



Maturation, Hatchery, and Nursery Techniques for Chinese Catfish, *Clarias fuscus*, in Hawaii

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Introduction and Background

The Chinese or Asian catfish *Clarias fuscus* (Figure 1) has been farmed and sold commercially in Hawaii since the early 1980s. The species was imported to Hawaii in the late 1800s by Chinese immigrants. Other species of the genus *Clarias* are widely farmed in Asia, Africa, and Europe. However, state and federal laws prohibit any further importation of *Clarias* into the U.S.

C. fuscus was spawned in captivity in Taiwan in the 1970s. Maturation, spawning, rearing and marketing methods for Chinese catfish under Hawaii conditions were developed by Hawaii Fish Company in the early 1980s. Hatchery and production techniques were further developed and extended to the aquaculture community by the Hawaii Institute of Marine Biology (HIMB), supported by the U.S. Dept. of Agriculture, U.S. Agency for International Development, UH Sea Grant, and the Hawaii Aquaculture Development Program (Fast and Young 1988; Young et al. 1989; Young and Fast 1990).

Farm production grew rapidly for several years following technology development and extension. Recently, total production and price have fluctuated considerably from year to year (Table 1). Nearly all the crop is sold live, with a good deal of the marketing done by the producers themselves and by small-scale brokers. The market on Oahu is reasonably well understood; the situation is less well known on the neighbor islands.

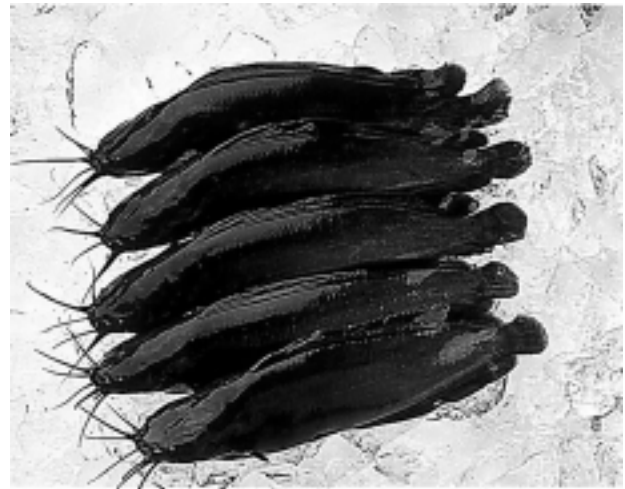


Figure 1. Chinese catfish, *Clarias fuscus*. Photo by Hawaii Aquaculture Development Program

The reproduction and culture techniques were presented in research papers, extension workshops, and in a videotape distributed by UH Sea Grant (Fast and Young 1988). In addition, there are various unpublished materials on catfish culture. As the industry has matured, researchers, extension workers, and business operators have made innovations and improvements in culture technique, most of which have not been documented or communicated.

This Extension Bulletin aims to provide an updated, working summary of maturation, hatchery, and nursery techniques for Chinese catfish, *Clarias fuscus*, in Hawaii. These procedures represent a good teaching model for hormonally induced fish spawning, par-

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Table 1. Production, value, and average price for Chinese catfish in Hawaii, 1990-1999. Data from Aquaculture Development Program, Hawaii Dept. of Agriculture.

Year	Production lb	Value \$	Average Price \$/lb
1999	32,000	133,000	4.15
1998	106,100	317,000	2.99
1997	36,200	205,300	5.67
1996	58,100	284,200	4.89
1995	64,100	351,000	5.47
1994	68,000	372,600	5.48
1993	34,900	202,900	5.81
1992	53,100	299,400	5.64
1991	60,600	338,000	5.58
1990	40,200	225,100	5.62

ticularly because the Chinese catfish is hardy and its eggs and fry are large. Therefore, university, community college, and high school classes around the state can benefit from an updated printed information resource on this subject. Also, the Extension Service has become increasingly aware of public interest in fish breeding, with specific requests for information and workshop level training. Induced spawning of egg-laying fishes is an important part of this set of information. Finally, existing producers may benefit from updated information.

