Aquaculture Extension Manual No. 40 July 2008

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For comments and inquiries:
SEAFDEC Aquaculture Department
Tigbauan, Iloilo 5021, Philippines

Tel (63-33) 511 9172
Fax (63-33) 511 8709
Email aqdchief@seafdec.org.ph
bookstore@seafdec.org.ph
AQD website http://www.seafdec.org.ph

FOREWORD

Catfish is one of the most important freshwater food fishes in Southeast Asia. In recognition of its importance, AQD has been conducting researches to further improve technologies on broodstock and nursery development, grow-out techniques, and the development of feed formulations for catfish from the nursery to grow-out phase.

This manual was published to disseminate science-based aquaculture technologies developed by AQD to assist catfish nursery and hatchery growers in producing high-quality fingerlings.

We also hope that researchers in the field of fisheries, students and teachers could benefit from the information on the breeding and seed production of this important aquaculture commodity.

Let us continue working together for the development of the fisheries industry.

Joebert D. Toledo, D. Agr.
Chief
SEAFDEC/AQD

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INTRODUCTION

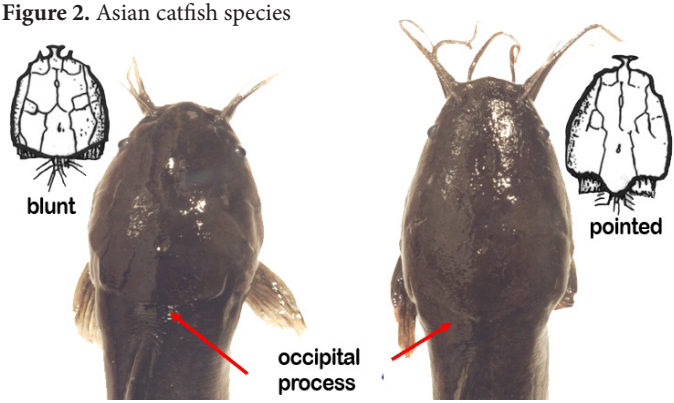
Catfishes are widely distributed in many countries in Asia, Africa, Europe as well as Central, South and North America. Some species form a significant part of inland fisheries, several have been cultured, and many species are of interest to the aquarium industry. Except for Families Ariidae (*Arius manilensis* or "kanduli") and Plotosidae that have marine species, catfishes generally inhabit freshwater environments. Species cultured as food fish primarily belong to Families Ictaluridae (channel catfish), Siluridae (European catfish), Pangasidae (*Pangasius* from Vietnam) and Clariidae (Asian catfishes), which contributed more than 1.6 million metric tons to global catfish production in 2005.

Most catfishes in the Philippines are under the Family Clariidae. They have elongated bodies with long dorsal (usually without spines) and anal fins, and four pairs of barbels or "beards" located near the mouth. Barbels are highly sensitive taste organs used by catfishes in search for food. The pectoral fins have strong spines. Catfishes also have suprabranchial organs which enable them to use atmospheric air. With their pectoral spines and suprabranchial organs, catfishes can leave water and walk on land for several hundred meters. The most studied and of great importance in fisheries and aquaculture among clariid catfishes are the Asian catfishes *Clarias macrocephalus* and *C. batrachus*, and the African catfish *C. gariepinus*.

Figure 1. The Asian catfish *Clarias macrocephalus*

Before the early seventies, the native catfish *C. macrocephalus* was abundantly found in rice fields and other natural habitats in the Philippines. Introduction of a related, faster-growing species from Thailand, *C. batrachus*, briefly promoted the culture of catfish in the 1970s, but was hampered by lack of cost-effective spawning agents, lack of seed supply, and lack of cost-effective diets. The African catfish was introduced to the Philippines in the late 1980s. It is a much bigger fish than the native and Thai catfish, which are almost similar in size and appearance. The native catfish can be distinguished from the Thai catfish by the shape of the occipital process (the center of the head portion when the fish is viewed dorsally), blunt or rounded in

Figure 2. Asian catfish species



the former and pointed in the latter, and presence of white spots along the sides of the body in *C. macrocephalus. C. gariepinus* also has a pointed occipital process. Of the three *Clarias* species, *C. macrocephalus* is preferred because of its tender and delicious meat. It is also resistant to diseases, can be stocked at higher densities, and has low requirements for water quality. *C. macrocephalus* is sometimes crossbred with the African catfish to get better-tasting and bigger-sized fish. This kind of hybrid forms the bulk of catfish production in Thailand.

This manual summarizes the techniques developed at SEAFDEC/AQD on the breeding and seed production of the native catfish.

