

SEAFDEC Asian Aquaculture



IN THIS ISSUE
**Marine hatcheries in Taiwan,
Indonesia, Philippines**



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Four departments were established in the Member-Countries; one of them, the Aquaculture Department (**AQD**) located in the Philippines, pursues aquaculture research and development

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Our cover

Indoor rearing tanks for grouper in Taiwan. Facilities such as these were formerly used in tiger shrimp hatcheries
Photos by Josephine N. Nocillado and I. Chiu Liao

Around the World

The health and future of coral reef systems

Coral reefs are among the most productive ecosystems on earth, providing valuable ecosystem uses. Their high productivity has prompted the World Conservation Strategy (IUNC/UNEP/WWF) to recognize coral reefs as some of the essential global life support systems necessary for food production, health and other aspects of human survival and sustainable development. The resources derived from coral reefs also provide food security to millions of people living along the tropical coastal communities.

Corals are colonial organisms that consist of thousands of polyps. They flourish in clear, shallow warm water with temperature between 18 to 30°C. Distribution of corals is limited to depths shallower than 100 m because light is essential for their survival. Salinity preference of corals is 32-40 ppt.

But the rapid growth of human population places a heavy burden on these resources. Degradation of coral reefs is common. For example, El Nino-induced increases of sea temperature cause bleaching that degrades many of the world's coral reefs.

Threats to coral reefs may be broadly divided into two distinct groupings: that caused by man and his activities, and those considered to be natural causes. Among man's activities are coastal development, overexploitation, inland and marine pollution, and soil erosion. An analysis published by the World Resources Institute, Washington DC, in 1998 determined that 58% of the world's coral reefs are at a medium- to high-level risk of degradation and that greater than two thirds of the reefs that are outside the Pacific Ocean are threatened.

Natural occurrences that degrade the coral reefs are the significant increases in global temperature that cause the bleaching of corals, tropical storms, volcanic, and tectonic activity, and crown-of-thorns starfish outbreaks. Bleaching of corals results to reduced reproductive capacity and recruitment, reduced growth, and change in coral community composition. While storms and volcanic disturbances can cause massive damage to coral reefs, damage tends to be localized. But in

➤ NEXT PAGE

Philippines affirms to support AQD



Recognizing SEAFDEC/AQD as one of the most relevant research institutions in the Philippines and in Southeast Asia, Agriculture Undersecretary and SEAFDEC Council Director for the Philippines Cesar Drilon affirmed government support for AQD "to enable this institution to successfully pursue its goals and objectives."

Drilon made this statement in his keynote speech during AQD's 28th anniversary program July 6, 2001 at Tigbauan, Iloilo, Philippines.

With the opening of the Biotech Laboratory in the morning of the same day, Drilon pointed out that aquaculture will undoubtedly need new technologies to keep up with rapid population growth and make fish farming more cost effective and the country's fish products more globally competitive.

He lauded AQD's efforts in cloning the growth hormone of milkfish and rabbitfish.

"I hope such developments will result in fast growing fishes," Drilon added.

Referring to the Mariculture Park project, Drilon praised AQD for its efforts in technology transfer, and encouraged it to continue and sustain the development of established technologies.

➤ NEXT PAGE

Usec. Drilon, BFAR Director Malcolm Sarmiento and AQD Chief Rolando Platon (top to bottom) speak before officials, staff and guests during AQD's 28th anniversary program



Around the World ... continued

extreme cases, recovery may be severely retarded. Outbreaks of the coral-feeding crown-of-thorns starfish can be devastating to coral reefs but explanations to explain the phenomenon have not been satisfactory.

Coral reefs are resilient ecosystems, thus, recovery is possible either thru natural or assisted ways. But the length of time of such recovery is difficult to predict and may depend upon the magnitude of the degradation. Other factors that would affect recovery are the alleviation of disturbances, influx of coral larvae from other reefs, timing of the disturbance, survival of some polyps in the community, and survival of adult corals in deeper water. If recovery is assisted, it is important to outline definite goals and determine the likelihood of the corals to recover.

Majority of the coral reefs are within the national boundaries of developing nations. Characterized by widespread poverty and overpopulation of the coastal zones, the future of such reefs could be jeopardized. The systematic implemen-tation of coastal zone

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coral reefs.
Further-
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global
warming
and rising
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clearly

show that reef management and conservation is “no longer the sole responsibility of countries with coral reefs.” Making sure that the world environment is friendly to the coming generations is a responsibility of all nations — including the industrialized, first-world nations of Europe and North America. [REF: Souter DW and Linden O. 2000. *Ocean and Coastal Management* 43: 657-688]

➡ NEXT PAGE

Drilon reminded the audience of AQD’s pioneering efforts in aquaculture.

“The breakthroughs AQD achieved in aquaculture research, especially the breeding of the giant tiger shrimp continues to benefit countless Filipinos and other people in the ASEAN region.”

The technocrat also urged AQD scientists, researchers and other people involved in aquaculture not to rest on their laurels. He encouraged them to bring technologies down to the marginalized folks in order to raise food production and make significant changes in the lives of these people.

Other activities held during the anniversary celebration were the following: (1) launching of the AQD Library’s aquaculture collection online or on the web; (2) the annual DK Villaluz Memorial Lecture delivered by Dr. Ben Malayang who spoke about environmental governance and issues on tenure in aquaculture; and (3) the launching of seven new publications -- a tilapia manual, a report of AQD’s coastal resource management in Aklan, proceedings volume of two technical conferences, a textbook on fish health management, a manual on shrimp culture, and a summary of AQD accomplishments in 2000. These activities were held on July 4, 2001. — *JR Paniza*

Mariculture park: a first in the Philippines

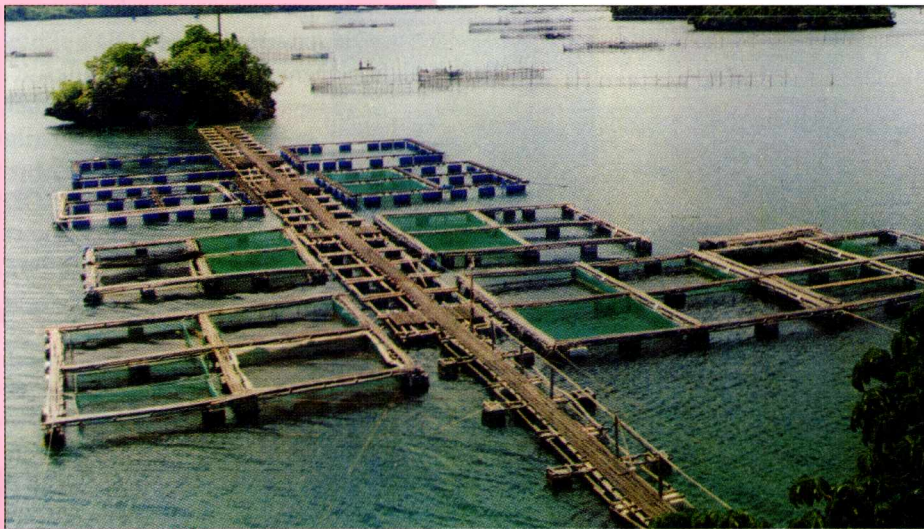
For many years, the vast expanse of the sea has remained an untapped frontier for food production by means of aquaculture. This is starting to

change with the concept of a mariculture park. A pilot park will be tested by SEAFDEC/AQD in the bay area where it has a marine substation. This is located in Igang, Guimaras Island, central Philippines.

The concept of a mariculture park is akin to the land-based industrial park. Aquaculture spaces will be made available for lease, and the cost required for deep sea cage farming is shared by the tenants. Fees can be based on a fair return of investment for the infrastructure amortized over a period of say, 10 years or longer.

The basic component of a mariculture park is a communal mooring system where prospective cage operators could fasten their cages. Several service facilities are also provided like a nursery, working platform for harvesting, feed warehouse, and technician’s quarters. A resident technical expert would be on-call to implement production protocols and preventive disease diagnostics.

The pilot park — called Igang Mariculture Park — is 14 meters deep at low tide. It will serve as a demonstration and training facilities on the



The Igang Mariculture Park, Guimaras Island, west central Philippines

Around the World ... continued

Global efforts needed to manage the world's marine areas

There are initiatives to manage and protect marine areas and their resources from pollution problems brought about by artificial chemicals, radioactive substances, overfishing and overwhaling, degradation of the ozone shield in the atmosphere and increase of UV-radiation in the sea surface, over emissions of CO₂, warming of the climate and rise in sea level.

According to environmentalist Terttu Melvasalo of Helsinki, Finland, there is urgent need for global cooperation to manage the world's marine areas and their resources. But he recommends that implementation of programs of cooperation should be done at the regional level. Because of differences between regions regarding natural resources, social, economic and cultural development, it is not possible to find a single model for the implementation of pollution reduction programmes. Different regions should adopt different strategies and institutional arrangements in order to achieve results and improve their water environment.

Political agreement with governments concerned should be implemented primarily by national institutions from the region, in close coordination with an effective network of international organizations with links to the private sector, industry, international financing organizations and relevant NGOs.

An example of this cooperation and networking by governments is the Baltic Sea Joint

➡ NEXT PAGE

operation of a mariculture park. In the site, AQD has conducted baseline environmental assessment in coordination with the Philippine government's environment body. AQD is monitoring water parameters like dissolved oxygen and biological oxygen demand as early warning system against pollution.

There are cages for demonstration purposes already in place at the park. These cages have galvanized iron pipe frames, with concrete blocks used as sinkers at the corners. Access is through wooden catwalks made to float on plastic drums. A pontoon bridge, which secures the cage set-up, allows regulation and expansion of the operations. Milkfish will be the first commodity to be farmed.

The target beneficiaries of the park are the fisherfolk. AQD will be arranging a skills and development training on cage farming to maximize the benefit of the park. The technology for cage farming would be simplified, and with the park facilities, low-cost.

The mariculture park is a collaborative project with the Bureau of Fisheries and Aquatic Resources and the provincial government of Guimaras. -- E Aldon

AQD hosts SEA's government consultation on responsible aquaculture

SEAFDEC/AQD hosted Southeast Asia's third and final *Government Consultation for the Code of Conduct for Responsible Fisheries -- Aquaculture Development* (RCCRF-AD) at the Days Hotel in Iloilo City, Philippines, July 17-19, 2001.

Participants from ASEAN discussed and finalized the guidelines on the various aquaculture-related issues, among them: (1) responsible development of aquaculture, including culture-based fisheries, in areas under national jurisdiction; (2) responsible development of aquaculture, including culture-based fisheries within transboundary aquatic systems; (3) use of aquatic genetic resources for the purposes of aquaculture, including culture-based fisheries; and (4) responsible aquaculture at the

➡ NEXT PAGE

Fisheries officials in ASEAN get together for a responsible cause



Around the World ... continued

Comprehensive Environmental Action Programme that was established in 1992 within the framework of the Helsinki Commission to restore the Baltic Sea to sound ecological balance.

It focuses on six major elements:

- policies, laws and regulations
- institutional strengthening and human resources development
- investment activities
- management programmes for coastal lagoons and wetlands
- applied research
- public awareness and environmental education

From this experience, the United Nations Environment Program (UNEP) organized in 1995 an international conference and adopted the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities. The programme improved on the learnings of the Baltic Sea Programme and called for the development of a clearing-house mechanism to provide a referral system through which decision-makers at the national and regional levels can access current information, practical experience and scientific and technical expertise. Social, economic, legal and financial advice by participating governments was also seen as necessary to establish a data directory, information delivery system and infrastructure.

Some gaps identified in this experience were: (1) there are high-level decisions that are far behind the schedule of implementation, e.g. slow progress in efforts to stop the global degradation of coral reefs; (2) there is a lack of effective mechanisms in sharing experiences and implementing coral reef management initiatives, sustainable fisheries management, control of pollution from land-based activities and sea-based dumping, among others.

But the initiative looks toward the future in the following terms:

- relevant scientific studies/international scientific programs to provide stronger support
- active regional cooperation in marine environmental issues
- formation of a universal body to access the necessary political and financial commitments of governments
- the increasing influence of NGOs on public awareness about marine environmental questions [REF: terttu.melvasalo@kolumbus.fi; *Ocean and Coastal Management* 43 (2000) 713-724]

production level.

Dr. Yasuhisa Kato, special advisor of the SEAFDEC Secretariat, reported on the progress of the RCCRF Program. He said that SEAFDEC-organized subcommittee meetings have formulated many recommendations. Some of these include the governments' active involvement in international meetings on trade, discussion of regional or government policies at a more conscious level, and the review of these policies.

Dr. Kato also enumerated issues of regional concern: (1) mangrove-friendly aquaculture, (2) trade issues, (3) management methods, (4) statistics, and (5) waste reduction.

The target year for the implementation of the Code of Practice is 2002. -- JRP

AQD hosts Philippine gov't consultation on sustainable fisheries

SEAFDEC/AQD hosted April 18-19, 2001 a seminar to discuss issues, problems and developments pertaining to fisheries in the Philippines, in preparation for the *ASEAN-SEAFDEC Millennium Conference on Sustainable Fisheries* to be held in Bangkok, Thailand November 19-24 this year.

About 100 participants from the academe, government institutions and the private sector, including AQD officials and senior researchers, discussed issues and problems about aquaculture production, fisheries management and post-harvest technology and processing. Discussions were done vis-à-vis national programs and policies, practical solutions and areas of collaboration. Multi-sectoral cooperation among national government agencies, local government units, non-government organizations, fisherfolk organizations and state colleges and universities was emphasized as necessary for the development of the fisheries industry in the country. This is in terms of technical, policy, financial, advocacy/information dissemination and research support.

Output from the national seminar will be made as the basis for the technical working documents, draft resolutions and plans of action to be presented at the Millennium Conference.

The Philippines was the second SEAFDEC member country to conduct a national seminar in preparation for the Millennium Conference. Newest member Cambodia held its own seminar in February. Indonesia, Malaysia, Brunei Darussalam, Singapore and Myanmar held their own seminars in the middle of the year.

AQD studies mangrove capacity to process effluents from shrimp ponds

Three SEAFDEC/AQD scientists are presently involved in a study that looks into the capacity of mangroves to process shrimp pond effluents. The project, considered to utilize "virgin" mangroves, is part of AQD's thrust on sustainable shrimp farming through a more efficient "zero waste" discharge system.

In previous mangrove-friendly aquaculture projects in Banate, Iloilo, it was observed that ponds planted with mangrove seedlings and used as

Around the World ... continued

Changes in the ocean's trophic compositions attributed to efficient fishing gears

The technological revolution of the '50s and the '60s involved the rapid application of synthetic fibers to improved fishing gears. This led to large scale mid-water trawling and purse seining by industrial fleets, increasing the vulnerability of small pelagic stocks -- fish living near the surface of the open sea -- over the past few decades.

According to scientists John Caddy and Luca Garibaldi, this technological evolution is mainly responsible for the apparent decline in average trophic level harvests in areas with large stocks. [The trophic level refers to a stage in the food chain where energy is transferred; for example, the trophic level of plants as primary producers of energy, or of animals including fishes as herbivores or carnivores.]

The scientists also say that the decline involves changes in ecosystems rather than continuous changes in relative harvest rates. This phenomenon is important as it reflects both ecological change and changing exploitation strategies. The scientists say there are possibly four reasons for this:

- fishing down marine food webs
- bottom-up effects due to increased/decreased nitrification
- new technology or changes in commercial interests and market-driven exploitation matters
- long term environmental or ecological change

But reason number three appear to be supported by the strongest evidence. [REF: *Ocean and Coastal Management* 43 (2000) 615-665]

The Mediterranean: wild fry collection and transplantation

A study by Sherif Sadek (Arab Aquaculture Consultants, Cairo) and Dan Mires (Kibbutz Ein Hamifratz Fish Farm and Hatcheries, Israel) discussed the wild fry of sea bream, sea bass and mullets, and the efforts of some countries to regulate collection and transplantation.

The culture systems of these euryhaline marine fishes -- widespread in some Mediterranean countries -- include extensive, semi-intensive and intensive monoculture and polyculture with tilapias and carp in inland dams, lakes and lagoons.

➡ NEXT PAGE



Project site in Bugtong Bato, Panay Island, west central Philippines

catchment ponds (for effluents) have higher biophysicochemical levels and bacteriological matters reflecting active degradation of wastewater from culture ponds. Mangrove seedling planted in the area also have higher growth rates.

On May 3-4, 2001, scientists Celia Lavilla-Torres, Dr. Jurgenne Primavera, Dr. Aurelio de los Reyes and Training and Information Head Pastor Torres, Jr. visited another project site -- in Ibajay, northern Panay. They supervised the documentation of mangrove population in the effluent pond, the installation of blower and electricals and aerators, and well as the community structure of the impounded mangrove wetland.

Training on mud crab hatchery starts

A training course on mud crab seed production will be held August 14 - September 14, 2001 at SEAFDEC/AQD.

The training course is in support of the growing popularity of mud crab farming which has become an important source of income among small-scale fish farmers in the Philippines. Citing the notable increase in the national average production of mud crab (*Scylla* species) -- from 339 kg per ha per crop in 1975 to 975-1104 kg per ha per crop in 1990 and 1979-3230 kg per ha per crop in 1999, AQD researchers see the encouraging opportunities for its culture. But at the same time, they said that the limited supply of seed stock or "crablets" which are sourced mainly from the wild, remains a big constraint to the expansion of the industry.

Wilfredo Yap, AQD's technology verification and commercialization head, said that work on crab larval rearing started in the Philippines in the mid 1970's but these have been sporadic and survival rates were low and inconsistent.

But in 1997, AQD started developing a technology for large-scale production of mud crab juveniles. AQD intends this hatchery technology to help maintain the sustainability of mud crab farming and reduce pressure on natural stocks.

Co-sponsored by the Australian Center for International Agricultural Research (ACIAR), the training course aims to provide marginal

➡ NEXT PAGE

Around the World ... continued

In Egypt, translocation of marine fishes to lakes is deemed necessary to compensate for the loss of endemic freshwater fishes, and as the practice continues, the marine species have become a major component of lake fisheries. But there are concerns that the selective, massive translocation of genetic stocks from one region to another could eventually endanger some endemic species.

Recent reports of shortage, especially of mullet fry, is pushing the need for government regulation as well as the establishment of marine hatcheries in this region, especially in Egypt.

The Suez Canal, its adjacent lakes, the Nile effluents and discharge canals leading to the Mediterranean are the main sources of the seasonal mullet and other euryhaline fish fry catches in Egypt. In the Venice region, wild fry that enter lagoons during the autumn migration towards the sea are captured and grown there. In France, fishing groups in the past did the commercial collection of wild mullet fry along the Arcachon coast on the Atlantic Ocean.

Total catch varies from year to year in different areas, depending on meteorological and oceanic changes that affect their spawning and the consequent distribution of eggs and fry. Eventually, seasonal factors as well as continuous collection have affected natural stocks. Because of this, governments -- through their respective agriculture ministries -- have started to regulate the quantity and species of finfish fry collected from the wild.

The French Ministry of Agriculture no longer permits the catch of wild fry other than eel elvers. In Egypt, low prices of fry caught in the wild have been established as an incentive for aquaculture development. In Portugal, the collection of wild fry has been banned since 1992 even if fishing licenses for the collection of mollusk seeds are still issued. These regulations brought about the development of marine hatcheries that produced 6.1 million and 4.5 million

fish farmers, hatchery operators, technicians and aquaculturists with technical knowledge and skills in crab seed production, with emphasis on *Scylla serrata*.

The course covers topics on the following: (1) biology of mud crab and the identification of *Scylla* species; (2) broodstock management and induction of maturation; (3) culture of natural food organisms and preparation of formulated feeds; (4) larval and nursery rearing techniques; and (5) grow-out culture.

Practical work will include mass production of natural food organisms, preparation of formulated feeds, larval rearing, nursery rearing, feeds and feeding, water management, pond preparation and fertilization, and harvesting, packing and transporting.



This year's batch of aquafarming trainees during the opening program

Training on sustainable aquafarming systems

In an effort to promote farming systems proven and verified to be environment-friendly, sustainable and socially equitable, an international training course entitled *Management of Sustainable Aquafarming Systems* was conducted May 9-June 15 at SEAFDEC/AQD in Tigbauan, Iloilo.

Thirteen (13) participants from countries in Asia and Africa came to attend this five-week course.

AQD Chief Dr. Rolando Platon said the participants' attendance was a recognition of the importance of aquaculture "as the fastest growing food production system especially in Southeast Asia where people eat fish because it is the cheapest source of animal protein."

"This is not so in developed countries like the United States and in Europe where eating fish is a choice for its low cholesterol," Dr. Platon said.

He also related that there has been a marked decrease in the consumption of fish, especially since 1995 because of the declining catch from capture fisheries.

"The deep sea can no longer provide for our need for fish. Our seas and oceans have reached their limit," he said. He attributes this to destructive fishing methods that have exploited the world's existing marine resources.

➤ NEXT PAGE

sea bream and sea bass juveniles, respectively, in the country in 1998.

Sadek and Mires recommended proper management of fishing practices as well as transport techniques as necessary to prevent wastage of these vital commodities. They also pointed out that since aquaculture needs to become more self-sufficient in order to help sustain natural stocks, more fish hatcheries will have to be built to support production activities. [REF: *The Israeli Journal of Aquaculture – Bamigdeh* 52 (2), 2000, 77-88]

Transgenic fish: an evaluation of benefits and risks

Transgenic organisms (=genetically modified organisms or GMOs) now offer the opportunity to improve both production and characteristics of conventional strains of animals and plants currently exploited in agriculture and aquaculture.

In the case of transgenic fish, potential applications include growth enhancement, freeze resistance and cold tolerance, salinity and disease resistance, sterility, metabolic modification and fishpharming. The latter is the use of transgenic fish for the production of pharmacological

➡ NEXT PAGE

But aquaculture itself has been suffering from the adverse effects of the indiscriminate application of technological advances “mainly because of human greed for increased profit.” Thus the need for this training course.

Dr. Platon proceeded to give a rundown of AQD facilities and research activities for the development of aquaculture techniques. Some of these are the breeding and hatchery technology to refine culture techniques and enhance the growth of marine species, as well as effective feed formulation to explore vegetable replacement for animal protein (in fish meal). The latter is an effort to come up with formulations that do not contribute to water pollution.

These techniques are included in the design of the training course which would help provide the participants with technical knowledge and skills for the actual operation and management of aquaculture facilities and technology for various marine species like fish, crustaceans, molluscs and seaweeds.

AQD joins technology caravan

SEAFDEC/AQD joined forces with two of the country’s leading fisheries institutions in extending fisheries technology to residents in northern Philippines April 23 to May 5.

Dubbed as the *Fisheries Technology Caravan*, the activity carried the theme “Aquaculture for Rural Development,” making people the focal point in alleviating poverty by providing livelihood in the countryside. It started off in Malolos, Bulacan then La Trinidad, Benguet, Vigan, Ilocos Sur, Tuguegarao City and finally, in Alaminos, Pangasinan.

