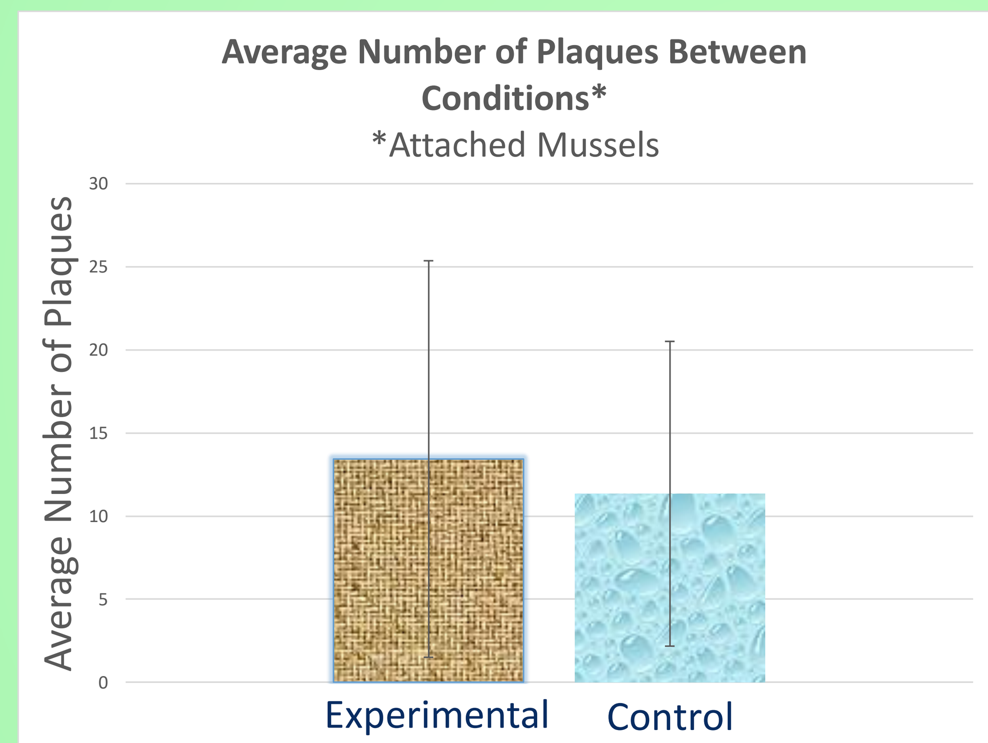

Figure 5: Average number of plaques for control and experimental conditions, excluding mussels which did not attach. Error bars represent + - SD.