BROODSTOCK DEVELOPMENT AND MANAGEMENT

FACTORS TO CONSIDER

Source

- Can be obtained from lakes, rivers, tributaries and other freshwater bodies
- Are caught by hand or indigenous fish traps

Transport

- Can be transported in any container made of styrofoam, plastic, metal and the like
- Container can be filled with pond or river water just enough to cover the catfish
- Aeration is not needed since catfish can breathe atmospheric oxygen

Figure 3. Earthen pond and concrete tanks for maintaining catfish broodstock

Preparation of tank or pond

- Broodstock can be stocked at 10-15 pieces/m^2 in earthen ponds or in concrete tanks lined with mud at the bottom (Fig. 3)
- Ponds are maintained at 70-100 cm water level

Feeding

- Catfish are carnivores. They feed naturally on insects, shrimps, worms and organic detritus, but easily accept artificial feeds
- SEAFDEC has formulated a broodstock diet that can replace trash fish when fed at 3% of the body weight

Table 1. Composition (%) of SEAFDEC broodstock diet for catfish*

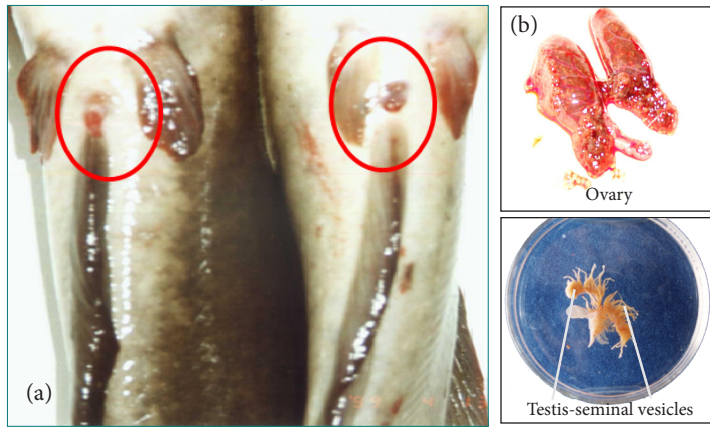
Ingredient	Composition (%)
Fish meal	15
Defatted soybean meal	35
Meat and bone meal**	22.4
Copra meal	3.44
Cornstarch	2
Soybean oil	3
Vitamin mix***	3.55
Ricebran	15.61
Total	100

*Estimated nutrient content (dry matter basis) : crude protein 35-37%, crude fat 9-10%, crude fiber 4-5%, crude ash 14-15%, and nitrogen-free extract or digestible carbohydrate 30-32%
**Not available in the market. Substitute the level with other ingredients available in the area. A suggestion is a 1:1:1 ratio of cracked corn, snail meal and crab meal (or dried trash fish)
***Commercially available

BREEDING

At 3-4 months, sexes can be distinguished externally by the presence of elongated, urogenital papillae in the males, and a round opening in the females at the lower, ventral side of the body (Fig. 4a). Age determines maturation in catfish. When fed properly, catfish mature in about 6-8 months. The reproductive organ consists of a pair of ovaries with unfertilized eggs in the females, and a pair of testis found at the anteriormost region, followed posteriorly by a pair of seminal vesicles with about ten fingerlike projections in the males (Fig. 4b).

Figure 4. (a) distinguishing features of male and female catfish
(b) catfish reproductive organs



Male Female

The natural breeding season in catfish varies from place to place, but usually starts during the rainy season. Although catfish contain unfertilized eggs year-round upon reaching maturity, these are not released spontaneously when catfish are held under captive conditions. This is because gonadotropin is not released, although it reaches a high level when the fish attains sexual maturity. Gonadotropin is a hormone produced in the pituitary gland that affects reproduction in fishes. The different hormones used are meant to facilitate the release (luteinizing-hormone releasing hormone or LHRH) or increase (human chorionic gonadotropin or HCG, pituitary gland extract or homogenates) gonadotropin levels in the body of the fish. LHRH is used alone or in combination with dopamine antagonists, e.g., pimozide (PIM) or domperidone (DOM). Dopamine is found in the brain, which inhibits the release of gonadotropin from the pituitary glands.

Catfish are best induced to spawn using hormones starting in May, the start of the rainy season in the Philippines. January to April is not a good time to induce catfish to spawn because females have relatively fewer eggs and males have fewer sperm inside their bodies. For induced spawning, choose bigger females since fecundity increases with size, and bigger males with whitish urogenital papillae to get a greater amount of milt.

Follow these procedures in inducing catfish to spawn:

DAY 1 - 6:00-7:00 AM

Fish stocking

- Drain the tank or pond in the early morning and get at least 20 males and 50 females
- Place males and females in separate holding containers
- Cover the tanks with nets

Figure 5. Holding containers for male and female catfish broodstock prior to induced spawning work

Hormone preparation

- Hormones to be injected should be ready before 3 PM
- Use either one of these methods: pituitary gland extracts, HCG, LHRHa + PIM or DOM, Ovaprim, or Ovatide (Table 2)

Table 2. Methods used in the induced spawning of *C. macrocephalus*

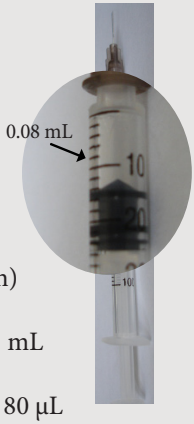
Inject females with	strip after
A : 1 pituitary gland (homogenized)/100 g BW	13 -14 h
B : 4 I.U. of human chorionic gonadotropin (HCG)/g BW	13 -18 h
C : 0.05 µg luteinizing hormone-releasing hormone analogue (LHRHa) + 1 µg pimozide (PIM)/g BW	16 -20 h
D : 0.5 µL Ovaprim /g BW	16 -20 h
E : 0.2 -0.5 µL Ovatide/g BW	16 -20 h