Participants were teachers, students, fisherfolks and fish farmers who flocked to the lecture rooms to listen to experts discuss their topics

of interest. Topics included the grow-out culture and breeding of various aquatic species, processing, value added products, and micro-enterprise management development and marketing.

Participants also had stories to tell. For instance, Robert Solano of Tuba, Benguet said that he grows tilapia with rice and has been getting more from both activities. Moreover, he is able to use less fertilizer because the water coming from the pond is already fertile. He said that he plans to visit AQD soon to get more ideas because he wants to go into commercial tilapia culture.

➡ NEXT PAGE

Table 1. Possible risks and benefits attendant on the exploitation of transgenic fish in aquaculture [Fish and Fisheries (2000) 1: 146-172]

Risks	
Deleterious to the health of consumers	Very low
Shows no advantage over non-transgenic	Low
Becomes undesirable alien species upon release or escape	? Requires control
Interbreeds with wild individuals, upon release or escape, resulting in permanent presence of transgene in wild populations	? Requires control
Dies out quickly, upon release or escape, but adversely affects ecological balance initially	Low
Benefits	
Leads to lower cost, faster growing strains available for aquaculture	High
Leads to availability of disease resistant strains	Low in short-term
Brings strains of fish with other desirable traits: cold tolerance, freeze resistance or salinity tolerance	Fairly low in short-term
Reversible sterile strains of transgenic fish becomes available, allowing safe use in aquaculture	Medium probability in medium-term
Offers fish farmers possible exploitation of cheaper and 'greener' diets	Medium probability in long-term
Used for production of valuable pharmaceutical proteins	High probability in medium-term

proteins. Currently, the only application which has reached the point of large-scale outdoor trials is growth enhancement.

However, these applications also raise concerns regarding the possible deleterious effects of escaped or released transgenic fish on the natural ecosystem. As fish are potentially highly motile, secure containment is not always easy to achieve.

Table 1 (overleaf) presents the probable risk and benefits of the exploitation of transgenic fish in aquaculture as concluded in a study conducted by Norman Maclean and Richard James Laight of The University of Southampton, UK. [REF: Fish and Fisheries (2000) 1: 146-172]

THIS SECTION IS EXCERPTED OR SUMMARIZED FROM JOURNAL PAPERS BY M SURTIDA, A ESPANO, A SURTIDA, E GASATAYA, RIY ADAN



Resource persons from SEAFDEC, BFAR and PCAMRD share their expertise with fishfarmers, government workers and students in northern Luzon



On the other hand, AQD, BFAR and PCAMRD experts found it a pleasure to assist people. "We feel nice about having helped people improve their lot. It is very inspiring to discuss with them because it means that they have a real interest in aquaculture," they said.

The activities culminated in Alaminos, Pangasinan, May 5, where certificates of appreciation were awarded by Agriculture Secretary Leonardo Montemayor to officials and resource persons involved in the project. Guests included the DA Undersecretary for Fisheries Cesar Drilon, BFAR executive director Atty. Malcolm Sarmiento, PCAMRD director Dr. Rafael Guerrero, AQD admin and finance head Mr. Dan Baliao and the local executives of the different municipalities in Pangasinan. - ET Aldon



Dr. Millamena

AQD has two new senior scientists

SEAFDEC/AQD recently appointed two new senior scientists -- Dr. Oseni Millamena and Dr. Teodora Bagarinao.

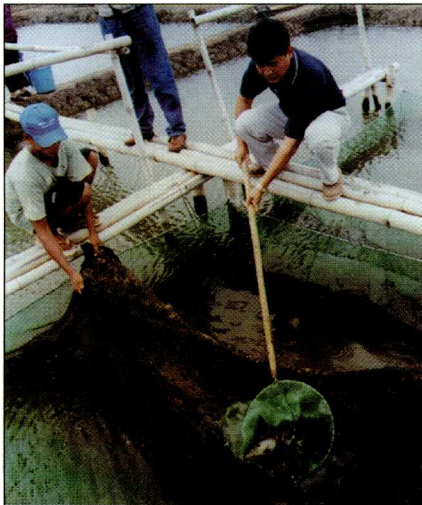
Dr. Millamena is the main proponent in the development of a broodstock diet for the mud crab *Scylla serrata*, a practical diet for the juvenile grouper *Ephinephelus coioides*, and the large-scale production of mudcrab juveniles using developed broodstock hatchery techniques.

Dr. Bagarinao, on the other hand, wrote the book "The Biology of Milkfish *Chanos chanos*" in 1991 and the more comprehensive "Ecology and Farming of Milkfish" in 1999, and edited the conference proceedings "Towards Sustainable Aquaculture in Southeast Asia and Japan" in 1995. She also serves on the editorial board of two scientific journals. She set up the AQD's museum in 1993 and later proposed the construction of FishWorld, a museum ecopark dedicated to informal public education about aquatic ecosystems, responsible fisheries and aquaculture, environment protection and sustainable development.

The appointments were announced during AQD's 28th anniversary program on July 6. Dr. Millamena and Dr. Bagarinao joined the Department on April 19, 1976 and January 16, 1978, respectively. —JRP



Dr. Bagarinao



AQD hosts ACIAR seminar on grouper

Researchers and representatives of the aquaculture industry from ASEAN were participants in the seminar on the "Progress of Grouper Aquaculture Research" held July 10-12 at SEAFDEC/AQD. Sponsored by the Australian Center for International Agriculture Research (ACIAR), the seminar tackled research results on feeds and feeding techniques, larval rearing, and others. Middle photo shows ACIAR's Barney Smith discussing issues with participants; and, at left, AQD's Joebert Toledo leading the sampling of grouper cultured at the Dumangas Brackishwater Substation in the Philippines.

AQD in JICA exhibition

SEAFDEC/AQD participated in an exhibit for the *Japan International Cooperation Agency (JICA) Consultative Meeting among ASEAN-Member Countries* on June 19-21, 2001 in Manila, Philippines.

AQD is one of the implementing agencies of the Third Country Training Programme (TCTP) in the Philippines. Since 1996, AQD has been implementing the TCTP on Responsible Aquaculture Development and Coastal Resource Management. Implemented by phases comprising five sessions per phase, the training program's second phase will start in September.

The exhibit featured the activities of TCTP trainees. Training and information head Pastor Torres Jr. represented AQD in the meeting.

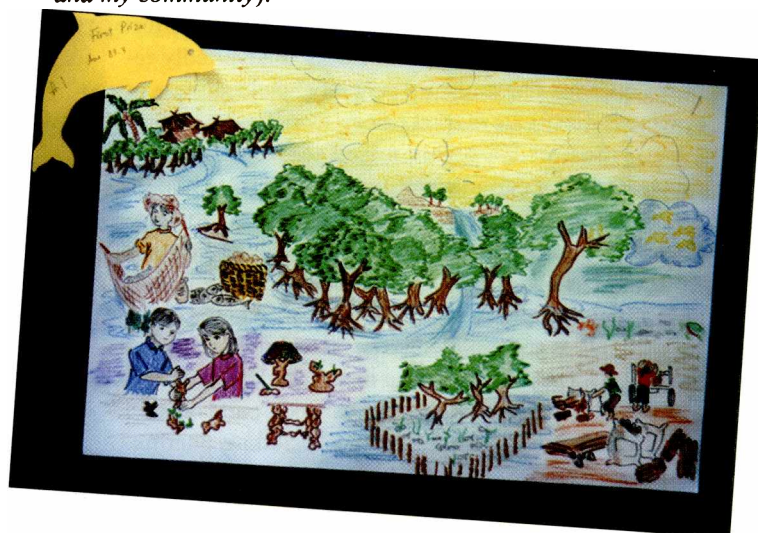


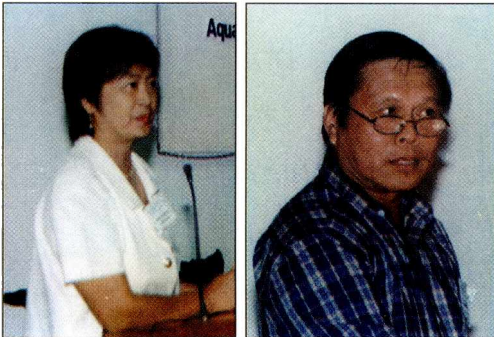
Viewing the AQD exhibit are Undersecretary Franklin Ebdalin of the Department of Foreign Affairs; Ms. Margarita Songco, assistant Director General of NEDA; and Mr. Hideo Ono, JICA Resident Representative to the Philippines

AQD celebrates Aquaculture Week 2001

In celebration of Aquaculture Week 2001 held July 9-13 at AQD, various competitions were held to emphasize the relevance of aquaculture in the lives of people. There was the Best Seafood Dish Contest for chefs with the theme: "Seafood from aquafarms: healthy, novel, versatile and gourmet." School children, both elementary and high school, also competed in the photojournalism and essay writing contests (*Aquaculture for Food Security in the Philippines*), and writing a fish story (*From the fish farm to the dinner table*).

At right is the winning entry by April Rose Drilon, a grade six student from the Colegio del Sagrado Corazon de Jesus, in the drawing/painting contest (*Mangroves are important to me and my community*).





*Dr. Anne Hurtado (left), AQD expert on seaweeds, listens to the suggestions of participants (upper left and above) while Oscar Monsales, secretary of the Seaweeds Industry Association of the Philippines, shares his experiences and observations on the farming of the seaweed *Kappaphycus**

Workshop pushes creation of Code of Practice for seaweed industry

The recently concluded National Seaweed Planning Workshop pushed for the creation of a Code of Practice for the seaweed industry in order to minimize industry malpractices and sustain its position in the international market. It will adopt systems of policies and standards to govern in the farming and procurement practices of seaweeds for farmers, traders, processors, and entrepreneurs. The Bureau of Fisheries and Aquatic Resources (BFAR) was designated lead agency in the drafting of the code.

Seaweed farming is a major livelihood among coastal communities, particularly to some 180,000 families in the Sulu archipelago. In 1999, Philippines exported more than 35,000 tons of dried seaweeds worth US\$ 44 million, making the country the 4th largest producer of seaweeds and the 8th largest producer of carrageenan in the world. However, improper post-harvest management in cleaning, drying by salting or steaming, adulteration of seaweeds with sand, dust, and dirt for added weight, storage, and baling inadvertently reduces quality. The moisture content and cleanliness of seaweeds dictate its market price.

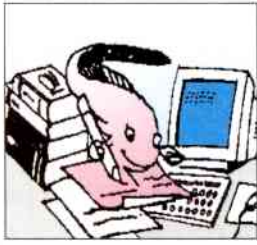
Seaweed, a highly priced sea vegetable, is a raw material for carrageenan, agar and alginates. These extracts are used to gel, thicken or suspend in the processes of emulsion, stabilization, binding, and dispersion. The carrageenan and agar are also major ingredients in dairy products like ice cream, milk, chocolate; surgical jellies and ointments, cosmetics and healthcare products. They are also used in softdrinks; processed meat, bread, and pet foods; air freshener, paints and in many other industrial applications including pharmaceuticals.

The two-day workshop, held at SEAFDEC/AQD in Tigbauan, Iloilo on August 2 and 3, discussed the research and development programs of different participating agencies, identified and validated the problems and concerns of the seaweed industry, and agreed on strategies of solving problems in seaweed farming like disease management, manpower development and management, post-harvest processes, post harvest facilities and research funding.

Participants are from the Seaweed Industry Association of the Philippines; Kasangnayan Seaweed Planters Association, Zamboanga City; Western Mindanao Seaweed Industry Foundation; CP Kelco Philippines, Inc.; Growth and Equity for Mindanao; Bureau of Agricultural Research; BFAR Regional Field Offices IV, V, VI, IX, and ARMM; Department of Science and Technology – Industrial Technology Development Institute, Science and Technology Promotion for Mindanao, and Technology Application and Promotion Institute; Mariano Marcos State University; University of San Carlos; Mindanao State University – Tawi-Tawi Institute of Technology and Oceanography; Zamboanga State College of Marine Sciences and Technology; PCAMRD; UP Marine Science Institute; UP in the Visayas; and AQD. They all agreed to support each other's research and development programs to optimize resources, and to solve problems in the industry in terms of expertise, research, facilities, and financial resources.

AQD, one of the workshop organizers, now focuses on the utilization, and strain improvement of some commercially important seaweeds – *Kappaphycus* and *Gracilaria* or *Gracilariopsis*. The latter addresses problems on the quality of seedstocks due to vegetative propagation by fragmentation.

Strain improvement through the application of advanced technology in seaweed is through tissue culture and protoplast isolation. Studies are also directed towards the production of high yielding and disease resistant seedstocks, and high agar and carrageenan quality seaweeds. -- JRP



AQD Research Publications

Reprints of papers listed here may be requested directly from AQD authors or from the AQD Library

Compiled by the AQD LIBRARY <library@aqd.seafdec.org.ph>

Baticados DB, Agbayani RF. 2000. Co-management in marine fisheries in Malalison Island, central Philippines. *International Journal of Sustainable Development & World Ecology* 7 (4): 343-355

Abstract. This study, conducted from November 1995 to February 1996, describes the evolution and impact of fisheries co-management arrangements in a coral reef fishing village at Malalison Island, central Philippines. The island is the site of a community-based fishery resources management project of the Southeast Asian Fisheries Development Center Aquaculture Department, funded by the International Development Research Centre of Canada.

Using a case study approach and inferential statistics in the analysis of data, the co-management arrangements on the island are perceived to be successful based on equity, efficiency and sustainability criteria. Fishers, represented by the Fishermen's Association of Malalison Island (FAMI) who form the core group, participated actively in the management of fishery resources with legal and financial support both from the municipal and barangay (village) government. Potential problems nonetheless, still exist with the ambivalent attitude of fishers toward rule-breaking, especially of fishery rules directly affecting them. The future of co-management arrangements will largely depend on how the fishers and other stakeholders maintain and build earlier initiatives with the eventual phasing out of SEAFDEC/AQD from the island. The rapid population growth could also affect project gains.

Gallardo WG, Hagiwara A, Snell TW. 2001. Use of GABA to enhance rotifer reproduction in enrichment culture. *Aquaculture Research* 32 (3): 243-246

Abstract. Gamma-aminobutyric acid (GABA) has been shown to enhance the reproduction of the rotifer *Brachionus plicatilis* Muller in stressful culture conditions. During the enrichment of rotifers for feeding to marine fish larvae, they are usually stressed as a result of exposure to different marine oils and high population densities. This typically results in decreased rotifer survival, reproduction and swimming activity. In the present study, we used GABA to increase rotifer reproduction and the swimming activity of rotifers in enrichment cultures. GABA treatment 24 h before high density enrichment enhanced reproduction during enrichment culture, but not when carried out simultaneously with enrichment. Swimming activity was not significantly affected by GABA treatment 24 h before or simultaneously with nutrient enrichment.

Gapasin RSJ, Duray MN. 2001. Effects of DHA-enriched live food on growth, survival and incidence of opercular deformities in milkfish (*Chanos chanos*). *Aquaculture* 193 (1-2): 49-63

Abstract. The use of commercial enrichers to improve the nutritional quality of live food in larviculture of milkfish was investigated. Fish were either fed rotifers cultured on *Chlorella* sp. and newly hatched *Artemia* nauplii (Control, Trt I) or rotifers and *Artemia* given DHA en-

richment diets (DHA-treated, Trt II). Results showed survival was significantly better ($P < 0.05$) in the DHA-treated fish than in the untreated fish after 25-day culture period. Although growth was not statistically different ($P > 0.05$) between the control and DHA-treated fish during the hatchery phase, extensive rearing of the postlarvae (fry) in nursery ponds for another 60 days showed that DHA-treated fish exhibited significantly better ($P < 0.05$) growth than the untreated fish. Opercular deformities in 85-day old milkfish juveniles were also significantly lower ($P < 0.05$) in the DHA-treated fish than the control. Survival after nursery culture, however, was high for both treatments but not significantly different ($P > 0.05$).

The lack of a viable and reliable method of mass culturing copepods as live food in the hatchery makes the use of off-the-shelf commercial enrichment diets for rotifers and *Artemia* a practical option in the larval culture of milkfish.

Hurtado-Ponce AQ, Liao LM. 1998. The genus *Gracilariopsis* (Rhodophyta, Gracilariiales) in the Philippines: morphological and taxonomic confirmations. *Philipp. Scient.* 35: 141-151

Abstract. Reports of the economically-important agarophytic seaweed genus *Gracilariopsis* Dawson from Philippine waters are verified for the first time. Cystocarpic, spermatangial and tetrasporic materials collected from various localities in eastern Panay and northwestern Negros islands conform to the circumscription of this recently reinstated genus. Materials as referred to *Gracilariopsis heteroclada* Zhang & Xia after morphological comparisons with type materials from Southern China. In addition, a discussion of the complicated nomenclature history of this species is included.

Another putative *Gracilariopsis* species is reported from Zamboanga City based on cystocarpic materials alone. This species differs from *G. heteroclada* with its smaller gonimoblast cells and larger height:width ratio of the gonimoblast mass. Vegetatively, the thallus is smooth, devoid of fine, determinate branchlets observed in *G. heteroclada*.

Lio-Po GD, Traxler GS, Albright LJ, Leano EM. 2000. Characterization of a virus obtained from snakehead *Ophicephalus striatus* with epizootic ulcerative syndrome (EUS) in the Philippines. *Diseases of Aquatic Organisms* 43(3):191-198

Abstract. This is the first report of the isolation and characterization of a fish virus from the Philippines. The virus was isolated using snakehead spleen cells (SHS) from severely lesioned epizootic ulcerative syndrome (EUS)-affected snakehead *Ophicephalus striatus* from Laguna de Bay, in January 1991. The virus induced cytopathic effects (CPE) in SHS cells yielding a titer of 3.02×10^6 TCID₅₀ ml⁻¹ at 25 degrees C within 2 to 3 d. Other susceptible cell lines included bluegill fry (BF-2), catfish spleen (CFS) and channel catfish ovary (CCO) cells. Replication in Chinook salmon embryo cells (CHSE-214) was minimal while Epithelioma papulosum cyprini cells (EPC) and rainbow trout gonad cells (RTG-

2) were refractory. Temperatures of 15 to 25 degrees C were optimum for virus replication but the virus did not replicate at 37 degrees C. The virus can be stored at -10 and 8 degrees C for 30 and 10 d, respectively, without significant loss of infectivity. Viral replication was logarithmic with a 2 h lag phase; viral assembly in the host cells occurred in 4 h and release of virus occurred 8h after viral infection. A 1-log difference in TCID 50 titer between the cell-free virus and the total virus was noted. Freezing and thawing the virus caused a half-log drop in titer. Viral exposure to chloroform or heating to 56 degrees C for 30 min inactivated the virus. Exposure to pH 3 medium for 30 min resulted in a more than 100-fold loss of viral infectivity. The 5-iododeoxyuridine (IUdR) did not affect virus replication, indicating a RNA genome. Neutralization tests using the Philippine virus, the ulcerative disease rhabdovirus (UDRV) and the infectious hematopoietic necrosis virus (IHNV) polyvalent antisera showed slight cross-reaction between the Philippine virus antiserum and UDRV but established no serological relationship with SHR and IHN virus.

Transmission electron microscopy (TEM) of SHS cells infected with the virus showed virus particles with typical bullet morphology and an estimated size of 65 x 175 nm. The Philippine virus was therefore a rhabdovirus, but the present study did not establish its role in the epizootiology of EUS.

Madrones-Ladja A. de la Peña M. 2000. Hatchery management for the window-pane shell, *Placuna placenta* Linnaeus, 1758. Phuket Marine Biological Center Special Publication 21(1): 189-1945

Abstract. To relieve pressure on wild stock population, hatchery technique for the window-pane shell, *Placuna placenta* Linnaeus has to be developed. A study was conducted to determine the suitable algal diet for *P. placenta* during gonad development and larval rearing. Sexually immature *P. placenta* broodstock were reared in the estuary or in tanks for four months. Tank-reared animals were fed daily mixture of *Isochrysis galbana* (T-ISO) Parke and *Tetraselmis tetrahele* (G.S. West) at 100,000 cells/ml, 1:1 (100-1:T), or 200,000 cells/ml, 3:1 (200-31:T) combinations. Monthly gonad histological examination showed that sexual maturity was attained by animals fed 200-31:T diet after four months but not in 100-1:T. Estuary-reared broodstock had the highest gonad index among treatments after the first month, but did not reach sexual maturity until the end of the conditioning period. Sexually mature *P. placenta* from 200-31:T fed-group spawned when exposed to UV light-irradiated seawater. One-day old larvae were reared in UV light-irradiated seawater until metamorphosis to plantigrade. Larvae were fed daily with monoalgal diet of *I. galbana*, *T. tetrahele*, or *Chaetoceros calcitrans* (Takano) at densities of 10,000-30,000 cells/ml. Larval settlement was observed in all diets after 14 days. Survival rate at metamorphosis was highest (12.60%) when diet of *I. galbana* was used, but lowest in *T. tetrahele* (5.1%) ($P < 0.05$). Average shell length increment during the 14 days rearing period were 11.0, 11.38, and 9.92 $\mu\text{m day}^{-1}$, for *Isochrysis*, *Tetraselmis* and *Chaetoceros* fed larvae, respectively.

Tendencia EA, de la Pena LD. 2001. Antibiotic resistance of bacteria from shrimp ponds. *Aquaculture* 195(3-4):193-204

Abstract. The incidence of antibiotic resistance was compared in bacteria isolated from pond water, pond sediment, water and sediment from the receiving environment (area where water from pond drains, which is 0 and 50 m away from the exit gate, in this study) and cultured shrimp from ponds that have not used any antimicrobials, ponds that

have previously used antimicrobials and ponds that are currently using oxolinic acid. Most of the bacteria isolated from all sample and pond type were *Vibrio*. Among the *Vibrio*, *V. harveyi* were most commonly isolated. Multiple antibiotic resistance (MAR) to at least two antimicrobials was highest in ponds currently using oxolinic acid (24% of bacteria isolated from such ponds), followed by those that have previously used antimicrobials (19%) and the least was those from ponds that have not used any antimicrobials (17%).

The lowest incidence of antibiotic resistance was observed in ponds that have not used any antimicrobials (41% of the isolates from such ponds). Among the individual antibiotics, incidence of resistance to oxytetracycline was highest (4.3% of the total number of isolates) followed by furazolidone (1.6%), oxolinic acid (1%) and chloramphenicol (0.66%).

Resistance to individual chemotherapeutants did not reflect the pattern of antimicrobial use with ponds that have previously used antimicrobials showing the highest incidence of resistance to one antimicrobial (12% of total isolates from such ponds). Resistance to both oxolinic acid and furazolidone (15% of total number of isolates) was highest compared to other antimicrobial resistance profiles (1-12%). Multiple antimicrobial resistance and intermediate reaction to at least one antimicrobial are associated with antimicrobial use.

