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Managing Hatch Rate and Diseases in Catfish Eggs

Brian C. Small[1]

Managing egg diseases and improving hatch rates in channel catfish hatcheries requires good husbandry and continuous attention to detail. The optimal health of developing embryos is best ensured with healthy broodfish, a good environment, limited handling, and isolation from pathogens. Prevention should be considered the first line of defense when managing egg disease and survival.

Simple management strategies, such as disinfecting the hatchery before the hatchery season, having separate nets and equipment for each hatching trough, disinfecting hands, disinfecting egg masses before bringing them into the hatchery, and using a pathogen-free water supply, help prevent the introduction of infectious pathogens into the hatchery. The goals of a good hatchery management program should be to prevent disease and provide the optimal environment for embryo development and survival.

Specific information on hatchery management and water quality can be found in the SRAC publications listed at the end of this publication. The focus here is on improving hatch rates and managing common egg diseases.

Understanding catfish embryo development

The most productive method of producing catfish fingerlings is to transfer eggs to a hatchery after spawning (Fig. 1). The management techniques discussed in this publication focus on production systems with dedicated hatcheries for incubating eggs. In these systems, spawning containers (Fig. 2) are often checked every day to every 3 days, so that eggs are collected at various stages of development. The age or developmental stage of the embryo can be a significant factor in managing for disease. Stress can be more harmful at early developmental stages and can result in poor survival. Understanding the progression of development is important for improving hatch rates, and estimating the age of catfish eggs helps when planning chemical treatments.

The time it takes for catfish eggs to hatch depends on water temperature. Channel catfish typically spawn in the spring, when water temperatures are between 70 and 84 °F (21 and 29 °C). At these

Figure 1. Commercial channel catfish hatchery.

[1] USDA-ARS Catfish Genetics Research Unit, Thad Cochran National Warmwater Aquaculture Center, Stoneville, Mississippi

Figure 2. Recently spawned channel catfish egg mass in spawning container.

temperatures, the time from spawn to hatch is 5 to 10 days (Fig. 3). The exact time of spawning usually is not known, so the age of eggs must be estimated visually. Figure 4 illustrates how to estimate egg age at 78 °F (26 °C) based on visual observations of embryo development. You will need to adjust for temperature using the relationship in Figure 3 as a reference.

Preventing egg death

The factors that can cause dead eggs (eggs that have stopped developing) include excessive handling, overcrowding, high temperature, water hardness, and transport delays. Important hatchery water quality parameters are reviewed in SRAC Publication No. 461, and degassing is reviewed in SRAC Publication No. 191.

Excessive handling

Embryos in the early development stages are sensitive to handling and should be handled as little as possible to prevent mechanical injury.

Overcrowding

Many factors affect the maximum loading rate a hatchery can sustain. Generally, 1 to 2 pounds (0.45 to 0.9 kg) of egg mass can be incubated in a single hatching basket 8 inches wide x 16 inches long x 4 inches deep (20 cm x 41 cm x 10 cm). Egg masses should not overlap substantially. Over-crowding causes poor water circulation and makes it easier for diseases to transfer between egg masses.

Temperature

Temperature is an important environmental factor that affects egg development, hatch rates and disease susceptibility. Newly spawned eggs are more sensitive to temperature changes than eggs more than 24 hours old, in which the embryonic outline (the beginnings of a catfish fry) can be observed (Fig. 4b). If eggs less than 24 hours old are moved from a pond to hatchery water of a substantially different temperature, they must be acclimated to prevent a high mortality rate.

If the water temperature of the pond, transport container, and hatchery differ more than 5 to 7 °F (2 to 3 °C), eggs should be water-tempered for 15 to 20 minutes for each 5 °F (2 °C) of difference. Eggs can be tempered by using a hose to slowly run hatchery water into the transport container until the water temperature in the container matches that in the hatchery. The optimal temperature range for incubating catfish eggs is 78 to 82 °F (26 to 28 °C). At temperatures above and below this range, hatch rates will be reduced by egg death and disease (Fig. 5).