- Determine or approximate the total body weight of female catfish to be injected

METHOD A : For pituitary gland extracts

Get pituitary glands from sexually mature fish
Add 1 mL of physiological saline or 0.9% NaCl (dissolve 0.9 g NaCl in distilled water to reach final volume of 100 mL solution)
Macerate using a small vortex mixer, and get the extracts using a glass syringe

METHOD B : For HCG



Dose of HCG : 4 I.U./g body weight (BW)
Injection volume : 1 µL /g BW

A 100-g female (100 g x 4 I.U./g) will receive 400 I.U. or 0.08 mL of HCG

Concentration of HCG available : 5000 I.U./1 mL (HCG solution)

400 I.U. : volume of HCG solution needed = 5000 I.U. : 1 mL
volume of HCG solution = 400 / 5000
volume of HCG solution = 0.08 mL or 80 µL

Prepare human chorionic gonadotropin (HCG) by dissolving 1 vial containing 5000 I.U. HCG in 1 mL physiological saline or 0.9% sodium chloride (dissolve 0.9 g NaCl in distilled water to reach final volume of 100 mL solution)

METHOD C1 : For LHRHa + PIM

For LHRHa

Dose of LHRHa : 0.05 µg/g body weight (BW)
Injection volume : 1 µL/g
Total body weight of females to be injected, e.g. (100 g x 2 fish) x 2[¤] = 400 g

Total amount of LHRHa needed : 400 g x 0.05 µg/g = 20 µg
Total volume of LHRHa needed : 400 g x 1 µL/g = 400 µL

Concentration of LHRHa needed : 20 µg / 400 µL = 0.05 µg / µL
Concentration of LHRHa available per ampule or vial : 250 µg

0.05 µg : 1 µL = 250 µg : volume of liquid (0.9% NaCl) to dissolve LHRHa
volume of liquid = 250 µL/0.05
volume of liquid = 5000 µL or 5 mL

To prepare LHRHa , dissolve LHRHa (250 µg) in 5 mL physiological saline or 0.9% sodium chloride

A 100-g female 100 g x 1 µL/g) will receive 100 µL or 0.10 mL of LHRH

[¤]Allowance for spillage

METHOD C2 : For PIM

Dose of PIM : 1 µg/g body weight (BW)
Injection volume : 1 µL/g
Total body weight of females to be injected, e.g. (100 g x 2 fish) x 2¤ = 400 g

Total amount of PIM needed : 400 g x 1 µg/g = 400 µg
Total volume of PIM needed : 400 g x 1 µL/g = 400 µL

*Two solvents (dimethylsulfoxide or DMSO, and propylene glycol or PG) are used to dissolve PIM at 1:9

400 µL/10 parts (1 part DMSO + 9 parts PG) = 40 µL/1 part (DMSO)
40 µL/1 part x 9 parts (or 400 µL - 40 µL) = 360 µL (PG)

1. Weigh 400 µg of PIM and place in a test tube
2. Add 40 µL of DMSO and dissolve the PIM using the vortex mixer
3. Add 360 µL of PG to the solution and mix well with the vortex mixer

A 100-g female (100 g x 1 µL/g) will receive 100 µL or 0.10 mL of PIM

¤Allowance for spillage

- Ovaprim and Ovatide are commercial preparations containing LHRHa and domperidone. These are in liquid forms and ready for use, after knowing the body weight of the female catfish

METHOD D : For Ovaprim

Dose of Ovaprim : 0.5 µL/g body weight (BW)
Injection volume : 1 µL/g BW

A 100-g female (100 g x 0.5 µL/g x 1 µL/g) will receive 50 µL or 0.05 mL of Ovaprim

METHOD E : For Ovatide

Dose of Ovatide : 0.2 µL/g body weight (BW)
Injection volume : 1 µL/g BW

A 100-g female (100 g x 0.2 µL/g x 1 µL/g) will receive 20 µL or 0.02 mL of Ovatide

Injection or hormone administration

- Place 5 mL of the anaesthesia (2-phenoxyethanol) in a pail containing 10 liters of tap water and mix well
- Place several females at one time into the pail and remove individually the fish that are less actively swimming around with a scoop net
- Briefly pat dry the fish with a towel
- Get and record the body weight of the fish
- Wipe the site to be injected with a cotton moistened with rubbing alcohol
- Inject each fish on the dorsal musculature using a disposable tuberculin syringe at 1 µL per g body weight
- Put all injected fish in one tank or container and place a net cover