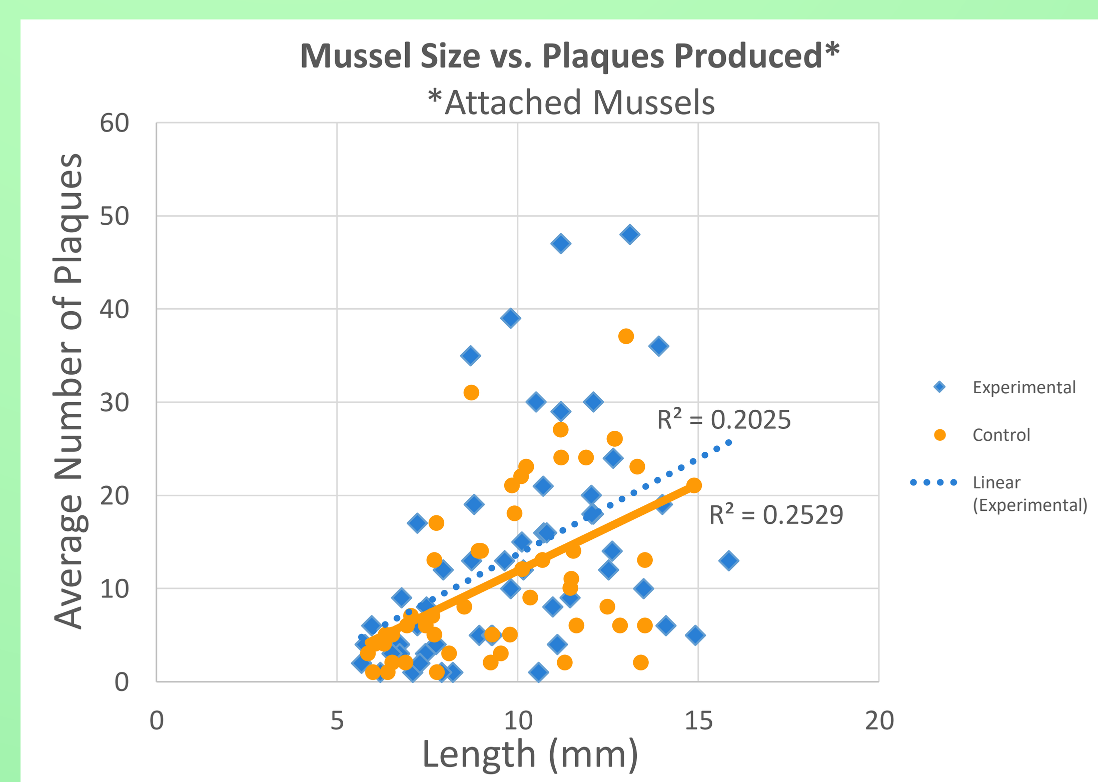

Figure 6: For mussels across all trials which *did* attach, size vs. number of plaques is plotted. Across both test groups, larger mussels generally produced more threads.

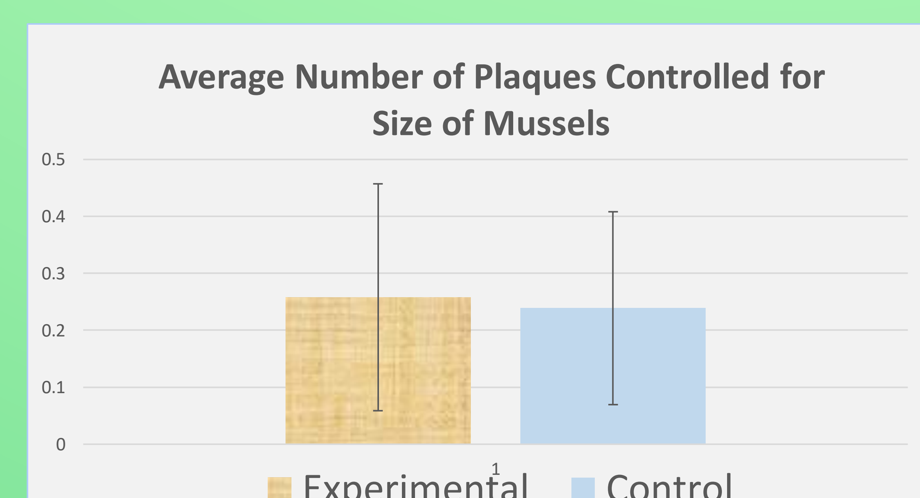

Figure 7: Comparison of the number of plaques divided by the size (l x w) of each mussel, excluding mussels which did not attach.

Results

- 140 mussels were used, and each was exposed to its respective condition for 24 hours on average.
- Although some mussels did not produce byssal threads during the experiment, we found no differences in the number of mussels that attached between experimental and control treatments (X^2=0.679, p>0.05)
- As seen in figures 5, 6, and 7, of those mussels that did attach, we found no significant different in the average number of plaques between the control condition and the experimental condition for either total number of plaques (*t*=1.06 *df*=138, p=0.14) or plaque number divided by mussel size (*t*=1.98, *df*=102, p= 0.6).
- No significant difference between ingested fibers in control and experimental mussels using UV oxidation to separate fibers from mussels (control: m=1.75 +/- 1.71; exp: m= 2.6 +/- 1.14).

Discussion

- Presence of microplastics did not significantly affect the number of byssal threads with plaques produced in this study.
- The concentration of microplastics that the mussels were exposed to in this study was much higher than the reported concentration of plastic in Lake Michigan, which is 1.9 - 32 particles per cubic meter (Baldwin et al. 2016).
- However, the exposure time to plastics could have been too short and not allowed the mussels to ingest plastic for significant differences to be seen (control: m=1.75, exp: m= 2.6). Therefore, future experiments could involve increasing exposure time.
- Additional considerations include different ages of mussels across trials, possible over or underfeeding of mussels, and the possibility of mussels already habituated to plastics due to plastic presence in Stone Lake.
- The mussels were also less mobile in later trials; more of them were found unattached and not having changed position in their finger bowls compared to earlier trials where they were more likely found clinging to the vertical sides of the finger bowls. However, no significant differences between treatments were revealed when these trials were excluded.
- Future version of this experiment should examine the long term effects of microplastics on mussel behavior as opposed to short trials.

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