Hybridization Potential of the Invasive Dreissenid Zebra and Quagga Mussels


Zebra mussel

Quagga mussel

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Abstract

Zebra and quagga mussels originated in Eastern Europe and were introduced to the United States in the mid-1980s. After spreading from the Great Lakes throughout much of the eastern United States, including Texas, both species have become major ecological and economic pests. The objective of my project is to investigate the hybridization potential between two invasive dreissenid species, Dreissena polymorpha (sebra mussel) and Dreissena rostriformis begensis (quagga mussel). I will analyze fertilization success, gamete compatibility, larval development, and competitive sperm binding to determine the success and viability of hybridization. Understanding this is important, as hybridization could increase genetic diversity, novel advantageous traits, and the potential for range expansion.

Introduction

Zebra mussels and quagga mussels originated in Eastern Europe and were introduced to the United States in the mid-1980s. After spreading from the Great Lakes throughout much of the eastern United States, including Texas, both species have become major ecological and economic pests. Their dense colonization clogs water intake structures, disrupts food webs, and contributes to biodiversity loss. Although they are often found together, quagga mussels frequently replace zebra mussels over time, likely due to their ability to survive in deeper and muddier environments.

Both species are broadcast spawners, releasing eggs and sperm into the water column, which creates the potential for hybridization when populations overlap. However, it remains unclear whether they can successfully hybridize or produce viable offspring. Understanding this is important, as hybridization could increase genetic diversity, novel advantageous traits, and the potential for range expansion.

The objective of my project is to investigate the hybridization potential between two invasive dreissenid species, *Dreissena polymorpha* (zebra mussel) and *Dreissena rostriformis bugensis* (quagga mussel). I will analyze fertilization success, gamete compatibility, and larval development to determine whether hybridization can occur. By inducing spawning in both species, I will conduct controlled conspecific and heterospecific fertilizations to test whether sperm from one species can fertilize the eggs of the other. Subsequently, if sperm can bind to heterospecific eggs, I will determine if conspecific sperm outcompete heterospecific sperm.

Objective

To determine the potential for hybridization between zebra and quagga mussels based on several steps in the early reproductive process.

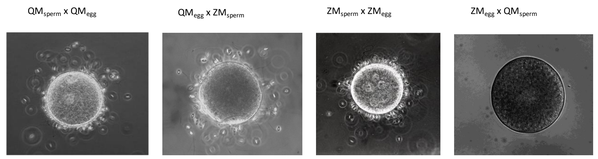
Experimental Design

Zebra mussels will be obtained from Texas lakes by Dr. Misamore. Zebra and quagga mussels from Wisconsin and Michigan will be provided by colleagues from the USGS and NOAA respectively. Aubryanne will induce mussels to spawn using standard lab techniques utilizing exposure to serotonin. Once gametes are collected, both conspecific and heterospecific fertilizations will be conducted. Samples will be taken at various timepoints postinsemination to determine degree to which the two species gametes interact. Steps in the fertilization process to be addresses with be sperm binding to the egg, egg activation and the resumption of meiosis, sperm entry into the egg cytoplasm (fertilization), 1st cell division, and larval development to 24hrs. Any larvae produced will be collected and sequenced using genetic markers specific to each species to verify the presence of a hybrid. To evaluate sperm competition, fluorescent lectins which bind to the surfaces of sperm in a species-specific manner will be used to separate zebra and quagga mussel sperm. Simultaneous inseminations will be conducted to determine if there is any competitive advantage for conspecific sperm relative to heterospecific sperm. Most of these techniques utilize standard protocols used by my lab. Genetic analysis will utilize pre-existing primer already available.

Survival of mussels under elevated temperatures

Sperm Chemoattraction

Sperm are drawn to the egg surface by a chemoattractant jelly layer surrounding the egg. There are slight morphological and biochemical differences between zebra and quagga mussel egg jelly layers. When presented with heterospecific eggs, ZM sperm were drawn to QM eggs but there was less interaction between ZM eggs and QM sperm. QM eggs typically have a more robust jelly layer.



SPERM BINDING

Inseminated eggs were examined 5-min postinsemination and the number of equatorial bound was determined.

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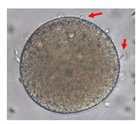
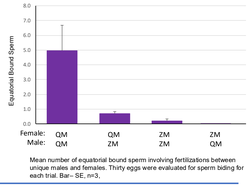

Phase contrast micrograph of inseminated QM egg with ZM bound sperm. Arrow indicates equatorial bound sperm.



Mean number of equatorial bound sperm involving fertilizations between unique males and females. Thirty eggs were evaluated for sperm biding for each trial. Bar– SE, n=3.

SPERM Entry

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Zygote Cell division – 1st Cleavage

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Formation of swimming larvae

Inseminated eggs were examined 24 hr postinsemination (PI) to determine if embryonic development continued to the ciliated, swimming larvae formation.

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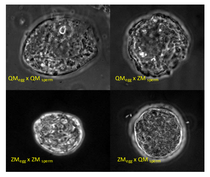
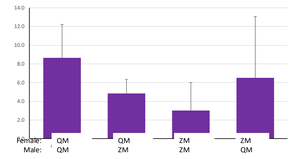


Swimming larvae from conspecific and heterospecific crosses.



Mean number of swimming larvae observed 24hr post fertilization for conspecific and heterospecific crosses. n=3, Bar – SE.

Conclusions

Obvious sperm binding occurred in 3 of 4 crosses, but was lowest with ZM eggs. Swimming larvae were observed in all four crosses, including ZM eggs x QM sperm which had minimal obvious sperm binding.

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