Maturation, Assessment, and Selection of Breeders

Chinese catfish become reproductively mature (females having large enough and sufficiently developed eggs, males having active sperm) in captivity. At times, they have spawned (released and fertilized eggs) without hormone injection or other special treatment. However, this has rarely been observed in Hawaii, and in any case would not provide sufficient control to be commercially useful. Therefore, hormone injections are used to finalize maturation and induce spawning.

In Taiwan, catfish mature seasonally between March and October. In Hawaii, mature fish are found in captive stocks from approximately mid-April through October. Artificial manipulation of environmental cues can improve spawning success near the

extremes of this period, or may extend the season beyond the usual limits (Young and Fast 1990, Rottmann et al. 1991a). Manipulations include control of temperature within the range 25 to 30 °C (77 to 86 °F) and photoperiod (length of daylight) at more than 12 hours per day. Temperature control is the most important and generally least expensive measure. Temperature may be increased in maturation tank waters by insulating the tanks sides to prevent nighttime heat loss, covering the surface at night for the same reason, using electrical heating devices, keeping the tank in a greenhouse, or having a transparent cover on the tank to create greenhouse effect.

Breeders are usually obtained by holding fish over from past years' crops. For best results, breeders should be more than 1 year old and heavier than 150 g (the larger the better for females). Wild fish may be collected in natural waters, ponds used for other purposes, or flooded fields, but this is not commonly practiced in Hawaii. Breeders should be collected at least several weeks in advance of spawning, held at temperatures between 25 and 30 °C, and fed regularly. Trout chow fed once per day at 2% body weight per day (BWD) is adequate. Proper care and acclimation of bloodstock will improve egg quantity and quality.

Final selection of fish for a spawning session (Figure 2) begins with deciding how many fingerlings are desired as a product, doubling this number, and obtaining sufficient females to yield the resulting number of eggs, using estimates of 3,000 - 20,000 eggs per female depending on size. Recent experience with the stock at the UH Hilo farm showed that it was reason-



Figure 2. Students at UH-Hilo farm selecting breeders. Photo by Jim Szyper.

able to expect about 5,000 eggs from females of 300-400 g body weight. For example, if the target hatchery production is 20,000 fingerlings and it is estimated that the females will yield 5,000 good eggs each, then 8 females would be selected, aiming for a yield of 40,000 eggs. This means, finally, that at least 10 females should be prepared for assessment, in case some are not ready or to account for other factors in egg quality. Ripe, gravid females have firm, rounded abdominal areas and genital pores (posterior to – on the tail side of – the anus) that are reddish, rounded, not protruding much, and invaginated at center. Male genital pores are white, conical, protruding, and black at the tip. Because milt (sperm with fluid) is not expressible from males (as it is for some other fish species), males of similar age and weight to the females are simply selected in numbers equal to at least one per female.

Once brood stock are selected, further handling proceeds in small containers. Attention should be given to using only clean, chlorine-free water for all steps to follow. Females must be further examined for eggs of sufficient size and maturity. Both females and males are weighed before injection with hormone, for determination of the proper dose. Fish may be anesthetized before further handling to minimize risk of injury, and to prevent muscle contractions from ejecting the injected hormone. Fish may be handled for assessment and injection without anesthetic, if care is taken to minimize potential injury and loss of skin mucus due to thrashing. They can be immobilized by partial wrapping of the body in soft-textured hand nets. Anesthesia is always in order before the later steps of stripping eggs from females and killing males to obtain the testes.

The brood stock (both males and females) are anesthetized by immersion in a solution of MS 222 (75-100 mg/l). It is convenient to hold a small number of fish in 10 liters of water in a plastic bucket, in which case addition of 750 mg of MS 222 makes a solution of 75 mg/l. Other anesthetics have been used effectively; proper concentrations differ. Fish are kept immersed until they cease to move (3 to 5 minutes), at which point handling should proceed promptly.

