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Milkfish Breeding

The milkfish *Chanos chanos* is a food of the common *tao* (man) and one of the most important fishes farmed in the Philippines. It is also a cultural symbol in the country, a national fish no less.

To develop the milkfish industry, the Philippine Government established the National Bangus Breeding Program (NBBP) in 1981. NBBP was undertaken by the Department of Agriculture and the SEAFDEC Aquaculture Department with funding support from the International Development Research Centre of Canada. NBBP's target is commercial production of fry using the milkfish breeding and hatchery techniques developed by SEAFDEC.

NBBP has twelve project sites, one in each of the country's regions. The Philippine Government recently decided to privatize the NBBP stations when technical and administrative problems remain unsolved. There was no commercial production of milkfish fry in most of the stations despite almost 10 years of operation.

The questions that potential investors are now asking themselves are:

- **What is the economic prospect of milkfish breeding in the country?**
- **Is the bangus breeding technology "ripe"?**
- **How much money will be invested?**
- **Where are these stations to be privatized? What about their status?**
- **What are the mechanics of the privatization?**
- **Where will we get the human resources to run the business?**

This issue on milkfish breeding attempts to answer these questions.

The milkfish fry industry in the Philippines

Milkfish is cultured in brackishwater ponds and freshwater pens. Research at the Department of Agriculture, however, has indicated that culture in pens in open sea is possible.

There are an estimated 176,000 ha of ponds and 5,000 ha of pens in the country producing milkfish, requiring an estimated 804 million fry annually. Aside from grow-out farms, the gathering and rearing of milkfish fry is a multimillion peso industry that provides livelihood and income to thousands of small fisherfolk.

A study conducted by the International Center for Living Aquatic Resources Management (ICLARM) estimated that 1.15 billion fry can be collected from the wild. However, there is fry shortage in the country. This is due to inefficient fry collection and handling techniques, and overexploitation of traditional fishing grounds, including illegal catching of broodstock or *sabalo*.

The type of fishing gear used to catch fry varies, depending on topography of fry ground, wind direction, current, and tidal fluctuation. Collection is usually done at high tide during full moon and new moon or when wind direction is favorable.

The country's milkfish grounds are located in the waters off Cagayan, Lingayen Gulf, Manila Bay, Batangas, and Albay in Luzon; Iloilo, Antique, Negros and Cebu in the Visayas; and Zamboanga, Cotabato, and Davao in Mindanao. In Luzon, fry are available from March to August, with the peak months in May to July. In the Visayas, fry are gathered from March to January, with the peak months in April to June. In Mindanao, fry are collected throughout the year -- the peak season is from March to May. But fry catch in many areas has declined. In Bicol (Albay) for instance, only 12 million fry were collected in 1980 compared to 25 million in 1978. In other areas like the Sulu Sea (Zamboanga), fry productivity has been maintained and this is attributed to the coral reefs that serve as fry refuge.

There is also much loss of fry due to inefficient handling and rearing techniques. From the time the fry are caught to the time they are harvested in ponds and pens, only 39% of the total fry collected are estimated to survive.

Studies to improve survival rates -- e.g., techniques for catching and handling fry and for rearing the fry to fingerlings -- should be pursued. It would also help the industry if technologies for spawning milkfish in captivity and production of fry in hatcheries are refined and extended. In addition, the anti-illegal fishing laws should be strictly enforced and natural spawning grounds protected from destructive fishing practices.

Sources: ***Agribusiness Weekly,*** 11-17 Sept. 1990; ***Agribusiness Monitor,*** Oct. 1990; ***Philippine Daily Inquirer***, 2 July 1992.

Exporting milkfish fingerlings is illegal!

The Philippine Government considers illegal the export of bangus fingerlings (or *hatirin* in the local language). This refers to fish measuring 25-100 mm and which have been grown for some time in nursery ponds.

- Fisheries Administrative Order No. 173 - 1, Series of 1991.

"Did you see any milkfish broodstock?" "Nope."

Philippine Daily Inquirer, 11 Nov. 1988

Milkfish broodstock technology of SEAFDEC/AQD

SEAFDEC/AQD scientists have been working on milkfish breeding since the late 1970s. Following successful breeding of milkfish in captivity, SEAFDEC/AQD published in 1984 a guide for the establishment and maintenance of milkfish broodstock.

This guide was updated in late 1992, now considering several developments -- improved egg collection techniques, a standard egg transport procedure, the spontaneous maturation and spawning of milkfish in concrete tanks, and an improved hatchery technology.

SEAFDEC/AQD's broodstock management techniques are described below.

Sources of broodstock

Milkfish juveniles (weight, 250-350 g) can be obtained from brackishwater ponds and fish pens where they have been cultured for a few months to a year.

Milkfish juveniles are transported to the broodstock cages or tanks in a floating fish cage or in a 1.5-m dia. canvas tank with 0.5-m deep water with aeration. The canvas tank may be suspended at the back of a pick-up truck or placed in the hull of a pumpboat.

For a start, about 100 juveniles can be stocked in a 10-m dia. cage or tank. After three years, half of this stock can be transferred to another 10-m dia. cage or tank until maturity is attained. At this time, another 100 juveniles can be stocked in another 10-m dia. cage or tank.