Transport delays

On larger farms, difficult logistics may cause eggs to sit in spawning cans at the pond side or in transport containers on vehicles for prolonged periods of time. Eggs should not be left on the pond bank for more than 15 to 30 minutes because long transport times and poor water conditions during transport (e.g., temperature and dissolved oxygen) result in egg death. In fact, it has been reported

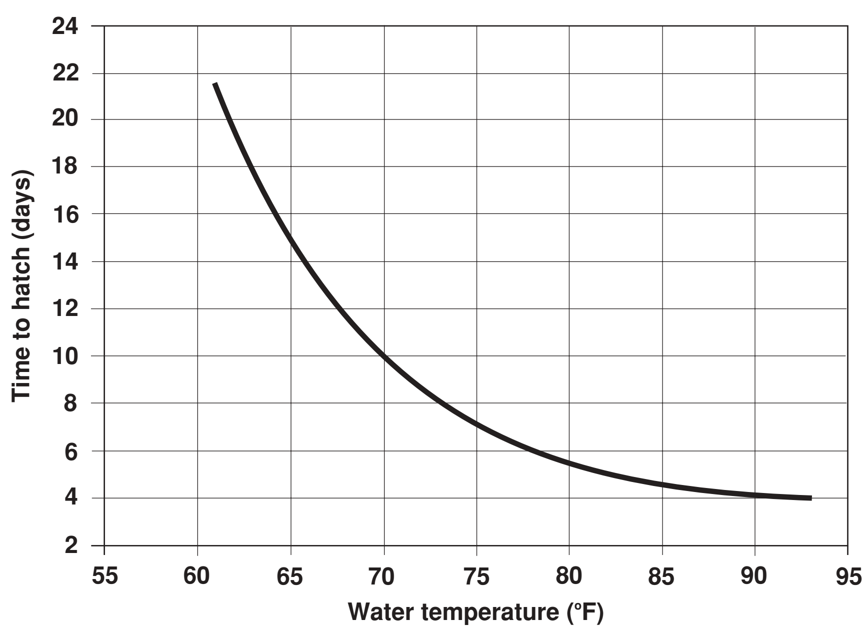

Figure 3. Effect of water temperature on time to hatch for channel catfish

that egg masses left unprotected in cans on the pond bank for 30 minutes have up to 25 percent lower hatch rates than eggs transported quickly.

If transport time may exceed 30 minutes, eggs should be put in insulated containers with well-oxygenated water (> 5 ppm dissolved oxygen). Fill transport containers with pond water to help prevent shock caused by differences in water quality and temperature. When the quality of pond and hatchery water is significantly different, be sure to temper the eggs by slowly exchanging the transport container water with hatchery water.

Water hardness

The calcium component of water hardness plays an important role in catfish fry development. Hatch rates from eggs incubated in water with less than 10 ppm calcium hardness during the first 24 hours after spawning are reduced by as much as 70 percent. Low calcium hardness during later stages of development can cause up to a 25 percent reduction in hatch rates. For this reason, it is important to maintain adequate calcium hardness in the hatchery water—a minimum of 20 ppm, especially during the first 24 hours after spawning. During periods of low calcium concentration, as when a metering pump fails, newly spawned eggs (less than 24 hours old) can be left in the pond an extra day or a calcium chloride solution can be added to hatching troughs designated for new spawns.

Removing dead eggs

Regardless of the cause of death, dead eggs should be removed to prevent disease outbreaks. Live eggs are transparent and progress from a pale yellow to an orange–red color as they mature. Dead eggs are often difficult to identify during the first day or two after spawning. But by the third day, dead eggs typically appear opaque and colorless. Some dead eggs also may be enlarged. When dead eggs are observed, they can be removed by hand, being careful not to damage nearby live eggs. Egg masses older than 24 hours should be turned over periodically in the hatching basket and inspected for fungus and bacteria. This should be done at least twice daily, but no more than four times daily, until hatching begins.

Managing disease

More serious than dead eggs themselves is the fact that they are often attacked by disease pathogens that can then spread quickly to adjacent live eggs.

