Spawning & Rearing Bivalve Mollusks:

Part 2: Larviculture

Grade Level:
5-12

Subject Area:
Biology, Aquaculture

Time:
Preparation: 10 minutes
Activity: 10 minutes
Clean-up: 10 minutes

Student Performance Standards (Sunshine State Standards):

06.03 Illustrate correct terminologies for animal species and conditions (e.g. sex, age, etc.) within those species (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.14. 19, 31, 33).

11.01 List and explain the meaning of morphology, anatomy, and physiology (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.7).

11.02 List and describe the physiology of aquatic animals (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 28, 29, 31, 32, 33, 34, 36, 40, 41, 42, 43, 45, 46, 47,48, 51SC.912.L. 18. 7, 8, 9).

11.10 List and describe the major factors in the growth of aquatic fauna and flora (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.1, 2, 3).

12.01 Recognize and observe safety practices necessary in carrying out aquaculture activities (LA.910.1.6.1, 2, 3, 4, 5; LA.910.4.2.2, 5).

13.02 Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.17.2, 3, 7, 10).

13.03 Explain, monitor, and maintain freshwater/saltwater quality standards for the production of desirable species (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.01 Identify factors to consider in determining whether to grow an aquaculture species (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.3).

14.02 Identify/describe facilities used in a grow-out operation (LA.910.1.6.1, 2, 3, 4, 5;

LA.910.2.2.2).

14.04 Determine the purpose and functions of a hatchery (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.05 Identify and describe the sexual reproductive process and methods of reproducing aquaculture organisms (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.16.3).

14.06 Identify and describe the spawning facilities used in aquaculture LA.910.1.6.1, 2, 3, 4, 5; (LA.910.2.2.2).

15.01 Identify the types of growing systems and important factors in their selection, design, and use (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

Objectives:

1. Students will be able to describe reproductive biology and spawning of bivalve mollusks.
2. Students will be able to explain how bivalve mollusk larvae develop.
3. Students will be able to describe the conditions used in hatcheries for commercial production of bivalve mollusks.
4. Students will be able to apply techniques used for small-scale, experimental mollusk larviculture.

Abstract:

In this lesson, students will acquire skills in using an ocular micrometer to measure the length of bivalve larvae, monitor the density of larvae in their culture system, and understand production protocols used in bivalve hatcheries. This activity will take a period from each class over approximately a two-week period – the time for larvae to develop from egg to metamorphosis (setting). One or two students would exchange the water (10 minutes) while other students would sample for larval density and place samples under the microscope (with ocular micrometer) to measure growth. This could be done in groups, rotating on a daily basis, and all of which could be done tangential to other classroom activities.

Interest Approach:

Now that students have successfully spawned bivalves, they should adapt a nurturing approach to seeing the larvae survive, grow, and develop into juvenile shellfish. This project will take only a few minutes of each day for students to exchange the water on the bivalves, establish clam density (e.g. survival) and monitor growth rate.

Student Materials:

1. *Introduction to the Biology of Mollusks* handout

Teacher Materials:

Material	*Store*	*Estimated Cost*
Introduction to the Biology of Mollusks handout copies	NA	NA
SPAWNING MATERIALS (per group)		
Assorted containers (buckets, dishes, etc.)	WalMart, Home Depot	$3 and up
Means to heat water (microwave, aquarium heater)	NA	NA
Means to cool water (refrigerator, freeze-pacs, frozen water in soda bottles)	NA	NA
Ripe bivalve mollusks	NA	NA
Paper towels	Local grocery store	$3 and up
Hand sanitizer	Local grocery store	$3 and up
Dissecting microscope	Carolina Biological	$100 and up
1 ml pipettes	Aquatic Ecosystems	$10 and up
Algae starter culture	Aquatic Ecosystems	$50 and up
Aerator	NA	NA
Sieves (made from 35 μm mesh screens)	Aquatic Ecosystems	$40 and up

Student Instructions:

(Continued from previous lesson plan)

1. If spawning does occur, collect the eggs on a 35 μm sieve, rinse thoroughly, and place in a bucket with 10 liters of seawater.
2. Observe the developing eggs and trochophore stage under a compound microscope, and using an ocular micrometer determine the diameter of the eggs and trochophore larvae.
3. The next day (24 hours later), use a 1 ml pipette and a dissecting microscope, to estimate the number of larvae in the 10 liters. (example: 50 larvae/ml sample x 1000 ml/L x 10 L = 500,000 larvae. Adjust the larval density to 5 veligers/ml and discard the remaining larvae.
4. Each day, exchange the water in the bucket by collecting the larvae on the 35 μm sieve, gently rinsing, and replaced in another clean bucket filled with seawater (to 10 L). Again, take a 1 ml sample and calculate larval density using a dissecting microscope and measure size (shell length and width)

using a compound microscope with an ocular micrometer.

5. Continue this routine daily until the clams reach pediveliger stage (8 to 10 days, depending on temperature. At this point, the larvae will settle to the bottom, reabsorb their velar lobes, and become bottom (benthic) dwellers. This process is called metamorphosis or setting.

Teacher Instructions:

Preparations:

1. The teacher should have the necessary equipment (e.g. microscope, pipette, sieve, glassware, and replacement water) ready for the students.

Activity:

1. The teacher should coordinate with students to facilitate the exchange of water in the culture vessel, taking a sample to determine larval density (i.e. survival), and have a working microscope with ocular micrometer to measure growth. This can be a single station at the back of the classroom with individual students quietly going to the station and making their measurements while the teacher is conducting class.

