Mummichog Aquaculture Methods: Indoor Egg Collection

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Mummichogs spawn in the wild from early spring into late summer. Under natural conditions this spawning behavior provides a constant supply of eggs for up to six months. Yet fecundity of mummichogs is not as high as many other baitfish species, so aquaculture methods for this speices must ensure maximum egg collection and fry survival. Bringing broodstock into a controlled environment for spawning, such as an indoor recirculating aquaculture system, will guarantee reliable spawning conditions. In order to maximize yield and workflow in the mummichog hatchery, we have developed species-specific egg collection techniques that are outlined below.

Bringing Nature Indoors

The current trend in baitfish aquaculture research and practice is to bring broodstock (mature, spawning fish) indoors rather than leave them in outdoor systems such as pools or ponds. This method provides closer control over temperature, salinity, photoperiod, and other parameters that one cannot control in outdoor systems.

Natural spawning conditions should be adhered to when considering which factors are best to spawn fish in an aquaculture setting. For mummichogs, *Fundulus heteroclitus*, this means average summer levels of water temperature, salinity, and photoperiod. In our facility we maintain our recirculating indoor systems for mummichog spawning at 80 °F (26 °C), 10 ppt, and a photoperiod of 15 hours of light to 9 hours of dark. Fertilization success in this species is greatly reduced in low salinity and fresh water so a salt concentration of 10 ppt, or a third of full strength ocean water, is the lowest recommended. Sterilized seawater may be diluted to the appropriate salinity or de-chlorinated tap water can be brought up to salinity with added aquarium-grade sea salts. To sterilize seawater it must be chlorinated and aerated for 48 hours. Excess chlorine can be removed using sodium thiosulfate.

Currently, nearly all mummichogs that are used for bait and broodstock are collected from the wild. If collecting broodstock from the wild, an aerated, salted tank is needed in addition to any permits required by your state.

Pair of mature mummichogs: male on left, female on right. Photo: Cory Janiak.

Females can be differentiated from males by their ovipositor on their anal fin, but more easily by their lack of dark coloring that is typical of males in spawning coloration. While larger females can carry more eggs, older fish (3 years old) may expire before the end of the spawning season. Males are mature at one inch, (25 mm) females are mature at 1.5 inches (38 mm). Small broodstock may not provide an adequate volume of eggs and can escape though small mesh. Two year old broodstock—about three inches (76 mm) in length—are typically a safe middle ground.

Collecting Eggs

In their natural environment, mummichogs lay their eggs during spring tides on a variety of substrates: at the leaf bases of salt marsh cordgrass, between gaping ribbed mussel shells, and on mat-like surfaces of algae and sand. When these exceptionally high tides recede, the eggs continue to develop out of water for as long as two weeks until the next high enough tide rewets them. When eggs are re-wet, fry begin to hatch out within a matter of minutes. From a production standpoint, this means that peaks in egg production can be seen following a semi-lunar cyle, associated with the full and new moons.

Mummichogs will spawn over egg collectors placed below the surface of the water. Spawning mats composed of latex coated coconut fiber are widely available and commonly used for other species, though we have reservations with using them at our facility. First, adults are known to burrow into loose matrix of the mats and consume the eggs, thus inhibiting maximum production. Debris is shed from the mat during regular usage can cause maintenance issues within recirculating systems.

Another concern is removal of eggs from these mats. Mummichog eggs develop better in air than in water, and eggs need be removed from collectors regularly to ensure healthy development and limit age variance within cohorts. For spawning mats, this requires aggressive tapping over a bin and shaking in water to remove as many eggs as possible. Not only is this time consuming and inefficient, it releases more mat debris which should be separated from eggs prior to incubation. It should be noted, however, that researchers grow-

ing Gulf killifish (*Fundulus grandis*) in Louisiana have also expressed concern with excessive labor and debris related to egg removal from the mat. They increased their efficiency by eliminating the labor required to separate eggs from mats and incubate eggs successfully without removing them from the mat at all.

Egg Collector Design

Researchers at the DSU Aquaculture Research and Demonstration Facility have been working to determine egg collection methods that ensure maximum egg harvest with minimal labor required. Since spawning mats proved to be problematic, developing a more efficient egg collector was a top priority. To determine a better egg collector we evaluated design, ease of egg removal, time taken (labor hours) required to remove and clean eggs, number of fertilized eggs collected, and ultimately the number of viable fry hatched from collected eggs. Alternative egg collector designs took into account two key features: reduction of burrowing into collector and elimination of debris. After rigorous design testing we determined that a disk-style collector (the Janiak collector, illustrated above) was the most effective at meeting all of these criteria. This collector design is comprised of a series of hard plastic disks (e.g., HDPE or PVC) spaced evenly along a spindle with smaller plastic discs. The spaces should be just over 2 mm apart, which is the average size of eggs.

Eggs that are deposited in the spaces adhere to the side of the disk and do not fall through. Crevices created by the separator disc facilitate a high fertilization rate—over 95% compared to other, more open designs. These spaces are flushed constantly, though not rapidly, which removes metabolic waste and provides eggs with oxygen-rich water.

Removal of eggs from this style of collector is quick and easy: simply loosen the disks by untightening the wingnuts on the ends and rinse the eggs free with water. This can be done by swishing the loosened collector in a bucket of water. Eggs can then be rinsed over a screen to remove any fine debris and then placed in foam-lined tubs for incubation.

What else can you do to improve production?

Now that DSU researchers have determined a superior egg collector for use with mummichogs, other parameters of egg collection are being examined to maximize yield and efficiency. We examined two factors: depth of collector in tank and weekly collection frequency.

As mentioned before, mummichog eggs develop better out of water. Eggs that are maintained in an oxygen-rich humid environment, such as a foam incubation tub hatch out better developed and larger than those incubated in water. If eggs are removed immediately after being laid they will spend less time in water and more time in air before they are ready to hatch. However, more collections during the week means more hours of labor. We compared the amount of labor required for collecting eggs two or three times per week against weekly yield and determined that fry yield is not increased with more frequent collections. Collecting eggs biweekly is the optimal freqency to collect eggs. Cohorts are within a close age range (3-4 day difference maximum), which means that they will all hatch when initiated at two weeks and size variation should be minimized. Also, handling time necessary for collection is reduced, effectivley minimizing labor costs.

Why look at depth? In the salt marsh, mummichogs lay their eggs in the shallows during high tides. After testing collectors placed at different depths, we determined that on a biweekly collection mummichogs lay their eggs equally at all depths, but on a triweekly collection they produce more eggs in shallow collectors. Since we determined that a biweekly collection regime was more efficient for labor, collectors can be placed at any depth.

Summary

Mummichog eggs should be collected twice per week using disk collectors. Following these procedures will ensure maximum egg production, healthy egg development, minimal cohort age variation, and effective time managment.

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