Santiago CB, Focken U and Becker K. 2000. Voluntary feed intake and energy partitioning in tilapia (*Oreochromis niloticus*) fed diets with different protein/energy levels. IN: Chevalibog A, Jakobsen K (eds). Proc. 15th Symp. Energy Metabolism in Animals; 11-16 Sept 2000; Denmark. EAAP Publication No. 103. p 181-184

Abstract. In order to investigate the effect of different protein/energy levels of diets (two commercial and one laboratory) on voluntary feed intake and energy partitioning in tilapia (*Oreochromis niloticus*), 15 fish with an initial body mass of 33 g were individually in respirometric chambers for 42 days and offered 3 diets *ad libitum*. The protein contents of the diets were 36.1, 33.8 and 36.8% (dry matter base); the energy content 18.9, 18.4 and 19.2 kJ GE/g and 11.7, 10.5 and 15.4 kJ ME/g. The initial body composition and energy content was estimated from a control group. Feed consumption was recorded for each individual fish. Body mass development was monitored weekly. At the end of the experiment, the fish were sacrificed and their chemical composition (protein as N6.25, lipid, ash) and gross energy content determined. To establish energy budgets, ingestion (I) was calculated from feed intake, retention (P) from accretion in the carcass, heat production \dot{Q} from oxygen consumption (indirect calorimetry) and apparently non-utilised energy (faecal and non-faecal losses, U) by difference from energy ingestion.

In the beginning, food consumption amounted to approximately 5% body mass equivalent (BME) per day for all groups and gradually decreased to 2.5, 2.8 and 1.6% BME by the end of the experiment. While the food consumption was significantly different between the treatments, there were no significant differences in the body mass development. Average final body mass was 98.6, 93.8 and 103.7 g. Energy retention was 29.7, 29.2 and 44.4% of GE ingested; heat dissipation 32.1, 27.9 and 36.0%; faecal and non-faecal losses 38.2, 43.2 and 19.6%. For all energy budget parameters, values for the laboratory diet were significantly different from those of commercial feeds 1 and 2. Calculation of metabolisable energy from ingested feed revealed no significant differences in the energy uptake, suggesting that the voluntary feed uptake was controlled by the demand for metabolisable energy. The fish were able to completely compensate for the lower ME content of the commercial feeds by increasing voluntary feed intake. ###

SEAFDEC/AQD Seminar Series



Dr. Peterson



Dr. Stuckle



Dr. Mizukami



Dr. Siar

Eric Peterson: engineering for sustainable shrimp farming

The seminar given by Dr. Peterson at AQD on March 13 was a summary of a paper he presented at the *Aquaculture 2001 Meeting* held January 21-26 in Tampa, Florida. Dr. Peterson is a Research Fellow at the Aquaculture CRC and School of Engineering, James Cook University, Townsville, Australia.

Investors in shrimp farming, Dr. Peterson said, basically find it hard to operate when they fail to engage suitable consultants. Developers in aquaculture should allow more capital investment at the beginning so that long-term operational costs may be minimized. There are many multi-disciplinary firms which have learned from the success and failures of many industries, and which can provide facilities that are durable and efficient.

Dr. Peterson related the factors which developers of shrimp farms should consider before purchasing property where they would build a shrimp farm. These include what he calls a "schematic design" to be made by an engineer for developers before they head into full-scale development.

The primary factor is site selection, which is the basic foundation of the profitable farm. It should:

- be accessible to waterways with sufficient tidal flushing to provide good water quality
- be located high enough above the tide to avoid acid sulfate soils and provide good drainage
- have soil with sufficient clay content so ponds will not leak, but must also have aggregate content
- have access to freshwater, electricity and a quarry to provide inexpensive sand and gravel

He also cited the importance of topographic surveys and schematic hydraulic designs for candidate sites. He stressed that shrimp farm construction and management involve different technical specialties. Construction involves soil stability testing, slope design, hydraulic structures, and pump stations. Intensive aquaculture

projects also require aeration and electric systems.

Furthermore, Dr. Peterson said, shrimp farming operations are more likely to succeed if they involve engineers to handle design and operations. He also mentioned some figures as going rates for engineers involved in advising or consultancy:

- 2% charge for schematic design and final construction
- 3% charge for supervision of contractors
- 5% for drawings and contract specifications

He cited several kinds of engineering skills for specific jobs. For example: civil engineers for hydraulic design and supervision, aquaculture engineers for selection of aeration equipment, electrical engineers for power distribution and geodetic engineers for earth-moving operations, slopes, etc.

Dr. Peterson has a Ph.D. from James Cook University, Australia (1999), a BS in Environmental Engineering (*summa cum laude*) from Michigan Technological University, USA (1994), a BS in Mechanical Engineering from the University of Massachusetts (1982) with concentration on thermo-fluids. In addition, he is a professional mechanical / environment engineer examined and registered in the states of Minnesota (1990) and Michigan (1994). He has had a post doctoral fellowship in civil and environmental engineering at James Cook University.

Yuzuru Mikuzami: application of biotechnology to macroalgae

Dr. Mizukami is a JICA expert on seaweed biotechnology dispatched to SEAFDEC/AQD on a short-term assignment (February 27 to May 25) to work on the development of seaweed aquaculture biotechnology. His co-workers at AQD are Dr. Anicia Hurtado and Ms. Rovilla Luhan. Presently, he is a professor at the Aquabiology Department of the National Fisheries University, Japan.

On March 29 at AQD, he discussed the commercially important red algae *Porphyra yezoensis* and *P. tenera* (also called "laver") that are extensively cultured along the coasts of Japan.

"Laver" is estimated to have a commercial value of about one million US dollars per year in Japan, hence the relentless effort to improve its culture stock and culture techniques.



Engr. Gaston Griesbeck



Dr. Arnil Emata

Dr. Mizukami presented data on the application of some biotechnology techniques such as cell fusion, mutant production, DNA polymorphism and foreign gene introduction to improve and discriminate "laver" culture strains. His study showed positive results.

Dr. Mizukami has a good number of research studies published in peer-reviewed journals. He is a graduate of Hokkaido University (Ph.D. Botany, 1973).

Imelda Stuckle: research and training program of SEAMEO BIOTROP

Dr. Stuckle made her sales pitch on April 2 to solicit collaborative support from SEAFDEC/AQD along the lines of research, training, and information dissemination on areas that serve the mutual interests of both institutions. She is the Deputy Director for Programme and Marketing of SEAMEO BIOTROP, Southeast Asian Regional Center for Tropical Biology

SEAMEO BIOTROP was established in 1968. Since then, it has significantly contributed to human resource development in the region in the area of tropical biology. It aims to become the leader in this field by promoting regional networking and partnership in human resource development, research consultancy, information dissemination and other related activities, and to ensure the sustainability of these endeavors.

SEAMEO BIOTROP has ten Asian member-nations in its fold. Its program thrusts are: tropical ecosystem and environmental impacts; biodiversity conservation; sustainable development and environmental and forest biotechnology.

BIOTROP's activities include: research, training, workshops/symposia, publications, consultancies, laboratory services (analyses and rentals) which they do in collaboration with both national and international organizations or agencies.

Its laboratories include: a remote sensing and ecology laboratory, ecosystem modelling/ ICSEA laboratory, pollution control, pest and diseases management, biotechnology and tree breeding, silviculture of natural products, herbarium, an automatic service station, and standard service laboratories which offer plant and soil analysis, tissue culture, food analysis and DNA sequencing.

Among BIOTROP's training courses for 2001 which have direct bearings to AQD are: (1) Planning and management of eutrophication on lakes and reservoir; (2) Bioremediation in aquatic systems; (3) Advances in molecular biology techniques to assess microbial biodiversity; (4) Bioprospecting; and (5) SGIS and remote sensing in coastal zones.

Last year, 324 participants from various member-countries attended their training sessions. Recently, BIOTROP, in cooperation with the graduate programme of the Bogor Agricultural University, opened the study programme of Master of Science in Information Technology for Natural Resources Management. The graduate programmes are open to SEAMEO member countries.

BIOTROP's headquarters is in Bogor, Indonesia.

Susana Siar: knowledge of gender, space and resources in small-scale fishing -- the case of Honda Bay, Palawan

The paper is part of Dr. Siar's dissertation at the University of Hawaii at Manoa, leading to her doctorate in Geography. She is head of AQD's socioeconomics team.

On April 5, she discussed how fishers and gatherers, as resource users, develop an intimate understanding of their environment based on everyday experiences and interactions. She said that the involvement of men and women in using the resources arise from or depends on the gender division of labor and space.

The inter-tidal zone, for instance, is associated with women's activities such as shell and sea cucumber gathering, whereas the coral reefs and deep water are associated with fishing activities of men. The socialization of children into fishing reinforces the gender division of labor in fishing.

The methodology used in Dr. Siar's study was structured interview which includes free listing, file sorting and ranking to generate data on knowledge and perception about the fishery resources upon which the people's livelihood depends. Resource mapping with a separate group of men and women showed not only users' knowledge about coastal resources but also their relationship with other resource users.

Dr. Siar has a BS degree in Human Ecology and an MS degree in Rural Sociology earned both from the University of the Philippines at Los Baños.

Gaston Griesbeck: freeze drying and vacuum concentration

Griesbeck, 62, was born in Koeln, Germany. He is a mechanical and refrigeration engineer by profession. Since 1965, he has specialized in freeze drying technology and has a world-class experience in the construction and development of freeze dryers in the



Freeze dryer

laboratory, pilot or production scale — both for the pharmaceutical and food industries.

Two years ago, he moved permanently to Villa, a suburb south of Iloilo City, Philippines, as the Far East regional manager of VIRTIS.

VIRTIS is a big and world-famous manufacturer of a wide range of laboratory, pilot and production freeze dryers. In addition, it also has vacuum concentrators, fermenters, and homogenizers in its product lines. Its headquarters is in the United States.

In 1999, Engr. Griesbeck established his company, LYOTEC Consulting Services with a laboratory in his house in Villa, Iloilo. In his laboratory, he is able to find out the best and most economical conditions for any product. According to him, it is through freeze drying that products mainly of biological origin such as tissues, tissues extracts, bacteria, vaccines and sera are converted to dry products. The process avoids enzymatic, bacterial, and chemical changes.

He further added that freezing condition is extremely important for successful freeze drying. With his patented system, it is possible to find out exactly the eutectic point. After this, it is necessary to find the optimal temperature and vacuum profile for the freeze drying process. All of this is possible with his existing freeze dryer.

Engr. Griesbeck is willing to share his knowledge and skills about freeze drying and vacuum concentration with interested parties through seminars and workshops. He can be contacted through e-mail: lyotec@gmx.net or telefax: (63)33-3374655.

Arnil Emata: breeding the mangrove red snapper *Lutjanus argentimaculatus*

Dr. Emata's study showed that sexual maturation among male red snappers happen in the fourth year of rearing, among females in the fifth year. The reproductive cycle begins in March, reaching its peak in May to September and declines in October to December. Both sexes remature every month during the peak of their reproductive cycle.

Dr. Emata, head of AQD's breeding section, discussed his results on April 26.

Induced breeding trials under standard conditions revealed that 100 ug per kg LHRHa, 1000 IU per kg hCG and 1500 IU per kg hCG effectively produced spawned eggs and larvae. 1000 IU per kg hCG may be the practical agent for induced spawning of snapper based on success rates in producing eggs and larvae, frequency of spawns with egg collection greater than 1 million per spawn and cost. Egg quality was not significantly different between the effective hormonal doses but 1000 IU per kg hCG, however, had lower commulative survival rate from eggs to normal larvae (20%) than those of 100 ug per kg LHRHa (26%) and 1500 IU per kg hCG (31%).

Snappers reared in both cages and tanks spawned naturally from March to December reaching a peak during May to August in conformity with its cycle of gonadal development. Eight females kept in a 6 mm diameter cage produced a maximum of 66.5 million eggs in a spawning season with 40% of its spawns having egg collection greater than one million per spawn.

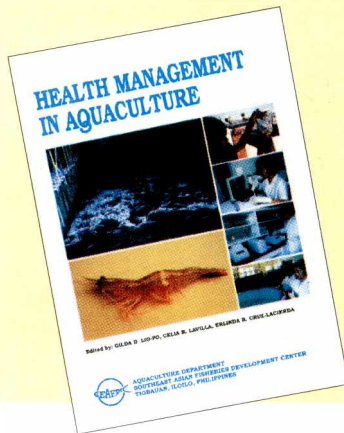
Collection of eggs spawned in tanks or cages ranged from a few thousand eggs to 4.5 (tanks) and 6.3 (cages) million eggs. Ninety percent (90%) of the eggs were fertilized and about 72% had developing embryo. Most of the spawns occurred between the last quarter and new moon phases (36% and 47% of the total spawns, respectively).

-- By AP Surtida

NEW!

Health management in aquaculture

(textbook for aquaculture classes)



"The book is easy to understand even by high school students," says fisheries student Rhodo Servidad. "We just need to read it thoroughly."

Servidad is one of the students of BS Fisheries at the Iloilo State College of Fisheries (ISCOF) in northern Iloilo who are the initial users of the textbook. The students of Mindanao State University's

School of Marine Fisheries and Technology at Naawan, Misamis Occidental are also testing the book.

This pioneering effort of SEAFDEC/AQD, the publisher, is an answer to the need for educational materials on aquaculture which are more relevant to the tropics -- where the Philippines and the rest of Southeast Asia are located.

The textbook is about major diseases that occur in Asia. It puts emphasis on diseases of cultured warmwater fish and crustaceans, most common of which are catfish, milkfish, and tiger shrimp. It contains up-to-date knowledge on causative organisms, and measures for disease prevention and control. It has topics on harmful algae, immunology, and molecular biological diagnostic techniques.

Aside from students, the textbook can be useful to fishfarmers, farm workers and technicians, fishers and women in fishing communities.

For ordering information, see page 63, this issue.

Aquaculture Clinic



QUERY

What are the factors that decrease dissolved oxygen in the ponds at night?

REPLY BY **J. BUENDIA**, INFORMATION ASSISTANT

There are two sources of dissolved oxygen (DO) in water: atmospheric oxygen and photosynthesis. Atmospheric oxygen in contact with the water surface is an unlimited source of oxygen. But, its diffusion and subsequent dissolution into water is a very slow process. The major source of DO in ponds is photosynthesis. Under clear daylight, photosynthesis can produce more oxygen than is being consumed by both plant and animal respiration in the entire day. At night, photosynthesis does not take place and therefore respiration reduces the DO content of the water. Some chemical reactions also use up dissolved oxygen. Bacteria reducing organic matters require DO. Concentration of dissolved oxygen is limited by its solubility.

Factors that contribute to decrease DO at night and which may bring it to critical levels are:

- **Water supply**
 - incoming water from a deep well or deep water from a reservoir may be low in DO
 - respiring or decomposing algae in surface water supply may reduce DO
 - water inflow is too small; this cannot help increase pond water with low DO
- **Low pressure**
 - cool rain or strong wind can cause the pond water to turn over, bringing the deoxygenated bottom water to the surface
 - several days of cloudy skies or rainy weather can reduce oxygen production through photosynthesis
- **Temperature**
 - a period of very hot days increase water temperature, reduce solubility of DO and increase fish requirement of oxygen
- **Biological / chemical oxygen demand**
 - plankton turbidity is too high, and too much oxygen is consumed at night for respiration
 - there is too much decaying organic matter, and too much oxygen is used up for its decomposition
- **Fish stock management**
 - there are too many fish in the pond which consume O₂ for respiration
 - fishes are overfed resulting in fish wastes or feces, and/or unconsumed food decaying at the bottom

Update, FYI

Feedback on the mollusc issue

This pertains to the article "Giant Clam Culture" in the Aquaculture Illustrated section which appeared in September - October 2000 issue.

I would like to commend your staff for the wonderful illustrations, as my particular research interest is on giant clams (Family Tridacnidae). Let me add the following information:

- there are nine (9) reported species belonging to the F. Tridacnidae, but seven are known from Philippine waters.
- they are listed by the IUCN as threatened species, except for *Tridacna crocea*, which has just been recently delisted. CITES lists the Family Tridacnidae in Appendix II, indicating that their trade is regulated.
- the international collaboration with ACIAR for giant clam research ended in 1992. Since then, IDRC-Canada, PCAMRD, and PCASTRD has provided research funds to UP-MSI until 1999. Presently, PTA is funding UP-MSI for giant clam culture and restocking in the Hundred Islands National Park (northern Philippines)
- on the last illustration showing three men carrying clams – may I comment that when a giant clam is placed in a reef, its normal position is upright rather than on its side. This is because the clam needs to be able to expose its mantle to sunlight so that its zooxanthellae can photosynthesize.
- the UP-MSI contact persons are Prof. Edgardo D. Gomez and me.

More power! Yours truly,

S. Suzanne Mingoa-Licuanan, Ph.D.

Another double issue?!

Dear readers:

It just so happens that there was a lot of materials on our first issue this year, the one on careers in aquaculture, hence the double issue. We found the same for marine hatcheries, our present feature. A double issue again! But even then, we still feel we are barely scratching the surface. You could ask for your money back, of course {g} or you could sit back and enjoy reading! Our apologies if this is an inconvenience. Sincerely, SAA staff-- PS. Now we are even running out of space ...

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www.seafdec.org.ph

Marine hatcheries

TAIWAN, INDONESIA, PHILIPPINES

Hatcheries are necessary to support aquaculture production. They provide a more sustainable alternative to taking seedstock from natural or wild sources. As an investment, marine hatcheries -- for milkfish, grouper, pearl oysters -- are attracting more attention in the wake of the shrimp industry slump.

This issue explores the interlinking factors in the development and sustainability of the hatchery industry – technology research and extension on broodstock management, seed production and feed development, a stable market demand for fry. It also gives a hint about the politics of the trade – e.g., (the lack of) government support in terms of policies on fry importation and the protection of local fry producers.

The article on Taiwan's hatchery industry shares a key element in the success of the industry in that country – close kin relations providing a strong support system that ensures quality production and a stable market outlet for fry.

Indonesia's milkfish hatchery points out the support given by big-scale hatcheries to small-scale ones which are operated by fisherfolk living along Indonesia's shorelines. Small-scale hatcheries help increase the income of these fisherfolk.

In the Philippines, milkfish hatchery is on top but hatcheries for abalone, mudcrab, pearl oysters, and corals are emerging. There is also an update of the government's work on breeding the saline tilapia.

Last but not least, this issue presents the R&D of SEAFDEC/AQD.

We hope this issue would give you a lot of new ideas.

What is a hatchery?

Hatchery is a place for large-scale production of fish eggs, larvae and/or fry.

In practical terms, a hatchery is a building that houses tanks and equipment for egg incubation and rearing of larvae. It is an artificial life-support system for fish taken out of its natural habitat.



a beaker of eggs larvae fry, for stocking in nursery/grow-out

The hatchery is the first phase of a production system aimed at producing food fish for the human population. The next phase is nursery rearing. The final phase is grow-out culture in ponds, pens or cages where fishes are grown to marketable size.

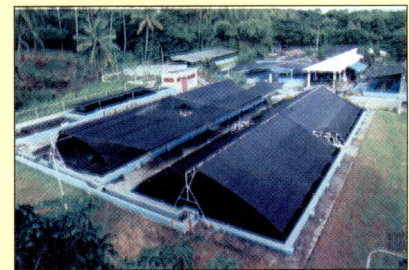
Here's what a hatchery looks like:



I CHIU LIAO 1993

◀ a pond spawning facility in Taiwan equipped with aeration to facilitate fertilized egg collection

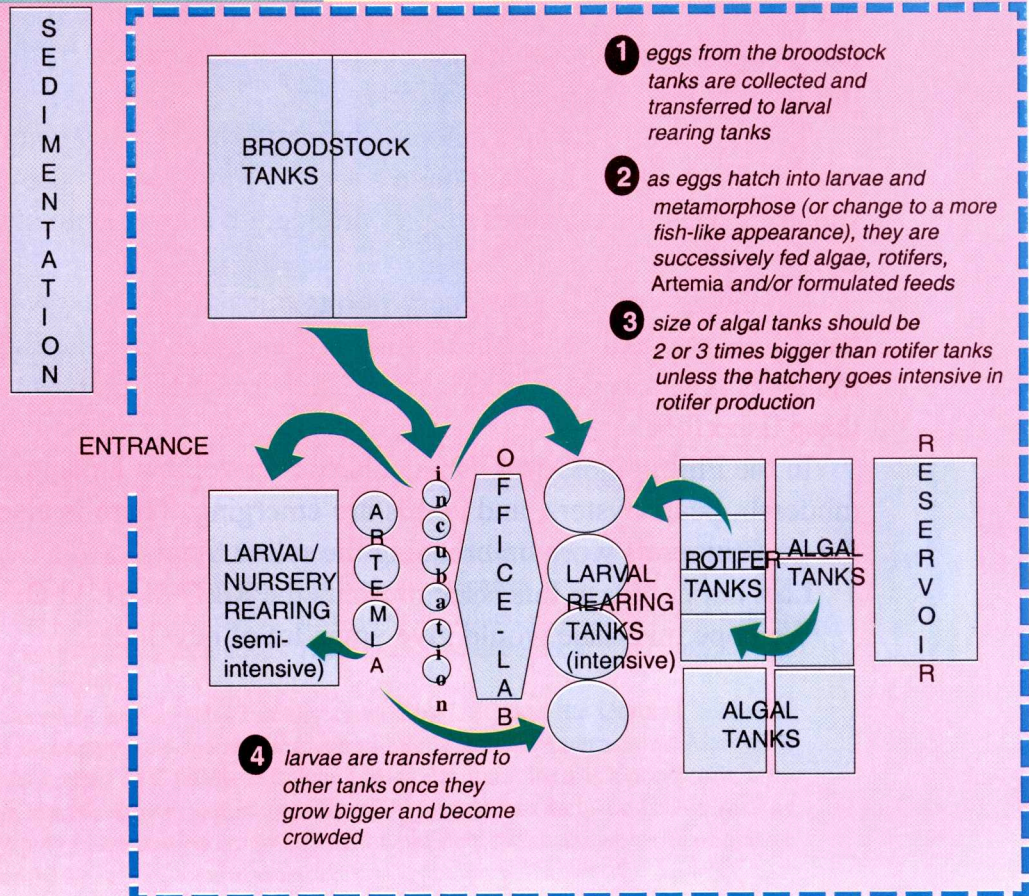
▶ the integrated broodstock-hatchery complex of SEAFDEC in the Philippines



The hatchery is designed such that the flow of work of hatchery technicians can be made efficient, and the stress to fish due to handling is minimized (green arrows). This hatchery design is that of SEAFDEC's hatchery demonstration complex (not drawn to scale; generalized layout)

Not shown are the water supply-discharge, aeration and electrical lines. They are considered most critical in hatchery operations.

If you're a new entrepreneur, hiring a good aquaculture engineer who is conversant with hatchery operations is but prudent.



