Analysis of Hybridization Potential Between the Invasive *Dreissena*

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ABSTRACT

Zebra and Quagga mussels are aquatic and highly invasive freshwater bivalve molluscs native to Eurasia. They have spread at an exponential rate into bodies of water throughout the country by means of our interconnected waterway. Prior analysis of their distribution has determined a consistent global pattern in which a population of zebra mussels initially invades a body of water and subsequently, a population of quagga mussels is established in the same region. Despite differential habitat preferences, both species have been found to live and reproduce in the same location. Since both species exhibit broadcast spawning as a reproductive mechanism, the potential for hybridization exists; this potential was analyzed via evaluating the initial fertilization and early embryonic cleavage stages required for production of viable hybrid offspring. A series of hybridization crosses were performed and compared against a control. Fertilization events observed and analyzed included motility and chemotaxis, the acrosome reaction, sperm binding and entry into the egg cytoplasm, and finally cleavage and early development. Inability to produce viable offspring suggests a hybridization-block has been established between the two species at the level of fertilization or early development.

INTRODUCTION

- The Zebra Mussel (*Dreissena polymorpha*) and the Quagga Mussel (*Dreissena bugensis*) are invasive freshwater bivalve molluscs native to Eurasia.
- Zebra and Quagga mussels are morphologically similar with slight variations in shell shape; Quagga mussels exhibit a slightly larger size. (Fig. 1)
- They exhibit relatively similar economic and ecological impacts on infested waters.
- Both species exhibit broadcast spawning as a reproductive mechanism: gamete release, fertilization and larval development all occur in the water column.
- While numerous studies have looked at various fertilization aspects in both groups, there has not yet been an extensive study determining the potential for hybridization between the two groups.
- Based on the similarities in gamete morphology, reproductive mechanism and habitat distribution, the potential for hybridization should exist.

Figure 1. Zebra mussel (left) and quagga mussel (right) are similar in coloration pattern but have slight morphological differences. Zebra mussels have a flattened base while quagga mussels are more curved. Quagga mussels typically get to a larger size than zebra mussels.

OBJECTIVE

- To determine if potential for cross-hybridization exists between Zebra and Quagga Mussels, and the specific fertilization stage at which this potential develops, or alternatively, is inhibited.

GAMETE MORPHOLOGY

- Based on previous descriptions of gametes, a comparative analysis of gamete morphology was performed. [1]

Sperm Morphology

- Sperm of both species consist of a prominent acrosome, nucleus, 4 mitochondria and single flagellum. They differ in that zebra mussel sperm cell bodies are straight (Fig. 2a) while quagga sperm are curved (Fig. 2b).

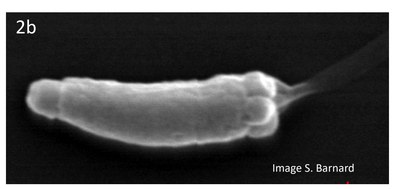


Fig. 2. Quagga (QM) and Zebra mussel (ZM) sperm show differences in cell body morphology.

Egg Morphology

- Eggs of both species are similar in size (Fig. 3) and contain minimal yolk . The most apparent difference is in the jelly layer surrounding the eggs which is more prominent in quagga mussels (Fig. 4).

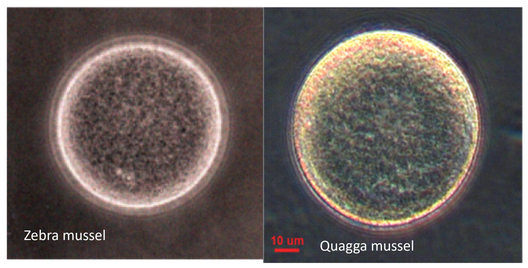


Fig. 3. Zebra mussels eggs (left) are approximately 60 um in diameter while quagga muscle eggs are only slightly larger (~76 um)

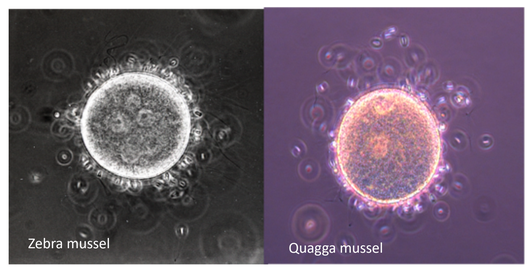


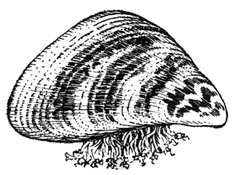
Fig. 4. Zebra mussel (left) and Quagga mussel (right) eggs are surrounded by a thick jelly layer that functions as a chemoattractant for sperm

METHODS

- Collection of mussels – Zebra mussels were collected from Lake Bridgeport, TX. Quagga mussels were provided by the National Park Service at Lake Mead.
- Spawning of mussels – Mussels were spawned by submersion in 1 mM serotonin for 20 min in isolated test tubes. Males typically spawn in 15 min. while females take 60 min. After sufficient sperm is released by male into test tube, remove male to prevent the resiphoning of sperm. Place spawning females in crystallizing dish (5o mm x 70 mm) on black background, which contrasts against white eggs.
- Combine gametes and observe results.

HYBRIDIZATION ANALYSIS

- **The following crosses will be preformed to compare fertilization events and evaluate the potential for hybridization**
  - ZM eggs x ZM sperm ZM eggs x QM sperm
  - QM eggs x ZM sperm QM eggs x ZM sperm
- **The Following events of fertilization and early development will be determined for each cross.**
  - Chemoattraction
  - Binding
  - Sperm entry
  - Egg activation/polar body
  - Cell division
  - Larval development



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Literature Cited.

[1] Walker, G.K., M.G. Black, C.A. Edwards. 1996. Can.J.Zool 74:809-815