Figure 6. Injection of hormones

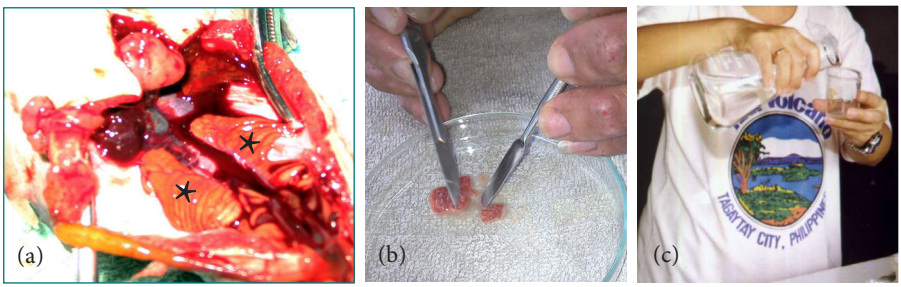
DAY 2 – STARTING AT 8 AM OR 16-20 HOURS AFTER INJECTION

- Try exerting gentle pressure on the lower abdomen of the hormone-injected females while inside the tank
- If eggs easily ooze out from most females, males can be sacrificed

Sacrifice of males

- Place 5 mL of the anaesthesia (2-phenoxyethanol) in a pail containing 10 liters of tap water and mix well
- Place several males at one time into the pail and remove individually the fish that are less actively swimming around
- Briefly pat dry the fish with a towel
- Place each male in the ventral position, and cut up the middle part of the body using a scalpel or scissors
- Dissect a pair of testes-seminal vesicles located on both sides of the body and place in a Petri dish

Figure 7. To obtain milt or hydrated suspension of sperm: (a) sacrifice male and dissect the reproductive organ (with asterisks); (b) remove and macerate the testis-seminal vesicles in a Petri dish; (c) add saline solution to the macerated reproductive organ



- Add 0.9% NaCl or physiological saline into the Petri dish and remove excess blood from the organ with the scapel
- Briefly blot dry the organ with tissue paper and transfer to a clean Petri dish
- Macerate the organ and add 0.6% NaCl (get 67 mL of physiological saline solution and add 33 mL of distilled water) to obtain milt solution
- Transfer the milt solution in a small beaker
- Milt from two males can be pooled together

Stripping of females

- Anaesthetize each gravid female
- Dry the body especially the lower ventral abdomen with a towel
- Press the abdomen of the female to strip eggs into a clean, dry bowl or basin
- Several females can be stripped simultaneously or one after the other, and their eggs combined in the bowl or basin
- Eggs from 4-5 females can be pooled in the same basin or bowl

Figure 8. Stripping of female catfish

Artificial fertilization

- Pour the milt solution into the bowl or basin containing the stripped eggs and mix for 30 to 60 seconds using a feather
- Add approximately 5 mL of tap water to the bowl and mix further to ensure fertilization
- Transfer fertilized eggs to a scoop net and wash with running tap water for about a minute to remove excess milt
- Spread the eggs on a monolayer on the net tray inside a flow-through hatching trough

Figure 9. Artificial fertilization (*left to right*): mixing the eggs and sperm using a feather; transferring the fertilized eggs to a scoop net and washing with running tap water; spreading the eggs on a monolayer in a flow-through hatching trough

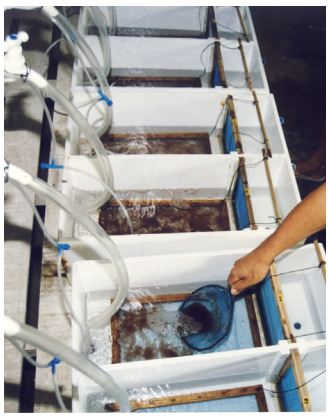


Figure 10. Incubation of eggs in containers made of (a) marine plywood or (b) plastic basin

NOTE: Speed is important in doing the above procedures since sperm are motile for only a few minutes, stripped eggs are viable for about 1-2 minutes, and closure of the micropyle (the opening on the egg through which sperm enter to fertilize the egg) occurs within a few seconds

Incubation of eggs

- Use rectangular containers made of marine plywood or plastic basin to incubate eggs (Fig. 10)
- Place fertilized eggs on a framed screen net tray (Fig. 11) suspended on a slanting position inside the incubation container
- Have a flow-through, recirculating water supply during incubation until hatching of the larvae, which is about 24-30 hours when the water temperature is 26-30°C
- Supply freshwater by gravity flow from elevated reservoirs and maintain at a water level of about 10 cm inside the trough. A standpipe may be placed at the opposite end of the water inlet
- Use rain water during incubation to get high fertilization and hatching rates of the eggs

