

What are the latest developments in marine hatchery?

By **AJ España**

The outbreak of diseases in tiger shrimp as the prime aquaculture commodity during the past several years became a catalyst for the industry to rethink its methods of production. As a result, there came changes in approaches to fish farming in consideration of the industry's impact on the welfare of people as resource users.

The industry now recognizes the need for diversification of aquaculture products. In Southeast Asia especially, the culture of milkfish, sea bass, grouper, snapper and rabbitfish is continually enhanced in order to provide better alternative food fish for the people. However, large-scale production is still hampered by the lack of a reliable source of fry.

This article looks into propagation technologies, mainly based on researches conducted and made available to the public by SEAFDEC/AQD. Issues and problems are discussed as shared by experienced aquaculture practitioners.

Technology update

Presently at AQD, scientist Dr. Arnil Emata said that breeding and fry production of economically important marine fishes are being refined. Present studies focus, but are not limited to, ensuring consistent high egg and larval quality, minimize deformities of hatchery-produced fry, development of artificial larval diet, and better management techniques for larviculture. All these should enhance survival rate and provide notable hatchery techniques.

Ms. Marietta Duray, another AQD expert, said that in terms of technical viability, milkfish and sea bass hatchery techniques have been refined and are now adopted by the private sector. However for sea bass, the major problem is on marketing of fry.

On the other hand, there are workable hatchery technologies for grouper, snapper and rabbitfish that need further refinement and verification to ensure the economic viability of the commodities. Ms. Duray pointed out that the high-priced *Artemia* as larval feed for later stage development continues to hinder commercial production and private sector adaptation.

The table next page is a matrix summarizing the developments and limitations in the hatchery technology for marine commodities. Readers are enjoined to look up listed references for a detailed description of these research findings.

Milkfish

Dr. Emata said that AQD has developed the breeding and hatchery technology for this species to supplement natural supply, meet the demands of fishfarmers and ensure the sustainability of the

industry. Milkfish is the most popular cultured food fish in the Philippines, Taiwan and Indonesia. In the Philippines, it has long become an export product, and yet remains quite affordable to the average-income Filipino. Its wet market price ranges from P40 to P60, although it can cost as high as P90 during lean periods. In Taiwan, milkfish costs P100 per kilo.

AQD has gone from induced spawning of adult milkfish (1976) to fry production in the hatchery (1992). The typical larval culture process of milkfish in AQD involves the immediate collection of eggs to prevent cannibalism by the broodstock by using a manually operated sweeper-type egg collector in cages. Fine mesh nets attached to an airlift system made of 4" diameter PVC pipe collect the eggs in concrete tanks.

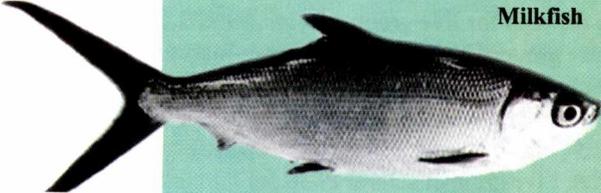
As related by Dr. Emata, "The hatchlings are fed with rotifers (natural zooplankton) and formulated diet. After about three weeks in the hatchery, they are harvested for stocking in nursery ponds before growout."

AQD's researchers have found out that the development of larval feeds can reduce the rotifer requirement and consequently cut production costs. This diet may be fed to milkfish larvae in combination with rotifers starting day 2 or day 8, and may be used as sole feed starting day 15. The artificial diet is formulated to meet the nutrient requirements of the larvae.

One of the problems in milkfish hatchery fry production is the existing misconception among milkfish farmers that hatchery-bred fry are inferior to those sourced from the wild. This actually has some basis because market appeal involves fry quality and uniformity of size. A study by AQD researcher Grace Hilomen-Garcia found out that hatchery-bred fry easily fatigue even at lower swimming speeds than wild fry, and much so for smaller fry compared to larger fry.

