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Artificial Incubation of Fish Eggs[1]

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Many fish species require that their embryos (eggs) incubate and hatch in open water. Eggs are broadcast in the water column and either float or sink; adhesive eggs may attach to plants or hard substrates (rock or gravel). Eggs from other fish are laid in a nest, and parent(s) provide a constant water flow by fanning their fins. Some fish also incubate eggs in their mouths where movement of the gill plates provides both gentle tumbling and water circulation. Artificial incubation and hatching of fish embryos simulate these natural processes. In the wild, eggs (or egg masses) are susceptible to predation, and are easily damaged by the continual change of the natural environment. The advantage of man-made hatcheries is that the environment can be controlled and manipulated.

Developing embryos and newly-hatched larvae (fry) are the most sensitive and delicate of the stages in the life history of a fish. Therefore, great care must be taken to provide them with the proper incubating and hatching environment. Water temperature, light, water quality, water flow, shock prevention, and type and size of the egg are very important considerations.

Artificial incubation of fish eggs is a hatchery practice that will increase the economic efficiency of a commercial fish culture operation. Hatching rates and survival will be increased using artificial incubation. Also, removal of the eggs from the parents may increase egg production by shortening the time for another spawning to occur.

Proper Incubation of Fish Eggs

Spawning of broodstock, embryo development, survival, and growth of fish larvae occur within a narrow range of water temperatures. Incubation temperature has a direct effect on the timing of embryonic development and thus determines hatch rate. Fish development and hatching is delayed at low temperatures, and accelerated at high temperatures. Incubating temperatures are also known to modify the behavior of larvae and determine certain morphological characteristics. There is an optimum temperature required for each developmental life stage, and these vary among species. Water temperatures should be maintained with minimal fluctuations, preferably no more than ± 1°C (2°F) from optimal. If a species' optimum water temperature for incubation is unknown, use the optimum temperature of a related species or of a fish that inhabits a similar geographic area. In general, optimum temperatures for spawning, incubating, and rearing newly-hatched tropical ornamental freshwater species are 24-28°C (75-82°F). Avoid temperatures above or below this range. Poor embryo survival, low hatch success, reduced growth rates, larval deformities, and increase in fry/larvae diseases often result from temperature fluctuations or temperatures outside the optimum range for the species.

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The amount and incidence of light received during incubation can affect both fish development and larval survival. Incubation of fish embryos should occur in either dim light or darkness. Light can also be used to synchronize hatching. Many species of fish will not hatch in daylight, therefore, if the lights are switched off, hatching will occur a few hours later.

Because of their size and permeability, fish embryos and larvae are susceptible to many types of organic or inorganic materials dissolved or suspended in the water. These may include gases, minerals, metals, and particulate matter from rocks, soil, plants and animals. It is essential to know the water quality standards for embryos and larvae of the particular fish species. General water quality standards used in fish culture can be used as a reference point for hatchery water. These standards are available in aquaculture textbooks or from the Florida Cooperative Extension Service.

During incubation, a constant water flow is essential for preventing accumulation of waste products and allowing gas exchange between the egg and the surrounding water. Constant motion also appears to be necessary for successful hatching for some species of fish. Proper water flow also reduces mechanical abrasion. Eggs of many fish are sensitive to mechanical shock and should not be moved during certain times during development. For example, eggs of salmon and trout can only be moved during the first 36 hours after fertilization. Thereafter, the eggs are kept still until the embryo eye becomes visible. The amount of water flow necessary for proper incubation of fish embryos depends largely on egg density (how heavy and large eggs are in water). Some fish eggs are quite dense and sink to the bottom when released. Other eggs become buoyant as they "water-harden" and free-float in the water column or at the surface. Some eggs have hair-like structures or specialized coatings that make them sticky. Some eggs have an oil drop in them and they float on the surface.

Egg diameter is also an important consideration during incubation. Screen mesh size should prevent the passage of eggs while allowing sufficient water circulation and detering debris collection. Most ornamental fish eggs are around 0.8 mm in diameter, however, the size range is wide. Eggs can be as large as 1.5-2.0 mm for some ornamental catfish, and as small as 0.4 mm for gobies.