Figure 11. Screen net tray to be placed inside the hatching trough

HATCHERY

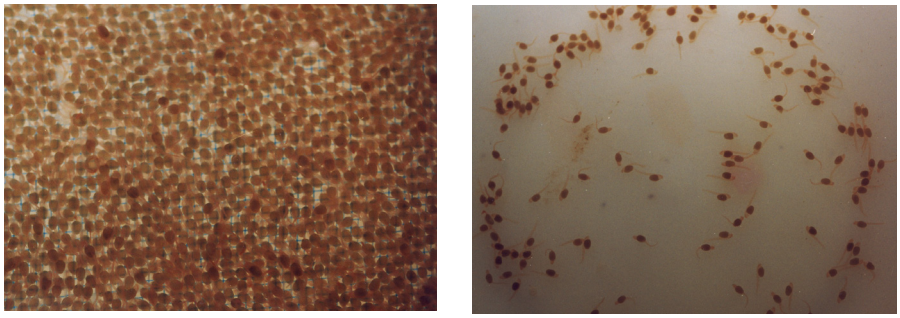
DAY 0 LARVAE

- Observe if most larvae have hatched 24-30 hours after fertilization and incubation
- Slowly move the framed screen net tray to drop the newly hatched larvae into the bottom of the trough, leaving only the dead eggs and unhatched larvae on it
- Newly hatched (day 0) larvae measure 4-4.5 mm
- Larvae can be maintained in a static system
- Start the culture of *Moina* (see separate section on p. 13)

DAY 1-2 LARVAE

- Larvae wriggle vigorously
- Healthy larvae start to group together at the corners, while larvae that are scattered eventually die (Fig. 12)
- Clean the hatching troughs by siphoning off dead eggs or larvae, mucus and other foreign bodies at the tank bottom
- Change 30% of the water in the trough
- Maintain larvae in a static system

Figure 12. Healthy *(left)* and unhealthy *(right)* catfish larvae



DAY 3 LARVAE

- Follow the same procedures in maintaining Day 1-2 larvae
- Hatch *Artemia* cysts (see separate section on p. 13)

DAY 4-6 LARVAE

Larvae are actively swimming, and yolk is now almost resorbed. The mouth of the larvae is functional and the barbels are longer. Size of larvae ranges from 7 to 8 mm, and larvae weigh about 3 mg each.

Larvae are transferred to bigger tanks, fed with *Artemia* (see separate section on p. 13), and maintained under the following conditions:

- Reduce the amount of water in the incubation trough
- Place the trough with the larvae inside a bigger tank for about 15 minutes for acclimation
- Pour larvae from the trough into the tank
- Siphon dead eggs, larvae or excess feed daily at the tank bottom before replenishing the rearing water and feeding the larvae
- Keep the water level at 10-15 cm in depth to allow the larvae to gulp air at the water surface
- Provide mild aeration to ensure oxygen supply to the larvae
- Place substrates of old nylon nets made into ribbon strips tied to sinkers at the bottom of the tanks to serve as resting places for the larvae after feeding
- Place shelters for smaller larvae to minimize being eaten by the larger larvae
- Change about 30% of the water in the larval rearing tanks daily
- Feed catfish larvae with newly hatched nauplii of the brine shrimp or *Artemia* at 10 individuals per mL twice a day

DAY 7-10 LARVAE

- Larvae closely resemble the adult body form
- Follow the same protocol in maintaining Day 4-6 larvae
- Feed with the cladoceran *Moina*/*Daphnia* if available at 5-10 individuals/mL for another 4 days; otherwise, continue feeding *Artemia* nauplii
- Start feeding the larvae with formulated diet (Table 3) in the morning on day 10; give natural food organisms in the afternoon
- Change 50% of the water daily from thereon

DAY 11-14 LARVAE

- Fry measure 11-14 mm and weigh 15-20 mg
- Change about 50% of the water in the larval rearing tanks daily
- Give formulated diet containing 40% protein with a particle size of 150-200 microns in three rations daily at 100% of the body weight or *ad libitum*
- Transfer larvae to nursery system on day 15

CULTURE OF NATURAL FOOD ORGANISMS

Artemia

The brine shrimp or *Artemia* is popularly used in rearing fish fry and postlarval crustaceans due to its high protein content. *Artemia* is commercially available as dry cysts, and used as freshly-hatched naulii.

- A day before feeding to fish larvae, weigh 5 grams of *Artemia* cysts per liter
- A day before use, disinfect cysts by soaking them in hypochlorite solution (add 40 mL of 5% liquid bleach or chlorox in 10 L tap or seawater) for 15-20 minutes
- Rinse and wash cysts with tap water/seawater on a screen
- Incubate *Artemia* cysts in a hatching medium with seawater for 24 hours. Provide aeration
- Maintain temperature within 25-30°C. Illuminate cysts continuously using 1-2 40-watt fluorescent bulbs at 10 cm above the water surface of the tank
- To feed fish larvae, remove aeration from the *Artemia* hatching tank after 24 hours and cover the upper part with a black cloth or plastic sheet for 5 minutes to separate nauplii
- Harvest *Artemia* nauplii by siphoning using a 100-150-micron silkscreen, starting at the very bottom of the container where nauplii are crowding

Moina and *Daphnia*

Moina and *Daphnia* are small crustaceans that are used as larval food for freshwater fishes. These are found in reservoirs, ponds, ditches, etc. *Moina* is smaller than *Daphnia*.