The same study indicated that hatchery-bred fry could suffer from deformities like deformed opercular bones and branchiostegal rays and membrane which expose the gills. More extensive deformities of larvae could affect the growth and survival of milkfish during grow out.

In an experiment by Neila Sumagaysay with Hilomen-Garcia and Luis Maria Garcia using hatchery-bred deformed and non-deformed juveniles, it was found out that the final weight, specific growth rate and survival of the non-deformed fish after four months of culture were significantly higher than those of the deformed fish. Production did not significantly differ between the unmixed non-deformed and the mixed deformed and non-deformed fish. But survival of the deformed stock was definitely lower than that of the non-deformed stock.

SPECIES	TECHNOLOGICAL VIABILITY	ECONOMIC FEASIBILITY
 <p data-bbox="574 205 667 226">Milkfish</p>	<p data-bbox="727 205 1141 281">Developed: artificial larval diet as replacement for <i>Artemia</i>; broodstock diet; broodstock transport</p> <p data-bbox="727 310 1109 386">Developing: enhanced larval feeds to improve resistance to salinity and stress and lower incidence of deformities</p>	<p data-bbox="1162 205 1370 386">Locally-produced hatchery-bred fry suffer in competition from those sourced from the wild and those imported from Taiwan and Indonesia</p>
 <p data-bbox="574 422 667 443">Sea Bass</p>	<p data-bbox="727 422 1122 623">Developed: grading and transport techniques to reduce fry mortality; reduced use of <i>Artemia</i>; improvement of egg quality by establishing effects of various fatty acids on fertilization rate, hatching rate and percentage of normal zygotes; spawning through proper use of LHRHa</p>	<p data-bbox="1162 422 1370 443">Limited market of fry</p>
 <p data-bbox="574 684 667 705">Grouper</p>	<p data-bbox="727 684 1117 781">Developing: use of copepod nauplii to improve larval survival rate, and thyroid hormones to advance larval metamorphosis</p> <p data-bbox="727 814 1130 1016">On-going studies: broodstock dietary manipulation to improve egg/larval quality; effects of environmental factors on egg/larval survival and larval nutrition, digestability of protein ingredients and replacement of fish meal to reduce dependence on trash fish, prevention and control of diseases</p>	<p data-bbox="1162 684 1370 835">There is a large potential for live-fish market but production is limited due to low survival rate in the hatchery</p>
 <p data-bbox="529 1056 662 1077">Red snapper</p>	<p data-bbox="727 1056 1084 1098">For verification: effect of salinity on larval survival</p> <p data-bbox="727 1131 1125 1228">On-going studies: broodstock diets; effect of feeds and stocking density on larval survival, use of hormones to hasten metamorphosis</p>	<p data-bbox="1162 1056 1312 1077">Limited market</p>
 <p data-bbox="570 1371 678 1392">Rabbitfish</p>	<p data-bbox="727 1371 1130 1446">Developing: improved growth (larvae and early juveniles) through growth hormone and diet manipulation</p> <p data-bbox="727 1480 1084 1577">Further studies needed: effects of environmental factors, natural food, nutritional requirements and stocking density on fry survival</p>	<p data-bbox="1162 1371 1370 1551">Limited due to still developing hatchery technology, and high freight and handling costs due to low packing density of fry or juveniles</p>

But Dr. Emata said that these problems are being worked out. AQD researchers are generally optimistic that hatchery-bred milkfish fry will later gain widespread acceptance. Besides, the situation could be similar to that of the tiger shrimp when its hatchery business was just starting.

Ms. Hilomen-Garcia and fellow AQD researcher Joebert Toledo established that timing the transport of eggs and larvae

during periods when they are not too sensitive to risks or injuries is one way of reducing stress. The sensitivity of milkfish embryos to mechanical shock varies during development — the C-shaped eyed stage may be manipulated or transported with minimum risk or injury. Newly-hatched larvae are also more tolerant of stress during transport.