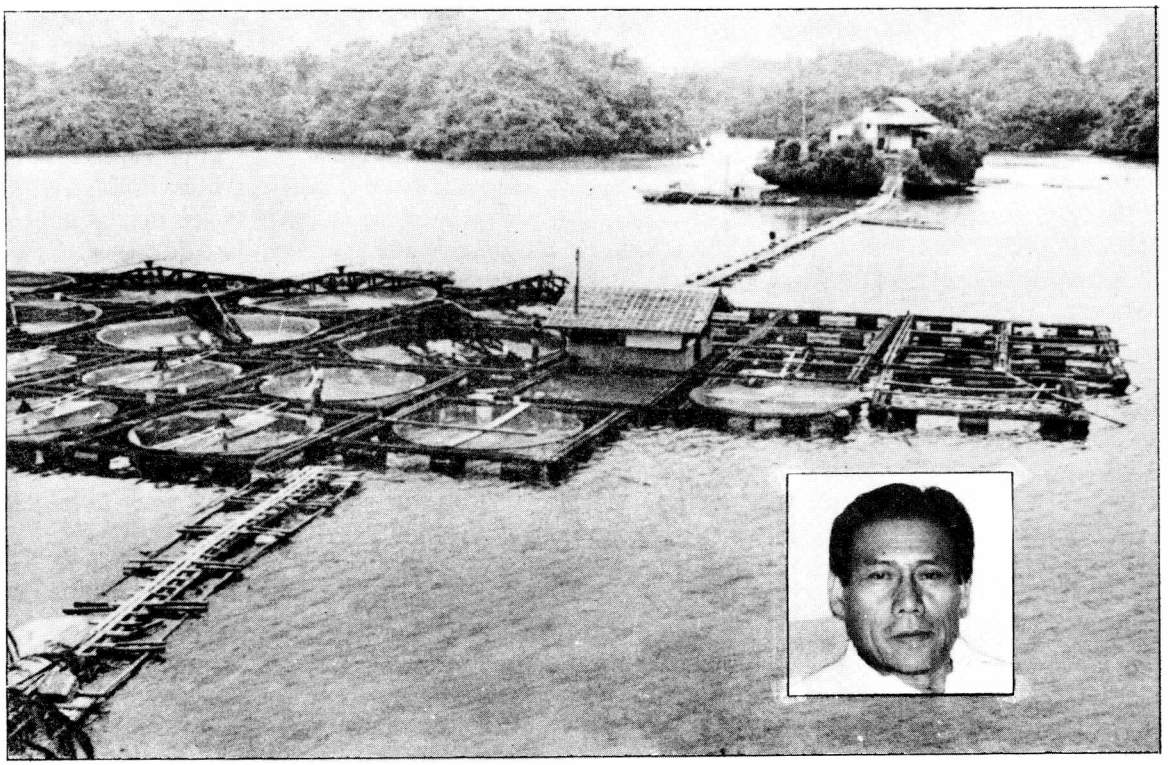
Holding facilities for broodstock

Floating cages must be located in a well protected area with minimum wave action even under adverse weather conditions. The site should have good water circulation, sandy-muddy substrate, and a minimum water depth of 5 m at the lowest tide.

Milkfish are then reared in 6- or 10-m dia. x 3-m deep floating net cages. Coralon net (mesh size, 5.7 cm; size of twine, 210d/60) previously treated with coal tar is used as cage netting. A net allowance of about 30% is provided to have good water exchange. The top is covered with a similar net size to prevent fish from jumping out. The bottom is covered with fine knotless net (mesh size, 3 mm) to retain sinking food. The cages are supported by floats which are either cylindrical styrofoam or empty plastic drums (0.6-m dia. x 1 m) fitted to the cage frame, but allowing for easy rotation to check fouling. Canvas cloth or fine net (mesh size, 1

In the book-launching ceremony of the manual on Management of Milkfish Broodstock held March 4 at Iloilo City, SEAFDEC/AQD Chief Efren Ed. Flores (far left) noted that the manual's mass reprinting will be funded by the Fisheries Sector Program of the Department of Agriculture. This is significant in view of the Philippine Government's move to privatize the NBBP stations.

Senior author Arnil Emata (far right) hands over a complimentary copy to the representative of the private sector, Dr. Salvador Dolar. Looking on is Dr. Cesar Villegas, Head of AQD's Training and Information Division.



The Igang Marine Station or IMS is one of SEAFDEC/AQD's three research stations, and where breeding technology for fishes -- milkfish, grouper, and sea bass -- are developed. In 1982, milkfish was spawned for the first time in captivity by the team headed by endocrinologist Dr. Flor Lacanilao (inset).

mm) is wrapped around the floats for protection against fouling organisms.

Cage maintenance is done regularly and involves:

1. Daily inspection to detect tears in the netting and to remove debris and fouling organisms;
2. Periodic rotation of cylindrical floats, repainting of wooden frame or galvanized iron (GI) pipe with coal tar; and
3. Changing of nets every 2 months or as needed to protect it from fouling organisms.

Fouled nets are sun-dried, cleaned, and repaired. When the spawning season starts, nets are left alone so that fish are not disturbed. Stress results in gonadal regression and delay of spawning.

Land-based concrete tanks measuring 8 m x 8 m x 2-m deep are sufficient for milkfish broodstock. A double pipe drainage is installed to allow water to flow out from the bottom. Water inlets and aeration lines are located at the top. A black sack cloth covers the tank to minimize excessive growth of algae.

Daily water inflow should be adjusted to change at least 50% of the water volume. The sides and bottom of the tank should be brushed monthly. The tank can be drained to at least a foot in depth for brushing. During the spawning season, water inflow should be increased so that brushing and draining can be minimized.

In both tanks and cages, optimum stocking density should not be more than 1 kg/m^3.

Feeding

Two- to four-yr old milkfish are fed twice daily with commercial fish pellets (24% protein) at 3% of their total body weight. Upon nearing maturation by the fourth year, fish are fed twice daily with commercial shrimp pellets with 36-42% protein and 6-8% lipid. Daily feeding ration is increased to 4% of total body weight. Feeds are broadcast to the fish by hand.

Determination of gonadal development

From the fifth year and thereafter, the fish are sampled in March and in November to determine the stage of gonadal development and to determine the sexual composition of the stock. A sex ratio of one female to one male or two females to one male is adequate for egg production. Unsexed fish can be kept in a separate cage or tank to be sexed later in the season or in the next season. Excess males can be sacrificed, or released to the sea in order to save on feeds. (See separate section on reproductive biology, p.7.)

The stage of gonadal development can be monitored through the cannulation biopsy technique. To facilitate this, the nets of the floating cages are lifted gradually, or the concrete tanks drained. Disturbance must be minimized to prevent any physical injury to the fish.

Fish are individually scooped out and then placed in a 400-l fiberglass tank containing 200 l seawater and 200 ppm (40 ml) 2-phenoxyethanol (an anesthetic). The anesthetic should be mixed with a little water before it is placed in the tank. Anesthetized fish are characterized by loss of balance (ventral side up), immobility, and rapid and shallow opercular movement.

Fish are weighed and then transferred to a shallow trough (0.5 m x 1.5 m x 0.15-m deep) containing 100 ppm 2-phenoxyethanol to keep the fish anesthetized.

Cannulation biopsy is done in the following manner:

In the wooden trough, the fish is laid on its dorsal side. To determine the presence of white viscous milt, its ventral side is gently pressed, starting from halfway of the abdomen to the anal region.

If no milt oozes out, a cannula (or polyethylene tubing with a 0.86 mm inner dia. and a 1.52 mm outer dia.) is inserted into the genital pore. Difficulty in inserting the cannula through the genital pore may be encountered among broodstock undergoing their first maturation and among fish examined early in the breeding season. The free end of the cannula is held in the mouth. The cannula is aspirated while slowly being withdrawn from the fish.

The cannula is immediately inspected. A milky whitish substance indicates a maturing or mature male. Spherical yolky oocytes appear translucent to opaque (quite distinct from fatty tissue which lines the abdominal wall). Cannulated gonadal tissue are then blown into a small covered tube and 5% formalin solution is added to preserve oocytes for examination and measurement.

A few oocytes are pipetted from the tube and placed on a glass slide. The diameter of 10-30 oocytes are measured under a microscope provided with an ocular rule. Oocyte size indicates degree of sexual maturity. Females with an oocyte diameter equal to or greater than 0.67 mm are considered near final maturation and spawning. As revealed by induced spawning studies, those with oocyte diameter less than 0.67 mm are maturing or early matured.

Following sampling, the fish are placed in a recovery tank with flow-through water and aeration. Fish must be fully recovered and swimming normally before they are returned to the main tank or cage. Recovery from anesthesia in fresh seawater can be facilitated by holding the fish in the caudal peduncle and swinging it back and forth until opercular movement becomes normal and equilibrium is regained.

Spawning and egg collection

Mature milkfish are left to spawn naturally in cages or tanks.