- Allow water to stand for 2 days in a tank
- Soak chicken manure in a sack for 1-2 hours before transferring to the production tank at a rate of 20 g/ton (Fig. 13)
- Add *Moina/Daphnia* starter
- Maintain water depth at 40-50 cm
- *Moina/Daphnia* spp. can be detected after 2-4 days
- Harvest *Moina/Daphnia* nauplii by siphoning or draining on the 5th to 8th day of culture with an 80-100-micron plankton net

Figure 13. Culture of *Moina*: soaking of chicken manure in a sack; tanks covered with nylon screen

NURSERY

Fifteen-day-old fry can be reared in net cages installed in different nursery systems e.g., pond, tank, or lake until they reach 3-5 g in body weight and 6-8 cm in total length, the recommended size for stocking in grow-out ponds.

POND

- Use 100-200 m^2 earthen pond. Place 20-24 units of 2 x 2 x 1.5 m net cage with a mesh size of 0.5-1 cm
- Provide shelters made of twigs or nets tied unto PVC pipes or placed at the bottom of each cage. Shelters should occupy about 40% of the pond bottom
- Fertilize the pond water by suspending 2 sacks of cow dung on opposite corners of the pond
- Apply 10-20 kg of agricultural lime per pond, settle for 3-5 days then release the old water. Let in water at a depth of 10-20 cm
- Change the pond water when necessary and maintain a depth of 70 cm
- Stock 15-day-old fry at 100-800 pieces/m^2 (or 57-570 pieces/m^3)
- Feed fry (Table 3) with the same formulated diet given to fry in the hatchery phase at 20% of the average body weight during the first week, 15% on the second week, and 10% thereafter. Feeding is done in equal rations twice a day at 9 AM and 3 PM

Figure 14. Net cage nursery in pond

Table 3. Composition (%) of catfish fry/fingerling diet*

Feed ingredient	Composition (%)
Peruvian fish meal	35
Defatted soybean meal	25
Bread flour	10
Cod liver oil	3
Soybean oil	3
Vitamin mix**	3
Mineral mix**	1.5
Rice bran	19.5
Total	100

*Estimated nutrient content (dry matter basis) : crude protein 38-40%, crude fat 10-11%, crude fiber 3-4%, crude ash 8-9%, and nitrogen-free extract or digestible carbohydrate 30-31%
**Commercially available

TANK

Figure 15. Net cage nursery in tank

- Disinfect tanks prior to use
- Use 3-ton rectangular tank. Add 2-3 cm soil to cover the bottom. Place 3 units of 1 x 1 x 1.5 m net cage with a mesh size of 0.5-1 cm in each tank
- Provide with shelters made of bundled nets or straw placed at the bottom of each tank. The shelter should occupy 30% of the tank bottom
- Hang 10 kg of cow dung inside the tank to fertilize the water
- Stock 15-day-old catfish fry at 100-400 pieces/m^2 (or 57-230 pieces/m^3) early in the morning or late afternoon to avoid stressing the fish
- Apply the same feeding method employed in pond nursery set-up

LAKE

- Construct the module in accordance with the size of the cages to be installed using bamboo poles and polyrope #10. Provide set-up with wave breakers using old nets
- Construct or fabricate 1 x 1 x 1.5 m net cages using hapa nets, polyrope #8 and polyrope #2 of 1 mm diameter (also called *pamitis*). This may be done simultaneously with the construction of the module

- Install hapa net cages in the module with at least 25% clearance from the water level. The net must be submerged at most 1 m in the water to allow fish easy access to atmospheric oxygen
- Provide net cages with a feeding tray
- Stock net cages with 15-day-old catfish fry at 100 pieces/m^2 (or 57 pieces/m^3). Stocking of fry should be done early in the morning at calm water conditions
- Provide net cages with shelters such as water hyacinth or water cabbage
- Apply the same feeding method used in pond and tank nursery set-up

Figure 16. Lake-based nursery set-up

HEALTH MANAGEMENT

Catfish may develop diseases caused by viruses, bacteria, fungi and parasites that can result in mortalities. Details on said diseases are described in Lio-Po et al. 1992; 2001 (see References section on page 22). Prevention may be achieved by practicing biosecurity measures such as requiring health certification of fish before purchase, formalin baths before purchase, applying prophylactic treatment during transport (oxytetracycline), segregating new fish stocks from existing farm stocks for at least two weeks in a separate tank, providing individual tools for each tank/pond, health monitoring of fish, etc.

If stocks show disease signs, the condition should be correctly diagnosed to determine the appropriate treatment.

For most parasitic infestations and other external infections, salt water bath is suggested, or use formalin as an alternative treatment.