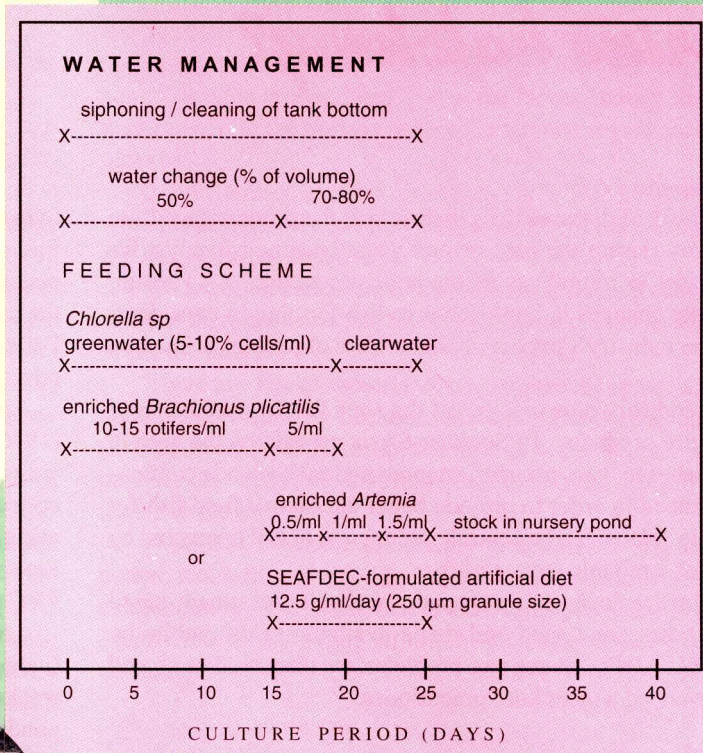
Though people say that raising fish, like growing plants, is an art that needs one to have the so-called "green thumb," this is not strictly true. There is a blueprint or master plan for operating hatcheries -- a result of several years of experimentation and trials by aquaculture researchers. But a "blue" thumb would not come amiss, some researchers say, especially for grouper/snapper/rabbitfish production.

This chart for milkfish, for example, is a classic presentation of hatchery operations. (This chart has previously appeared in this newsletter, June 1999 issue.) ↪

How would you read this chart? First, note the culture period at the bottom. This is the length of time that the larvae are expected to stay at the hatchery (usually 25 days), that is, from hatching as eggs to the time they can be sold to the grow-out people. If the larvae stay beyond 25 days, it is advisable to transfer the stock to a nursery pond.

Then look up the most important hatchery activities, that of WATER MANAGEMENT and FEEDING SCHEME. This chart advises that from day 0 to day 25, the tanks must be cleaned daily, and the milkfish larvae are fed with the phytoplankton called *Chlorella* up to day 20, etc.

There is an overlapping of feed types used. This would prepare or condition the larvae for the next feed type.



A detail not reflected in the above chart is the production of food for the larvae -- dubbed "natural food" if these are alive and swimming, otherwise called "artificial diet" or made by human hands.

Natural food production must start at least two weeks before the hatchery receives eggs or larvae. *Brachionus* and *Artemia* are of the size that would fit into the mouth of the milkfish larvae. Don't let the milkfish starve to death. It would be your loss.

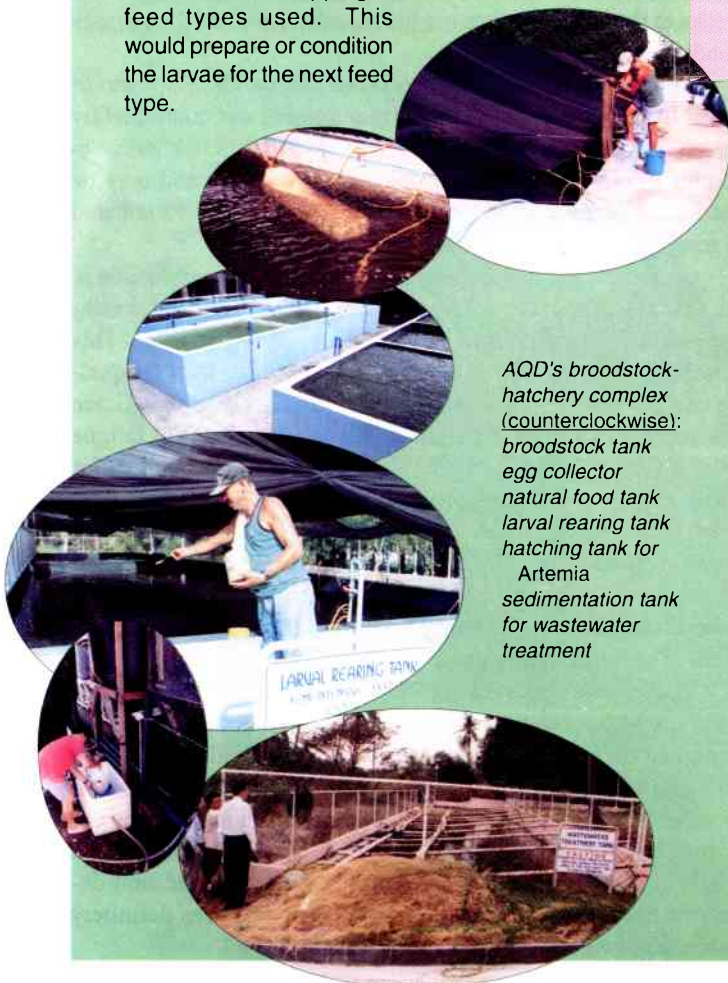
Stocking densities for eggs, larvae, fry or the natural food are part of the packaged technology for the hatchery. Larvae are usually stocked at 30 per liter of rearing water. There are ways of counting the stock without adding stress to the animals.

There are other things to remember as well. These include frequent monitoring of the stock and making sure that the life support systems (aeration, recirculating water if applicable) are always running.

A good hatchery technician could do all these hatchery routine jobs, and watch out for potential problems as well. When you need expert advice, call on some aquaculture consultants!

Welcome to the hatchery business.

-- BY MT CASTANOS



AQD's broodstock-hatchery complex (counterclockwise):
 broodstock tank
 egg collector
 natural food tank
 larval rearing tank
 hatching tank for Artemia
 sedimentation tank for wastewater treatment

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.

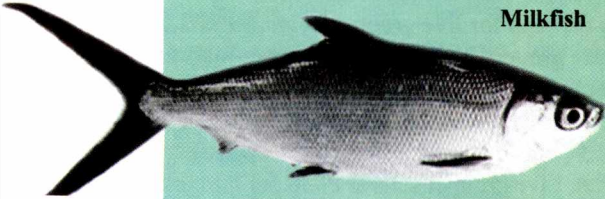




As related by Dr. Emata, "The hatchlings are fed with rotifers (natural zooplankton) and formulated diet. After about three weeks in the hatchery, they are harvested for stocking in nursery ponds before growout."

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="574 201 667 226">Milkfish</p>	<p data-bbox="727 201 1141 281">Developed: artificial larval diet as replacement for <i>Artemia</i>; broodstock diet; broodstock transport</p> <p data-bbox="727 306 1110 386">Developing: enhanced larval feeds to improve resistance to salinity and stress and lower incidence of deformities</p>	<p data-bbox="1159 201 1378 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="574 422 667 447">Sea Bass</p>	<p data-bbox="727 422 1122 627">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="1159 422 1378 447">Limited market of fry</p>
 <p data-bbox="574 682 667 707">Grouper</p>	<p data-bbox="727 682 1117 783">Developing: use of copepod nauplii to improve larval survival rate, and thyroid hormones to advance larval metamorphosis</p> <p data-bbox="727 808 1133 1014">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="1159 682 1378 837">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="527 1052 662 1077">Red snapper</p>	<p data-bbox="727 1052 1084 1098">For verification: effect of salinity on larval survival</p> <p data-bbox="727 1123 1127 1224">On-going studies: broodstock diets; effect of feeds and stocking density on larval survival, use of hormones to hasten metamorphosis</p>	<p data-bbox="1159 1052 1313 1077">Limited market</p>
 <p data-bbox="570 1367 678 1392">Rabbitfish</p>	<p data-bbox="727 1367 1133 1446">Developing: improved growth (larvae and early juveniles) through growth hormone and diet manipulation</p> <p data-bbox="727 1472 1084 1581">Further studies needed: effects of environmental factors, natural food, nutritional requirements and stocking density on fry survival</p>	<p data-bbox="1159 1367 1378 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.

➡ NEXT PAGE

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

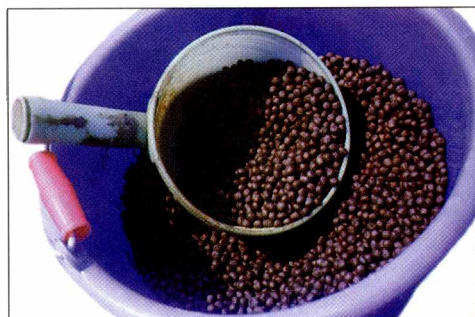
Like the grouper, red snapper enjoys a high demand both in the local and foreign market. Live snapper sells at P150-P200 per kilo in Manila.

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:

Overview of the marine fish hatchery industry in Taiwan

Josephine N. Nocillado and I Chiu Liao
Taiwan Fisheries Research Institute
199 Hou-Ih Road, Keelung 202
Taiwan



*T y p i c a l
broodstock ponds
(right) in Taiwan.
Striped threadfin
broodstock are
held in the pond on
the lower right. At
left is formulated
broodstock diet*

During the Lunar New Year, the grandest of all holidays in Taiwan, images of fish are prominently displayed everywhere. Among the Taiwanese, fish is considered auspicious and a symbol of bounty. This is because the pronunciation of “fish” (yü) is similar to that of “surplus” (yü), indicating abundance and prosperity. A fish specialty, with the fish preferably presented in its entirety, is a constant fare on the dining table during special occasions. And in the true Taiwanese tradition, this most special dish is served as the last course, something truly worth waiting for, and remembered.

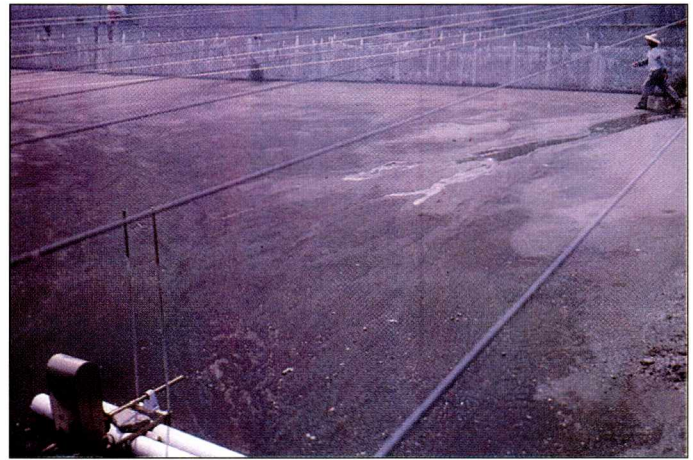
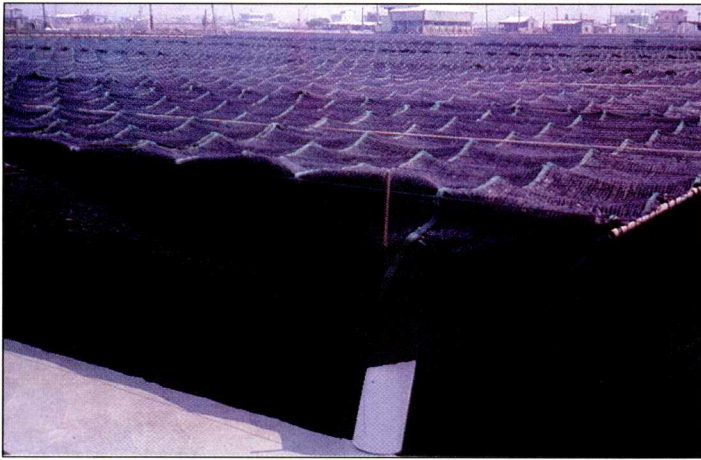
Not surprisingly, fish culture is itself an age-old tradition in Taiwan. Rearing fish in captivity is almost an art form for many Taiwanese aquafarmers who inherited the skill from many of their forebears. Milkfish was the first species to be cultured on a large scale as far back as the 17th century. The second culture species of historical significance made substantial contribution almost three centuries later. Mozambique tilapia was successfully introduced from Singapore after the Second World War by two returning Taiwanese soldiers, Chen-Huei Wu and Chi-Chang Kuo. From the thirteen fish that reached live in Taiwan, a tilapia culture industry flourished, supplying the much needed animal protein of the Taiwanese after the war. Today, tilapia in Taiwanese is known as “Wu-Kuo yü”, in honor of the two soldiers who brought the fish with them to Taiwan.



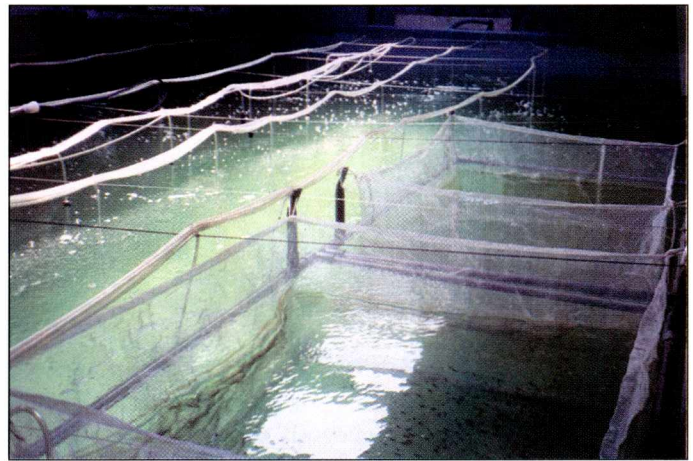
It was in the 1960s that the first successes on artificial propagation were achieved, this time in several species of Chinese carps and other tilapias. Art and science combined, fish propagation in Taiwan took off to a great start.

The first marine fish to be bred in captivity was the grey mullet. Highly valued for its roe, the grey mullet was first induced to spawn in 1968. The completion of its life cycle in captivity was fully achieved in 1976. In the late 1970s, the milkfish and breams were added to the growing list of propagated marine fishes. Recent additions to this list reflect the changing taste of local consumers as a result of economic gains and the requirements of the export market, particularly its high-end sector. Pompano, red drum, cobia, great yellow tail, snappers, groupers, and jacks have, very recently, been successfully propagated on commercial scale.

➡ NEXT PAGE



Typical outdoor larval rearing pond: black sackcloth is used to reduce sunlight penetration and prevent algal bloom (top, left). A pond being prepared for stocking (top right).



Indoor rearing tanks for grouper in Taiwan. Facilities such as these were formerly used in tiger shrimp hatcheries (above)

Characteristics of the industry

“Division of labor” characterizes the marine fish hatchery industry in Taiwan. A “core hatchery” holds the broodstock, produces the fertilized eggs and sells them to affiliate larval rearing hatcheries, constituting a “group.” In selling the fertilized eggs, priority is always given to the affiliate larval rearing hatcheries before any sale is done outside of the group. At any given time, the core hatchery may hold as much as twenty different species of broodstock.

Natural food may be produced in the larval rearing hatchery. Otherwise, they are obtained from commercial suppliers. For instance, blocks of frozen copepods and tiny shrimps can be easily purchased.

Nursery rearing until the fingerling stage may also be done within the larval rearing hatchery. For species that requires prolonged nursery rearing, such as the groupers, raising until the marketable size may be done by a nursery grower, who buys the larvae from the larval rearing hatchery.

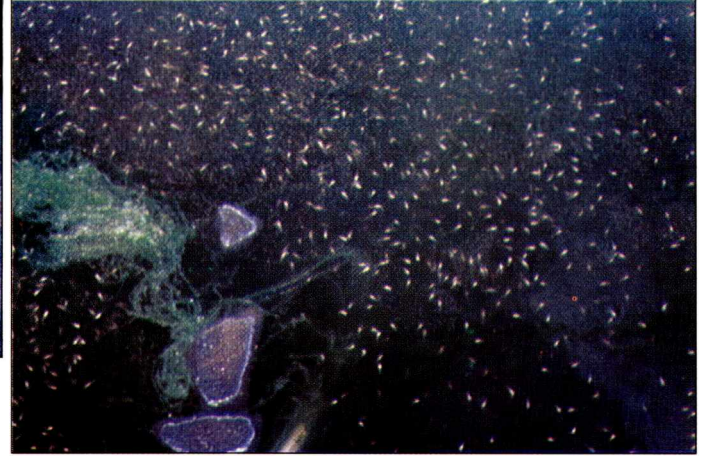
Most fish hatcheries in Taiwan are family-owned. It is not uncommon that within a particular group are relatives or close friends. It is essential that the larval rearing hatchery owner earn the trust of the fertilized egg supplier before admission into the group is allowed. This somehow is an insurance that the fertilized eggs will not go to waste. Group members care for each other, not only on technical matters, but also including marketing of the fertilized eggs, larvae, and fingerlings.

Hatchery type: outdoor ponds vs. indoor tanks

Broodstock are invariably held in outdoor ponds. Larval rearing and nursery facilities are either indoor tanks or outdoor ponds. A typical broodstock and outdoor larval rearing pond has concrete dikes, a sandy bottom, and on the average about 600 m². The water depth in broodstock ponds ranges from 1.5 to 2 m while outdoor larval rearing ponds are 1 to 1.5 m deep. Formerly used for giant tiger shrimp larval production, indoor tanks are concrete and usually less than 100 tons.



Blocks of frozen copepods (above, left) and Acetes (middle photo) are broken into pieces. Being frozen, the pieces float and as they melt slowly, the fish larvae feed on individual copepod or shrimp (right)



Larval rearing outdoors is more popular than larval rearing indoors. In outdoor ponds, natural food organisms grow, water quality does not deteriorate quickly, larval rearing duration may be extended, and operating cost is low. It is also a common observation that larvae reared in outdoor ponds are of better quality. The larvae of some species, such as the red snapper and cobia, are best reared in outdoor ponds. Operation in outdoor ponds is very flexible. Aside from larval rearing, ponds can be used sometimes to exclusively grow natural food, such as rotifers.

Management

Both outdoor and indoor hatcheries have a flow-through water supply system. Broodstock ponds are equipped with as much as three paddlewheel aerators per pond. Outdoor larval rearing ponds may have one to three paddlewheel aerators depending on the stocking density. In order to prevent algal bloom, outdoor ponds are covered with black plastic shade.

Broodstock are fed formulated diets. Larvae are provided a combination of natural food, either live or frozen, and formulated diets. This practice prevents low survival rates that may result from nutritional deficiency.

A hatchery is normally managed by only one full-time staff, although assistants are hired during pond preparation and harvest.

Outlook

When it comes to achievements, the marine fish hatchery industry in Taiwan can speak for itself. Once an importer of marine fish larvae and fingerlings from many of its Asian neighbors, Taiwan now exports them to Japan, China, Viet Nam, Hong Kong, the Philippines, Malaysia, and Indonesia. There are now at least 60 marine fish species in which commercial larval production is possible. Such diversity renders enormous marketing flexibility for the Taiwanese aquafarmer. And speaking of the Taiwanese

aquafarmers, their role in the sustained success of their marine fish hatchery industry is not to be underestimated. They are dedicated more than their task requires. Their homes are erected adjacent to their hatcheries. They are on call twenty-four hours a day, come rain or shine.

Their successes notwithstanding, the marine fish hatchery industry in Taiwan is not totally without pitfalls. Diseases are a threat. Land subsidence is common in areas where hatcheries are concentrated. Overproduction becomes a problem once in a while. These, of course, do not discourage those in the industry and the research community to move even further along. If anything, these challenges inspire them to scale new heights, perhaps in very similar fashion as their oldest milkfish broodstock. Already twenty-eight years old, they endured the early trials of artificial propagation, and up to this time, still spawning strong!

ACKNOWLEDGMENTS

We thank Mr. Henry Wang of Aquaculture Taiwan Resources Co., Ltd. for his very kind and generous assistance during the hatchery tour. We acknowledge Mr. Eddie L.C. Chang of Tung Shin Fish Fry Hatchery and his group for unselfishly sharing their time, insights, and fragrant and flavorful Taiwanese tea.

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The technology for milkfish hatchery in Indonesia

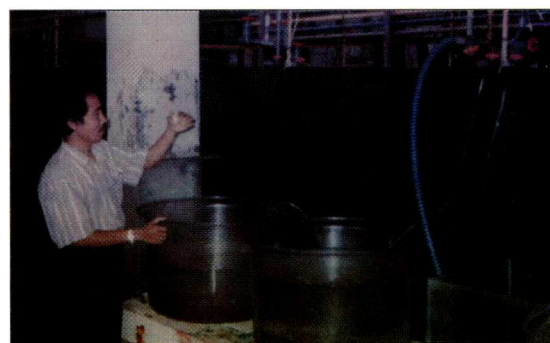
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Determination
of gonadal ►
maturation



Measuring
the weight
◀ of
broodstock



Egg ►
incubation
in the glass
tank

Milkfish is one of the most popularly cultured species of fishes in the domestic and international market. It is consumed either fresh or processed. The culture of milkfish, which is the oldest fish cultured in Indonesia, started in Java around the 14th century. Recently, almost all provinces in Indonesia have gone into the trade.

Indonesia has around 4.5 million hectares of mangrove areas. Only 270,000 hectares have been used for pond culture. About 10% of this is used for intensive shrimp culture and polyculture of shrimp with milkfish and other species. Therefore, the demand for fry which is estimated at 4.35 billion a year is not met. Available fry produced is only 1.5 billion a year. Based on the total area of fishponds (*tambak*), if the stocking density is about 10,000 fry per hectare, the estimated total fry needed is about 2.5 billion for every culture cycle.

NOTE This article is the result of the author's volunteer research work at Loka, a research institute for coastal fisheries in Gondol, Bali, Indonesia

The gap between demand and supply of milkfish fry has to be met in order to avoid a decrease in production of milkfish and supply of fry (from the wild). Fry production through the hatchery method is one of the best solutions to the problem.

To answer the demand for milkfish fry in Indonesia, a series of studies on artificial fry propagation has been conducted since 1988 at Loka, Gondol, Bali. Since 1993, fry production of milkfish through artificial propagation has been known and practiced in big and small scale hatcheries. Apart from Gondol and Negara in Bali, some milkfish hatchery now operate in Situbondo, Tanjung Kodok (in East Java), and recently in South Sulawesi.

The milkfish hatchery system

Production of milkfish fry has been practiced in Indonesia both in big scale and small scale hatchery (or backyard hatchery) technology. Small scale hatchery production is popular because of the minimal risks, low operational costs and good income. Small scale hatcheries can help ward off poverty because it helps increase the income of fishers. On the other hand, big hatcheries

are operated with the aim to produce good quality and low priced fry in large quantities in time with the culture cycle.

A big-scale hatchery or complete hatchery is a unit which produces eggs and fry of milkfish. Small scale hatchery only produces fry and are operated in a cluster of houses near the sea-shore. Big-scale hatcheries support the fry production of small-scale hatcheries with the excess eggs they produce. In one run of spawning, a big-scale hatchery can produce about 300,000 to 1,000,000 egg.