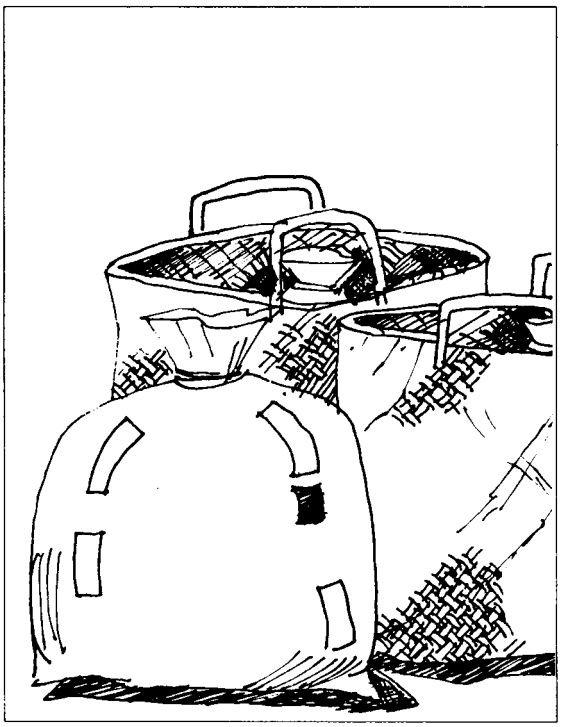
When spawning is expected, the cage is prepared for the collection of spawned eggs. A manually operated egg collector is installed over the floating cage. The egg collector is constructed of two parallel GI pipes (0.75-in. dia.) connected to a central shaft supported by a wooden truss frame. A fine net (mesh size, 0.6-0.8 mm) is attached to the parallel pipes with a detachable conical net bag on the far end. A bamboo pole attached to the central shaft serves as a handle for manual rotation of the egg collector around the cage.

To retain spawned eggs, a 5.8- or 9.8-m dia. circular *hapa* net made of nylon netting (mesh size, 1 mm) is installed inside the 6- or 10-m dia. floating net cage, respectively. A half sack of sand or gravel is dropped to the bottom of the *hapa* net lining to maintain its cylindrical shape. The *hapa* net is set in place at night. It is taken out of the water at daytime on alternate days to extend its life span and to increase the water circulation in the cages. As soon as eggs are

found during sampling of water from the cage, confirming that spawning has occurred, the egg collector is operated within 10 min. to an hour. Delay in collecting eggs can drastically decrease egg collection as egg cannibalism by milkfish spawners is known.

In land-based broodstock tanks, the presence of eggs is checked daily around midnight by scooping water in a beaker. When present, the eggs are immediately collected. The egg collector consists of 2 airlift PVC pipes (4-in dia.) with outflows directed to a 1 m x 1 m x 1 m *hapa* net supported by a PVC pipe frame. Two egg collectors are installed in each tank at the corners opposite the water inflow. Additional airlift pumps are installed with their outflows directed towards the egg collectors. The *hapa* nets are raised and rinsed, and the eggs scooped out. The nets are cleaned and sundried during the day, then installed at night in anticipation of the next spawning.

Fertilized milkfish eggs are spherical, finely granulated, pelagic, non-adhesive, transparent with a slight yellow tinge, and have no oil globule. A developing embryo is visible 10 h after spawning. The time of spawning may be back-calculated from the stage of embryonic development at the time of egg collection.



Following collection in cages, the conical bag is detached and placed in a pail containing 10 l of seawater. Milkfish eggs should not be allowed to stay out of seawater for more than a few minutes. The eggs are released from the net bag, taking care to dislodge eggs sticking to the net. The collected sample is then aerated to keep the eggs afloat, then transferred to a container with 400-l filtered seawater.

Determination of percent egg viability

The percentage of viable eggs is the ratio of the total number of live eggs to the total number of eggs. This value is used to monitor the performance of a batch of eggs and is also used in computing the hatching rate and the number of larvae stocked.

Viable or live eggs are transparent with a narrow perivitelline space and a blastodisc. Depending on the time of egg collection, an embryo may be visible. Dead eggs are opaque, and the unfertilized ones have no perivitelline space.

Transport of eggs

The hatchery must be located as close as possible to the broodstock cages or tanks to minimize mechanical damage of eggs due to handling and transport.

The time spent for preparing eggs for transport and transport of eggs itself should be kept to a minimum. About an hour prior to transport, packing preparations should be underway following these steps:

Shut off the aeration. Swirl the water in the container at least once to concentrate dead eggs at the bottom. Siphon out dead eggs.

Set a double-lined plastic bag inside the *bayong* and fill with about 15 l filtered seawater (salinity, 28-32 ppt).

Scoop eggs with a fine mesh (0.6-0.8 mm) scoop net. With a beaker, take about 150-200 ml of eggs from the scoop net and quickly transfer to the *bayong*. About 60,000 eggs are contained in 100 ml.

Saturate each plastic bag with oxygen and seal tightly with rubber bands.

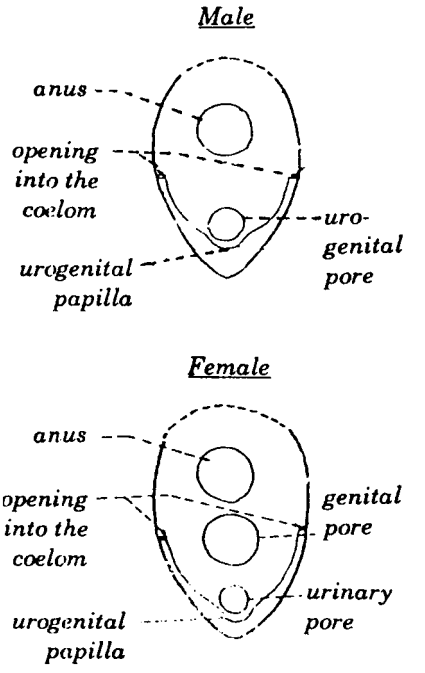
Bayong bags should be kept in the shade throughout transport. Water temperature in the

(to page 8 please)

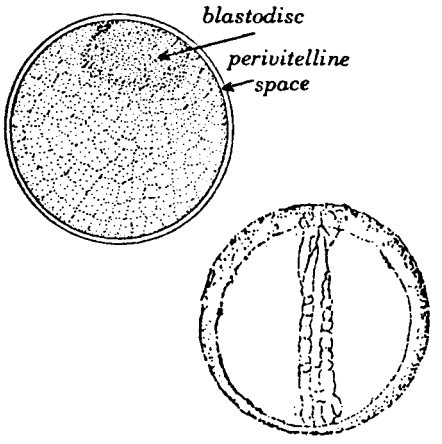
A lesson in milkfish reproductive biology

Captive milkfish mature and spawn naturally at about five years of age. Tank- or cage-reared adult milkfish weigh around 2.5-9.0 kg. Among captive females, the ratio of gonad weight relative to body weight (gonadosomatic index, GSI) ranges from 0.05% (immature) to 4.46% (mature). In contrast, mature ovary can take as much as 25% of body weight of wild-caught milkfish. Captive females produce an average of 200,000 eggs/kg. Immature captive males have a GSI of 0.1% that increases to 4.0% as maturity is attained.