For assessment of egg maturity, a cannula, a thin clear plastic tube of 1.4 mm ID, 1.9 mm OD, and more than 20 cm length (8 in) is gently inserted one inch or more into the genital pore of the female (Figure 3), and gentle suction is applied to the tube by mouth or bulb to collect several dozen oocytes (late stage eggs)



Figure 3. Students at UHH farm sampling eggs from females for measurement. Photo by Jim Szyper

from inside the ovary. The cannula is then withdrawn and the eggs deposited into a petri dish. The eggs (with a little water added to disperse them) are immediately examined under a dissecting microscope: good, ready eggs are >1.5 mm in diameter, opaque, and light tan or buff colored, possibly with a pale green tone. Eggs that are of poor quality or not ready are indicated by diameter <1.3 mm, and appearing clear, red, or broken of any color. Cannula tubing can be purchased from veterinary or scientific supply sources.

Hormone Injection

Final maturation of eggs and sperm, and release of eggs from the female ovary are induced by injection of both males and females with human chorionic gonadotropin (HCG) or carp pituitary extract (CPE). This bulletin gives specific quantities only for use of HCG. The handling methods apply with either hormone preparation (Rottmann et al. 1991b). Fish are removed from the water, weighed, and injected promptly with the appropriate dose. Fish are injected with a dose of 4 IU (international units) per gram of body weight (Table 2), using a 1 ml syringe with a No. 25 x 5/8" needle. The weight of each fish is used to quickly calculate the volume of HCG solution to be used. The fish is injected in the large muscle just below the anterior part of the dorsal fin. Fish should be immediately returned to clean water. After all fish are injected, they are placed, with sexes separated, into

Table 2. Calculations for preparation and use of HCG solution. The solution should be prepared freshly for each spawning date.

- 1. Prepared solution.** HCG, dry solid, 10,000 IU per vial, is packaged with separate vials of saline diluent solution. Use a syringe to take up 2.5 ml saline diluent; add this solution to the HCG vial, and mix. $10,000 \text{ IU in } 2.5 \text{ ml} = 4,000 \text{ IU / ml} = 400 \text{ IU / } 0.1 \text{ ml}$.
- 2. Dosage rate.** The HCG dosage rate is $4 \text{ IU / gram (g) of fish body weight} = 400 \text{ IU / } 100 \text{ g fish weight} = 0.1 \text{ ml / } 100 \text{ g fish weight}$.
- 3. Dose preparation.** Weigh fish; calculate dose using the information in 2. above or refer to table below. Take this amount into syringe. Control and estimate syringe contents to nearest 0.01 ml, e.g., 0.34 ml for a fish of 340 g. It is not essential that the amount of HCG be measured to high precision; take only the time needed to be reasonably close.

Fish Weight g	Injection Volume ml	Fish Weight g	Injection Volume ml	Fish Weight g	Injection Volume ml
200	0.20	300	0.30	400	0.40
225	0.23	325	0.33	425	0.43
250	0.25	350	0.35	450	0.45
275	0.28	375	0.38	475	0.48

holding containers until the recommended holding period has elapsed: 12 to 14 h at 30 °C; 16-20 h at 25 °C. Holding tanks should remain as undisturbed as possible, covered and isolated from human activity.

Spawning and Fertilization

When the holding period after injection is completed, both males and females are anesthetized. This step is done here even if anesthesia has been omitted earlier. Females and males may be manipulated simultaneously or in sequence with females first. For females: the skin is blotted or dried well with a paper towel or cotton cloth – water *must* not drip into the egg mass. Eggs are expressed manually from females by stroking the abdomen toward the genital pore (Figure 4); eggs are collected in a dry plastic container (they will become sticky upon fertilization and may be difficult to remove from glass). For mass production, eggs of all females may be mixed for the fertilization step, but it is prudent to first express the eggs from each female into its own container to be sure that the batch is not damaged or bloody, which would contaminate the other eggs. Anesthetized males are killed by cutting through the vertebral column behind the head with a stout knife or surgical shears (Figure 5a). Dissecting scissors or a sharp knife is used to open the body cavity from genital pore to gill area (Figure 5b).