Milkfish fry production from big- and small-scale hatchery has supported the development of milkfish culture and the tuna fishing industry in Indonesia. Milkfish fingerlings are among the best bait used in tuna fishing. In Benoa Bali, at least 50 rean (1 rean is equal to 5,000 fingerlings and equivalent to 100 M Rupiahs) are needed daily by fishing boats as tuna bait.

Site selection for milkfish hatchery

Site selection, considering both the technical and non-technical aspects, is a necessary requirement for hatchery operation. A major technical criteria in selecting a site for a milkfish hatchery is as follows:

- The area should be flood and pollution-free, and should be near the water source
- Adequate good quality sea and freshwater should be available the whole year round
- The area should be near the broodstock source

The non-technical criteria includes accessibility to transportation (for the transport of broodstock and fry); supply facilities like feeds, fertilizer, chemicals, etc; and labor support.

Operation of milkfish hatchery

Activities in big scale hatchery of milkfish production are as follows (see also chart next page):

Broodstock rearing. Broodstock may be reared in ponds or cages. The author has conducted some studies in the preparation of milkfish broodstock to be used in the hatchery. The broodstock is reared in cages using different quantity and quality of feeds to accelerate both body weight and gonad development. Broodstock should be more than five years old, with a body weight of more than 4 kg, and with a body length between 58 to 60 cm. This criteria should be used to ensure quality production of milkfish fry in the hatchery.

Hormone implantation. Successful spawning of milkfish broodstock is done in the rearing tank with the use of LHRHa (luteinizing hormone-releasing hormone analogue) and MT (17 α methyl testosterone) applied by implantation to the broodstock to accelerate gonad maturation. Hormone application is conducted every month between 6 to 12 times based on the gonad maturation level until the broodstock has spawned naturally. Pellets are used for hormone application. The doses are presented in Table 1.

Pellet hormone implantation is done by injection on the dorsal part of the broodstock. It is only applied to broodstock that has a body weight between 4 to 7 kg, with a body length between

Table 1. **Doses of hormone pellet implantation in milkfish broodstock**

	Doses
First month	200 μ g LHRHa
Second month	200 μ g LHRHa
Third month	250 μ g 17 α -MT
Fourth month	200 μ g LHRHa
Fifth month	200 μ g LHRHa
Sixth month	250 μ g 17 α -MT

60 to 70 cm and is estimated to be 4 to 7 years old. This is because the gonad of 4- to 7-year old broodstock is already well-developed, since the aim of hormone application is to accelerate gonadal maturation.

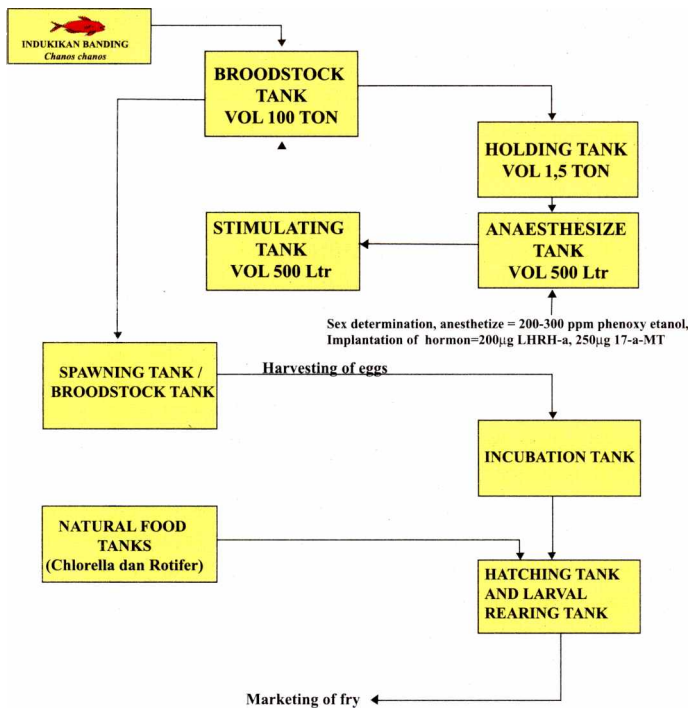
Broodstock maintenance. Care of milkfish broodstock that has been implanted with hormone should be carefully conducted. This is important so that gonadal development can be observed. Milkfish broodstock are reared in 100 ton capacity tanks (with a depth of 2 meters and a diameter of 8 meters) with a density of 25 broodstock in one tank. Broodstock tanks should be circular in order to facilitate natural spawning.

Sex determination is an important factor in broodstock maintenance even if it is difficult to do. It should be carefully conducted to prevent the broodstock from easily getting stressed. Broodstock from the rearing tank is transferred to the stimulating tank (with a capacity of 1 to 1.5 m³). Water in the stimulating tank should be continuously aerated. Prior to sex determination, broodstock is anesthetized using phenoxyl ethanol with a dose of 200 – 300 ppm. When the broodstock begins to look sluggish, a cannula (0.9 mm diameter) is carefully inserted in its sex organ. The tip of the cannula is pushed in, then carefully pulled out. If the liquid in the cannula takes a round shape, the broodstock is female. If it remains as a thick liquid, the broodstock is male.

After sex determination, the broodstock is directly transferred to another stimulating tank and is moved to and fro until it recovers from the anesthesia. The male and female broodstock are then transferred to the rearing tank with a ratio of 1 male to 1 female (1:1).

Water quality is another important factor in broodstock rearing. Salinity of 34 ppt is required. This is also an important requirement in the spawning and harvest of eggs. Fertilized eggs have a buoyancy while unfertilized eggs are those that sink to the bottom of the tank. To maintain water quality in the broodstock tank, a flow through system is applied with 100 to 150% exchange rate per day. During broodstock rearing, supplemental feed is given at 5% of BW, twice daily – one in the morning and one in the afternoon.

Egg production and harvest. The use of hormones can accelerate spawning, affect the fecundity and egg quality of milkfish. Studies using this method have shown that rearing of 20 male and 40 female broodstock produced 45 million eggs, while rearing 35



Schematic diagram of the milkfish hatchery

male and 55 female broodstock produced 50 million eggs in 1991 and about 60 million eggs in 1992. Broodstock with 4-6 kg body weight produced 300,000 – 600,000 eggs in one spawning. Spawning is done on a staggered basis so the broodstock could spawn 8 to 15 times a year. Production of eggs follows the natural spawning peaks during the months of September to December, and decreases from January to March. It drastically decreases during June to August.

Mature broodstock usually spawn between 23:30 to 01:00 or around midnight. Collection of eggs is conducted at 07:00 am.

Harvested eggs are placed in glass containers from which fertilized and unfertilized eggs are selected. Fertilized eggs are characterized by a clear transparency while unfertilized eggs are whitish. After the separation and sampling of fertilized eggs, pre-incubation is conducted for three hours. Then the eggs are transferred to 500-liter fiberglass tanks for incubation until they hatch. Strong aeration should be applied during incubation to improve hatching rate. Water temperature should be between 26-29.5°C. Fertilized eggs that incubate at 34 ppt and temperature of 31.5°C hatch after 20.5 – 22 hours.

The study which was conducted by the author in 1995 and 1996 in Loka, Gondol, Bali showed that hatching rate was 60-70%.

Larval rearing. Newly-hatched larvae are then transferred to 10-ton larval tanks. These usually have a body length of 4-5 mm with a relatively big yolk-sac. About 3/4 of the larvae's body length, the yolk-sac is found along the head to the anus of the milkfish larvae.

Aeration should be maintained carefully. It should not be too strong.

Larvae should be fed with *Chlorella* sp. at a density of 2-3 x 10⁵ cells per ml. Rotifer (*Brachionus plicatilis*) is given starting the second day with a density of 10-15 individual per ml up to day 6. At day 7, density of rotifer is increased to 20-25 individuals per ml. Starting day 9 and day 10, water in the larval tank is changed at 10% daily. It is then increased based on the age of the larvae. When the larvae are 21 days old, water exchange is 100% per day. At day 10-12, nauplii *Artemia* can also be given, increasing this to not more than 10 individual per ml at the 21st day. To maintain water quality, tank bottom is cleaned daily and water temperature is maintained at 27-31°C, salinity at 30 ppt, pH at 7-7, dissolved oxygen at 5-7 ppm and water level in the larval tank at 125 cm.

Harvest of fry is conducted after 21 – 25 days by reducing the water level in the tank and transferring the fry to the containers. They are then ready to be sold.

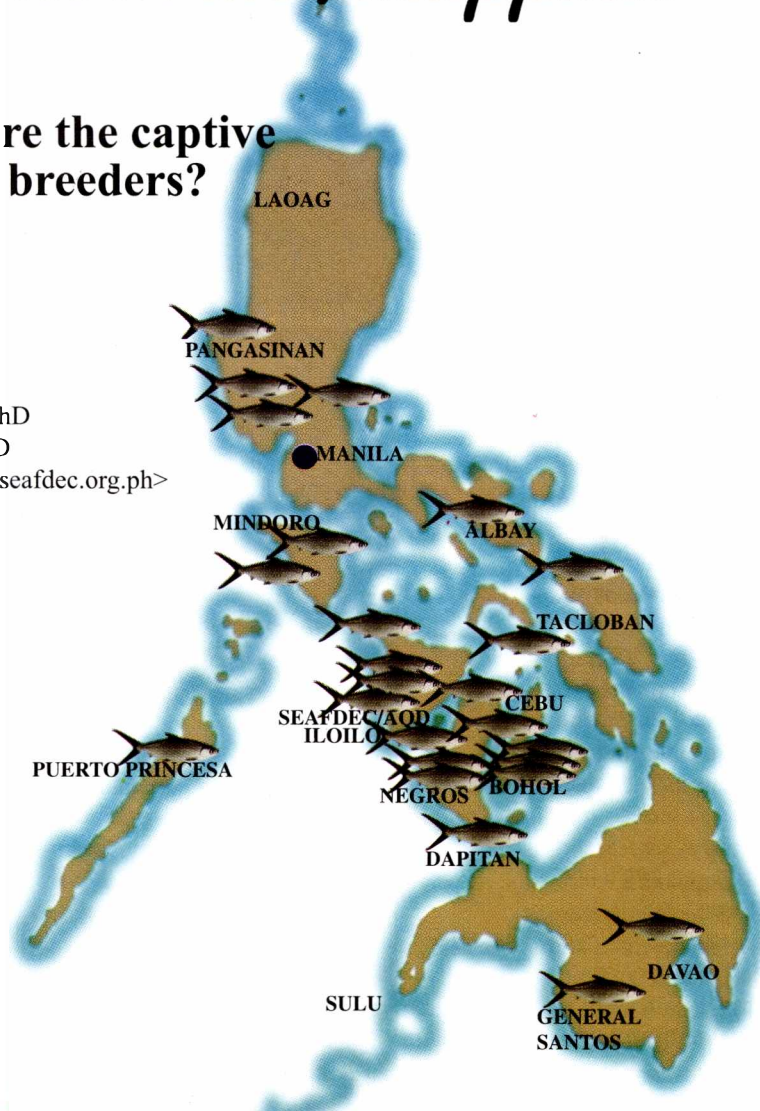
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Updates in the Philippines

Where are the captive milkfish breeders?

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Marañon's milkfish broodstock spawn naturally following transport

Two hundred 7-year old pond-reared milkfish broodstock (average body weight of 2.5 kg) owned by Alfredo Marañon Jr. have been successfully transferred using SEAFDEC/AQD's broodstock transport technique. The milkfish are now in two units of 10-m floating netcages in Escalante, Negros Occidental.

Three days following their transport on June 18 and 19, the broodstock began to feed. On August 6, these spontaneously spawned, indicating no adverse effect on the physiology during transport and the reliability of AQD's technique. The milkfish are still spawning up to this time.

The Marañon case joins other transport incidences so far undertaken by AQD for the private sector.

Owner / location	Rearing facility	No. of broodstocks	Age	Remarks
PACIFIC FARMS Alaminos, Pangasinan	Cage	35	15 yrs	Spawning but no fry production
BFAR-NATIONAL INTEGRATED FISH TECHNOLOGY DEMO CENTER Dagupan, Pangasinan	Tanks	200	5 yrs	Spawning recently reported
GOOD FRY HATCHERY Masinloc, Zambales	Cage	40	15 yrs	Spawning but no fry production
JTV FARMS Magsaysay, Occidental Mindoro	Pond	4 000	5 yrs	No spawning reported
BFAR Region IV Naujan, Oriental Mindoro	Pond	230	4 yrs	No spawning facilities
BFAR Region IV Searanching Station Puerto Princesa, Palawan	Cage	280	5-11 yrs	No spawning reported

SUMMARY

Most of the 17,443 milkfish broodstocks are located in central Philippines. There are 13,420 broodstocks in ponds; 2,081 in cages; 842 in tanks, and 1,100 in pens. The youngest is 3 years, the oldest 23 years old.

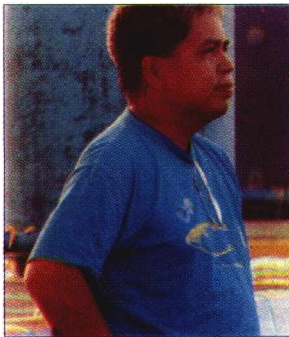
Producing and selling milkfish fry: the experiences of a government and a private hatchery

By **MB Surtida** and **AP Surtida**

Milkfish culture depends heavily on availability of fry supply which comes both from the wild and from hatchery production. But supply from the wild has been steadily decreasing through the years even as demand for fry has increased because of the intensification of grow out farming practices. This means that the milkfish hatchery industry must produce fry for grow out production as fast as the demand increases.

From 1980 to 1997, aquaculture registered a steady growth rate compared with the commercial and municipal sectors. Milkfish constituted the bulk of aquaculture production contributing 186,000 tons on average to total sectoral production. Compared with major fishery commodities, milkfish share of total aquaculture production was 29.65%, second to seaweeds and followed by tilapia. By year 2003, additional requirement for milkfish fry at 2.5% annual growth rate is 260 million. Can the milkfish hatchery industry produce enough fry to sustain production growth?

The following are observations of medium-scale milkfish hatchery operators and their experience regarding their fry production.



Director Westly Rosario greets the early morning sun at NCAMFRD with guarded optimism. In his short stint there, he has done wonders for the institution

NCAMFRD in Pangasinan

The National Center in Aquaculture and Marine Fisheries Research and Development (NCAMFRD) Complex — National Research and Development Institute (NFRDI) of the Department of Agriculture (DA) is a 24-hectare complex for fishery research, production, and training along the Lingayen Gulf in Dagupan City, Pangasinan in Luzon.

Among many of its major projects is the commercial milkfish fry and fingerling production.

NCAMFRD runs an integrated milkfish broodstock and hatchery complex. According to Mr. Westly

Rosario, the director of the complex, they have a 10 million fry target production up to year 2002. They are quite optimistic that this year they will produce more than one million milkfish fry. So far, this early, they have already produced about 60,000 fry. Their broodstock tanks contain breeders with a density of 75 fish per 100-120 tons.

In a report by Eva de Leon titled “Bangus hatchery goes into commercial production” published in the *Philippine Star*, 10 June



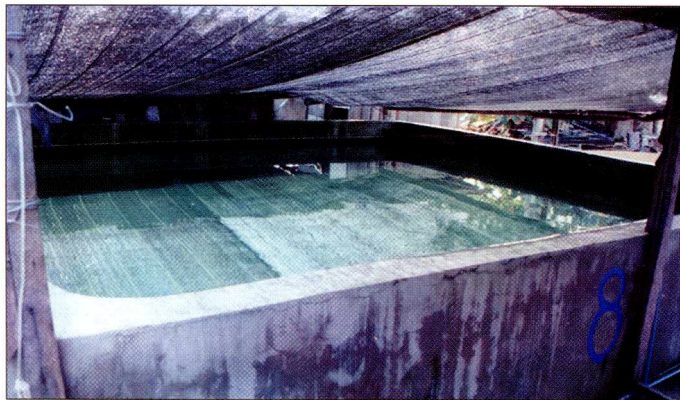
The National Center in Aquaculture and Marine Fisheries Resources Development (NCAMFRD) in Dagupan, Pangasinan has 10 grow-out seawater ponds. Priority is given to hatchery-reared milkfish



Technician Armando dulay feeding at larval tanks



Feeding time for hatchery-bred milkfish in one of NCAMFRD's grow-out ponds



The natural food circular tank (1) and larval rearing tank (2) at the Aznar milkfish hatchery in Talisay, Cebu

2001, NCAMFRD distributed about 200,000 fingerlings each in Regions 1, 2, 3, Davao, Zamboanga, and the Cordillera Autonomous Region (CAR). Fingerlings are sold at 20 centavos below the current commercial price.

NCAMFRD has three broodstock tanks with 167 breeders, both male and female. So far, there are 66 spawners now laying eggs. These spawners are domesticated milkfish coming from different places: Sual, Pangasinan; Tiwi, Albay; and Alaminos, Pangasinan. NCAMFRD researchers are waiting for the arrival of the Iloilo broodstock coming from the University of the Philippines in the Visayas (UPV).

NCAMFRD says spawners lay an average of 150,000 eggs each; fecundity is 200,000 per kg for each female breeder; and that spawning ratio of male to female is 1:1. The average age of the fish is five years and above. NCAMFRD has some 20-year-old broodstock from Alaminos, Pangasinan.

According to Mr. Rosario, spawners are given commercial feeds but these are reformulated by adding vitamins and fish oil.

NCAMFRD uses the flow through system in water management — 200% daily in water change. Another means of eliminating waste is by siphoning which is done three times a week.

Hatching has to be done in separate tanks, otherwise the adult 'sabalo' or spawners will eat the eggs that they laid.

For its hatchery facilities, NCAMFRD has incubation tanks for eggs, and ten 10-ton rearing tanks. The stocking density in the latter is 30 larvae per liter.

The hatching rate is 67%, and survival rate is 33%. Larval culture is 21 days prior to its release in grow-out fishponds. Larvae are fed with rotifer, starting day 2 to day 16. From day 16-21, they are given artificial feeds with cornstarch cooked like 'polvoron' (fine dust confectionery) with milk. Feeding is done once a day. At the grow-out pond, however, they are fed 3-5 times a day with commercial feeds.

NCAMFRD does daily siphoning of tanks to avoid rancidity of water due to uneaten feeds.

They don't use *Artemia*. Instead, they use copepods as supplementary feeds which are collected from nearby fishponds.

With regards to diseases, Mr. Rosario has some suspicion that the possible source of deformities in fry is *Artemia*. But he has no empirical data yet to back up his suspicions. They have a collaborative project with the Marine Science Institute of the University of the Philippines in Diliman to study the genetic DNA sequencing of both hatchery-bred and wild spawners from different sources. The study is ongoing.

There are some abnormalities, according to technical aide Armando Dulay, like some fry exhibit exposed gills, or crooked bodies, but their Fish Health section is continuously studying these cases.

Other marine fish species being studied at the complex are: grouper, *Caranx*, seabass and siganid. But the extent of study is not as advanced as that of milkfish.

The Aznar hatchery in Cebu

The Aznar milkfish hatchery has been operating for four years and uses a hatchery technology that has been verified at SEAFDEC/AQD. It has several floating broodstock cages stocked with 400 breeders in Pangangan, Bohol. The cages (2 sizes, seven 10 and two 6 m dia, 3 m depth) are framed with polyethylene pipe and fiberglass at the top and bottom to retain its shape while in use. The cages were designed by Engr. Matias "Bombi" Aznar, an avid fish hobbyist, who says that his interest in fish as a boy prodded him to put up a multi-species hatchery to be able to "restock our seas" and arrest fishery decline.



Engr. Matias "Bombi" Aznar intends to patent his floating broodstock cages in Pangangan, Bohol

Eggs from the broodstock (the cages are installed with egg collectors) in Bohol are transported to Talisay, Cebu for rearing. The Cebu hatchery has concrete broodstock (6 x 6 m), larval rearing (4 x 10 m), reservoir (10 x 10 m) tanks, and circular (10 m) natural food canvas tanks. Mr Aznar believes that one must have a nursery pond (he has 4 ha) to grow 21-day old larvae to fingerlings. His experience shows that it is better to grow milkfish to fingerlings in ponds before stocking them in cages. He sells his fry at P 0.40 - 0.50.

➡ NEXT PAGE

His broodstock are fed with commercial pellets while his larvae are fed *Chlorella* and rotifers, not unlike other commercial production methods. Survival from newly hatched larvae is 20 - 40%. Considering his number of breeders with the above survival rate, his average production can be modestly big and suggests surplus for the hatchery market. He sells fry to customers in Cebu and does not have a problem with acceptability. He explains that his Talisay hatchery near his buyers in Cebu and his breeders in Bohol can supply fry demand anytime.

But he assures us that his problem is not acceptability. It is overproduction. He steadily produces fry but he cannot sell them. His consultant, Albert Gaitan, says that at present, they have a million fry but there are no buyers. "Luzon is the biggest fry buyer, but unless we are able to pierce that market area, we would not be able to sell our produce. Our problem is not acceptability. It is the importation of fry from Indonesia and Taiwan that saturates the Luzon market," Totong says.

He further says that the Philippines should be exporting fry by now, and not allow importation.

"The bottom line of fry hatchery production is market, not acceptability," he says.

Conclusion

The above interviews and other conversations with hatchery producers show that the milkfish fry hatchery technology is now acceptable to most grow out milkfish producers. But hatchery producers say they cannot sell their fry despite intensive production methods now adopted by growout producers. They say that imported fry from Taiwan and Indonesia that floods the Luzon market should be regulated especially during peak months of wild fry availability. Added to this, they say that more processing plants for grow out production must be established. They believe that increased grow out production would invariably benefit the hatchery industry. The export ban on milkfish fry must also be lifted as the Philippines now has the capability to export especially during peak production months. It is ironic that a technology was expensively developed and pushed for acceptability only to cause frustration and losses to those who adopted it. ###

Update on BFAR's saline tilapia breeding

At the moment, there are two national programs in the development of saline tilapia in the Philippines -- the BFAR-FAC¹ project in Nueva Ecija and the Molobicus-NFRDI-NCAMFRD² project in collaboration with PCAMRD³ in Dagupan City. The hybridization of two tilapia strains, *Oreochromis niloticus* and *O. mossambicus* is being studied at NCAMFRD to come up with a first generation hybrid (F₁) that is fast growing like the *nilotica* and high saline tolerant like the *mossambica*.

According to Mr. Westly Rosario, director of NCAMRD, the F₁ hybrids can survive and grow at 15-25 ppt. The Molobicus Project Protocol, which is the title of the study, is aimed at the breeding of hybrid nursery and sex-reversal of the fingerlings.