Types of Fish Egg Incubators

A wide variety of devices are used for incubating fish eggs. For practical purposes, we have classified fish egg incubators into three major types: egg mats, trays, and conical incubators. Their use is based primarily on the density of the eggs to be hatched, their stickiness, and the sensitivity of the eggs to mechanical shock. Figure 1, Figure 2, and Figure 3 illustrate the three general types of fish egg incubators.

Egg mats are used primarily for adhesive eggs. By simulating a spawning substrate (plants, rocks, etc.), they serve as egg collectors and provide a place for egg attachment. Since egg mats also serve as a stimulus for spawning, they are also known as spawning mats. Mats consist of bundles of fibrous material arranged in a variety of forms and made from a variety of different materials (plastic shreds, air filters, spanish moss, coconut fibers, horse hairs, etc.) (Figure l, a and b). Typically, egg mats are suspended in the water column or laid along the bottom or sides of the spawning container. The mats can be removed from the spawning container and suspended in the air where they can be kept moist at all times with a fme spray of water. The oxygen content of air is about 20 times more than water, thus increasing gas exchange between the egg and the thin film of water that surrounds them. For spawning and incubating eggs of many ornamental fish, such as angelfish, discus, and corydoras catfish, mats are often replaced with bottle brushes, pots, or slates that are made of plastic, glass, clay or rock (Figure 1c).

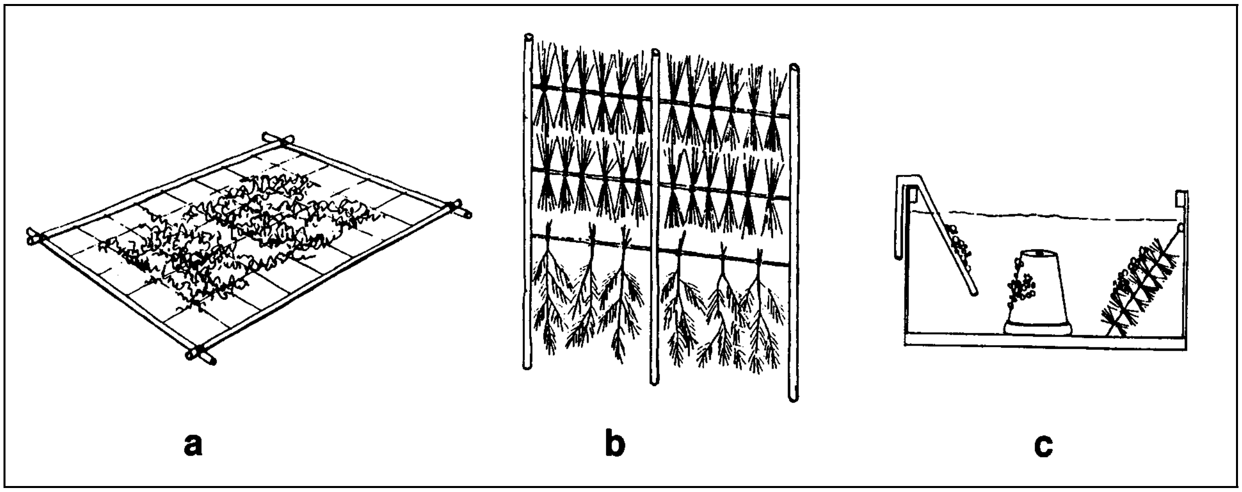

Figure 1. Egg mats: frameworks with a) spanish moss and b) bundled fibers; c) slate, claypot and bottle brush.