Care should be taken to avoid puncturing the intestines or major blood vessels. Cutting the body wall in a flap as done in laboratory dissection is helpful. Testes (elongate white or lightly colored organs alongside the intestines) are removed to a petri dish and blotted dry of body fluids or blood (Figure 5c). Testes are cut or chopped into thin pieces with a scalpel or single-edged razor blade, and mixed with water at about 10 ml water per gram of testes (Figure 5d).

The sperm and water mixture is added to the eggs immediately upon preparation. The egg mass with sperm is swirled gently to mix. After 15 seconds, water is added to cover eggs by 1 to 2 cm. Gentle stirring is continued for an additional 15-30 seconds, after which the eggs are allowed to stand for 6 to 7 minutes. During this time, it is helpful to carefully remove particles of testes or any other bloody tissue from the mixture. Finally, eggs are rinsed with water and transferred to the incubation container (Figure 6).

Egg Incubation and Hatching

Eggs may be incubated in well-aerated flowing water or, in lower densities, in relatively static water moved only by gentle aeration. Optimal temperature is 25-28 °C. Macdonald jars (Figure 7a), trout egg trays (Figure 7b), or other devices may be used, giving at-



Figure 4. Eggs are expressed manually from the anesthetized female by stroking the abdomen from anterior toward the posterior genital pore. Photo by Priscilla Billig

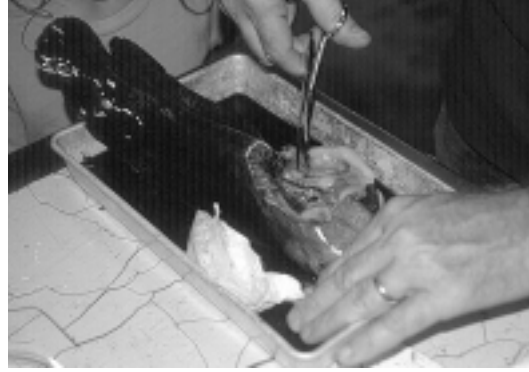


Figure 5. Preparation of sperm mixture for egg fertilization. 5a. Anesthetized males are dissected with scissors to open the body cavity.

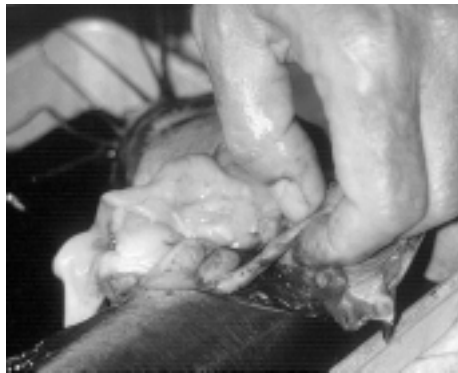


Figure 5b. Testes, flattened off-white organs on either side of gut, are removed.



Figure 5c. Testes are cut or chopped into thin pieces, and



Figure 5d. Mixed with water using about 10 ml per gram of testes. Photos by Priscilla Billig



Figure 6. Eggs are mixed with sperm preparation in a plastic container, allowed to stand a few minutes, and rinsed. Photo by Tolu Rasmussen



Figure 7. Examples of egg incubation devices. 7a. Macdonald jar: the round interior bottom helps incoming water to keep eggs suspended. Photo by Jim Szyper



Figure 7b. Trout egg tray: water flows through screened layers in sequence from top to bottom. Photo by Tolu Rasmussen

tention to size of the screen mesh that retains the eggs, which should be 1 mm or less for catfish.