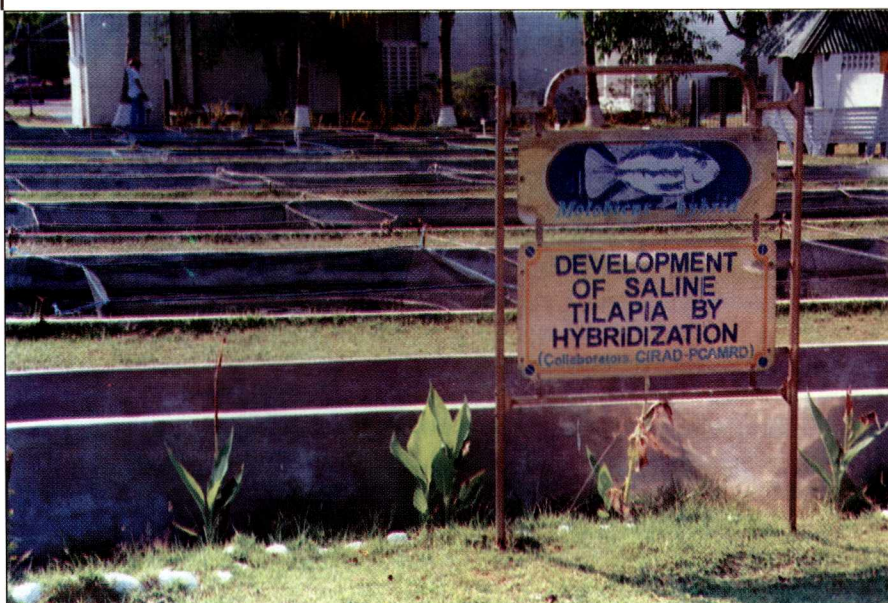
Breeding of hybrids is done in concrete tanks or hapa nets with 1-3 x 5 x 1 meter specification. It is estimated that in about 45 hapa nets, 10,000-20,000 eggs or fry can be harvested every 10-20 days. The fast growing *O. niloticus*, otherwise known as GET, GIFT, *pla-pla* or giant tilapia, can be purchased in different areas of the country. This strain has a thick flesh, small head, is voracious, and easy to breed.

Sexually mature males weighing 50 g should be used in hybridization. Acclimation is done by letting species loose in concrete tanks or hapa. Aeration is done if necessary.

On the other hand, *O. mossambicus* females which are sexually mature should be caught and selected from many milkfish ponds to be used as parents of the F1 hybrid. They are acclimatized by adjusting the salinity of the pond where they were caught.

Breeding is done in freshwater, that's why *mossambicus* should be acclimatized with decreasing ppt everyday (1-3 ppt). Needed are clean water, aeration, and feeds for the female parent. Breeding is done among 30 female *mossambica* with 10 male *nilotica* in 1.3 x 5 x 14 hapas. Same-sized tilapias should be matched. This matching is called MONI or *Mossambica* and *Nilotica*.

Harvesting of eggs is usually conducted during the summer months or warm weather. Harvesting is done by separating the breeders from the eggs by using scoop nets. The eggs are released in concrete tanks. Meanwhile, sac fry should be placed in an incubator. Incubation should last until the fry can swim.



Sex reversal into an all-male tilapia is done to ensure fast growth and avoid non-stop breeding. Sex reversal is done by feeding females with male hormones, either in concrete tanks or hapas. A round concrete tank with a diameter of one and a half meter and a depth of half a meter can accommodate 5,000-10,000 fry. The best ratio, however, is five fry for each liter of water. The tank should be placed in a shady area to avoid fast algal growth. Aeration should be provided.

Commercial feeds with 35% crude protein are used. They are ground or milled to ensure fine grain. About 0.6 grams of 17 α methyltestosterone is mixed with half a liter of 90-95% ethyl alcohol. Mixing a kilogram of feeds is done slowly by means of a sprayer. A bowl of fine china is used in mixing hormones. Drying the alcohol in the feed should be done under the shade. It should be refrigerated. One kg of hormone-treated feeds can be used for 3,000 fry in 21 days.

Feeding is done 3-5 times daily. Amount of feeds is 15-20% of fry weight. If the fry reaches 15 mm, feed can be reduced to 10% until it becomes male.

Harvesting can be done after 21 days, but it is better to extend treatment from 25-28 days.

Fry are harvested using a B-net. Average weight of fry after treatment is 0.1-0.3 g.

The reversed fry can be sold or stocked for grow out when they reach 1 g.

At BFAR's National Brackishwater Aquaculture Technology Resource Center in Pagbilao, Quezon province, also in Luzon, the grow-out aspect of saline tilapia is done. According to Mrs. Florida Arboleda, resident senior aquaculturist, their saline strains are similar to the Dagupan strain. The main difference lies in the thrusts of their projects. Mrs. Arboleda said NCAMRD is more research and academic-oriented, whereas theirs is applied and more extension-oriented.

Their original stock came from Professor Lourdes Dureza of the College of Fisheries at the University of the Philippines in the Visayas. This was fine-tuned by PCAMRD before it was passed on to be used in their national program.

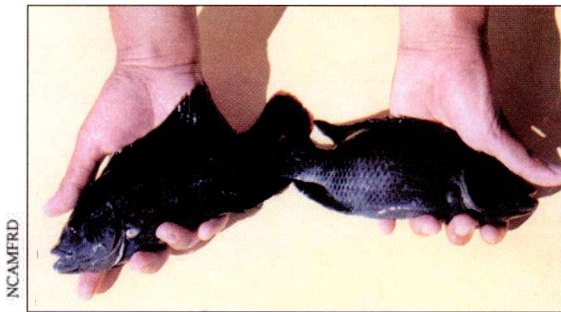
Asked about how it differs from the jewel tilapia of VY Domingo in Negros province, Mrs. Arboleda said that their stuff is *mossambica* crossed with *nilotica*, whereas the jewel is a *hornorum* crossed with *nilotica*.

She said that their hybrids can tolerate up to 25-30 ppt; and 40 ppt is a possibility.

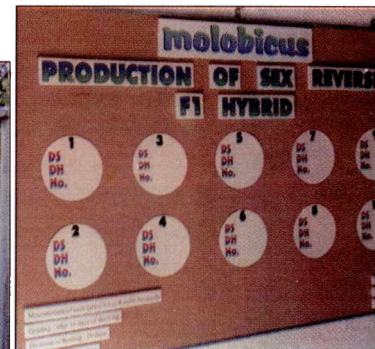
The Pagbilao complex is more than a hundred hectares and serves as a demonstration center for the grow-out of various aquaculture species, particularly of milkfish cage culture. It also incorporates a fisherfolk and livelihood component.

Sex-reversed molobicus F1 hybrid tilapia grows very well in 26 ppt brackishwater ponds (below)

Molobicus hybrid (male on top)



Saline tilapia studies at NCAMFRD (pictures at left and below). Various backcrossings are shown at right



- ¹ Bureau of Fisheries and Aquatic Resources-Fisheries and Aquaculture Center
- ² National Fisheries Research and Development Institute-National Center in Aquaculture and Marine Fisheries Research and Development
- ³ Philippine Council for Aquatic and Marine Resources Development

Promising marine species for hatchery

By the **SAA Staff**

In addition to the more established marine-cultured species like milkfish, which has an integrated broodstock and hatchery system well-studied and adopted, commodities like seabass, snapper, and grouper are slowly coming into their own. With research and development institutions like SEAFDEC/AQD constantly doing studies on broodstock and hatchery systems, it's just a matter of time and some fine-tuning to get their technologies verified and extended to the eager aquaculturist.

Meanwhile, we focus our attention on less familiar species. We try to examine the merits and viability of their hatchery technology.

For mudcrab hatchery, we went to Catbalogan in Samar and pearl oysters to Palawan. Finally, for abalone and corals, we went to Cebu and its neighboring islands to report on their current hatchery status.

The following are the field reports of our SAA staff.

Abalone hatchery in Guiuan, Samar

The Department of Agriculture-Bureau of Fisheries and Aquatic Resources Research Outreach Station for Fisheries Development is an office that maintains a multi-species marine hatchery for stock enhancement in the municipalities of Eastern Samar. In collaboration with this office, the Guiuan Marine Development of the Guiuan Development Foundation partly funds the project.

Among the species for stock enhancement are the giant clam, abalone and lobster.

The abalone hatchery started operating in September 2000 with 30-35 broodstock. Spawning was done the following month (November) but survival was less than 1%. Spawning eggs were siphoned to basins with seawater for 12 hours. Until such time, they were stocked in settlement tanks (1 ton) with settlement substrates with settled diatoms in filtered seawater. Juveniles (2-3 mm shell length) were fed the seaweed locally called "culot" (*Laurencia*).



Mr. Jaime Salazar of DA-BFAR is optimistic about his abalone hatchery which follows SEAFDEC methods

Oddities and facilities for other species at NCAMFRD

L-R: Animal cemetery -- beached whales, dead dolphins and other endangered aquatic animals are buried here; silver perch hatchery; freshwater prawn hatchery; Caranx ignobilis, locally known as talakitok, maliputo or mamsa; and catfish hatchery



The seaweed is available during the northeast monsoon April - October ("amihan").

Problems in the hatchery as identified by Jaime Salazar, the center's head, are the unavailability of seaweeds during off-season, mortality, irregular spawning (first spawning in November was followed in December, then late March), and settlement plates get overgrown with filamentous algae. Mr. Salazar says that the seaweeds from the wild carry with it small crabs that feed on the larvae. Handling methods have yet to be perfected.

Mudcrab and other species at WESAMAR

WESAMAR⁴ is a Philippine government project funded by the European Union and implemented by the Department of Agriculture until the year 2000. By May 2000, a gap phase of transition was consolidated following EU's commitment of support for two years to sustain the strategies and operations of the project. Under this scenario, support was directed at strengthening the institutional capacity of the WESAMAR Federation of Cooperatives to manage the assets and projects that were turned over to it by WESAMAR.

One of many projects of WESAMAR is the multi-species hatchery in Burabod, Villareal, Western Samar. Today, it is under the supervision of Western Samar People's Aquamarine Ventures Corporation (WESAMARINE) since it was turned over in May 2000. Since its inauguration, the multi-species hatchery equip-

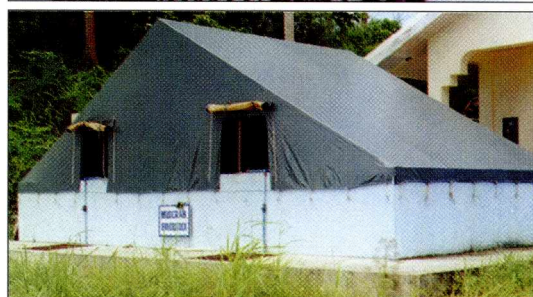
ment has been commissioned, and production has been initiated.

Four cycles of mudcrab production have been initiated. The first sales involved 1,200 45-day old crablets sold at P20 each. The next batch yielded 7,000 crablets and sold at the same price. Steady production has been achieved at 10,000 crablets per week.

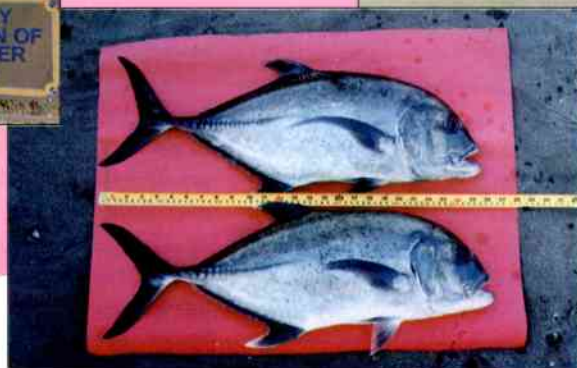
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*Mudcrab
spawner and
broodstock
tanks*



⁴ Western Samar Agricultural Research Development Program





Tanks for culture of algae (above), and WESAMARINE president Ernie Ridaja (right)



Lobster culture



Broodstock cages for lobster in Guian, Samar (right) and for grouper at WESAMAR (left)



Broodstock come from Catbalogan, Samar. Mudcrab producers' ponds are now assured of a steady supply of crablets.

Operation of the mudcrab hatchery follows the SEAFDEC/AQD method. Technical assistance was provided by AQD.

Mud crab broodstock are obtained from Catbalogan and Tacloban and held in 2 units of 5-ton tanks. Following the spawning, the crabs are removed from the tank and maintained individually in 500-liter tanks. Spawned eggs are attached to the abdominal flaps until hatching. Newly hatched zoeae are collected and placed in 10-ton rearing tanks. The zoeae are fed *Brachionus* and *Artemia* while crablets are fed finely chopped mussel. *Chlorella* or *Tetraselmis* are added in the rearing tank as food for the *Brachionus* and for water conditioning.

WESAMARINE's grouper hatchery was first used for mud crab, but it was plagued with problems. Broodstock are now placed in floating cages and concrete tanks and scheduled to spawn within the next months. Broodstock are now placed in floating cages and scheduled to spawn within the next months.

The multi-species hatchery is a project that intends to address the declining stock of mudcrab and grouper, two marine resources that have been declining due to unregulated and intensive gathering. It is part of a bigger mariculture development program covering culture technology, feed, and marketing of groupers, siganids, tilapia, and mudcrab. Eventually, the multi-species hatchery production would include shrimp.

Pearl Oysters in Busuanga, Palawan

People from Southern Marine Corporation (SOMMACO) and Hikari South Sea Pearl Corporation in the Calamian group of islands in Busuanga, Palawan sum up the hatchery technology for pearl oysters in the Philippines as still in the experimental stage. Different factors pose a limitation to the large-scale production of pearl oyster larvae.

Hikari resident manager Agustin Badon said that in general, only 70% of the hatchery aspect of pearl farming is established. The remaining 30% is "an art."

"It is not like the tiger shrimp industry where everything is already in place, so we know what problems to expect and the proper adjustments to make. In the pearl oyster hatchery, we cannot say which technique is effective and which is not. We simply look for solutions each time we encounter problems. If we can establish definite hatchery techniques for pearl oysters, we can produce five to six times a year." Presently, they are able to produce twice a year.

SOMMACO consultant Malou Sanchez on the other hand said that they have seen some improvements in the years they have spent in the culture of pearl oysters. Survival rate has increased to 90% and they have been able to improve the quality of the shells they produce.

“There are only about seven of us (corporations involved in pearl farming) here, so we are willing to share whatever resources we have. But the intricate process and the cost of technology involved allow us to produce pearl oyster larvae mainly for our own use.”

Ms. Sanchez called the hatchery stage as 0-40 — that is, the first 40 days in the life of a pearl oyster.

Spawning is done with the selection of male and female parent stock, from which eggs are produced. This occurs during day 0. Eggs are at the “d” stage during day 1 (as they take the form of the letter “d”) after which they metamorphose into the larval stage for five to six days until they reach the early umbo stage. Full umbo stage is at day 15. They grow into the pediveliger stage at days 16 to 21, and later develop into the spat stage as they begin to crawl and attach themselves to substrates. Culturists wait for the microscopic larvae to reach a shape or size that can already be seen by the naked eye. At day 40, they are ready for deployment in long lines out at sea.

Feed for the larvae during the hatchery stage consist of unialgal cells which SOMMACO buys either from SEAFDEC/AQD or abroad. There are unialgal cells in Philippine waters and but there is not enough people with the capability to do the isolation which itself takes a long process.

“We are in business more than in research so we do not have much time to do the isolation. But in the future, we expect to use solely local resources for our nutritional requirements,” she said.

She also said that they aim to come up with higher survival and very good genetic stock at the least cost of production.

SOMMACO has a building facility that facilitates an efficient flow of work inside. It requires the least number of people and the least number of movements. The water pump and filter systems are juxtaposed with the algal production facility where natural food is grown. Next to it is the larval rearing area which then flows into the nursery where the larvae are prepared for deployment.

John Hamiter, another consultant for SOMMACO, said that with this design, they have no need to go out of the building at all, especially during typhoons.

On the other hand, Hikari hatchery technician Redentor Diaz said that there are important factors to consider in the larvae culture of pearl oysters.

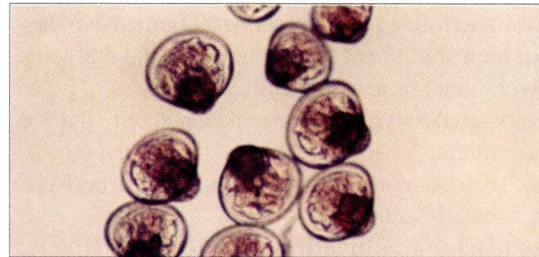
There are *Vibrio* bacteria which destroy the spats. Contamination is prevented by filtration and disinfection using chemicals (like hydrochloride). Abrupt changes in water salinity and temperature also affect the distribution of planktons that provide nutrients to the larvae.

“We have to ensure the quality or condition of spawners or parent shells from the wild. We have to be careful about food contamination. Failure to detect contamination in feeds which is usually due to the wrong culture of phytoplankton can result to mortality.”

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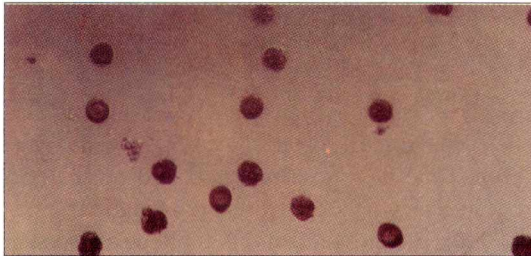
THE PEARL OYSTER *PINCTADA MAXIMA* PHOTOS BY SEA QUEEN AQUACULTURE SERVICES

The pearl oyster spawning



Larvae, umbo stage; 7 days after fertilization, approximately 160 microns

Fertilized eggs, about 60 microns, approximately 2 hours after fertilization (bottom)



Spats; about 21 days old at 350 microns



Juveniles; about 55 days old; size ranges from 1.0 cm to 2.0 cm



Lines of irony. Long lines used for the deployment or growout of pearl oysters also serve to encourage the growth of marine organisms. But they have caused the displacement of local fishers from their traditional fishing grounds

And this is just in the hatchery stage. Mr. Badon said that at most, they get 20% survival rate of the 500,000 mother of pearls deployed in long lines. This is why one has to have a “deep pocket” to go into pearl farming.

But one perfectly formed pearl fetches as much as \$500 in the international market.

At present, most pearl farmers use 20% wild and 80% hatchery bred parent shells because they do not want to deplete the sources from the wild. They prefer to use hatchery-bred parent stock because they are able to determine its condition.

Pearl farming has also created some controversies in Busuanga. Local fisherfolk complain that pearl farms have displaced them from their traditional fishing grounds and that long lines obstruct navigational routes especially at night.

Mr. Badon estimated that pearl farms take up about 10-15% of Busuanga’s sea waters.

“But they can’t discount the benefits that the pearl farms have given back,” Ms. Sanchez said.

Jonathan Sacamay, a cultivation technician of Hikari, expressed that pearl farms have provided a permanent source of income to workers both in and outside the locality. (A lot of Hikari workers come from Iloilo and other parts of the Visayas.) They help preserve the marine ecosystem and enhance the fishery stock as long lines also serve as aggregating devices that attract marine animals to spawn. Pearl farms discourage the practice of dynamite and cyanide fishing as this can be destructive to the mother of pearls being cultured underwater. Prohibition is done with the cooperation of the local government who derives income from the rent being paid by pearl farm operators.

Ms. Sanchez suggested as an alternative sea farming to be run by a cooperative of local fishers to be implemented in cooperation with different government and non-government agencies in the locality for technical and legal support. The cooperative can put up an artificial substrate to keep the fish from moving out. They can go into shellfish and seaweed culture, besides.



Algal production facilities at Hikari



“These local fisherfolk would provide their own security to protect the area from poachers and other destructive elements because they have something growing in it.”

Mr. Badon said that this could be a response to the issue between pearl farms and fisherfolk about the full exploitation of the sea.

“At present, pearl farms have the upper hand because they have the capital, facilities and security people. Giving out support services for the local fisherfolk to do their own fish farming activities can help create a balance of power among the stakeholders of Busuanga’s marine resources.”

Corals in Olango Island, Lapu-lapu City

Fishes are not the only marine species being farmed; corals are farmed too.

Coral reefs are among the oldest and the most biologically diverse element of the ecosystem. However, human activities have resulted to their near ruin. Most responsible for reef destruction is blast fishing. This, together with marine pollution, unregulated coastal development, deforestation and improved fishing gears bring about heavy pressure on coral reef productivity. Coral farming therefore offers a solution to this problem.

In the Philippines, a group from the University of San Carlos (USC) - Marine Biology Section led by Dr. Thomas Heeger and Dr. Filipina Sotto established the one and only community-based coral farm in the world with the objective of rehabilitating degenerated reefs. The Caw-oy Coral Farm, situated in Olango Island, Lapu-lapu City in central Philippines uses the fragmentation method following the concept that corals are capable of asexual reproduction. That is, they are vegetative and can regenerate by themselves fast.

“We are not transplanting corals but are just getting fragments or cuttings. We are very much against the idea of transplanting corals. It impoverishes the donor site. What would happen if the transplanted corals die? You would have two impoverished sites,” explains Joey Gatus, farm manager.

First, coral fragments or fist-sized cuttings are harvested from mother corals using pliers for the branching type (= *Acropora* spp. and *Pocillopora* spp.) and hammer or chisel for the massive (= *Favia* spp., *Favites* spp., *Montastrea* spp.), foliaceous (= *Mycedium* spp., *Echinopora* spp., and *Turbinaria* spp.) and encrusting (= *Montipora* spp. and *Podabacia* spp.) types. These are harvested from nearby reefs in the Olango island system. Trained and PADI⁵ certified fisherfolk divers do the harvesting, as this is a crucial part of coral farming. Harvesting or cutting is done with precision and care so as not to harm the sensitive corals.

The harvested coral fragments are tied to a mactan stone (a limestone that acts as a substrate) using a galvanized wire, and are then transferred to the coral nursery units (CNU) where they are left to regenerate and attach themselves to the substrate. It takes about three to four weeks for the fragments to be firmly attached to the substrate. Depending on the species, it takes one to three months for 6-8 cm coral fragments to grow into a suitable size ready for transplantation to a damaged reef.

CNUs are cement slabs measuring 1 m² (like a cement boxes without a top cover) that secure the fragments in place and protect them from sedimentation. One CNU accommodates an average of 50-60 coral fragments. CNUs are cleaned of sediment and algae and are monitored regularly. To date, the two-hectare Caw-oy farm has 286 CNUs with an estimated 22,000 coral fragments of 103 species of corals farmed.

⁵Professional Association of Diving Instructors

“We have already rehabilitated several reefs here in Cebu. We have deployed 4,000 coral fragments in the Plantation Bay Hotel and about 2,000 in Camotes Island. We are willing to give hands-on trainings to those who are interested to undertake this endeavor,” offers Gatus.

The farm will be three years old this October. The corals are already big and can now serve as donor or mother corals. In fact, Gatus and company are now planning for a second generation fragmentation.

On the other hand, the social component of coral farming is one important aspect for its success. Gatus explains that coral farming will not succeed if there is no commitment on the part of the community to support the project. It is difficult to sustain such program if the community does not understand the principles behind it and does not participate in its operation and maintenance.