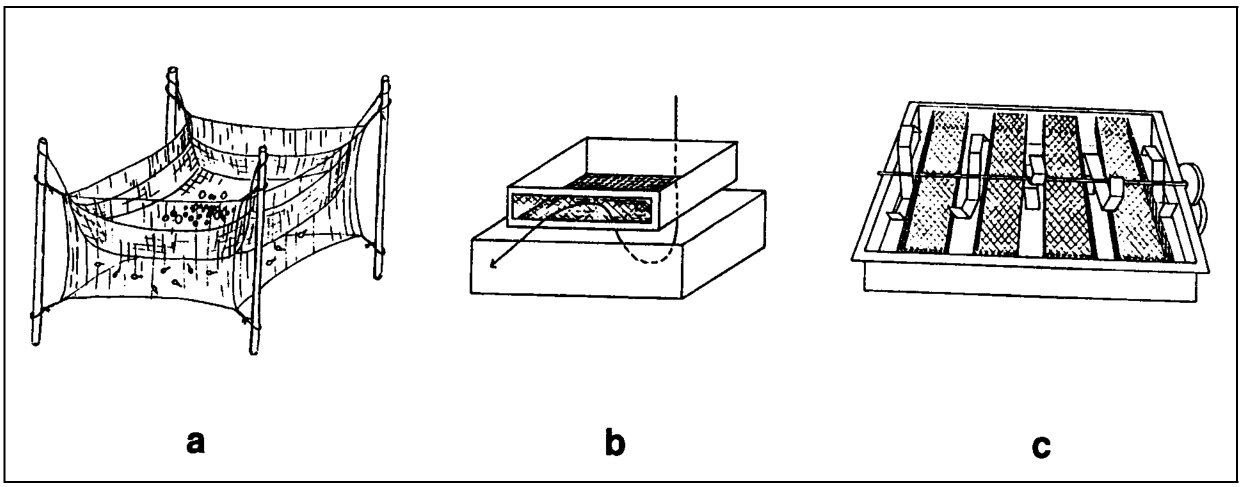

Figure 2. Incubators: a) traditional “happa” framework with fine mesh, b) basket-type, and c) multiple baskets with paddlewheels.

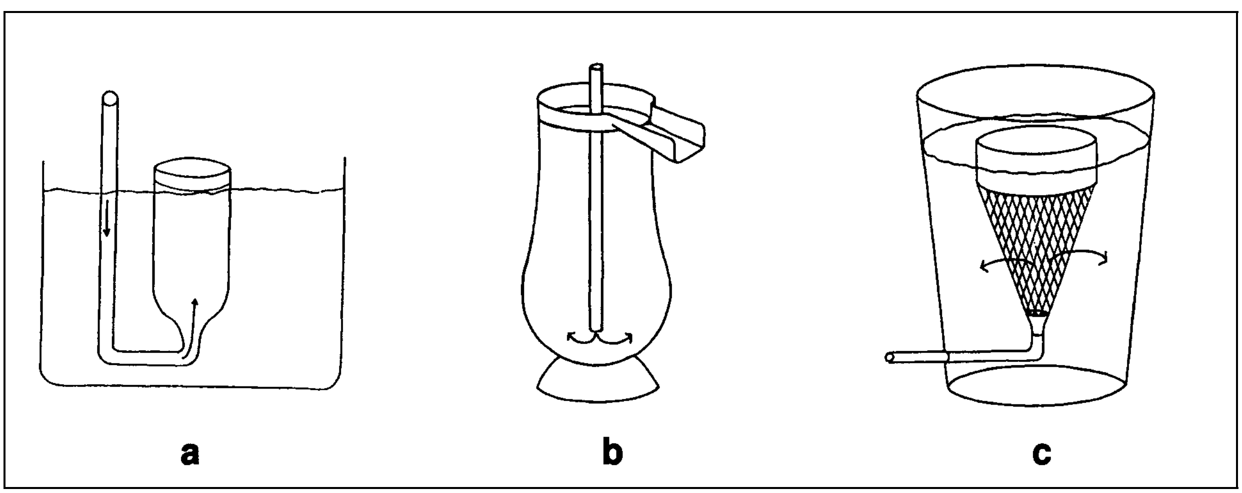

Figure 3. Incubators for non-adhesive eggs: All three devices provide gentle water circulation.

A tray-type incubator consists of a container that is screened or perforated, through which a flow of water permeates to supply the eggs with oxygen and flush away waste products (Figure 2). They are often designed so that water penetrates the tray from below and flows out over the upper edge. Since the eggs lay over a screen, tray-type incubators are ideal for fish eggs that can be injured by movement during incubation. Tray incubators can be stacked and provide easy access for removal of dead embryos. The newly-hatched larvae can drop through the screen holes minimizing handling and removal of the egg shells.

Tray-type incubators were originally designed to hatch trout and salmon eggs. The eggs of salmonid fish are large, non-adhesive and laid in a gravel bed during natural spawning. The eggs must remain still and in the dark since abrupt movements and direct sunlight affect embryonic development.