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Sea bass

Former AQD research staff and now private hatchery operator Albert Gaitan ranks sea bass as third to red snapper and grouper in market demand. Fresh sea bass sells at P100-150 in the local market. As with grouper, snapper and rabbitfish, sea bass are considered as an alternative food fish to shrimp and milkfish.

Sea bass are considered easy to breed and propagate and grow fast in farms. But there are details in the nursery phase which local growers are still unfamiliar.

Mr. Gaitan says that sea bass farmers tend to stock fry without much knowledge of rearing techniques. Negative results have discouraged them to go any further.

“The nursery phase is very critical for sea bass which are carnivorous by nature. ‘Grading’ has to be done every other day to separate the bigger fingerlings from the smaller ones in order to reduce mortality due to cannibalism.”

Mr. Gaitan recommends cage culture for sea bass in ponds or the sea as a feasible grow out method. Cages can be lifted at least twice a week to monitor the growth or increase in size of the fish (and minimize the incidence of the smaller ones getting eaten by the bigger ones) and cull or separate the bigger fish from the smaller ones.

On the other hand, Ms. Duray said that it is the lack of buyers of sea bass fry that is discouraging hatchery operators to go on. Most farmers get their stock of fry from the wild.

The following are the results of research activities at AQD on sea bass spawning and hatchery technology:

- *Egg quality assessment* – total saturated fatty acids, phosphoserine, and aspartic levels can have a positive effect on fertilization rates; DHA/EPA (eicosapentanoic acid) ratio on hatching rate; and DHA and aspartic acid content on the percentage of normal zygotes
- *Spawning by injection or implantation of hormones (such as luteinizing hormone-releasing hormone analogue or LHRHa)* — sea bass spawn when injected with an LHRHa solution or when implanted LHRHa pellets; spawning is significantly reduced if dissolved LHRHa solutions have been stored for more than 90 days in a refrigerator (4-10°C) or for more than 30 days at room temperature (28-30°C);
- *Reduction of the use of Artemia in sea bass seed production* — the brackishwater cladoceran *Diaphanosoma celebensis* can partially replace *Artemia* in rearing sea bass larvae; nursery rearing of small juveniles can be done in illuminated floating net cages; high zooplankton abundance at night under the 300 lux lamps increases the feeding incidence, gut contents, specific growth rate and survival of juveniles, relative to those in non-lighted cages; growth and survival are also enhanced in larvae fed with minced “trash fish” during the day;
- *Food preference and consumption go with larval growth* — from initial feeding with rotifer at 2.5 mm TL (day 2) to brine shrimp at 4.0-4.5 mm TL (day 10)

Grouper

There is a big demand for live grouper in local and international markets because grouper has become a favorite food for prestige dining, especially in Chinese restaurants. This demand has resulted to overfishing, thus the need for the captive culture of grouper. Captive culture could also lower the price of grouper in the local market. Live grouper sells at P550 per kilo in Manila. It sells a bit lower in Hongkong – P380 per kilo.

Aquaculture production of grouper is still low because of dependence on wild fry supply which has been greatly affected by environmental degradation, unsustainable supply of trash fish as feeds, and the emergence of diseases. AQD initiated researches in the captive culture of grouper and succeeded in making several breakthroughs since the first spontaneous spawning in 1990.

AQD has gone from the raising of broodstock in floating net cages and concrete tanks, as well as the hormonal sex inversion of females to functional males. It succeeded in effecting the maturation and year-round spawning, as well as the completion of the grouper life cycle in captivity. Intensive and semi-intensive hatchery production technique was also developed. However, survival from hatching to metamorphosis (35-60 days) is still low (at 2-10%) in existing hatchery techniques. Research conducted showed improved larval survival with the use of copepod nauplii, and advanced larval metamorphosis with the use of thyroid hormones.

AQD researcher Joebert Toledo said that on-going studies are geared towards the improvement of the quality of eggs or larvae by looking into broodstock dietary manipulation and the effects of environmental factors like temperature, salinity, and light and aeration intensity on the survival of grouper eggs or early stage larvae.