Under some conditions, chemical treatment of eggs may be necessary or desirable. Some incubation systems, such as Macdonald jars, require that the eggs be separate rather than stuck together or to a substrate. The sticky material that binds eggs can be removed by brief immersion and stirring in a solution of 15 g sodium sulfite (Na_2SO_3) in one liter of water. If the source water is of low alkalinity, the pH of the mixed sulfite solution should be adjusted to near the original pH of the source water by adding 10% hydrochloric acid (HCl) and testing pH during addition (Rottmann et al., 1991c). Eggs may be given a treatment with formalin (Tamaru et al. 1999) every other day or as needed based on observations to prevent fungal infection: water exchange is stopped (with aeration maintained), and the incubation vessel is made to a concentration of 100 ppm of the concentrated stock formalin solution as it comes from the supplier (i.e., 1 ml of stock solution in 10 liters of water). After one hour, flow is re-started and the system should be flushed well. This procedure is not necessary if hatches have been good and no fungus is seen. Dead eggs are removed by net or siphoned daily, unless they are very few, or the incubator takes them away from the fish automatically.

At the recommended temperature, sac fry begin to hatch at about 20 hours' incubation. If the incubation vessel is readily manageable (10-gallon aquaria are used at the UH Hilo farm), fry may be retained in the hatching vessel through yolk utilization and even for early feeding stages. Alternatively, they may be siphoned or gently netted out of the hatching vessel to a beaker or bucket for transport to the rearing environment.

Fry Rearing

Fry may be reared in 10-gallon glass aquaria with flow through water supply and screened inside standpipes (Figure 8). Maximum stocking density is 5,000-6,000 fish per 10-gal aquarium. Aeration is necessary because catfish do not begin air breathing until about 3 weeks of age.

Feeding may begin when it appears that 3/4 or more of the yolk sac has been absorbed, about 3 days after hatching; food must be available when the yolk is exhausted. There is an old tradition that fry need



Figure 8. Catfish fry in aquarium with screened inside pipe shown at the top. Photo by Jim Szyper

live food (freshly hatched brine shrimp or other items such as *Moina*), despite the fact that they do take other particles. The original information from HIMB said to feed a tank 4 times per day for the first month. For the first week under this method, 10 brine shrimp per fish per day were hatched, and divided into 4 portions. The feeding rate was increased to 20 brine shrimp per fish during the second week. In addition, each feeding included very small particles of prepared feed, such as "trout/salmon swim up starter feed." Care should be taken with any method to assure that the fish are well fed without overfeeding or fouling the tank water.

Brine shrimp cysts have become very expensive, and are now known not to be strictly necessary. Minced egg can be used during the first two weeks instead of live feeds. One hardboiled egg per day is prepared for each 5,000 fish. Two eggs are blenderized with 1/2 liter (2 c) water, or pressed through a fine stainless strainer. The daily ration is best divided into 2-4 feedings per day; uneaten feed should be removed once daily. Small particles of pellet feed should be offered at some time each day to get the fish familiar with it; they may be weaned to pellets alone after 2 weeks.

Grow Out Notes

Catfish have been grown in a wide variety of systems, including ponds, tanks, and cages. Their air-breathing ability makes them able to survive high density and low oxygen conditions, though growth and production are better under good conditions, as with any fish. In Hawaii, they are most often grown in tanks, and fed trout or salmon pellets. Research has been proposed to improve diets and production.

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Single copies of this work may be obtained from the corresponding author. For multiple copies contact Sea Grant Communications, 2525 Correa Road, HIG 210, Honolulu, HI 96822, telephone (808) 956-7410, fax (808) 956-2880, email uhsgcomm@hawaii.edu. The video has recently become available after being "out of print" for some years. It can be obtained from Sea Grant Communications.

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Suppliers

For readers' convenience, some current sources of hormones are given here. This mention does not constitute an endorsement by any of the organizations involved in this publication.

HCG:

HCG is presently permitted for sale for aquaculture only to designated sources. Contact the Hawaii Aquaculture Extension Service (first three authors of this publication) for information about access to this material.

CPE:

Stoller Fish Company, Inc.
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fax: (912) 336 4681
email: stollfish@rconnect.com

Argent Chemical Laboratories
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