Tray-type incubators also are formed into baskets and commonly used to incubate and hatch channel catfish eggs. The baskets are placed in a water trough, and paddlewheels, which are attached to the trough, provide aeration and gentle circulation of the water. Baskets can also be placed outside the spawning tank and then used as incubators. The "hapa" or net enclosures traditionally used for spawning, egg incubation, and larval rearing of common carp function sirnilarly to basket or tray incubators.

Fish eggs that are non-adhesive and require constant movement are commonly incubated in conical shaped tanks or jars where water flows into the bottom or top of the container (Figure 3). In this type of incubator the eggs are gently suspended and constantly tumble in the lower portion of the jar. The flowing water not only insures that good quality, well oxygenated water is constantly being replaced in the jar, but the tumbling of the eggs keeps them from collecting debris which can lead to fungal infections. These types of incubators can be set in series above a rearing tank. The larvae pour out of the incubators into the rearing tank as they hatch. A soft meshed material can be shaped into a cone and used as an incubator. It is advantageous to use screen because greater surface area is provided for water to flow out, preventing the eggs, yolk-sac larvae or the larvae from becoming crushed. Incubators made of net material require structural support and must be suspended inside a larger tank or placed into the rearing tank.

Setting the Flow Rate in Upflow Water Incubators

When first introduced to water, free-floating fish eggs will almost always swell in size as they absorb water, and usually become more buoyant. It is therefore critical to make adjustments to the water flow as needed during the first hour or so.

Once the flow has been set to keep the eggs in suspension, it is important to maintain that level until the eggs hatch. Depending on the species, this could be hours or days. Supplying constant pressure and volume of water is crucial. Do not use a pump or delivery system incapable of supplying constant pressure and volume of water to the jars.

A good way to insure that the volume and flow remain constant is by using a header system. A large diameter PVC pipe (minimum of twice the diameter of the pipe coming from the pump) is elevated above the incubators. An open-ended elbow is placed on the opposite end of the pipe to allow surplus water to exit (either as effluent in a flow-through or back to the sump in a water recirculating system). The supply lines for the jars are tapped into the large diameter "header" pipe, at equal elevations, thus supplying all jars with an equal beginning pressure. Each supply line has its own valve to control the flow to the individual jars, since the amount of eggs in each jar will not be the same. Even with a good header or other flow control system, the buoyancy of eggs will change over time. Periodically check to make sure that the eggs are tumbling properly.

Hatching jars should be placed so the overflow goes into the tanks where the fry will be reared. This eliminates the need for handling the fry. Some fry will swim with the current after hatch, while others will swim against the current. For the latter group, gently pour them out of the incubators, instead of increasing the water flow.

If working with an extremely large quantity of eggs, you may want to design a hatching tank. The tank should have a conical bottom and be made from a smooth surfaced material (rough concrete will damage many eggs). Again, stick with the principals; provide water temperature control and good water quality, dim lights, avoid mechanical shock and if necessary, gently tumble the eggs in the water column; do this and you will not go wrong.

Incubation and Hatching Systems are Simple to Make

Numerous types of fish egg incubators can be purchased commercially ready-to-use. They are commonly designed to hold thousands or even millions of eggs. They are also relatively expensive. Each unit may cost from $85–250. Because most ornamental fish do not lay large numbers of eggs (e.g., compared to striped bass or grass carp), and to save space and money, ornamental fish farmers can make their own incubators. The references below provide general descriptions and operating procedures of two water incubators that can be easily built using commonly available materials. The first design has been used successfully in hatching many different types of fish eggs, including the red-tail black, and rainbow sharks (*Labeo* spp.). The second design provides an option to incubate eggs of cichlid fish. Both incubators are extremely simple and inexpensive to make.

Summary

Incubation and hatching containers are extremely cost effective given the increase in hatching and survival rates which can be achieved. Artificial incubation of eggs is also necessary when spawning certain types of fish. The design of an incubator and water flow adjustments will depend on the species, egg density, adhesiveness, and susceptibility to mechanical shock. A biological knowledge of the species requirements is essential, however, the technical principles are simple: supply good quality water at a constant temperature, incubate in low light, and prevent mechanical damage to the eggs by providing gentle water flow over the eggs. Depending on your needs, you can utilize a system of several small incubators attached to a common supply line or a few large rearing tanks. Commercially manufactured incubators are available, but making your own can often save you water, space, and money.

References

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