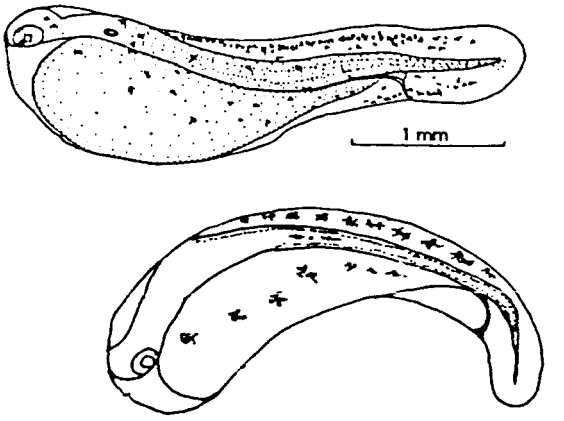
In captivity, milkfish broodstock are immature in December and January, gonadal development begins in February and March, and spawning occurs from April to November. This pattern is consistent with the occurrence of milkfish adults, eggs, and fry in coastal areas. The spawning season appears to coincide with a long photoperiod and relatively high temperatures.



Males and females can be differentiated based on their anal region.



A newly fertilized egg (1.1-1.25 mm dia.) and an egg with developing embryo.



A newly hatched normal larva and an abnormal larva.

Milkfish broodstock ... from p. 6

bags should not go beyond 30°C.

In the hatchery, each plastic bag is placed in a hatching tank with 400-l filtered and well-aerated seawater. After a 15-min acclimation, the plastic is opened and the eggs released. The eggs are stocked at 250-300 per liter.

Determination of hatching rate

Milkfish eggs hatch between 20 and 24 h from spawning at temperatures of 26-32°C and salinities of 29-34 ppt.

The number of normal larvae (straight body and without deformities) and abnormal larvae (curled body) is determined under a microscope. The hatching rate and percentage of normal larvae are also determined.

Hatching rate is the ratio of the total number of larvae to the total number of live eggs. The percentage of normal larvae is the ratio of total number of normal larvae to the total number of larvae. Both values are indicators of the performance of a batch of eggs.

Postscript

Research on broodstock nutrition is very important for further refining AQD's broodstock management techniques. The production of good quality eggs and larvae depends on proper broodstock nutrition. Another area for research is the method of obtaining gonadal maturation and spawning in milkfish outside its breeding season. Success in these two areas -- broodstock nutrition and off-season maturation and spawning - will augment the seed supply of milkfish perhaps to the point where dependence on natural supply will be minimized, if not, eliminated.

Source: AC Emata, CL Marte, LMB Garcia. 1992. ***Management of Milkfish Broodstock.*** SEAFDEC/AQD Aquaculture Extension Manual No. 20. 22 p.

References on milkfish available at SEAFDEC/AQD

Publications

- ***Biology of Milkfish (Chanos chanos).*** TU Bagarinao. 1991. 94 pp.
  Old price: ₱200 US$40
  New price: ₱100 US$20
- ***Milkfish Hatchery Operations.*** RSJ Gapasin, CL Marte. AEM No. 17, 1990. 24 pp.
  Old price: ₱80 US$30
  New price: ₱40 US$15
- ***Milkfish Abstracts.*** BRAIS. 1988. Bibliography Ser. No. 9. 104 pp.
  Old price: ₱150 US$35
  New price: ₱75 US$15
- ***Advances in Milkfish Biology and Culture.*** JV Juario, RP Ferraris, LV Benitez, Eds. Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, October 1983. 243 pp.
  Old price: ₱230 US$45
  New price: ₱115 US$20

Video tapes

- ***Caring for Milkfish Larvae.*** 14 min.
  Old price: ₱420 US$40
  New price: ₱200 US$20
- ***Milkfish from the Wild to the Farm.*** 16 min.
  Old price: ₱480 US$50
  New price: ₱200 US$20
- ***Milkfish Fry Collection, Handling and Storage.*** 16 min.
  Old price: ₱495 US$50
  New price: ₱200 US$20
- ***Milkfish Fry Acclimation and Fingerling Production in Freshwater.*** 10 min.
  Old price: ₱315 US$30
  New price: ₱200 US$20
- ***Milkfish Culture Systems.*** 10 min.
  Old price: ₱310 US$30
  New price: ₱150 US$15

Other references on milkfish that were not published by AQD are available c/o The Library, SEAFDEC/AQD, Tigbauan 5021, Iloilo, Philippines. When writing, please indicate specific area of interest, e.g., cage/pen culture.

Economic analysis of an integrated milkfish broodstock and hatchery operation

SEAFDEC/AQD Associate Scientist Renato Agbayani and colleagues determined the economic viability of an integrated milkfish broodstock and hatchery. They also noted the critical technical areas in its operation and recommended measures that would improve the profitability to levels attractive to private hatchery operators.

The economic analysis was prepared based on technical data obtained from experimental results of SEAFDEC/AQD:

- Number of mature female milkfish, 50 fish/cage
- Fecundity/kg per spawning of fish, 300 000 eggs
- Number of spawning/fish per year, three
- Fertilization rate, 85%
- Egg collection rate, 95%
- Hatching rate, 59%
- Survival rate in the hatchery, 30%
- Stocking density in the hatchery, 30 eggs/liter.

A 15-year development plan was prepared. The plan had the first 4 years of operation devoted to broodstock development, and one 10-m dia. floating cage was to be constructed each year. Every cage was to be stocked with 100 milkfish, each fish weighing about 250 g. In anticipation of the maturation and spawning of milkfish in the fifth year, the first hatchery facility was to be constructed during the fourth year and every year thereafter up to the fifteenth year to accommodate all the eggs produced in the floating cages. Table 1 shows the projected milkfish egg production for 15 years based on technical data. Spawning season is from May to October, with September as the peak period.

Projected cash flows for four cages of milkfish broodstock were computed for the entire 15 years. Table 2 shows the projected cash flows for the first 4 years for Cage 1. The initial infrastructure, e.g., guard house, caretaker's house and pump boat, are common costs for the four cages but are reflected in the cash flow of Cage 1.

The projected cash flow of the hatchery operation was computed from Year 4 to Year 15. The capital outlay for the initial hatchery facilities in Year 4 totalled ₱8,670,254 and the operating expenses in Year 5 reached ₱1 583 652. (Operating a milkfish hatchery is discussed in *Aqua Farm News*, Vol. VIII, No. 3, May-June 1990.)

The 15-year cash flow for an integrated milkfish broodstock and hatchery operation is shown in Table 3. Positive cash flow started in Year 8, after an investment of about ₱45 million.

The economic analysis using discounted cash flow at a discount rate of 8%, showed that net present value (NPV) was negative from Year 5 to Year 15 and internal rate of return (IRR) was likewise negative from Year 5 to Year 14. In Year 15, IRR registered a positive 4%. Despite the negative economic indicators, the IRR and NPV showed upward trends starting in the sixth and seventh years, respectively.

The seemingly poor economic indicators were due to:

- High investment in the hatchery facilities, especially in concrete tanks and life-support equipment; the high ratio of algal and rotifer tanks to larval rearing tanks (6:1) resulted in high expenditures on tanks; and
- Low utilization of hatchery facilities because of the short seasonal spawning which is only 6 months (May to October); the estimated capacity utilization is only about 30% over a period of 1 year.