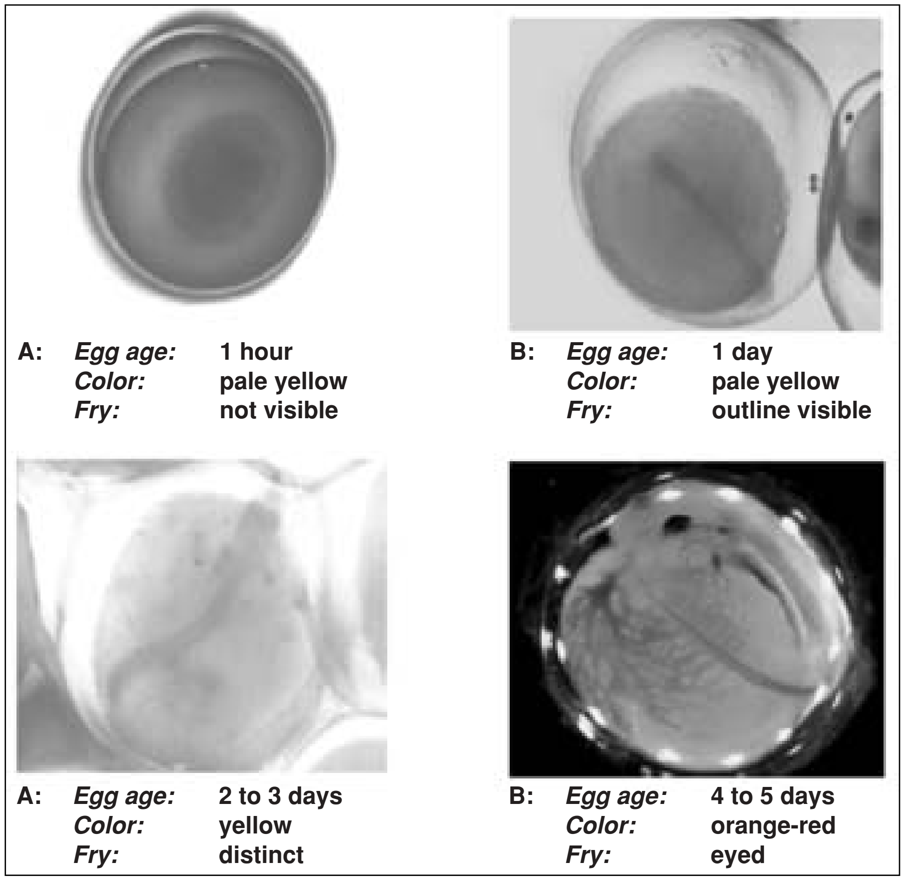

Figure 4. Development of channel catfish fry at 78 °F (26 °C).