Salt bath

1 Fill the pail with about 10 liters of full-strength seawater. If seawater is not available, dissolve 200-300 g of table salt in freshwater and add up to 10 liters
2 Add aeration to the pail
3 Place the fish in a net, and dip it into the pail for 2-3 minutes
4 Transfer the fish into a tank with clean freshwater
5 Repeat the same procedures for 3-5 days

Formalin bath

1 Fill the pail with 10 liters of freshwater and add 0.1 mL (or 100 µL of formalin
2 Aerate the pail vigorously
3 Place the fish inside the pail for about 1 hour
4 Transfer the fish to another container, with flow-through water for about 15-30 minutes
5 Repeat the same procedures for 3-5 days

For bacterial infection, oxytetracycline can be applied as either:

a Intramuscular injection for broodstock at 50 mg oxytetracycline per kg of fish per day for 10 consecutive days
b Incorporated into the feeds of larger fish at 2-4 g oxytetracycline per kg of feed for 10 consecutive days. This method is applicable only if the infected fish are eating
c Bath treatment for fry and smaller juveniles

Oxytetracycline bath

1 Dissolve 10 milligrams of oxytetracycline in 1 liter freshwater and place in a pail
2 Aerate the pail vigorously
3 Place the fish inside the pail for 24 hours
4 Transfer the fish to another container containing clean water
5 Repeat the same procedures for 7 consecutive days

FINANCIAL ANALYSES OF CATFISH BROODSTOCK, HATCHERY AND NURSERY OPERATIONS

Table 4. Technical assumptions

Items	Broodstock	Hatchery	Nursery
Target production/year		1,200,000 fry	300,000 fingerlings
Project duration (years)	5	5	5
Days of culture/crop		15	60
Number of runs/year	12 months	10	5
Total farm area (ha)			0.05
Number of cage, tank or pond	4 ponds	12 tanks	12
Size of cage, tank or pond	100 m^2 pond	1 ton tank	100 m^2 pond or 2 x 2 x 1.5 m cage
Age of fish (days)	180	4-15	15-60
Number of fish/run	20 males, 50 females	120,000	120,000 per ha
Feeding rate (% of body weight)	3	50	20, 15, 10
Cost of diet (P/kg)	30	30	30
Stocking density	10-15 pcs/m^2	1/liter	100/m^2
Survival rate (%)	0 – males, 90 – females	25	50

Table 5. Investment items, cost and depreciation

Items	Broodstock/ hatchery	Nursery	
		Pond	Lake
Total investment cost	150,800	52,000	61,000
Depreciation cost per year	16,810	13,500	1,100
Depreciation cost per run	1,681	2,700	220
Salvage value after 5 years	66,750	13,750	14,750

Table 6. Financial investment analysis

Items	Broodstock/ hatchery	Nursery	
		Pond	Lake
Project duration	5 years		
Gross revenue	2,466,750	3,013,750	3,014,750
Investment costs	150,600	91,000	114,000
Total costs	1,201,664	435,996	350,576
Net income	1,114,285	2,590,754	2,550,174
Net present value at 12%	670,555	1,586,068	1,624,571
Internal rate of return (%)	158	983	865
Discounted benefit cost ratio (%)	5.98	49	31

Table 7. Costs-and-returns analysis

Items	Broodstock/ hatchery	Nursery	
		Pond	Lake
Revenue			
Sale of fry	480,000	120,000	120,000
Cost per run			
Total variable cost (P)	8,560	68,986	68,515
Total fixed cost (P)	15,204	18,223	15,670
Total cost (P)	23,764	87,199	70,115
Economic indicators			
Income per run (P)	24,236		
Income per year (P)	239,667	164,004	249,424
Return-on-investment (%)	159	37	71
Payback period (years)	0.59	0.29	0.24
Break-even price (P)	0.2	1.45	1.17
Break-even production (pc)	600,832	43,600	35,058
Total capital investment required	167,919	189,952	198,030

Table 8.1. Sensitivity analysis of catfish broodstock and hatchery operations

	Net income (Php)	Return-on-investment (ROI)	Break-even price (Php/pc)	Break-even production	Net present value (NPV) at 12% (Php)
Survival rate (%)					
25 (1.200 M fry)	239,667	159	0.20	600,832	670,556
20 (0.960 M fry)	143,667	95	0.25	600,832	361,575
15 (0.750 M fry)	47,667	32	0.33	600,832	52,594
Price of fish (Php/pc)					
0.4	239,667	159	0.20	600,832	670,556
0.3	119,667	79	0.20	801,109	284,330
0.5	359,667	238	0.20	480,665	1,056,782
0.6	479,667	318	0.20	400,554	1,443,008
Variable cost (Php)					
20% increase	219,890	146	0.22	650,276	606,900
10% increase	229,778	152	0.21	625,554	638,728

Table 8.2. Sensitivity analysis on catfish pond nursery operations

	Net income (Php)	ROI	Payback period (year)	Break-even price (Php/pc)	Break-even production (pc)	NPV at 12% (Php)
Survival rate (%)						
50	164,004	38	0.29	1.45	43,600	1,586,068
40	44,004	10	0.90	1.82	43,600	1,199,842
60	284,004	65	0.17	1.21	43,600	1,972,294
Price of fish (Php/pc)						
2	164,004	38	0.29	1.45	43,600	1,586,068
2.3	254,004	58	0.19	1.45	37,912	1,875,738
2.5	314,004	72	0.16	1.45	34,880	2,068,851
Variable cost (Php)						
20% increase	86,751	17	0.52	1.71	51,325	1,536,340
10% increase	125,378	26	0.37	1.58	47,462	1,561,204