Government subsidy

The ₱45 million initial investment for an integrated broodstock-hatchery system which starts paying off after six years is no doubt unattractive to the private sector. The NBBP (see preceding sections) is a public investment in the milkfish industry with such a capitalization.

When the government invests in a project which benefits a particular sector of society -- in this case milkfish growers -- the unrecovered

Table 1. Projected milkfish egg production

	Year 5	Year 6	Year 7	Year 8
Quantity of spawners	50	100	150	200
Fecundity/kg of fish	300 000	300 000	300 000	300 000
Average weight of fish (kg)	3.00	3.13	3.25	3.38
Fertilization rate	0.85	0.85	0.85	0.85
Number of spawning/fish per year	3	3	3	3
Quantity of fertilized eggs	114 750 000	239 062 000	372 937 500	516 375 000
Collection rate	0.95	0.95	0.95	0.95
Quantity of collected eggs	109 012 000	227 109 375	354 290 625	490 556 250
Hatching rate	0.59	0.59	0.59	0.59
Quantity of hatched eggs	64 317 375	133 994 531	209 031 469	289 428 188

	Year 9	Year 10	Year 11	Year 12
Quantity of spawners	200	200	200	200
Fecundity/kg of fish	300 000	300 000	300 000	300 000
Average weight of fish (kg)	3.63	3.88	4.13	4.38
Fertilization rate	0.85	0.85	0.85	3
Quantity of fertilized eggs	554 625 000	592 875 000	631 125 000	669 375 000
Collection rate	0.95	0.95	0.95	0.95
Quantity of collected eggs	526 893 750	563 231 250	599 568 750	635 906 250
Hatching rate	0.59	0.59	0.59	0.59
Quantity of hatched eggs	310 867 313	332 306 438	353 745 563	375 184 688

	Year 13	Year 14	Year 15
Quantity of spawners	200	200	200
Fecundity/kg of fish	300 000	300 000	300 000
Average weight of fish (kg)	4.63	4.88	5.13
Fertilization rate	0.85	0.85	085
Number of spawning/fish per year	3	3	3
Quantity of fertilized eggs	707 625 000	745 875 000	784 125 000
Collection rate	0.95	0.95	0.95
Quantity of collected eggs	672 243 750	708 581 250	744 918 750
Hatching rate	0.59	0.59	0.59
Quantity of hatching eggs	396 623 813	418 062 938	439 502 063

cost is subsidized by other sectors of society. The government, however, can recover the cost of a project by improving the project's economic efficiency through sustained research and development efforts. An alternative action of the government in the case of the NBBP is to concentrate on egg production while maintaining pilot-scale hatcheries in selected sites for research, training and extension purposes, as is presently done. The fertilized eggs can be sold to private hatchery operators who are presently in shrimp (*Penaeus monodon*) fry production but can switch to milkfish as an alternative crop.

The cost efficiency aspect of the milkfish broodstock operation merits further discussion. During the first year, the cost of eggs ranged from ₱4,800 to ₱13,100/million, a very high figure compared to the market price of shrimp nauplii which cost between ₱2,500 to ₱3,500/million. The cost of milkfish eggs decreased during the fourth year of hatchery operation when incremental revenues became greater than the incremental costs. Costs level off from ₱1,900 to ₱2,400/million eggs. The cost of feeds was estimated to be about 46% of total cost over a 15-year period. The cost of rearing a 5-year old

Table 2. Cash flow projection of one unit floating cage milkfish broodstock for 4 years

Items	Year 1	Year 2	Year 3	Year 4
Capital outlay				
Infrastructure				
Floating cage	12 000			
Guard house[1]	5 000			
Caretaker's house and bodega[2]	50 000			
Egg collector				7 000
Equipment				
Pump boat	30 000			
Weighing scales	3 000		3 300	
Thermometers	300		330	
Refractometer	5 000			
Dissecting set	1 000			
Skin diving gear	2 000		2 000	
Subtotal	108 300		5 830	7 000
Operating expenses				
Fish stock	1 000	1 050	1 103	1 158
Feeds	2 549	5 578	10 545	76 687
Chemicals	5 000		5 500	
Nets	15 000		16 500	
Twines, ropes, etc	15 000		16 500	
Gas, oil and grease	15 000	15 750	16 538	17 364
Salaries				
Technician	24 000	24 000	26 400	26 400
Aide	12 000	25 200	39 690	13 200
Repairs and maintenance	5 415	5 415	5 707	6 057
Miscellaneous	5 000	5 000	5 000	5 000
Subtotal	99 964	80 943	142 379	144 707
Total cost per year/cage	208 264	80 943	148 209	151 707

[1]Off-shore; [2]on-shore.

milkfish broodstock weighing about 3 kg is about ₱8,000, using 1988 prices as the base.

The shrimp hatchery operators in the Philippines are encouraged to go into milkfish fry production as an alternative to shrimp fry in view of the latter's decreasing price. The government-operated milkfish broodstock stations can initially sell the milkfish eggs at a subsidized price to private hatcheries to encourage the private operators.

The investment requirement needed to put up a small-scale milkfish hatchery is estimated at ₱316,724. The working capital required is ₱36,624 which is good for two runs. The rest is spent on capital structures and equipment. The annual depreciation is ₱30 360, computed by a straight-line method based on the estimated economic lives of the various items of equipment and structures.

The cost-and-return analysis of a private milkfish hatchery can be based on the following production efficiencies:

- Hatching rate, 59%
- Survival rate, 30%
- Stocking density, 30 egg/l

The cost of eggs was placed at ₱2,100/million which was the leveling-off cost. The cost of inputs and milkfish fry was based on the prevailing market prices in 1989 in the province of Iloilo. The ROI is 63% and the payback period is 1.47 years. Feeds (*Artemia*) cost 9% and fertilized milkfish eggs cost 23% of total operating costs. There was a dramatic increase in the price of milkfish fry from ₱0.14 in 1988 to as high

Table 3. Cash flow projection for an integrated milkfish broodstock and hatchery project

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Cash outflow[1]						
Broodstock	208 264	172 389	282 011	378 377	457 804	718 661
Hatchery	0	0	0	8 670 254	10 116 186	12 853 459
Total	208 264	172 389	282 011	9 048 631	10 573 989	13 572 120
Revenue	0	0	0	0	2 199 654	4 811 744
Net cash flow	(208 264)	(172 389)	(282 011)	(9 048 631)	(8 374 335)	(8 760 376)

	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Cash outflow[1]						
Broodstock	808 246	832 313	977 823	990 823	1 233 038	1 207 765
Hatchery	15 872 259	9 494 494	9 788 120	10 316 319	11 794 723	11 526 545
Total	16 680 506	10 326 807	10 765 943	11 306 593	13 027 761	12 734 310
Revenue	7 881 636	11 458 686	12 922 852	14 504 787	16 212 609	18 054 951
Net cash flow	(8 798 870)	(1 131 897)	(2 156 909)	(3 198 194)	(3 184 848)	(5 320 640)

	Year 13	Year 14	Year 15
Cash outflow[1]			
Broodstock	1 333 964	1 429 413	1 571 518
Hatchery	12 669 615	13 881 656	1 982 633
Total	14 003 579	15 311 169	3 554 151
Revenue	20 040 995	22 180 507	24 483 867
Net cash flow	6 037 416	6 869 338	20 929 716

[1]Capital outlay and operating expenses.

as ₱0.70 in 1989. A conservative price of P0.45/fry was used in the cost-and-return analysis. There was not enough fry to supply the needs of brackishwater ponds estimated to be about 80% of a total of 207,000 hectares. Similarly, the ex-pond prices of table-size milkfish also rose dramatically by a minimum of 50% in 1989 as compared to the 1987 prices.