The Caw-oy Coral Farm involves around 25 families in its operation. Eight members are certified divers who are involved in the harvesting and deployment of coral fragments. They are also responsible for the maintenance of the CNUs. They are paid P200 per dive. The women, on the other hand, take charge of

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Joey Gatus shows a 3-year-old spiny staghorn coral *Acropora echinata* ready for second generation fragmentation



J LAGARE

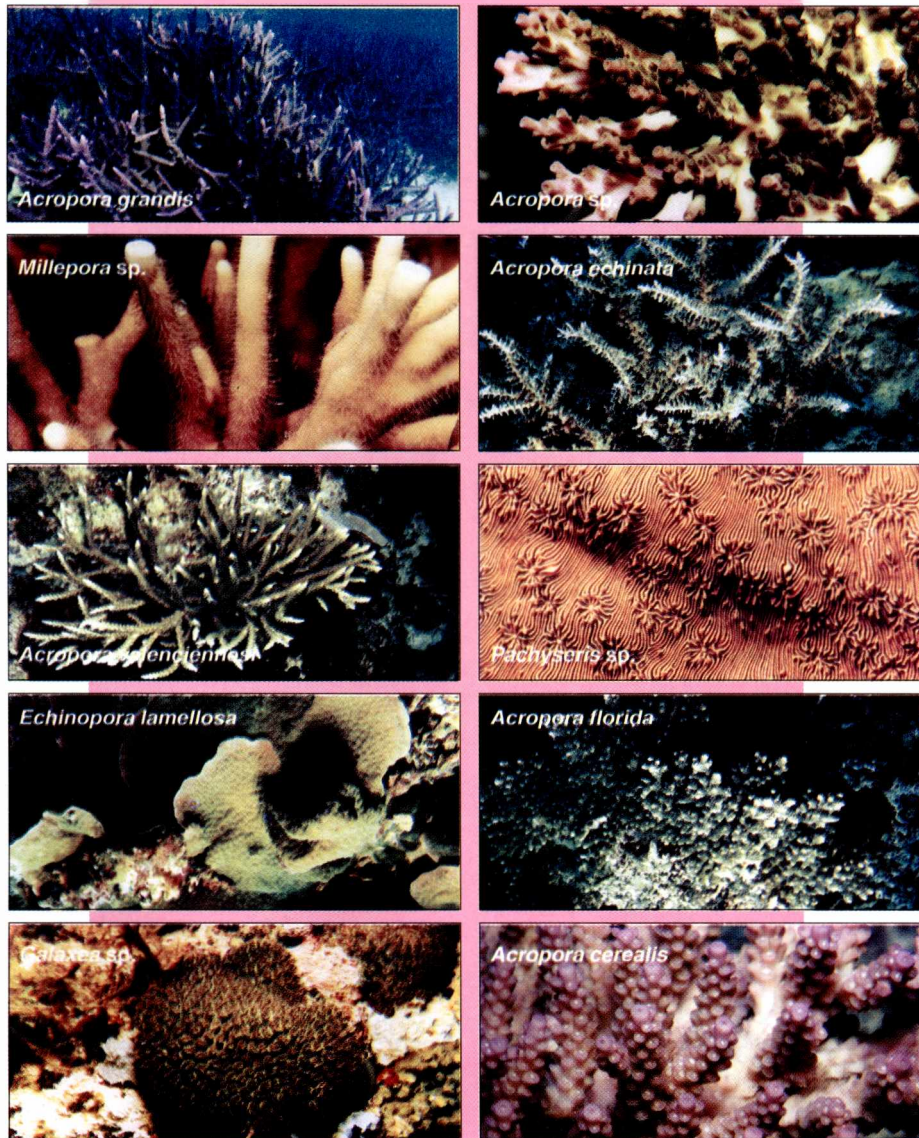


RY ADAN

The floating guardhouse serves as a working platform for the coral nursery, reception area for tourists and a starting point for the “coral trail”

**Some of the coral species
cultured at Caw-oy Coral Farm**

PHOTOS BY THOMAS HEEGER



tying the coral fragments to the limestone and are paid 60 cents per fragment. They usually finish 1,000 fragments a day. The farm also receives many local and foreign visitors that the Caw-oy families help entertain with cultural presentations and a demonstration of coral farming techniques. There is also the underwater coral trail, a must-see feature of the farm.

The Caw-oy coral farm was initially funded by USC and the German Technical Cooperation. At present, it is operated through a funding from the International Marinelife Alliance (IMA) under its Coral Reef Rehabilitation Program. IMA is a non-profit, non-government marine conservation organization founded to help conserve marine biodiversity, protect the marine environment and promote the sustainable use of marine resources for the benefit of local stakeholders.

Coral farming

COMMUNITY-BASED EFFORTS FOR REEF REHABILITATION, BIODIVERSITY CONSERVATION, AND AS A LIVELIHOOD OPTION FOR FISHERFOLK

PHOTOS COURTESY OF THE CAW-OY CORAL FARM / T. HEEGER



*A diver cuts off hard fragments of *Acropora valenciennesi* with pliers*



Fragments of strong-built ranching or other coral life forms are chipped off with hammer and chisel



*One week after cutting off fragment, the margin of a *Porites* colony has already started to overgrow the scar (arrow)*



Five weeks after fragmentation, the area has been completely overgrown (arrow)



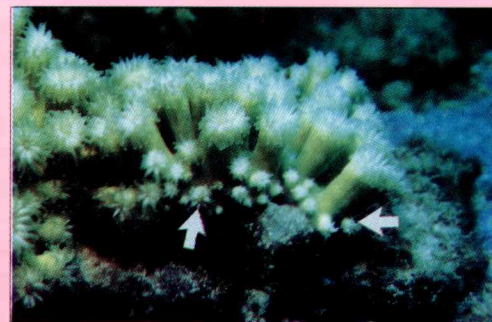
The fisherfolk are trained in fixing the coral fragments to the hard substrate



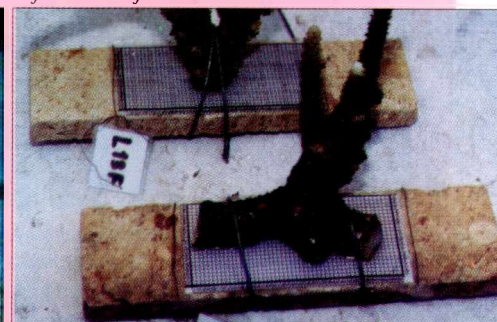
All fragments are placed inside a concrete square (1 m² inner area), which defines the Coral Nursery Unit (CNU), at a density of 50 to 60 fragments. The CNU wards off predators and the plastic canvass prevents the fragments from falling down due to the intensive activities of infauna and fish



*A fragment of *Acropora divaricata* 12 weeks after fragmentation. The secondary basal disc stabilizes the fragments on the substrate. Newly-formed ranches (arrows) follow the natural symmetry of the coral colony*



*Numerous buds on the side of *Galaxea fascicularis* fragments document fast regrowth at the fragmented site. This species is quite aggressive and needs to be distanced from other species as it can extend its sweeper tentacles up to 15 cm at night and harm adjacent coral colonies*



*An experimental set up of *Acropora grandis* fragments fixed horizontally and vertically (background) on the substrate with laminated grids to document the area and time interval of secondary basal disc formation according to vertical or horizontal orientation of the fragment*

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A view inside a CNU showing some of the 50-60 fragments. The number of fragments, which can be placed together, is species- and initial fragment size-dependent



An area of a nearby reef, which has been rehabilitated with tagged fragments of 22 different hard and soft coral species



A SCUBA diver checks the growth of fragments

“UPDATES IN THE PHILIPPINES”
 IS WRITTEN BY AP SURTIDA (SALINE TILAPIA),
 MB SURTIDA (ABALONE AND MUDCRAB),
 AJ ESPAÑO (PEARL OYSTER) AND
 RIY ADAN (CORALS)

SEAFDEC/AQD marine fish hatcheries ... from page 49

Viral and bacterial infection threatens hatchery production. Vibriosis associated with the appearance of red spots in the tank bottom and sides is effectively controlled with the application of freshwater directly to the infected area. Another common disease problem is the swim bladder stress syndrome (SBSS). Often mistaken as the gas bubble disease, SBSS is due to environmental stress contributed by high stocking density accompanied with high levels of ammonia. Preventive measures include the maintenance of good water quality, adequate nutrition, and reduction of environmental stress.

Production

Production of the eggs and fry of marine fishes at the AQD hatcheries vary. Milkfish eggs and those of other species not utilized for R&D experiments are sold to marine fish grow-out operators at 25% and 20% less the current prevailing market price, respectively.

Last year, AQD marketed a total of 1,822,247 fry (milkfish, 1,788,000; sea bass, 3,300; rabbitfish, 3,000; grouper, 20,796; and red snapper fry, 74,844) amounting P1, 250,944 (US\$25,019) to fish farmers in Manila, Pangasinan, Bulacan, Negros, Cebu, Leyte, and Panay (except Antique).

Egg disbursement “program” to private sector

With the creation of the Technology Verification and Extension Program (now known as Technology Verification and Commercialization Division) in mid-1996, AQD focused its efforts in promoting the commercialization of new and mature aquaculture technologies. This program facilitates the use and adoption of commercially viable aquaculture technologies to different beneficiaries in the region’s aquaculture industry - big and private entrepreneurs, farmer and fisherfolk cooperatives, local government units, and other academic and research and development institutions.

In 1998, AQD has instituted a Pond Cooperators Project that would continue to evaluate the performance of hatchery-reared milkfish fry in commercial grow-out scale. The cooperators are given up to 100,00 hatchery-reared fry for free on the agreement that they grow the fry using their own management and culture techniques and AQD can monitor pond production and other data. Recipients say that the hatchery-reared fry that were given with Vitamin C-enriched diets showed more resistance to stress and grew faster.

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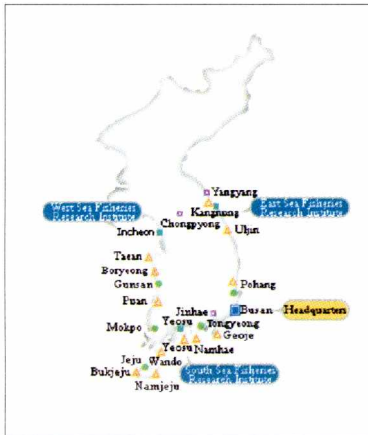
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What's on the web?

Virtual marine hatcheries

By **MT Castaños**

All kinds of marine hatcheries exist around the world for public education, stock enhancement of wild fish populations, research and profit. The list of marine species that these hatcheries work on is long and would sound exotic. For instance, what are rockfish, spotted seatrout, or even red drum? We feature some of these intriguing marine hatcheries in this issue.



View of Taean Marine Hatchery (top), and location of Korea's aquatic research stations

[//www.nfrda.re.kr/intro/organ/orf_1204_e.html](http://www.nfrda.re.kr/intro/organ/orf_1204_e.html)

KOREA: ACTION IN WANDO, BUAN, TAEAN HATCHERIES www.nfrda.re.kr

This website details the Korean government's research and education efforts for the fisheries industry. Dr. Jang-Uk Lee, the Director-General of National Fisheries Research Development Institute (NFRDI, established in 1921), said that the institute has played a pivotal role in investigating the marine environment and fisheries resources.

The Korean map on the left reflects the headquarters, laboratories and the marine hatcheries operated by NFRDI. Of particular interest are three marine hatcheries — in Wando, Buan and Taean. The Wando marine hatch-

ery is run by four researchers, one administrative staff, and three research assistants. They produce the seed of abalone, rockfish, red marbled rockfish, gray mullet and seabass. The numbers vary, from a low 50,000 to nearly 250,000 fry.

The Buan hatchery is run by the same number of people as Wando, and it also produces abalone and seabass, as well as Korean rockfish, oriental prawn, and blue crab. Production is from as low as 100,000 to over 13 million fry. The hatchery also studies webfoot octopus, stone flounder, and other species.

The Taean hatchery produces the Chinese white shrimp and Korean scallop in addition to abalone and Korean rockfish. Production ranges from 50,000 to over 10 million fry. The hatchery also studies techniques for propagating the ark shell, pen shell, and purplish Washington clam.

WESTERN CANADA: SHELL FISH HATCHERY www.islandscallops.com

The hatchery facility is located on the east coast of Vancouver Island, British Columbia. The website described the facility as having an onshore 1,000 m² shellfish hatchery; 600 m² marine fish, sea urchin, and abalone hatchery; an outdoor nursery and phytoplankton area with a total volume of 2 million liters of water; environment-controlled broodstock maturation; quarantine area for exotic species; and larval rearing area.

The hatchery is owned by Island Scallops Ltd. which describes itself as "Canada's largest private marine research hatchery and the first fully integrated cultured shellfish and marine fish producer." It produces the seed of the following: Japanese or Pacific scallop, Pacific oyster, European flat oyster, Manila clam, blue mussel or its custom-bred "golden" strain, Mediterranean mussel, rock scallop and sea urchin. They also offer live rotifers (*Brachionus*), the phytoplankton *Chlorella*, and algal paste (=cryopreserved) of *Tetraselmis*, *Nannochloropsis*, and *Isochrysis*.

The company says it welcomes research collaborations with private individuals or other companies.

CALIFORNIA: SEA WORLD www.hswri.org/FacilityHATCH.htm

"To return to the sea some measure of the benefit derived from



NEXT PAGE

Hatchery at Seaworld

www.hswri.org/facility_description.htm



Hatchery of high-value marine fishes in the Florida Keys
www.aquaculturecenter.com

The website describes the hatchery as having a live feed culture room (for rotifers and *Artemia*), hatching tanks, a larval rearing system, and a grow-out system. The hatchery also uses state-of-the-art recirculating technology (the site did not elaborate on this).

TEXAS: RAISING FISH FOR SPORTS FISHING
www.tpwd.state.tx.us

The Texas state government's Marine Development Center says it is one of the largest marine fish hatcheries in the world.

it" is the charter of The Hubbs Sea World Research Institute, a public, non-profit charity dedicated to studying the world biota and natural resources. Their hatchery is about 22,000 ft² and can produce 350,000 juveniles of white sea bass annually. They work on California halibut and giant sea bass as well. White sea bass are released to the wild when they are 8 inches long or after about 7 months of culture.

The broodstock holding area has four 6-meter pools and other tanks; the larval rearing area has 16 units of 500-gal incubators and another 16 units of 2,000-gal pools; the outdoor raceways are shallow, long concrete tanks. They also have an algae culture area. The seawater system is noted as automated and computer-controlled – water flow, backwash timing, data logging, broodstock temperature – and is linked to an emergency paging system.

MASSACHUSETTS: AQUACULTURE CURRICULUM
www.web.mit.edu/seagrant/education/hatchery.html

Educational outreach is the main component of the Massachusetts Institute of Technology's fish hatchery. They encourage tours and demonstrations of special interest groups, the general public, and schools. They have posted the outline of a high school curriculum (see box next page) for students to appreciate the role of aquaculture as an alternative solution to meet the growing public demand for seafood.

When it noted the decline of red drum populations in the '70s, it established a hatchery in 1982 and a year later, 120 red drum fingerlings have been reared in hatchery ponds and released to coastal waters. Since then, the center continues to produce "quality sport fish for stocking in Texas bays."

The website gives directions to locate the hatchery for a visit, and present the red drum's characteristics (one large black spot on the upper tail base), growth (record catch is an 83-lb fish), spawning habits (they mature in 3-4 years, spawn August to October in mouths of passes), movements (they move to the Bay of Mexico after they mature), feeding (they like small crabs, shrimps and worms), habitat (shallow water where their back can be exposed), and how to catch the red drum (they're willing to take baits).

MIAMI: MUTTON SNAPPER AND OTHER HIGH VALUE MARINE FISHES
www.aquaculturecenter.com

Located in the Florida Keys, the Aquaculture Center is a new, state-of-the-art hatchery facility for the production of high-value marine fish species. Here, environmental conditions are well-suited for rearing of current target species, including mutton snapper (*Lutjanus analis*), greater amberjack (*Seriola dumerili*), and the southern flounder (*Paralichthys lethostigma*). The facility includes twelve larval tanks with a total volume of 40,000 liters, enabling a stocking capacity of over 2,000,000 larvae at 50 per liter during each production cycle. The fingerling area comprises fifteen 20,000 liter tanks with a stocking capacity of 150,000 fry at 0.5 per liter. These fingerling tanks are also used as "mesocosms" for semi-intensive larval husbandry.

The Aquaculture Center says its goal is to offset the decline in commercial wild harvest by providing an alternative source of marine fish – the hatchery. It works with the University of Miami to develop hatchery technologies.

Their facility is designed to produce



Hatchery for trout and salmon in the heart of Wales
www.hgt.gwynedd.gov.uk/sg/Hatchery.htm

FOR EDUCATORS

Marine aquaculture: raising saltwater fish in your classroom

Aquaculture can be a learning tool with hatchery as a very important piece to the aquaculture puzzle. Below is a curriculum involving hatchery procedures developed by MIT Sea Grant for a classroom. [<http://web.mit.edu/seagrant/education/aquaculturecurriculum.html>]

Unit 1: Getting started – building a hatchery

This section focuses on the understanding of aquaculture and the different types of systems that culture aquatic species. Recirculating systems are the main concentration because of their broad scope and compatibility with environmental regulations. The major components of a recirculating system is discussed, as well as a design and construction of a functioning table-sized model. Included in this unit are tips on how to culture a species in the classroom and where to look for sources of eggs. *Activities: what species of marine fish can we culture in our classroom? Where can we hatch a fish?*

Unit 2: Getting your hatchery system up and running: instructions on maintaining your hatchery

This section provides guidance on setting up and maintaining the constructed table-top hatchery. The main focus is conditioning the system and the importance of distinct methods for different development periods.

Activities: How do we condition the tank to prepare for fish eggs? What do you do when the eggs arrive?

Unit 3: What do larval fish eat anyway? How do I raise food for my larvae to eat?

This section explains what are rotifers and *Artemia* or zooplankton and that they can be cultured and fed to the larvae. Procedures on how to culture the live zooplankton are included. The main highlights are how to build a live feed culture system, how to maintain cultured live animals and how to determine population sizes.

Activities: How many rotifers do I need? Rotifer production; Maintenance and harvesting of rotifers; Artemia production

Unit 4: Watching your fish grow and change: the developmental process of marine fish

The goal of this section is to use marine fish as an example of developmental biology. A brief summary of the developmental patterns of marine fish is included. The process on how to track the growth and development of the larvae in the hatching system is also incorporated.

Activities: What are the stages in the development of a fish? How long does it take for a fish to hatch? How do we monitor larval growth and development?

Unit 5: Taking care of your fish

This section gives guidelines on how to determine the health of the larvae. Observation is one of the most important aspects of hatchery work. Because the larvae are transparent at this stage, it is not easy to identify various developmental focus points.

Activities: How do I hatch, feed and care for these larvae? What do I do when the fishes no longer need rotifers and Artemia? What food would they eat?

Unit 6: Monitoring water quality

The quality of the tank's ecosystem is based on good water quality. The health and survival of the larvae is dependent on the maintenance procedures described above. Monitoring fish survival, growth and development are a means of identifying the quality of the water. To prevent possible die offs and other impacts on survivability (e.g., high bacterial load), the importance of monitoring the nitrogen cycle and bacterial level of the culture system can not be overstated. The water quality parameters and their acceptable limits are to be discussed.

Activities: Where does the water come from? Monitoring your system

800,000 fingerlings per year in eight production cycles. It produces fry of mutton snapper, greater amberjack, and southern flounder. The center can also provide technical assistance in grow-out techniques, cage technology and marketing, among others.

FORT PIERCE: A MARINE FISH WHOLESALER

www.orafarm.com

Florida plays host to the Oceans, Reefs and Aquariums, Inc. (ORA), described online as the "first economically successful marine fish hatchery, the only full scale marine ornamental hatchery in North America, and the first to impact significantly on the marine aquarium hobby."

It is located at the campus of Harbor Branch Oceanographic Institution in Fort Pierce. They say they are part of the Aquaculture Division and they sponsor the Center for Marine Ornamental Research. So far, ORA has cultured 10 species of clownfish, seven of dottybacks, one cardinal, two gobies and peppermint shrimp. They also produce angels, batfish and queen conch. The site says all the fishes are grown to an aquarium saleable size, have fully developed color, will acclimate easily, and will eat a variety of prepared foods.

To see is to believe. The site features virtual IPIX tours – interactive, spherical photographs offering browsers a complete field view as the site says – of their broodstock, larval process, and grow-out work. You need to download the IPX software first.

NORTH WALES: A FISHING SOCIETY

www.hgt.gwynedd.gov.uk/sg/Hatchery.htm

The hatchery of a uniquely named and nearly 100-year-old fishing society – The Seiont, Gwyrfai & Llyfni Fishing Society (1908) – is found in north Wales, the United Kingdom. The members built the hatchery in 1991 to produce rainbow trout, brown trout, salmon and sea trout fry to stock the lake and rivers where the society owns the fishing rights. Their area even features a medieval castle called Caernarfon Castle!

The site posts several pictures of the hatchery under construction and that of a man feeding the fish in an open raceway. A very nice map of what the members say is the "Heart of Snowdonia" is clickable, and gives your pictures of six-eight pound salmon caught and held up by proud society members. There are also lovely river views. ###

What's up at SEAFDEC/AQD?

Marine fish hatcheries

By **JR Paniza**

Research on larviculture at SEAFDEC/AQD is geared towards commercial scale hatchery production to augment fry and seedstock of grouper, snapper, sea bass, milkfish, and rabbitfish from the wild. AQD operates various laboratories and hatcheries to conduct research and experiments as well as verification runs and manpower development for the promotion of fisheries development.

Facilities

At the Tigbauan Main Station (TMS) in Iloilo, Philippines, the six 50-ton tanks and six 120-ton tanks hatchery building maintains milkfish, snapper, and grouper broodstock. In another building, the four 200-ton tanks keep milkfish broodstock.

Fish Hatchery I has three 10-ton, three 20-ton, sixteen 5-ton, and twenty 3-ton circular larval rearing tanks; eleven 5-ton rectangular larval rearing tanks; three 25-ton, and four 5-ton canvass for broodstock; fourteen 25-ton tanks for natural food culture; six 2-ton intensive rotifer tanks; and four 200-liter intensive rotifer tanks. On the other hand, Fish Hatchery II has six 40-ton, nine 10-ton, and twelve 5-ton rectangular tanks for natural food culture.

Moreover, the 4,047 square-meter Integrated Fish Broodstock and Hatchery Demonstration Complex, inaugurated in 1998, has two 500-ton spawning tanks, two 100-ton rectangular larval rearing tanks for semi-intensive culture of fish larvae, four 20-ton circular larval rearing tanks for intensive culture of fish larvae, four 20-ton natural food production tanks for the culture of rotifers and *Brachionus*, and two 40-ton algal tanks. It has support systems such as recirculating seawater system, continuous aeration, filter reservoir, settling and sedimentation tanks, and a small office. The complex showcases fish breeding and hatchery technologies, and demonstrates to fish farmers and entrepreneurs the commercial viability of such technologies. Its stocks include milkfish and grouper.