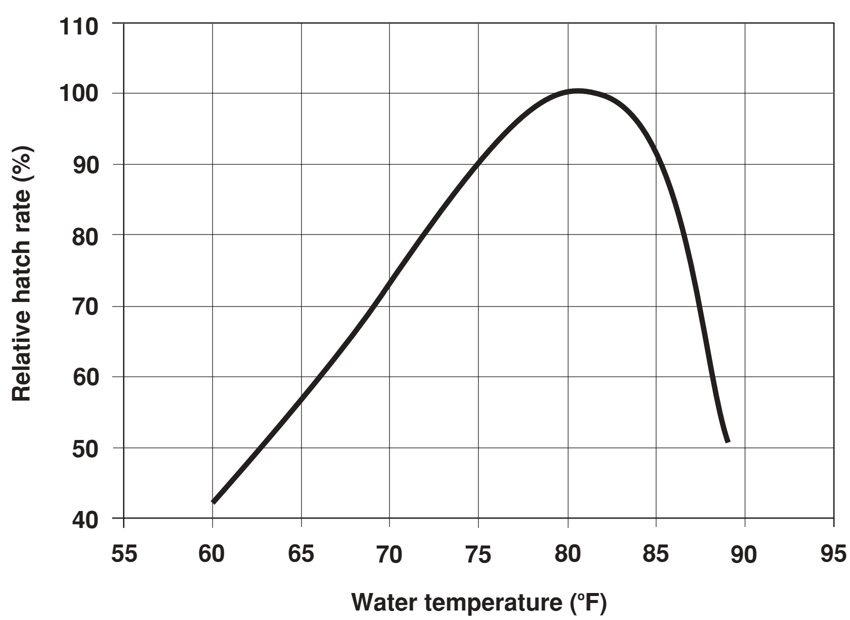

Figure 5. Effect of water temperature on channel catfish hatch rate.

Once a disease outbreak has begun, it can quickly get out of control.

Disease-causing organisms

Bacterial and fungal infections are the primary threats to catfish eggs. Bacterial infections most often occur when hatchery water temperature is higher than 82 °F (28 °C) and when hatching baskets are overcrowded. Bacterial egg rot appears as a milky white patch, often seen on the underside and in the middle of the egg mass. This patch of bacteria will contain dead and deteriorating eggs. It should be carefully removed, along with the surrounding dead eggs.

Fungus is more prevalent at lower temperatures, usually 78 °F (26 °C) and below. It rapidly attacks infertile and dead eggs. Fungal infections are easy to spot; they appear as white or brown cotton-like growths made up of many small filaments. If left untreated, these filaments can invade and kill adjacent healthy eggs, expanding to cover the entire egg mass and potentially every egg mass in the hatching trough. Mechanically removing dead and infected eggs can be time consuming, but is beneficial. Chemical control of fungal infections is quite effective.

Chemical disinfection

Regular disinfection of eggs with approved chemical disinfectants is a common practice in most commercial catfish hatcheries. The use of drugs and chemicals for disinfecting eggs in aquaculture facilities is regulated by various federal and state agencies. Treatments must be effective, safe and cost efficient. There are four options for the legal use of chemotherapeutants in the United States: 1) The chemical has been approved by the FDA; 2) The chemical is the subject of an Investigational New Animal Drug (INAD) exemption; 3) The chemical has been determined by the FDA to be of low regulatory priority; or (4) The chemical is not a low regulatory priority, but regulatory action has been deferred pending the outcome of ongoing research. More information on obtaining and using drugs and chemicals in aquaculture can be acquired through the FDA's Center for Veterinary Medicine (*http://www.fda.gov/cvm/aqualibtoc.htm*), which regulates the manufacturing, distribution, and use of animal drugs.

Biological, environmental and physical factors all play a role in the effectiveness of chemical treatments and must be considered when developing a strategy for managing egg disease. Each hatchery is unique in its design, its source and quality of water, its capacity, and its management. Visiting other hatcheries to discuss their disease management strategies is a good way to gather helpful information. The following information on chemical treatment methods is based on research, experience, and personal communications with hatchery managers and Extension specialists.

Biological factors. The primary biological factor to consider in treating eggs is the developmental stage of the embryo (egg age). Many studies have been conducted to determine the effects of treating eggs at various stages of development. In general, the egg is a very protective environment for the developing catfish embryo and chemical treatments will be safe if they are made at the correct concentration and are of the correct duration and frequency. However, newly hatched fry are vulnerable to chemical disinfectants.

Many treatment guidelines suggest treating until the "eyed" egg stage, the time when eye pigmentation (black eye spots) can be observed without magnification (Fig. 4d). Since not all the eggs in a mass, and certainly not all the eggs in a hatching trough, are at the same developmental stage, some eggs may begin hatching shortly after most of the eggs appear eyed. Stopping treatments at the eyed stage is good practice because the risk of killing hatched fry typically exceeds the risk of disease at this late stage of development. The exception is when disease has overwhelmed the egg mass. When trying to salvage severely diseased egg masses, the eggs should be placed in a quarantine trough during treatment.