Comparatively, the estimated ROI of a small-scale shrimp hatchery in 1986 was 90% but had deteriorated to a low 15-20% in 1989. About 50% of the small-scale hatcheries located in southern Iloilo experienced losses and stopped operation due to cutthroat competition.

If the survival rate improves from 30% to 40%, the ROI increases from 64% to 94%. At this level of profitability, the present shrimp hatchery operators will be encouraged to consider milkfish as an alternative crop. The break-even survival rate is 9%. The break-even price is P0.13/fry.

Recommendations

NBBP should concentrate on egg production and sell the milkfish eggs at a subsidized price to attract hatchery operators, and tap potential export markets for fry. (The government decided to privatize the NBBP stations. - *Ed.*)

SEAFDEC/AQD, on the other hand, should pursue research on: induced spawning during off-season to take advantage of higher prices and optimize hatchery utilization; improvement of production efficiency rates (egg and fry survival and egg hatching rate, higher stocking densities); and reduction of the number of tanks to reduce investment in life-support facilities.

Source: R Agbayani, N Lopez, R Tumaliuan, and G Berjamin. 1991. *Economic analysis of an integrated milkfish broodstock and hatchery operation as a public enterprise.* **Aquaculture** 99: 235-248.

The Philippines' milkfish breeding program

The Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippine Department of Agriculture reported the status of the National Bangus Breeding Program (NBBP), as of June 1992. The program established one project site in each of the country's regions.

The projects in Regions II and VIII were suspended because of frequent damage to cages by typhoons. In the Region VIII site in Tacloban, Leyte, 330 2-year old milkfish are reared in ponds.

REGION I

Location: NBBP office - Lucap, Alaminos, Pangasinan (300 km north of Manila); maturation cages installed in Hundred Islands (30 min. by motorboat from Lucap)

Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	85	9/6	4.5
2	49	8/8	4
3	50	8/8	4
	184		

Spawning record: 1986 - 1989, 1992

Hatchery: Existing but not producing well

REGION III

Location: Office and maturation cage - Bamban, Masinloc, Zambales

Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	44	9/6	3.5

Spawning record: March 1986

Hatchery: Existing but not operational

REGION IV

Location: Maturation cages - Tiniguiban Cove, Puerto Princesa City

Date started: 1983

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	18	9/0	5
2	30	5/0	3
3	70	5/0	3
4	200	4/0	2.5
	318		

Spawning record: 1989

Hatchery: Existing but not operational

REGION V

Location: Maturation cages - Damacan, Bacacay, Albay

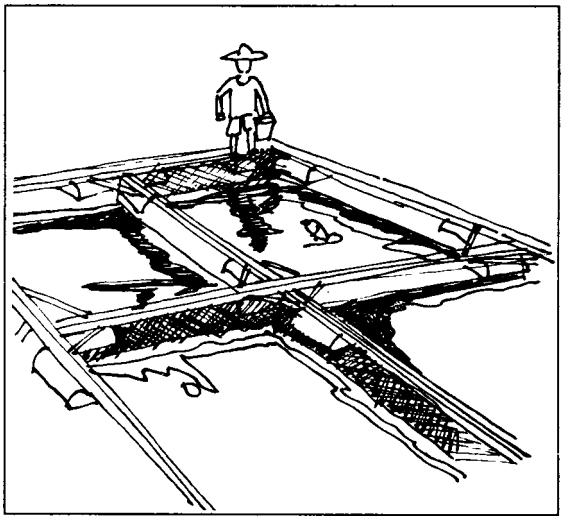
Date started: 1983

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	191	5/3	4.5
2	39	5/3	4.55
3	100	4/3	2.91
4	77	4/3	2.91
5	92	4/3	2.91
6	139	2/3	1.6
	638		

Spawning record: 1992

Hatchery: None



REGION VI

Location: Maturation cages - Barangkalan, Carles, Iloilo

Date started: November 1989

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	13	-	4.3

Spawning record: None

Hatchery: None

REGION VII

Location: Maturation cage - Pangangan Is., Calape, Bohol

Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	16	9/10	5.26
2	17	9/10	5.26
	33		

Spawning record: October 1986 - 1989

Hatchery: Existing but not producing well

REGION IX

Location: Maturation cages - Sangali, Zamboanga City

Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	7	5/5	3.5
2	108	4/9	3.0
	115		

Spawning record: None

Hatchery: None

REGION X

Location: Maturation cages - Punta Miray, Baliangao, Misamis Occidental

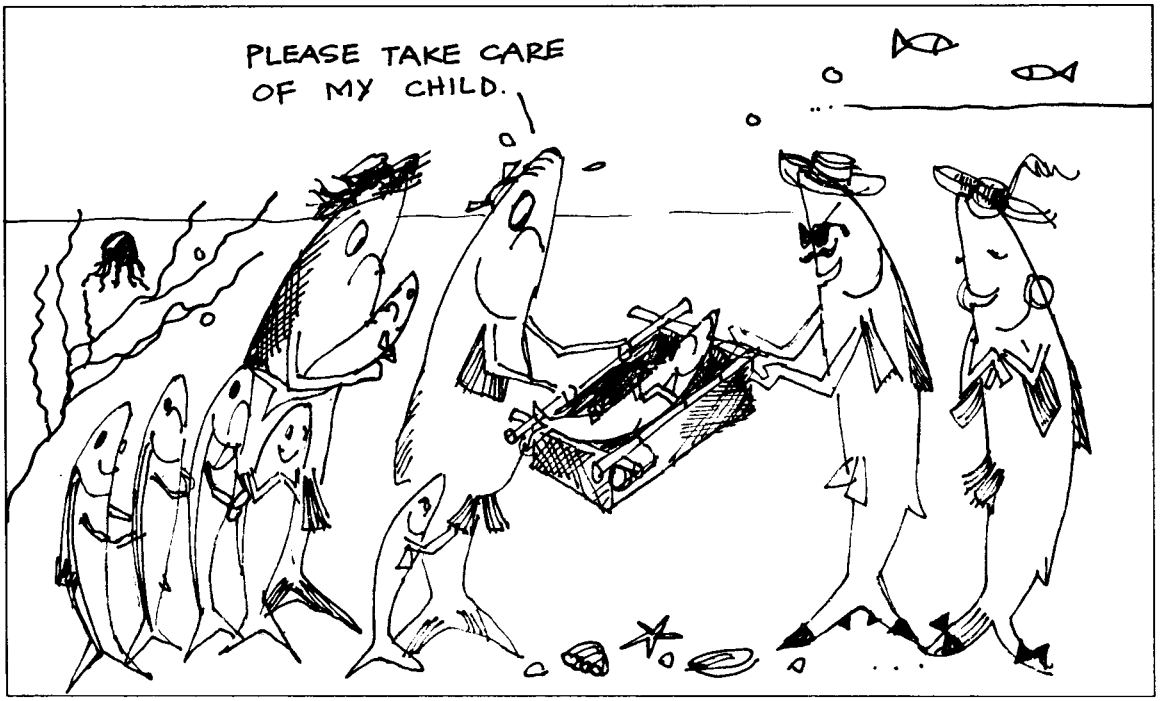
Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	8	8/7	4.4
2	90	5/9	3.9
	98		

