

Changing Food Webs in Lake Michigan: *Dreissena* and the Microbial Loop

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SUMMARY OF PROBLEM AND RESEARCH OBJECTIVES

The zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*) are changing the Great Lakes ecosystem and surrounding fresh waters. They alter ecosystems through their voracious filter feeding ability that removes algae, bacteria, and protozoa from the water column which disrupts the food chain for native organisms and increases the clarity of the water, allowing photosynthesis to occur in deeper waters expanding the habitat of submergent aquatic macrophytes. The microbial loop is an important part of the aquatic food web that feeds organisms in the second trophic level. Dissolved organic matter (DOM), which is released into aquatic ecosystems by phytoplankton, zooplankton, and bacteria, is utilized in bacterial growth and reproduction. A reduction in DOM and/or secondary production would have serious consequences on aquatic food webs, which would be observed at all trophic levels. Previous studies have demonstrated that DOM can provide 10-25% of the zebra mussel's maintenance ration, which indicates the uptake of DOM may be metabolically significant to them. With the increasing number of *Dreissena* in our fresh waters, this is a serious threat to the microbial loop and secondary production. Potentially, *Dreissena* can change the species diversity of the microbial loop and/or the levels of secondary production. Changes in secondary production can result in a cascade effect observed in the other trophic levels, which can challenge the viability of macroscopic life in fresh waters.

The testable hypothesis is that filter-feeding activities of *Dreissena* modify the quantity and quality of dissolved organic matter in the water, which in turn influences the amount of bacterial secondary production and possibly microbial diversity in fresh waters.

- The *first objective* is to determine if filter feeding will change the quantity of carbon substrates in the environment.
- The *second objective* is to determine if filter feeding modifies the quality of carbon substrates in the environment.
- The *third objective* is to determine if carbon substrates modified by the mussels can be utilized by fresh water bacteria isolated from Illinois water ways.

METHODOLOGY

The utilization and/or modification of dissolved organic matter by *Dreissena* will be studied using a defined medium. Adult quagga and zebra mussels will be collected from field sites and washed to reduce the number of microbes attached to their shells. Individual mussels will be placed into a test tube with a defined medium that includes

one carbon substrate. Changes in substrate concentration of these proteins will be determined using the Bradford assay. Qualitative changes, e.g., proteins to peptides and amino acids, will be determined using polyacrylamide gel electrophoresis to visualize and compare carbon substrate profiles before and after processing by the mussels in the assay. The processed substrates will be filtered and purified, if necessary, before examination on polyacrylamide gels.

Pure cultures of heterotrophic bacteria will be isolated from Lake Michigan waters that will be studied and identified using the BIOLOG microplate assay according to manufacturer's instructions. A portion of the defined medium that was metabolized by the mussels in the test tube assays will be filtered to remove any microbes and then used to prepare minimal growth media. Growth media with unmodified and modified carbon substrates will be inoculated with the bacterial isolates. The growth rates in media with modified and unmodified substrates will be compared to determine if filter feeding changes the ability of bacterial species to reproduce in the environment.

PRINCIPAL FINDINGS AND OBJECTIVES

The project was not completed during the time period due to unforeseen circumstances. The fact that *Dreissena* were unavailable to collect during November through March due to the weather made it difficult to complete the work during these months. Data was collected for the first and third objectives.

Objective 1: Protein from the cyanobacterium *Spirulina* was utilized in this study. The microorganism's microbial products could be DOM utilized by bacteria in fresh waters and potential food for *Dreissena*. *Spirulina* powder sold as a natural food supplement was the source of protein. The data indicate that *D. polymorpha* and *D. bugensis* decreased the quantity of the protein over 24 hours, and hence the availability of the protein to bacteria (Fig. 1). Control tubes indicated that the mussels did not contribute proteins to the assay, so the proteins detected were from the *Spirulina* (Fig. 1). These results support the hypothesis that *Dreissena* filter feeding can change the quantity of carbon substrates in the environment available to bacteria.