Environmental factors. Temperature and water quality affect not only the development and survival of catfish embryos in the egg, but also the effectiveness and potential toxicity of chemical therapeutants. However, this is generally not a problem over the range of water temperatures normally maintained in catfish hatcheries.

The organic load in the water system is another environmental factor that can affect chemical treatments. High concentrations of organics in hatchery water systems should be avoided because they provide a food source for pathogens and may increase diseases in the hatchery. High levels of organics also can reduce the effectiveness of chemical disinfectants such as formalin and hydrogen peroxide.

Physical factors. Water flow rates and volume largely determine how chemical treatments will be administered and how effective they will be. When determining the concentration of a disinfectant, the exact volume of water being treated must be known. If eggs are to be treated as a bath in the hatching troughs, the rate of water flow through the trough must be known to determine how long to expose the eggs to the chemical solution.

Turning off the water for bath treatments can be very risky, with millions of eggs possibly lost if water flow is not restored. It is safer to conduct flush treatments by adding the chemical to the trough with continuous water flow. The rate of water flow through the hatching trough will dictate whether the chemical concentration must be increased or decreased. Most recommendations for disinfecting catfish eggs suggest that the eggs be exposed to a treatment for 15 minutes at a given concentration. During flush treatments, faster flow rates must be compensated for by increasing the chemical concentration, while slower flow rates require a reduction in the concentration of chemical used.

There are many opinions as to how long and how often eggs should be treated. Treatments that are too short or infrequent will not kill the disease-causing pathogen, but treatments that are too long or too frequent may be toxic to the eggs. In both cases, hatch rates will be unacceptably low. A good hatchery manager will use the guidelines below as a starting point and adjust treatment methods accordingly.

Chemical disinfectants

Formalin. Formalin is an FDA-approved drug for the control of fungi on fish eggs. Some formalin products are available under the trade names Formalin-F® (Natchez Animal Supply Co.), Paracide-F® (Argent Laboratories, Inc.), and Parasite-S® (Western Chemical, Inc.). The maximum concentration for disinfecting catfish eggs is 2000 ppm for 15 minutes as a flush treatment. Under typical hatchery conditions, with an average of one volume exchange every 45 to 60 minutes, 2000 ppm can be toxic to channel catfish eggs. In most hatcheries, fungus can be controlled by treating with 100 ppm formalin for 15 minutes as a bath treatment. Turn the water off during treatment, but leave the paddles turning or air flowing from airstones. Flush completely with fresh water when treatment time has elapsed. For flush treatments, concentrations between 100 and 400 ppm formalin have been successful at temperatures of 75 to 86 °F (24 to 30 °C). Hatch rates tend to improve when formalin treatments are administered twice daily. Recommended formalin treatments are presented in Table 1.

Hydrogen peroxide. Hydrogen peroxide is currently an aquaculture drug of low regulatory priority according to the FDA. It is expected that hydrogen peroxide will eventually be approved by the FDA as a new animal drug and that the label will include the treatment of catfish eggs. As a drug of low regulatory priority, hydrogen peroxide can be used to control fungi on all life stages of fish, including eggs, at concentrations of 250 to 500 ppm active ingredient (100 percent hydrogen peroxide). Hydrogen peroxide is extremely caustic in its concentrated form and can be purchased as 3 percent, 35 percent and 50 percent solutions. The most practical concentration for use as a chemical disinfectant is the 35 percent solution, which often can be purchased in 55-gallon quantities. The effectiveness of hydrogen peroxide appears to be affected by temperature; toxicity may be a problem at higher temperatures. When hatchery water temperature is 78 °F (26 °C), a daily 15-minute bath of 250 ppm active hydrogen peroxide (715 ppm of 35 percent hydrogen peroxide) is as effective as formalin for disinfecting eggs and improving hatch rates. It is important to note, however, that twice as much hydrogen peroxide at this temperature is toxic to eggs. At cooler temperatures, hydrogen peroxide is less toxic and higher concentrations are more effective. Recommended hydrogen peroxide treatments are presented in Table 1.