Spawning record: None

Hatchery: None



REGION XI

Location: Maturation cage - Tagabuli, Sta. Cruz, Davao del Sur

Date started: 1981

Stock:

Cage	No. of stocks	Age (yr/mo)	Ave. body wt. (kg)
1	69	6/8	4

Spawning record: April 1986 - 1989

Hatchery: Existing but not operational

Region XII

Location: Parang, Maguindanao - three maturation cages but no stock

Date started: 1981

Hatchery: None

Problems

When the Department of Agriculture was reorganized in 1988, BFAR lost its administrative control over the NBBP stations. The stations were transferred to the regional offices; however, funds are often insufficient and released very late. Generally, the NBBP stations are poorly maintained and managed.

In spite of this situation, the broodstock in all the stations continued to spontaneously spawn. Some fertilized eggs were collected but the insufficient knowledge of the staff assigned in the sites and the poor hatchery facilities resulted in very low larval survival.

Privatization scheme

All the broodstock and cages in the project sites will be sold except in Regions I, V, and XI where 30 pieces in each station will be retained for research.

Price. Broodstock price is computed as: ₱1,000 multiplied by estimated age (measured in one unit per every year of life of broodstock). The minimum lot is 30 and the maximum, 100 pieces. Cages are sold based on assessed value.

The by-products of research are also sold: bangus eggs, ₱6,000 per million; and fry, existing market price.

Prices are subject to change.

Buyer. The potential buyer must be a Filipino citizen, a duly registered cooperative, or a Filipino-owned corporation. The capability of the potential buyer will be evaluated based on:

- Experience in hatchery operation
- Hatchery facilities
- Personnel or manpower complement
- Financial capability

Condition of sale. The Department of Agriculture reserves the right to monitor the operation of the hatcheries and broodstock farms including egg and fry production and management.

Sources: (1) NB Arevalo. 1992. *Bangus breeding program in the Philippines.* Paper presented at the **Aquaculture Workshop for SEAFDEC/AQD Training Alumni;** 8-12 September 1992; Tigbauan, Iloilo. (2) Department of Agriculture Order No. 8, Series of 1992, issued by Secretary Roberto Sebastian.

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- natural food production. This includes plankton counting techniques; media preparation for algal culture; scaling-up of culture; disinfection, decapsulation, and hatching of *Artemia.*
- feed formulation and preparation
- disease monitoring and identification
- fabrication of hatchery tools and equipment
- harvesting, packing, and transport of fry

The Department has conducted two sessions of this course in 1991 upon the request of the Department of Agriculture. Farmers' associations may request for a session, with expenses shouldered by the requesting party. Fifteen trainees may be accommodated in a session.

Write the Training and Information Division Head, SEAFDEC/AQD, Tigbauan 5021, Iloilo, Philippines.

~~FOCUS~~: Research and researchers on breeding

The Breeding Section of SEAFDEC/AQD was organized in 1986. Where before scientists were formed into commodity teams (e.g., shrimp, milkfish), they are now organized by disciplines — breeding, nursery, farming systems, feed development, and fish health. The rationale was that techniques can be standardized and adapted to practically any aquatic species. The demand for cultivable species, on the other hand, changes with consumer preference and market price. This is exemplified by the boom and bust of the shrimp industry in the mid-1980s.

The Breeding Section is one of the five sections in AQD. Its' research agenda on milkfish is long, and this includes: (1) refinement of broodstock management and (2) induction of maturation and spawning by hormonal and photoperiod manipulation. Other studies on milkfish, in collaboration with researchers working on other disciplines, are on the:

- refinement of hatchery techniques
- verification and economic assessment of hatchery and nursery techniques by private cooperators
- performance of hatchery-produced fry
- bioenergetic and nutrient cycle studies
- factors affecting recruitment and survival
- raciation and stock assessment
- development of practical diets for hatchery, nursery, and grow-out
- development of disease prevention and control methods for hatchery, nursery, and grow-out.

In 1992 alone, the Section's researchers authored 10 of the 57 scientific papers published in journals and credited to the Department. The researchers have also authored three how-to manuals for the fishfarmers and extension workers: *Management of Milkfish Broodstock*, 1992; *Milkfish Hatchery Operations*, 1990; and *A Guide to the Establishment and Maintenance of Milkfish Broodstock*, 1984. They have organized the *National Seminar-Workshop on Breeding of Cultured Finfishes in the Philippines* which will be held in May 1993.

The extension activities of the Section also include the training courses conducted by the Department, particularly *Marine Finfish Hatchery*, and consultations requested by the private sector and government agencies.

The researchers in the Section are:

- Josefa Tan-Fermin (MS Zoology, University of the Philippines, 1982)
- Luis Ma. Garcia (MS Zoology, University of Alberta, 1984)
- Clarissa Marte (PhD Zoology, National University of Singapore, 1990)
- Emilia Quinitio (MS Fisheries, University of the Philippines, 1980)
- Cesar Villegas (PhD Agriculture, Iowa State University, 1970)
- Arnil Emata (PhD Physiology, Louisiana State University, 1990)
- Joebert Toledo (MS Fisheries, Hiroshima University, 1990)
- Grace Garcia (MS Fisheries, University of the Philippines, 1991)
- Nieves Toledo (MS Fisheries, Kagoshima University, 1988)

Dr. Marte, Dr. Emata, and Mr. Toledo are working on milkfish; Mr. Garcia on sea bass and rabbitfish; Ms. Garcia on sea bass; Ms. Fermin on catfish; and Ms. Quinitio and Ms. Toledo on shrimp. Dr. Villegas is working on tilapia but he is presently designated Head of the Training and Information Division.

