

Mummichogs as a Model Species

Educational Tool and Research Opportunities

Delaware State University | Aquatic Sciences

Background

The mummichog, *Fundulus heteroclitus*, is one of the most abundant fish species in Atlantic salt marshes and tidal creeks. They live along the coast of North America from Labrador, Canada, south to northern Florida. Other common names are mud minnow, bull head minnow, bull minnow, killifish, salt marsh minnow, and gudgeon.

Since individuals are small (rarely reaching larger than 12 cm long) and extremely tolerant to a variety of environmental conditions and pollutants, this *Fundulus* species has become popular for laboratory use, with well over 3,000 peer-reviewed articles to prove as much. Its hardiness has also translated well to making it an excellent baitfish, preferred by many saltwater anglers.

As a marine baitfish, mummichogs are almost completely wild caught using minnow traps and seine nets. The



Cultured broodstock grown at the DSU Aquaculture Research and Demonstration Facility. Male on the left, female on right.



Mummichog

Fundulus heteroclitus

overlap in seasonal availability of mummichogs with the recreational fishing season is short, leaving a marine baitfish deficit for a large portion of the sport fishing season. Through our current research at the Delaware State University Aquaculture Research and Demonstration Facility, we seek to develop aquaculture methods for this fish to alleviate pressure on the sensitive ecosystem mummichogs live in, but also to increase the economic stability of the saltwater baitfish market.

Aquaculture methods

In order to develop aquaculture methods for a species, it is important to understand the natural history and life cycle of the species of interest. The following information will provide a brief summary for each stage in regard to mummichog aquaculture.

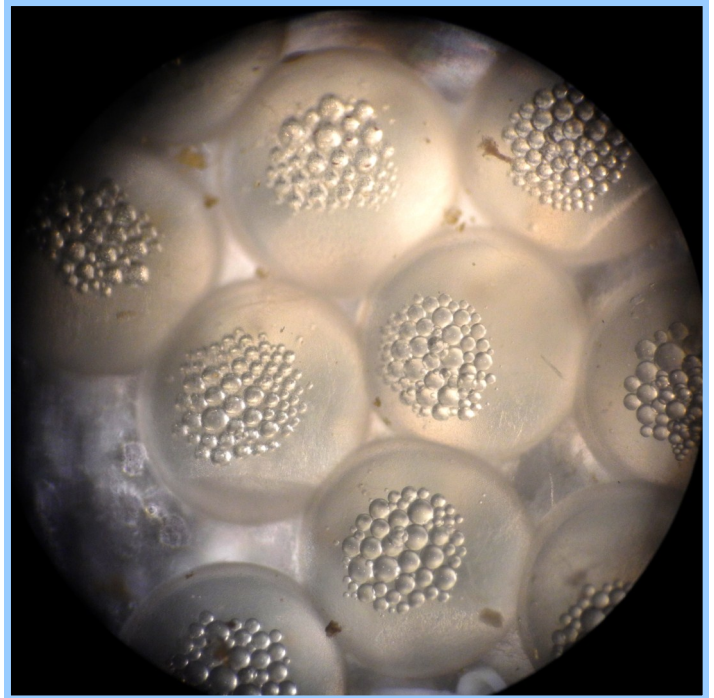
1. Broodstock

Broodstock refers to the adults that will be used to provide eggs and/or fry, depending on the species. Mummichog broodstock can either be grown from cultured stock or collected from the wild.

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Mummichogs spawn sequentially throughout spring and summer, typically after the water temperatures have reached 55 °F (13 °C). Fertilization is external and occurs between mating pairs on the salt marsh surface during spring tides, when high tides are characteristically higher in association with the full and new moons.

To create spawning conditions for broodstock, water temperatures in the system should be above 20 °C. Also, since these fish live primarily in brackish water, fertilization is best in salinities of 5-15 ppt. A good indication that fish are ready to spawn is the appearance of pairing behavior in conjunction with spawning coloration. Males will become noticeably dark with bands of silver spots and mustard yellow on the abdomen and fin tips. Females are larger than the males within their age class, remain a pale olive color, and may have swollen abdomens due to the presence of developing ova.



Freshly laid mummichog eggs under low magnification. Notice the oil globules in each. Mummichog embryology has been studied since the late 1800's due to the transparency of the egg shell.



Different egg collector designs deployed for spawning substrate selection trials. Capped PVC tubes act as floats and the harnesses they are attached to maintain collectors at a shallow depth below the surface.

2. Egg collecting

In the wild, mummichogs lay their eggs on mussel shells, algae mats, and within the leaf bases of salt marsh grasses. It is common practice in aquaculture to use spawning mats to mimic natural spawning substrates. When culturing mummichogs, spawning substrate should be submerged just below the surface of the water with enough room for spawning to take place on the surface of the egg collector.

Our current research focuses on identifying the best methods for egg collection. A simple, yet effective design is a shallow mesh covered tub immersed below the surface in a floating harness. It is important to consider the ease of use of a collector and the fact that the fish will eat their own eggs if the opportunity arises. Eggs should be collected at least twice per week, rinsed clean of debris, and then incubated.

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3. Egg incubation

Mummichogs are intertidal spawners. This means that while they may lay their eggs in the water, the tide recedes and their eggs are left exposed to air. Typically this lasts for up to two weeks until the next spring tide rewets them. In fact, mummichog eggs develop slower and suffer more deformations when incubated in water rather than air.

Aerial incubation can be performed in an aquaculture setting by spreading eggs between two sheets of hobby foam, misting them with brackish water, placing them within a tub, and holding them at a constant temperature. The eggs should be misted every one to two days to

maintain a moist—but not wet—environment. Also, the incubation temperature must remain constant (anywhere between 20 and 30 °C is a good temperature to maintain them at) to ensure even development.



Egg incubation tubs ready for a season of spawning. Each tub is fitted with two pieces of hobby foam. Latches keep lids secure without creating an airtight seal, thus facilitating air flow.



One-inch thick polyurethane hobby foam works very well as incubation media.



Peeling back the top layer of foam to reveal fully developed eggs ready to hatch.

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The eggs have a window of time in which they can hatch. At 20 °C the eggs will hatch between 9.5 days, when the embryo can first open its mouth, and 16 days, when the yolk is finally absorbed.

The cue for eggs to hatch occurs when they are removed from incubation and immersed in brackish water once again. All viable eggs will hatch within 30 minutes of immersion. Fry range from 5-7 mm in length upon hatching.



4. Growout

This is a very important stage for producing fish to sell or harvest. The amount of feed given, the frequency of food given, water quality, and stocking density all play vital roles in production levels. Mummichogs can grow successfully in water with a wide range of salinities, including freshwater. At the DSU Aquaculture Research and Demonstration Facility, we have grown mummichogs in both freshwater ponds and brackish water recirculation systems, and are now working on determining optimal stocking densities of these fish for growout.

Mummichogs in the classroom

Marine baitfish aquaculture is currently one of the newest, hottest topics in aquaculture research and development. Given the ubiquity of the mummichog, culture methods—once established—have the potential to be used by fish farmers and hatcheries along the Atlantic coastline. Raising mummichogs in your classroom or facility and collaborating with researchers and faculty from Delaware State University can provide an enriched educational experience. Students will not only have the opportunity to learn about aquaculture, but they will also gain hatchery experience, apply their animal husbandry knowledge, and participate in a growing network of research being conducted on this species.

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Photos by Cory Janiak.



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