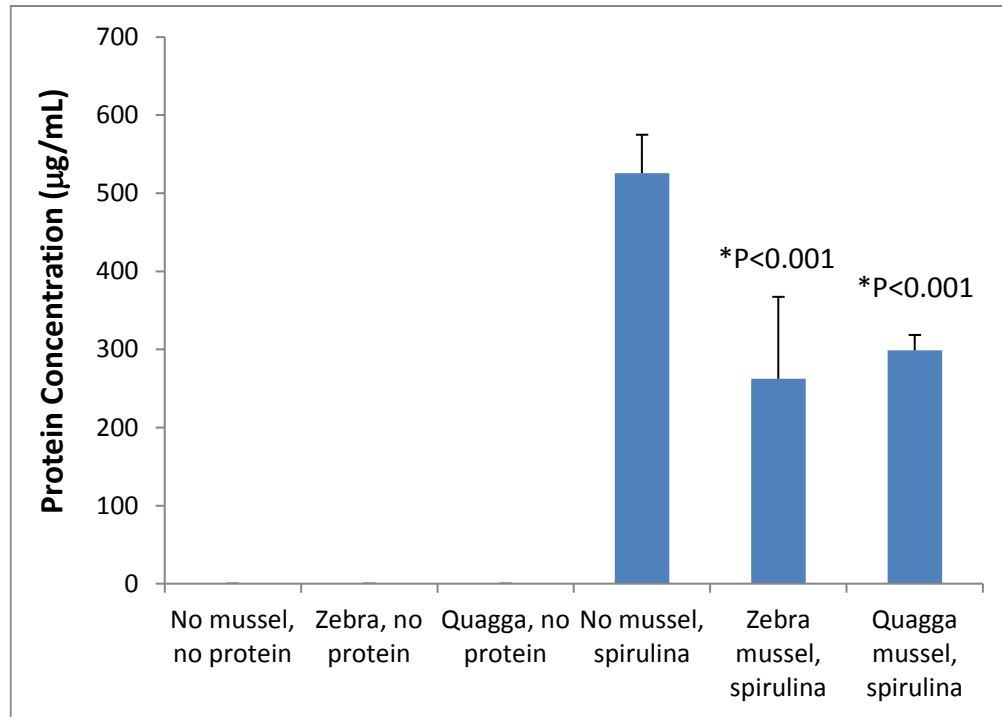


Figure 1. *Dreissena* decreases the quantity of *Spirulina* protein after 24 hours. The Bradford assay detected significantly lower levels of protein in test tubes with zebra and quagga mussels compared to tubes without the mussels. No proteins were detected in control tubes.

Objective 2: No work was completed on this objective.

Objective 3: The test tube assays confirmed that *Spirulina* is a viable protein source for use in this study to determine the effects of filter feeding on microbial diversity. The next step was to isolate bacteria that could metabolize the protein. A minimal culture medium was developed with the *Spirulina* protein as the sole carbon source. It was developed using the ingredients for minimal glucose medium, but substituting the glucose with *Spirulina* protein. Seventeen bacteria were isolated into pure cultures. The BIOLOG microplate identification system was utilized to determine species. Three bacteria were positively identified as *Aeromonas*, *Comamonas*, and *Exiguobacterium*. The remaining work for this objective was not completed.

STUDENT INFORMATION

Tami Roginski is an undergraduate Biology major who will complete a Bachelor of Science degree in December 2015. She plans to continue her studies at the graduate level at another institution.

PUBLICATION OR PENDING PUBLICATIONS

The results were presented by Ms. Roginski at the Lewis University STEM Undergraduate Research Experience on August 6, 2015. The work will continue during summer 2015 and should be completed by fall 2015. Findings will be presented at

regional and/or national meetings related to microbiology or ecology. A manuscript will be submitted to relevant journals with an appropriate readership. The support by the IWRC will be acknowledged.