Povidone iodine. Povidone iodine is also an aquaculture drug of low regulatory priority. Povidone iodine compounds can be used to disinfect catfish eggs in a solution of 100 ppm for 10 minutes. Daily iodine treatments are not as effective as daily formalin treatments for controlling fungal infections. Povidone iodine is, however, a very good preliminary disinfectant to use when transferring eggs from the pond to the hatchery. Bathing new egg masses for 10 minutes in a 100-ppm iodine solution before adding them to communal hatching troughs can substantially reduce the transfer of pathogens from the pond to the hatchery and may improve hatch rates by as much as 10 percent when used with daily treatments of either formalin or hydrogen peroxide. Povidone iodine should not be used on catfish eggs with visible eye spots.

Copper sulfate. Copper sulfate is currently considered an investigational new animal drug (INAD), and regulatory action has been deferred pending the outcome of ongoing research. The FDA's Center for Veterinary Medicine awards exemptions to allow for the purchase, shipment and use of investigational new animal drugs so that data about their effectiveness and safety can be collected. Data in support of copper sulfate as an egg disinfectant is currently being collected for use in the drug approval process. Preliminary data suggest that copper sulfate is an effective disinfectant for controlling fungal infections of catfish eggs when used as

Table 1. Recommended volumes of formalin and hydrogen peroxide for use as flush treatments to disinfect channel catfish eggs in a hatching trough containing 100 gallons of water.

	Milliliters (fluid ounces)	
Water flow (GPM)	Formalin (37% formaldehyde solution)	Hydrogen peroxide (35% solution)
1.0	10 (0.3)	40 (1.4)
2.0	30 (1.0)	75 (2.5)
3.0	50 (1.7)	110 (3.7)
4.0	70 (2.4)	150 (5.1)
5.0	90 (3.0)	190 (6.4)
6.0	110 (3.7)	225 (7.6)

Chemical volumes are provided as starting points and may require adjustment for unique hatchery conditions. Recommended treatment frequency is twice a day for formalin and once a day for hydrogen peroxide. DO NOT treat eggs that are hatching.

a once or twice daily 15-minute bath treatment at concentrations of 2.5 to 10 ppm. Higher concentrations of copper sulfate have been found to reduce hatch rates and may be toxic. Crystalline copper sulfate should be dissolved in hatchery water in a separate container, such as a 5-gallon bucket, and then added as a solution to the hatching trough. Do not use copper sulfate in aluminum troughs because it reacts with the aluminum and causes the trough surface to become pitted.

General recommendations

Although many factors can cause poor hatch rates, knowing the optimal conditions for handling and hatching channel catfish eggs and following good hatchery practices will reduce problems of disease and poor survival.

Recommendations include:

1. Learn to identify the general stages of embryo development in the egg.
2. Avoid delays and prevent water quality and temperature shock when transporting eggs from the pond to the hatchery.
3. Disinfect egg masses with povidone iodine before placing them in the hatching trough.
4. Maintain hatchery water temperatures between 78 and 82 °F (26 and 28 °C).
5. Avoid unnecessary handling of eggs during the first 24 hours after spawning.
6. Do not overcrowd egg masses in the hatching baskets.
7. Maintain adequate water hardness (> 20 ppm) in the hatchery.
8. Be familiar with the laws regulating the use of chemical disinfectants.
9. Treat catfish eggs daily with an approved chemical disinfectant to manage diseases and improve hatch rates.
10. Develop a management plan that meets the specific needs of the individual hatchery.

Additional resources

Hargreaves, J.A. and C.S. Tucker. 1999. Design and Construction of Degassing Units for Catfish Hatcheries. SRAC Publication No. 191. Southern Regional Aquaculture Center.

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Tucker, C.S. 1991. Water Quantity and Quality Requirements for Channel Catfish Hatcheries. SRAC Publication No. 461. Southern Regional Aquaculture Center.

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SRAC fact sheets are reviewed annually by the Publications, Videos and Computer Software Steering Committee. Fact sheets are revised as new knowledge becomes available. Fact sheets that have not been revised are considered to reflect the current state of knowledge.

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