Table 8.3. Sensitivity analysis on catfish lake nursery operations

	Net income (Php)	ROI	Payback Period (year)	Break-even price (Php/pc)	Break-even production (pc)	NPV at 12% (Php)
Survival rate (%)						
50	249,424	71	0.24	1.17	35,058	1,624,571
40	129,424	37	0.47	1.46	35,058	1,236,345
60	369,424	105	0.16	0.97	35,058	2,010,797
Price of fish (Php/pc)						
2	249,424	71	0.24	1.17	35,058	1,624,571
2.3	339,424	97	0.18	1.17	30,485	1,914,240
2.5	399,424	114	0.15	1.17	28,046	2,107,353
Variable cost (Php)						
20% increase	180,910	43	0.34	1.4	41,909	1,580,467
10% increase	215,167	56	0.28	1.28	38,483	1,602,519

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ABOUT THE AUTHORS

Dr. Josefa D. Tan-Fermin is a Scientist of the Breeding Section at AQD. She first worked as a research assistant under the Milkfish Broodstock Development Project in June 1979, eventually becoming a research associate in 1982. She finished her BSc in Biological Sciences in 1977 from the University of the Philippines in the Visayas (UPV), MSc in Zoology in 1982 from UP Diliman, and Doctor in Fisheries Science in 1997 from the Faculty of Fisheries, Hokkaido University. Dr. Tan-Fermin has worked on the different aspects of the reproductive biology and digestive physiology of milkfish, shrimp, sea bass, grouper, goldfish and catfish. These works were published mainly in refereed journals. Her doctoral dissertation and work on native catfish are results of continuing efforts to save this fish from extinction here in the Philippines.

Mr. Armando C. Fermin holds the position of Scientist and is currently the Program Leader of the Integrated Mollusk Program at AQD. He has more than 28 years of experience in aquaculture research, training, and extension obtained from his two employers, Central Luzon State University (CLSU) in Nueva Ecija, and AQD in Tigbauan, Iloilo. He worked on freshwater and marine aquaculture species like giant prawn, bighead carp, native catfish, seabass, and tropical abalone. He has published more than 30 articles in local and international journals and proceedings. He is a member of the International Abalone Society, Asian Fisheries Society, Network of Tropical Aquaculture Scientists, Tropical Marine Mollusks Programme, Philippine Aquaculture Society, and the National Research Council of the Philippines. He finished his BSc and MSc degrees from CLSU.

Ms. Ruby F. Bombeo is an Information Specialist of the Training and Information Division of AQD. She joined AQD as Research Technician in 1977. She has worked on natural food for fishes and the hatchery and nursery rearing of catfish. Along with her co-authors, she was a recipient of the Department of Agriculture (DA) Secretary's Award for Best Paper in the Aquaculture Research Category for the paper "Nursery rearing of the Asian catfish, *Clarias macrocephalus* (Gunther), at different stocking densities in cages suspended in tanks and ponds." She finished her BSc in Biology from Central Philippine University and her MSc in Fisheries (Aquaculture) from UPV.

Ms. Ma. Antonietta D. Evangelista is an Associate Researcher at AQD. She currently works on the culture of natural food organisms, and on the breeding, seed production and farming of the Asian catfish at the Binangonan Freshwater Station of AQD in Binangonan, Rizal. Her work on the "Culture of *Ceriodaphnia cornuta* in tanks and their utilization in the hatchery production of some freshwater fish species" won the 2004 AFMA R&D Paper Award (Agriculture and Fisheries Modernization Act for Research and Development) during the 16th National Research Symposium given by DA's Bureau of Agricultural Research. She earned her BSc in Fishery Education (cum laude) from Aklan National College of Fisheries in New Washington, Aklan and her Masters degree in Fisheries from UPV.

Dr. Mae R. Catacutan is a Scientist at AQD. She started working in 1978 as Research Aide of the Nutrition and Feed Development Section. Her work on aquaculture nutrition includes digestibility of feed ingredients, protein requirement, and vitamin C for popular species for culture. Her research work on the nutrition of important aquaculture species have been published in international journals. She graduated from Silliman University with a BSc Chemistry degree (cum laude) as a national state scholar. She obtained her MSc and PhD in Fisheries Science from Kagoshima University through scholarships from the Japanese government. She is a member of the Integrated Chemists of the Philippines, Asian Fisheries Society, and the National Research Council of the Philippines.

Dr. Corazon B. Santiago is a retired Scientist of AQD. Her work has been focused on establishing nutrient requirements of the larvae and broodstock of some freshwater fishes and developing fish feeds. She was also involved in a European Union-funded project on lake ecology and was active in the training projects of AQD. Dr. Santiago has published scientific papers in international and local journals and proceedings. Two of her publications were awarded the 1991 DA-BFAR Second Best Paper Award for Fisheries & Aquatic Resources and a special award at the 11th Dr. Elvira O. Tan Memorial Research Awards in 1997. She earned her BSc at the Mindanao State University (summa cum laude) and her MSc And PhD (major in fish nutrition) at Auburn University. She started her career as an instructor-researcher in 1972 at MSU Sulu College of Technology and Oceanography in Tawi-Tawi and in Naawan, Misamis Oriental.

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