Further studies, in collaboration with the Australian Center for International Agricultural Research (ACIAR), are presently conducted on the following aspects: (1) elucidating the development of the digestive tract and associated organs in relation to feeding techniques, (2) lipid nutrition in larvae – which could help stabilize survival in the hatchery, (3) digestibility of terrestrial (local) protein ingredients, and (4) replacement of fish meal in grouper diets which would reduce dependence on trash fish or fish meal-based diets.

Red Snapper

Like the grouper, red snapper enjoys a high demand both in the local and foreign market. Live snapper sells at P150-P200 per kilo in Manila.

AQD has established that red snapper can be bred and raised entirely in captivity. Dr. Emata says that production of fry through hatchery is now possible but refinements still need to be done. “Snappers require more food and a longer culture period (45 days) in the hatchery than milkfish.”

AQD researchers have come up with the following study results and observations from which hatchery techniques — especially on spawning, diet manipulation and feeding, stocking, as well as larval rearing – for red snapper can be based:

ery-related activities was enhanced. I am now more skillful in terms of actual propagation of different cultivable marine species. Specifically, I learned the appropriate engineering and biological consideration in designing marine hatchery. The most current application I did after the training was to design and renovate the hatchery building of our institute in Palawan. I was confident enough to do the job because of the knowledge I gained from the training. The things I learned also boosted my confidence both as an aquaculturist and as academician. I know that what I am sharing with my students and the Palaweños is the most appropriate technology available. For me, attending the MARFISH training at SEAFDEC/AQD is comparable to reading all the books on hatchery practices. The lectures were all comprehensive and informative. In fact, all courses offered were very educational, enlightening and rewarding.”



Ronald Sombero Batch '99

College of Fisheries
Mindanao State University
GENERAL SANTOS CITY

“Attending the MARFISH training broadened and improved my knowledge on the biology, hatchery and production (under controlled condition) of marine fishes. It opened a lot of possibilities for research work and other related activities on my

part. I am back to my teaching job and I am now more confident to deal with my research on marine finfish. The chance to meet people from other parts of the world, exchange ideas and work with them was also an added advantage of the training. It was really a great endeavor, a worthy experience!”



Latest developments in marine hatchery ... from page 24



Experimental rabbitfish fry injected with bovine growth hormone (top), and control fry (bottom)

- Snapper spawn naturally in captivity mostly during the last quarter and new moon (during the months of March to November); fecundity about 4 million per female per season; can be induced to spawn with the use of 1,000 IU per kg hcg or 100 µg per kg LHRHa
- Effects of diet and feeding techniques on survival rate — diet consisting of *Chlorella*, *Brachionus*, *Artemia* and minced trash fish — survival is highest when larvae are fed small *Brachionus* (<90 µm) during the first 14 days, and when fed *Artemia* at 2 per ml four times a day; larvae begin to feed on day 4, and rotifer intake and feeding incidence increase with age; larvae reared under ambient photoperiod, 24 hours light, and 16 hours light differ in the time taken for all to feed and in the time to empty the guts, but not in the survival rate of <3%
- Larvae stocked in 3-ton tanks at 1,500 or 3,000 or 4,500 per ton of water grow similarly to day 21, but with low survival of 2-4%; day 21 larvae stocked at 3 per liter in 200-liter tanks and fed *Artemia* alone, supplemental diet (Lansy A2) alone, or *Artemia* plus supplemental diet, do not differ in survival after two weeks; day 21 larvae fed *Artemia* immersed in thyroxine survive and grow as well as those without hormonal treatment but fed *Artemia*
- Survival of red snapper larvae is higher at 16 ppt (7-6%) than at 40 ppt (4-3%) during the first 21 days of rearing, but older larvae tolerate 16-40 ppt and abrupt changes in salinity. This can be attributed to the gills which have now begun to function
- Thyroid hormones (T3 or T4) accelerate metamorphosis in *L. argentimaculatus* larvae; three-week old larvae immersed in 0.01 ppm T3 or T4 complete metamorphosis after one week whereas those immersed in thiourea and those left untreated do not; five week-old larvae show a dose-dependent response to both hormones

Dr. Emata says that snapper aquaculture (breeding, hatchery and growour) needs to become more consistent in order for the industry to respond well to market demands. 

