Hard Clam Spawning Video

Most bivalve species (e.g., clams, oysters, mussels) spawn in the spring and early summer as seawater temperature rises and phytoplankton (i.e., food) density increases. In aquaculture, we simulate spring-time temperature (65-72^{o}F/18-22^{o}C) in tanks with broodstock (i.e., parental) clams to condition them for spawning (i.e., promote gonadal maturation). Clams may be in conditioning systems for 1-4 months depending on initial maturity. During this time they are fed phytoplankton (also called microalgae) daily and checked periodically for gonad maturation.

(1) When they are ready for spawning they are removed from the conditioning tanks to be cleaned, dead removed, and sorted by size or color. Cleaned and sorted clams are placed into a spawning tank and arranged in rows with their siphon ends pointing toward each other. They are rinsed one more time before filling the spawning tank with ambient temperature seawater.

(2) Spawning is initiated by using a method known as thermal shock. Water temperature is increased from ambient to 82-90^{o}F (28-32^{o}C) by the addition of heated seawater (100-115^{o}F/38-46^{o}C) to the spawning tank.

(3) Water is circulated from one of the tank the other using an airlift .

(4) Clam broodstock are allowed to acclimate to the ambient water temperature and water flow for 30-60 minutes before adding heated seawater. When a majority of clams have their siphons extended, smaller containers will be arranged around the tank for clams that are found spawning.

(5) Heated seawater is added slowly to the drain side of the tank so it will mix with water being airlifted back to the head of the tank. Temperature is checked periodically so as not to exceed 90^{o}F (32^{o}C).

(6) Clams are examined visually for extended siphons and pumping of water.

(7) Constant watching of the clams is necessary to find spawning males, which looks like a thin line of toothpaste ejecting from the exhalent siphon (closer to the umbo). As animals are found spawning they are removed from the tank and placed into smaller containers so that we may select for color and control fertilization.

(8) Eggs from a spawning female look like little sand grains ejecting from the exhalent siphon. Sometimes the eggs will come out in clusters or chunks and then break into individual eggs. Females will also be removed from the tank and placed into individual containers so that we may select for shell color and control fertilization.

(9) Females and males may shed feces before or after spawning, therefore the eggs and sperm are passed through a sieve with 300-500 µm openings to catch the feces and allow the eggs to pass through and be collected in a larger bucket.

(10 & 11) After sperm addition, the eggs and sperm are mixed and a sample of the egg suspension is taken to examine and count the number of eggs. Fertilized clam eggs may start dividing as early as 40 minutes after sperm addition.

(12) Once fertilization of eggs is verified, the embryos are placed into culture tanks at a density of about 10-20/mL and a small amount of phytoplankton is added. Twelve to sixteen hours later the embryos have developed into veliger larvae, which are 100-120 µm and feed on phytoplankton.

(13) By 24 hours the first water exchange is performed. Larvae are caught on sieves and the water changed daily to ensure the best environment for growth. Larvae look like tiny grains of sand on the sieve and are counted by sampling from a known volume of water.

(14) Larvae are placed back into their culture tank and phytoplankton is added daily. By day 7-10 the clam larvae will be about 200-250 µm long and ready to settle to the bottom, where they will spend the remainder of their life.

Oyster Settlement Video

Oysters reproduce like clams in that they shed their gametes into the water column where fertilization and development takes place.

(1) The earliest shelled stage is known as the veliger stage. Oyster larvae take 12-22 days of development, growing from about 50 µm to about 300 µm, before metamorphosing into juvenile oysters. Unlike clams, oysters exhibit an "eye-spot" in the center of the animal before they are ready to metamorphose or "set". The eye-spot detects light as oyster larvae like to settle on the underside, or shady side, of objects like shells and deeper in the water column. The veliger larvae move by their velums, which are ciliated lobes that also help capture food particles (i.e., microalgae). The veliger shell is translucent and you can see the internal organs (e.g., dark area is stomach, gills).

(2) Just before metamorphosis, the veliger larvae develop a foot. This stage is called the pedi-veliger. The larva crawls around testing the surface for an area to glue itself. In the video the particles are pieces of pulverized oyster shell and some settled oysters. If the area is not good it will swim upwards to move with the current and drop down to find a new area to search. Once it finds a good surface it will cement itself to the surface, usually another piece of shell.

(3) In the video, an oyster larva has attached and just started to cement itself, but another larva comes along and bumps it off. Behind the larva you will notice a set oyster spat opening and closing its shell. Once a larva cements itself permanently, it will lose its velum.

(4) The shell edge will grow onto the surface, further adhering the oyster to the substrate. The eye-spot may still be visible.

(5) The new shell edge is calcite, whereas the veliger shell is aragonite; both are calcium carbonate but have different crystal structure.

(6) Larvae and settled oysters are susceptible to diseases and parasites. In this video, the oyster larva is infested with ciliates that are devouring the fleshy inside.

(7) Oyster larvae that have metamorphosed and cemented themselves permanently are called spat. At this stage the shell is still translucent and the gills are still visible.