~~FOCUS~~: Training course on milkfish hatchery

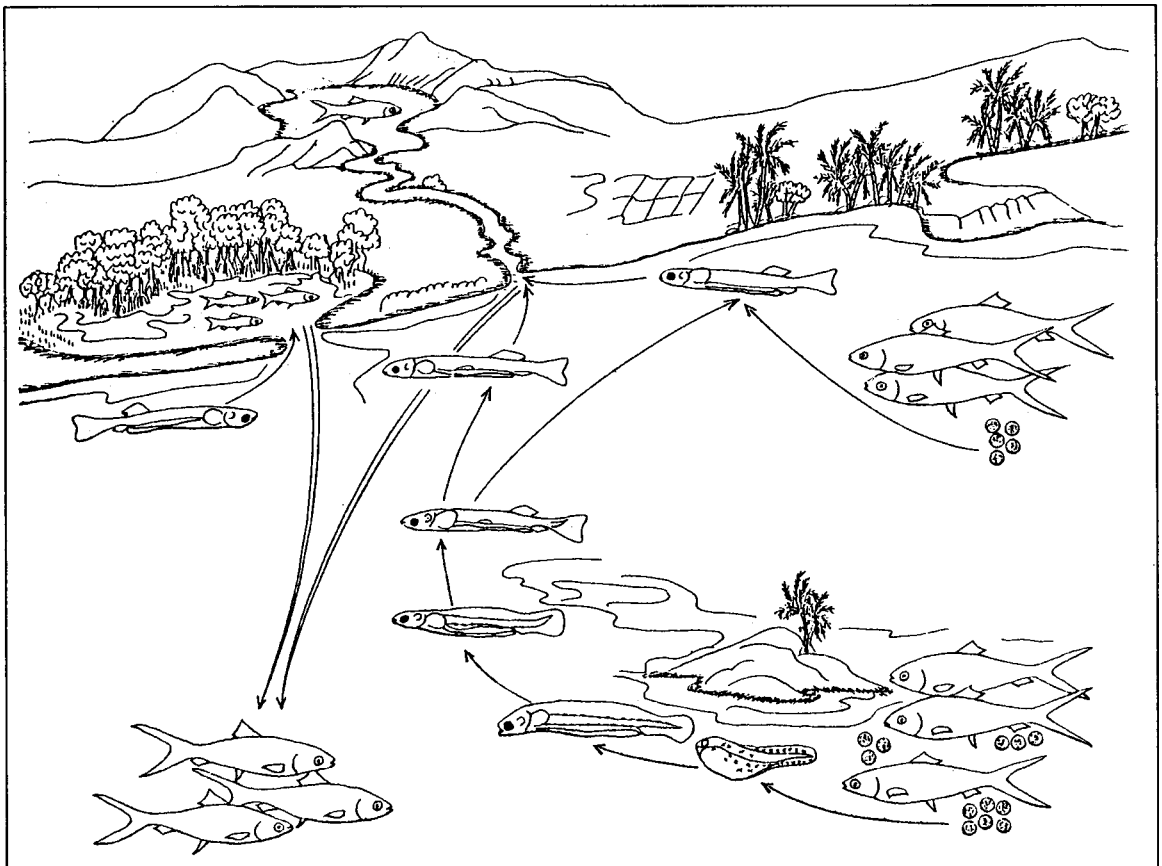
A one-month course on milkfish hatchery has been designed by SEAFDEC Aquaculture Department to update shrimp hatchery operators and technicians and government extension workers on new technologies of milkfish hatchery. It covers the basic concepts of milkfish larval rearing and production of natural food organisms required by larvae and fry. Among the lectures are:

- biology of milkfish
- broodstock development
- principles of milkfish larval rearing
- culture of phytoplankton and zooplankton including biology of *Artemia*
- nutrition of fish larvae
- disease prevention and control
- hatchery site selection and facilities
- economics of fry production
- fish cage culture

The practical work which is 70% of the course includes:

- induction of gonadal maturation and spawning
- monitoring of spawning
- egg collection, packing, and transport
- larval rearing, from incubation of eggs until 15 days old

to p. 15 please



In the wild, milkfish spawns in outer reefs or shoals and the fry are distributed nearshore where they are caught by fry gatherers. [TU Bagarinao. Systematics, distribution, genetics, and life history of milkfish, *Chanos chanos*. Environmental Biology of Fishes, in press.]

Aquaculture clinic

QUERY Can private hatchery operators collaborate with SEAFDEC/AQD especially in milkfish hatchery?

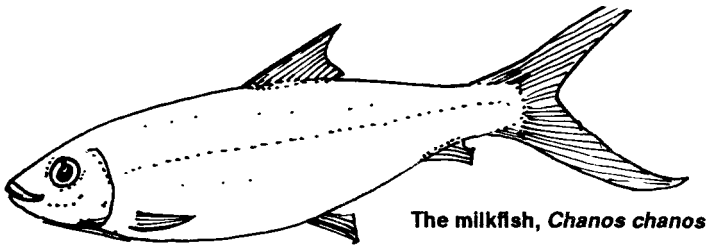
REPLY Yes, they can. SEAFDEC/AQD has an **Adopt-a-Milkfish-Broodstock** scheme that is being implemented (i.e., starting the 1993 spawning season) (see also *SEAFDEC Asian Aquaculture*, March 1993). The scheme is in line with the Department's efforts to extend milkfish broodstock and hatchery technology.

Cooperatives of private hatchery owners and individual private hatcheries with hatchery facilities in Region VI -- Iloilo, Capiz, Aklan, Antique, Guimaras, and Negros Occidental -- can avail of the scheme. The operator or his technician must have trained in marine fish hatchery operations at SEAFDEC/AQD and must have produced milkfish fry on a commercial scale. SEAFDEC/AQD extends technical assistance and provides the breeders (about 45-50), a cage, and an egg collector. The stock and the cages are in the Igang Marine Station in Guimaras. The cooperator shoulders all the expenses of maintaining the breeders. The adoption cost is estimated at ₱110,000 per season, and this already includes feed cost, 15% overhead cost , and 10% administrative charge. To give the operators the opportunity to gain experience in maintaining breeders, he (or his technician) is required to coordinate with AQD regarding the maintenance of the stock.

The cooperator gets all the eggs spawned by the adopted milkfish. SEAFDEC/AQD, on the other hand, reserves the **exclusive** right of the data gathered on the broodstock, hatchery, grow-out, and production of the fish. The Department also has priority in procuring the fry produced by the collaborating hatchery, of course, at prevailing market price.

To date, three hatchery operators have collaborated with AQD on this scheme: JSP Hatchery in New Washington, Aklan; Sweet Water Aqua Farm, Inc. or SWAFI in Roxas City; and Philippine Aquaculture Specialists, Inc. or AQUASPEC in Iloilo City.

For more information, write the Research Division Head, SEAFDEC Aquaculture Department, Tigbauan 5021, Iloilo. Tel. 271-009; FAX 271-008.



The milkfish, *Chanos chanos* Forsskal

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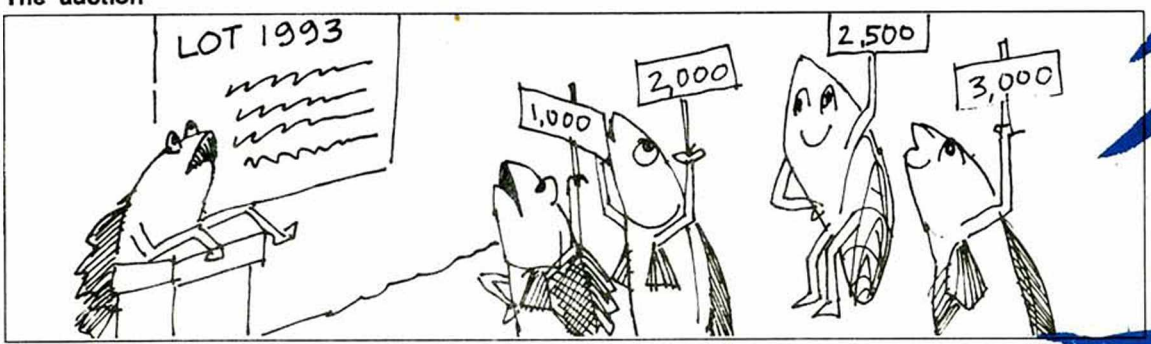
The auction



by I. Tendencia

Better life through aquaculture