“For one, a technique that will ensure high survival rate of snapper fry has not yet been generated.”

Rabbitfish

AQD has developed techniques to breed rabbitfish (*Siganus guttatus*) and produce fry. It is ideal for farming because it breeds in captivity, spawns regularly and eats algae – thus keeping production costs low. It sells at P90-P100 per kilo in Philippine wet markets.

Ms. Duray said that rabbitfish or siganid spawn whole-year round by natural methods and can be induced to spawn by hormonal treatment. Fertilization rates are relatively the same for both methods.

AQD researchers have also successfully cloned the hormone that controls growth in rabbitfish and produced the hormone using recombinant DNA technology. It started by having the growth hormone (GH) isolated from the fish's pituitary gland. It was then purified and its growth-promoting activity was tested in rabbitfish fry. When given as weekly injections, GH significantly increased the body weight and length of the fish.

Researchers are now studying more practical means of administering the hormone. This can be done by incorporating the fish's own growth hormone to fish diets through formulated feeds.

The use of the growth hormone can dramatically speed-up the slow growth of rabbitfish and make its marketability more attractive. Presently, fish farmers are hesitant to adopt its culture technology because of its extremely slow growth.

Moreover, Ms. Duray said that there have been buyers of rabbitfish fry from northern Philippines. But it turned out that the freight and handling cost is twice the price of the fry. Packing density is low due to sensitivity of the fry to transport stress and handling. This problem is presently being worked out.

Furthermore, hatchery technology for rabbitfish is slowly generating public interest. There are already inquiries from fish farmers in Naawan, Misamis Oriental, Zamboanga and Davao in Mindanao and as mentioned above in the Ilocos region in Luzon. Requests for technical assistance from AQD in rabbitfish hatchery have been pouring in.

Issues

A stronger link has to be made to make hatchery technologies more accessible to fish farmers in the private sector in the Philippines. Farmers should note though that some of these technologies are still in the process of refinement.

On the other hand, Mr. Toledo said that no hatchery (for grouper, for example) exists on a commercial scale in Asia, except in Taiwan. A related article (*on page 29*) describes how a pronounced support system helps groups of family-operators in Taiwan to become self-sufficient, for example, in the supply of eggs or larvae, and natural foods (for several marine species), thus reducing dependence on big commercial producers.

In contrast, AQD's Wilfredo Yap said that hesitance on the part of local entrepreneurs to venture into large-scale operations has hampered the development of the hatchery industry in the Philippines.

Records at the Bureau of Agricultural Statistics (BAS) in Iloilo, Philippines where AQD is based, indicate the following problems confronting local fry hatchery operators: lack of demand from buyers or growers (despite the big demand for market-sized products), labor intensive, and high operational cost even if market prices of fry remain low.

Aileen Jamandre, owner-manager of Jamandre Industries Inc, one of the leading fry hatchery companies in Iloilo, attribute this to “unsupportive government policies” that allow the importation of fry (tiger shrimp and milkfish, basically) from other countries which provides unfair competition because no production support is given at all to local producers like them.

“Over-production is such a big risk because growers would prefer to buy imported fry rather than those produced locally.”

Even big companies like Sarangani in southern Philippines are only now about to sell surplus fry of groupers, sea bass, snappers and other alternative marine species after the demand for these have begun to be expressed by private growers.

Sarangani's Rex Ticao said that previously, the company produced fry mainly for its own use because they were not sure of the outside market. However, Sarangani-developed hatchery technology has not been made available yet to the public.

There is therefore a growing need for development support in terms of technology research and facilities, as well as capital and marketing inputs in order to encourage the growth and stabilization of the fish hatchery industry in the Philippines and perhaps in the rest of Southeast Asia.

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