Post work/Clean-up:

1. Students should clean all glassware used in water exchanges and sampling.

Anticipated Results:

1. Students will observe growth of larval bivalves.

Support Materials:

1. *Introduction to the Biology of Mollusks* handout
2. *Molluscan Culture Overview* presentation
3. Video: *Hard Clam Spawning Procedures* (available at www.aquaculture-online.org)
4. Video: *Oyster Settlement* (available at www.aquaculture-online.org)
5. Clam Printables: http://homeschooling.about.com/od/freeprintables/ss/clamprint.htm
6. Whetstone, J.M., L. N. Sturmer, and M. J. Oesterling. 2005. Biology and culture of the hard clam (*Mercenaria mercenaria).* SRAC Publication No. 433. (http://srac.tamu.edu)

Explanation of Concepts:

Feeding and swimming mechanisms for bivalve mollusks (veligers)
Growth of bivalve mollusk veligers
Microscope skills and volume/density calculations

 **Support Materials** 

Introduction to the Biology of Mollusks

Mollusks are animals belonging to the phylum **Mollusca**. There are around 93,000 recognized extant species, making it the largest marine phylum with about 23% of all named marine organisms. Representatives of the phylum live in a huge range of habitats including marine, freshwater, and terrestrial environments. Molluscs are a highly diverse group, in size, in anatomical structure, in behaviour and in habitat. The phylum is typically divided into nine or ten taxonomic classes, of which two are entirely extinct. Cephalopod molluscs such as squid, cuttlefish and octopus are among the most neurologically advanced of all invertebrates. Either the giant squid or the colossal squid is the largest known invertebrate species. The gastropods (snails and slugs) are by far the most numerous molluscs in terms of classified species, and account for 80% of the total number of classified molluskan species.

Mollusks have such a varied range of body structures that it is difficult to find defining characteristics that apply to all modern groups. The two most universal features are a mantle with a significant cavity used for breathing and excretion, and the structure of the nervous system. As a result of this wide diversity, many textbooks base their descriptions on a hypothetical "generalized mollusc". This has a single, "limpet-like" shell on top, which is made of proteins and chitin reinforced with calcium carbonate, and is secreted by a mantle that covers the whole upper surface. The underside of the animal consists of a single muscular "foot". Although mollusks are coelomates, the coelom is very small, and the main body cavity is a hemocoel through which blood circulates – mollusks' circulatory systems are mainly open. The "generalized" mollusc feeding system consists of a rasping "tongue" called a radula and a complex digestive system in which exuded mucus and microscopic, muscle-powered "hairs" called cilia play various important roles. The "generalized mollusc" has two paired nerve cords, or three in bivalves. The brain, in species that have one, encircles the esophagus. Most mollusks have eyes, and all have sensors that detect chemicals, vibrations and touch. The simplest type of molluskan reproductive system relies on external fertilization, but there are more complex variations. All produce eggs, from which may emerge trochophore larvae, more complex veliger larvae, or miniature adults. A striking feature of mollusks is the use of the same organ for multiple functions. For example: the heart and nephridia ("kidneys") are important parts of the reproductive system as well as the circulatory and excretory systems; in bivalves, the gills both "breathe" and produce a water current in the mantle cavity which is important for excretion and reproduction.

The mantle secretes a shell that is mainly chitin and conchiolin (a protein) hardened with calcium carbonate, except that the outermost layer is all conchiolin. The mantle cavity is a fold in the mantle that encloses a significant amount of space, and was probably at the rear in the earliest molluscs but its position now varies from group to group. The underside of the body generally consists of a muscular foot, which has been adapted for different purposes in different classes. In gastropods, it secretes mucus as a lubricant to aid movement. In forms that have only a top shell, such as limpets, the foot acts a sucker attaching to the animal to a hard surface, and the vertical muscles clamp the shell down over it; in other molluscs, the vertical muscles pull the foot and other exposed soft parts into the shell. In bivalves, the foot is adapted for burrowing into the sediment; in cephalopods it is used for jet propulsion, and the tentacles and arms are derived from the foot.

Most mollusks have only one pair of gills, or even only one gill. Generally the gills are rather like feathers in shape, although some species have gills with filaments on only one side. They divide the mantle cavity so that water enters near the bottom and exits near the top. Their filaments have three kinds of cilia, one of which drives the water current through the mantle cavity, while the other two help to keep the gills clean. Each gill has an incoming blood vessel connected to the hemocoel and an outgoing one connected to the heart.

Most mollusks have muscular mouths with radulae, "tongues" bearing many rows of chitinous teeth, which are replaced from the rear as they wear out. This is primarily designed to scrape bacteria and algae off rocks. The particles are sorted by a group of cilia, which send the smaller particles, mainly minerals, to the prostyle so that eventually they are excreted, while the larger ones, mainly food, are sent to the stomach's cecum (a pouch with no other exit) to be digested. The anus is in the part of the mantle cavity that is swept by the outgoing "lane" of the current created by the gills. Carnivorous mollusks usually have simpler digestive systems.

A typical mollusk has: a pair of tentacles on the head, containing chemical and mechanical sensors; a pair of eyes on the head, a pair of statocysts in the foot which act as balance sensors; and a pair of osphra reproductive systems, two gonads sit next to the coelom that surrounds the heart and shed ova or sperm into the coleom, from which the nephridia extract them and emit them into the mantle cavity.