AQD's Igang Marine Substation (IMSS) in Guimaras Province has floating broodstock cages. Milkfish broodstock are stocked in 6-meter and 10-meter diameter cages, while other species like sea bass, grouper, snapper, and rabbitfish are held in 6-meter diameter cages. All cages have a net depth of 3 meters.

Operations

Marine fishes spontaneously mature and spawn at TMS and IMSS. Except for rabbitfish whose eggs are adhesive and demersal, the pelagic eggs of other species are collected by manual seining or by draining the water in the tank into an egg concentrator seine.



The Integrated Fish Hatchery Development Complex at SEAFDEC/AQD's Tigbauan Main Station (top), and a 20-ton circular larval rearing tank inside the complex



Manually operated egg sweeper used at the Igang Marine Substation

In milkfish floating cages, the AQD-designed manually operated egg sweeper is rotated three to five times around the cage to gradually collect eggs to the detachable conical net bag. For the rabbitfish, *Siganus guttatus*, an egg collector or substrate (=plastic sheets) is placed at the bottom of the tank prior to spawning and is eventually transferred to the incubation or rearing tanks.

Eggs are transported from IMSS to the hatcheries at TMS in double-layered oxygenated plastic bags placed inside a styrofoam box or a flat binder bag. Packing density ranges from 90,000 to 300,000 eggs in 8-10 liter of water depending on the species. Spawning eggs are temporarily stocked in incubation tanks and viable eggs are isolated by their higher degree of buoyancy.

For grouper, the incubation of spawned eggs is either conducted in 400 to 500 liter fiberglass tanks or directly stocked in larval rearing tanks. Stocking density varies from 5,000 to 10,000 eggs per ton for semi-intensive larvae culture or 30,000 eggs per ton for intensive larvae culture. At TMS, seawater and freshwater are supplied from the pump house / reservoir. Moderate aeration is provided to each tank.

Rotifers are essential in the initial stage of rearing the various fish larvae because of their size and the ease of culture. Most marine fish larvae are fed with rotifers on day 2 at 10-15 rotifer per ml. Newly hatched brine shrimp nauplii are usually given on day 15 starting at < 1 individual per ml. Feeding rate is gradually increased as the larvae grow.

A combination of a microparticulate feed and rotifer can result to bigger milkfish larvae. On the other hand, an AQD formulated milkfish larval diet containing adequate nutrition (highly unsaturated fatty acids and vitamin mix) was found to be an effective supplement for rotifers and alternative or complete replacement for the expensive brine shrimp nauplii. Furthermore, the copepod *Pseudodiaptomus annandali* is a potential substitute for *Artemia* as larval feed for milkfish. It results to better growth than when fed *Artemia* and *Brachionus*.

Milkfish are also observed to be more robust and to have slightly higher survival rates when reared in open outdoor tanks.

For rabbitfish, snapper and grouper larvae, screened rotifer can be used during initial feeding in the absence of SS-rotifer strain because of their small mouth.

The mortality of grouper is lower when fed with *Artemia* starting at day 21 instead of day 14. Two to three day-old larvae fed with *Acartia tsuensis* copepod nauplii, a cheaper substitute for *Artemia*, grew significantly faster and showed higher survival rate compared to those fed with rotifer only.

Rabbitfish and grouper larvae are reared initially in static water system for 5 to 7 days, otherwise, partial water change from 30-50% during rotifer feeding days and 50-75% on brine shrimp feeding period are followed. Larviculture of milkfish in open outdoor tanks requires greater volume of water to be changed, if not feasible, a flowthrough system is allowed for 1-2 hours until the water becomes clear of diatom bloom.

The initial stocking density used for most of these fish species is 30 larvae per l. For grouper, a stocking rate of 10-20 larvae per l is optimum.



Rabbitfish, sea bass, milkfish, grouper

Broodstock management and seed production of marine fishes

By **JR Paniza**

Since 1973 when SEAFDEC/AQD was established, its pool of experts carried out a regularly renewed comprehensive program of research, training, and information dissemination activities on five marine species: grouper (*Epinephelus coioides*), sea bass (*Lates calcarifer*), milkfish (*Chanos chanos*), rabbitfish (*Siganus guttatus*), and the mangrove red snapper (*Lutjanus argentimaculatus*). AQD has also verified in actual field conditions the technical, environmental, and socioeconomic considerations of the technologies it developed from research.

Following its first research breakthrough in 1974, the completion of the tiger shrimp life cycle by eyestalk ablation, AQD has kept on refining developed technologies to improve industry practices through innovative approaches like the application of biotechnology in aquaculture.

Rabbitfish

This fish is prized as much as other high value fish such as groupers and snappers. However, the slow growth of rabbitfish hampers the expansion of its culture. This problem is now being addressed with the use of growth hormones produced by the rabbitfish itself.

AQD researchers was able to obtain the growth hormone with the application of biotechnology. They first cloned the cDNA of rabbitfish growth hormone (GH) and the insulin-like growth factors (IGF I and II). This work was conducted at a laboratory in Japan.

The GH was tested at AQD's Tigbauan Main Station in Iloilo Province, Philippines. When given as weekly injections, researchers say, GH significantly increased the body weight and length of the rabbitfish. This means that with the growth hormone supplementation, the normal culture period of rabbitfish to reach marketable size can be shortened.

Moreover, AQD researchers emphasize that unlike the genetically modified organisms (GMO), which is practically the development of new species, the cloned GH is endogenous or produced by the same fish.

AQD's studies on broodstock management and seed production of marine fishes

Species	Research focus	Research results	Expert involved
Rabbitfish, <i>Siganus guttatus</i>	Seed production	Feeding larvae fed with any of the following resulted to comparable growth: (a) HUFA-enriched rotifers at 15-20 individuals per ml, (b) HUFA-enriched rotifers supplemented with an artificial diet (NOSAN R-1) at 0.5 g per ton per day, (c) <i>Chlorella</i> -fed rotifers supplemented with Nosan R-1, or (d) <i>Chlorella</i> -fed rotifers	Marietta Duray
	Application of biotechnology in aquaculture	Cloning and sequencing of the growth hormone (GH) Production of GH using recombinant DNA technology Cloning of insulin-like growth factors (IGF-I and IGF-II) Production of recombinant rabbitfish IGF-I GH mRNA was strongly expressed in the larvae from day 2 onwards while IGF-II seems to be expressed more than IGF-I during early development	Dr. Felix Ayson, Dr. Evelyn Grace de Jesus
	Intensive seed production	Faster growth compared to the control fish when given four injections of bGH once a week Fry treated with low dose of the hormone (0.01 µg per g BW) has faster growth than the group given the higher dose (0.1 µg per g BW) Juveniles grow better in dilute seawater than in full-strength water Survival of the larvae is highest in bigger tanks (3-5 tons) than in smaller tanks (0.0-0.5 ton)	
Milkfish, <i>Chanos chanos</i>	Application of biotechnology in aquaculture	Cloning and sequencing of growth hormone (GH) Cloning of the insulin-like growth factor (IGF-I) GH and IGF-I mRNAs were both detected in milkfish embryos but while GH expression increased as the larvae developed, there was no remarkable change in IGF-I expression from day 1 to day 10	Dr. Felix Ayson, Dr. Evelyn Grace de Jesus
	Larval food development	Larvae fed with <i>P. annandalei</i> gave better growth to the larvae than with <i>Artemia</i> and <i>Brachionus</i> AQD formulated diet is an effective supplement for rotifer and alternative for the expensive brine shrimp nauplii for milkfish larviculture	Romeo Caturao Ilda Borlongan

Milkfish

Several milkfish production technologies have been developed at AQD and subsequently adopted by the industry. Yet, problems on fry availability still exists in the Philippines. Studies to better understand growth regulation and factors that influence development of larvae and juveniles are among the focus of AQD's research on milkfish.

Research to address growth regulation, and develop methods to enhance growth in juvenile milkfish involve the isolation, and characterization of GH and IGF-I and II. Like the rabbitfish, milkfish GH and the IGF have also been cloned. Preliminary

work to produce recombinant growth hormone is underway and studies to determine when GH and IGF genes are expressed in embryos and larvae is being done.

In the hatchery, the cost of producing milkfish fry has been reduced through the development of larval feed for the larvae.

Mangrove red snapper

Recent developments in snapper aquaculture are focused on broodstock management and seed production to ensure fry availability.

Species	Research focus	Research results	Expert involved
Mangrove red snapper, <i>Lutjanus argentimaculatus</i>	Broodstock management	Broodstock fed with formulated diet is observed to have similar egg production, viability, and hatching rate per spawn as those fed with trash fish	Dr. Arnil Emata
	Seed production	Newly hatched larvae stocked at 15,000 larvae per ton of water in 3-ton tanks have higher survival than those stocked at 30,000 (4.0%) or 45,000 (5.0%) larvae per ton Treatment with thyroxine either through bioencapsulation with <i>Artemia</i> or by immersion of 25-day old larvae did not improve survival in comparison with the control groups (96.5-98.4%) Growth and survival of 30-day old larvae fed solely on <i>Artemia</i> were higher than those given with a mixed diet of <i>Artemia</i> and artificial diet (1:1), and artificial diet alone in three weeks Feeding incidence for the newly hatched larvae was equally higher under ambient light rearing than under 24 or 16 light period conditions	Marietta Duray
Grouper, <i>Epinephelus coioides</i>	Broodstock management	Advantage of using DHA in the diet over other treatments, as far as frequency of spawning and number of eggs produced are concerned	Dr. Veronica Alava, Dr. Gerald Quinitio
	Seed production	Best stage to disinfect eggs with iodine at 75 ppm for 10 minutes is when the embryo starts "twitching"	Eleanor Tendencia
		Survival of the larvae is highest in bigger tanks (3-5 tons) than in smaller tanks (0.5 ton)	Marietta Duray
Larval food development	Larvae fed with HUFA enriched rotifer were found to be more stress-resistant	Marietta Duray	
	Metamorphosis of larvae was enhanced with triiodothyronine, which is applied to the rearing water	Dr. Evelyn Grace de Jesus	
		Two to three-day old larvae fed with <i>Acartia tsuensis</i> copepod nauplii at their first feeding grew significantly faster and showed higher survival rate compared to those fed with rotifer only <i>Acartia nauplii</i> was found to have superior nutritive value than rotifer and is more appropriate for larvae at the early rearing stage	Joebert Toledo

Following the completion of its life cycle in captivity in 1999, AQD documented the induced and natural spawning of snappers in concrete tanks or floating cages. It has also formulated a broodstock diet to ensure egg and larval quality and minimize the use of trash fish. Moreover, an improved larval rearing method was developed using screened rotifers during the early feeding stages of the larvae.

Grouper

The continuing refinement of developed culture techniques for the grouper addresses the limited production due to dependence on wild fry supply, fish-by-catch, and parasitic infestations and other diseases. Studies on the grouper hatchery technology is also focused on economic viability and sustainability.

In year 2000, initial results of the effects of the nutritional

composition of diets on the productive performance of grouper indicated the advantage using DHA in the diet. A protocol for intensive larval rearing of grouper was also refined.

Sea bass

AQD modified the seed production technique for sea bass developed in Thailand to suit local conditions.

One of the studies, which ended in 1998, indicated the correlation of biochemical characteristics of fertilized eggs with egg quality. Another study suggests that mature sea bass can readily spawn by injection of frozen and thawed luteinizing hormone-releasing hormone analogue (LHRHa) solution or by implantation LHRHa pellets stored at room temperature.

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SEAFDEC/AQD's R&D milestones on hatchery of marine fish species

Milkfish *Chanos chanos*

- 1976 first induced spawning of adults from the wild
- 1978 successful larval rearing in the hatchery
- 1980 maturation and natural spawning of captive broodstock in floating sea cages
- 1981 start of the National Bangus Breeding Program (NBBP) to raise broodstocks in floating sea cages at 12 regional sites in the Philippines
- 1982 extension manual on spawning and larval rearing
- 1983 completion of the milkfish life cycle in captivity mass production of fry in the hatchery with eggs coming from natural spawning of captive adults
- 1984 start of regular training courses in milkfish hatchery
- 1986 maturation and natural spawning at four NBBP sites
- 1987 efficient egg collector developed for sea cages
- 1990 natural spawning of broodstock in concrete tanks
- 1991 refinement and verification of hatchery techniques mass production of fry in a private commercial hatchery
- 1992 technology transferred to more private hatcheries extension manual on broodstock and spawning
- 1995 formulation of effective diet for larvae in the hatchery privatization of NBBP stocks
- 1997 formulation of an effective broodstock diet
- 1998 improvement of fry quality through enrichment of live food assessment of commercial milkfish hatcheries improvement of egg handling and transport
- 1999 cloning of the GH, hormone that controls growth in the milkfish development of broodstock transport technique
- 2000 production of GH using recombinant DNA technology

Grouper *Epinephelus coioides*

- 1989 broodstocks raised in floating cages and concrete tanks
- 1989 hormonal sex inversion of females to males
- 1990 maturation and year-round spawning and larval rearing
- 1992 first fry production in the hatchery
- 1994 completion of the grouper life cycle in captivity, intensive hatchery techniques, fry production development of hatchery techniques
- 1995 sex-inversed males in natural spawning
- 1996 improved larval survival by use of copepod nauplii
- 1997 larval metamorphosis advanced by thyroid hormones
- 1999 refinement and verification of hatchery techniques

Rabbitfish *Siganus guttatus*

- 1983 first induced spawning of wild adults, first larval rearing
- 1985 year-round natural spawning of captive adults, mass production of fry in the hatchery
- 1986 completion of the rabbitfish life cycle in captivity
- 1988 refinement of hatchery techniques start of training courses including rabbitfish hatchery
- 1989 formulation of diet for early juveniles in the nursery
- 1999 cloning of the GH, hormone that controls growth in rabbitfish
- 2000 production of GH using recombinant DNA technology cloning of insulin-like growth factors (IGF I and II)

Snapper *Lutjanus sp.*

- 1993 first spawning in captivity
- 1994 production of fry in an experimental scale
- 1995 first natural spawning
- 1999 completion of the snapper lifecycle in captivity

On the other hand, the brackishwater cladoceran *Diaphanosoma celebensis* was tested as partial replacement of the expensive *Artemia* in larval rearing.

Marine ornamental fishes

The increasing demand for marine ornamental fishes has resulted in the exploitation of coral reef species and depletion of their habitats. To reduce the impact on wild population and ecosystems, AQD is carrying out breeding and seed production techniques for marine ornamental fishes. Methods for producing seahorse juveniles in the hatchery are being studied.

Meanwhile, improvement of captured broodstock and seed production of the blue tang *Paracanthurus hepatus* was conducted to characterize its spawned eggs and newly hatched larvae. Seed production studies are geared towards the improvement of water management and feeding schemes to increase larval survival.

Larval food

Cheaper substitutes for the expensive *Artemia salina* and *Brachionus plicatilis*, the two most commonly used natural food in fish larval rearing are being developed. These potential food substitutes are the copepods *Acartia tsuensis* (nauplii) and *Psuedodiaptomus annandalie*, and the AQD-formulated milkfish larval diet.

AQD's active pursuit of aquaculture technology does not end in the research and development on broodstock management and seed improvement of cultured species. AQD also spearheads the recovery of overexploited wild stocks through the promotion of responsible aquaculture management. This program integrates environmental responsibility with existing aquaculture practices in order to make the industry more sustainable and to secure the region's food resources.

Training course on marine fish hatchery

By **RIY Adan**

SEAFDEC/AQD has been offering a training course on marine fish hatchery (MARFISH) since 1985. Now in its 18th session, MARFISH has reached trainees from all over the world, with the bulk coming from the neighboring Southeast Asian countries.

The five-week training course deals with seed production of marine fishes including broodstock management and spawning, production of larval food, larval rearing and transport of eggs, larvae and fry. Lectures are given on the following topics: principles and concepts of sustainable aquaculture, biology of marine fishes, fish hatchery operations, design and construction,

production of natural food organisms, fish health management, fish nutrition, and aquaculture economics. Practical activities, on the other hand, includes larval rearing, natural food culture, feeding, water management, broodstock management, induced spawning, egg collection, harvesting and transport of eggs. Species of interest are milkfish, seabass, rabbitfish, snapper and grouper.

Special topics on grouper culture in ponds and cages and recirculating systems and their application in marine fish hatcheries are also included. The course cover approximately 20% lecture and 80% practical work – with AQD scientists and researchers as resource persons. All lectures and practical sessions are conducted at the Tigbauan Main Station. The trainees are also exposed to different aquaculture enterprises through field trips in Iloilo City and northern Panay. Moreover, group dynamics are conducted regularly to create a better working relationship among the trainees.

MARFISH training this year was held June 5 to July 13.

Trainees revisited

A look at AQD's trainees will reveal different backgrounds: mostly coming from the government sector and the rest from the private or business sector. We asked how they have been faring since their MARFISH training and here are their reply:



Nguyen Duy Hoa Batch '99
Research Institute of Aquaculture
HO CHI MINH CITY

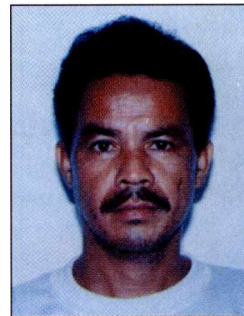
"The training has made a big impact on my profession. All the knowledge I acquired from the training have been successfully applied especially those in the seed production of seabass. After the MARFISH training, I implemented a study on seabass seed production. We improved some techniques based on SEAFDEC's protocol of induced spawning of seabass and we have successfully produced seabass with 420,000 one-month old juveniles at the end of 2000. A five-year project on grouper seed production supported by the Ministry of Fishery is now underway."



Wanidawati Tamat Batch 2000
Brunei Fisheries Department
BRUNEI

"In the duration of the course, I was able to obtain the latest scientific knowledge on seed production especially on the species I am interested in, snapper and grouper. Learning the current practical techniques in the culture of natural food organisms, water quality analysis, feed formulation and a lot more was also a big plus of the training course. After my attendance to the training, I

was assigned to the Marine Finfish Larval Rearing unit of the Aquaculture Section — this on top of my assignment as a phycologist. All the knowledge and the latest techniques gained from the course are applicable to my work, especially the feeding management of different species. Now, I am actively involved in marine finfish production and broodstock management. I can really say I am very satisfied with MARFISH."



Nelson Vasques Batch '97
Honda Bay Foundation Inc.
PUERTO PRINCESA, PALAWAN

"I am very much grateful to SEAFDEC for giving me the opportunity to attend the MARFISH training. The knowledge I gained from the training helped in my work as a technician at the Honda Bay Foundation, Inc. Many have shown interest on the MARFISH training, especially students and private fish pond owners. I always encourage them to apply so they can also experience what I have experienced. I am now on my own and am continuously applying what I learned from the training."



Augustus Avillanosa Batch '98
Aquatic Science and Technology Institute
State Polytechnique College of Palawan
PUERTO PRINCESA CITY

"It was a great opportunity for me to be one of the grantees of the fellowship training in MARFISH. My basic knowledge on hatch-

➡ NEXT PAGE

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 began 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.”

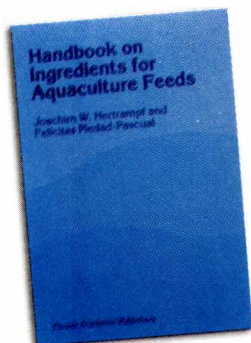
Even big companies like Sarangani in southern Philippines are only now about to sell surplus fry of groupers, sea bass, snappers and other alternative marine species after the demand for these have begun to be expressed by private growers.

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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Handbook on ingredients for aquaculture feeds

by Joachim Hertrampf, PhD, and Felicitas Piedad-Pascual, PhD
Illustrated by Sik Lee Ong

Aquaculture – or the commercial farming of aquatic organisms in a controlled environment – requires formulated diets composed of various ingredients. This *Handbook* aims for a better understanding of the food components that affect nutrition and feeding of cultured fishes and crusta-

ceans. Proper utilization of these foodstuffs can minimize environmental pollution and degradation.

An overview of the nutrition of aquatic animals precedes the discussion of each foodstuff. Traditional and non-traditional ingredients are considered in alphabetical order. To evaluate the value of each foodstuff, information is provided on its origin, economical significance, manufacture and processing followed by chemical, physiological and other properties. An important feature of the *Handbook* is the discussion of the feeding value of each ingredient and recommendations for inclusion rates, legal aspects and precautions for their use. There are 52 chapters in which 144 individual ingredients are considered. Included for easier understanding of the text are 443 tables and 80 figures with approximately 1,500 references. The *Handbook* is a guide for anyone interested in aquaculture. 2000, 624 p



Bibliography on golden apple snail now available on the net

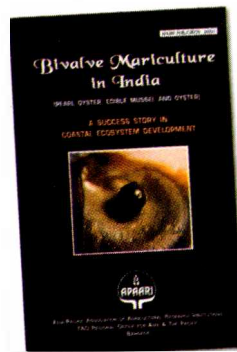
Bibliography on the golden apple snail (*Pomacea spp.*) has been compiled and made available on the internet – <http://www.applesnail.net>. This is by Arsenia Cagauan, Ravindra Joshi and Mario de la Cruz of the Crop Protection Division, Department of Agriculture-Philippine Rice Research Institute (PhilRice), Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Over 100 literatures covering varied topics, gathered from various sources are listed in this bibliography to supplement the earlier published bibliographies on golden apple snail and other molluscs (Acosta and Pullin, 1991 and Cariaso, et al, 1993).

The same bibliography can also be accessed at the PhilRice library or from the authors.

Bivalve Mariculture in India: a success story in coastal ecosystem development

By VN Pillai (editor), KK Appukuttan, V Kripa, TS Velayudhan, KS Mohamed, ACC Victor, PS Kuriakose, P Laxmilatha, P Muthiah (associates)



This publication by the Asia-Pacific Association of Agricultural Research Institutions (APAARI — Bangkok, Thailand) documents the experience of the Central Marine Fisheries Research Institute (CMFRI) in developing a full-fledged pearl culture technology and techniques for mussel and edible oyster culture. Most significant is the component transferring this know-how to farmers.

The book includes case studies on cooperative participatory efforts demonstrated, and technologies developed and practiced in the States of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. The social impact of these programmes is the development of group farming activity supported by financial aid from village level rural development programmes, and their resulting contribution to rural income generation.

Program partners include women as beneficiaries, e.g. as technicians responsible for implanting nuclei into pearl oysters and as farmers overseeing the culture and harvest of mussels and edible oysters in coastal areas.

For copies, please write to: *The Executive Secretary, APAARI-FAO Office, 55 Max Mueller Marg, New Delhi 110 003.*

International forum on tilapia farming set

An international forum on “Tilapia Farming in the 21st Century” is set 25-27 February 2002 at Los Baños, Laguna, Philippines.

Organized by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), Bureau of Fisheries and Aquatic Resources (BFAR) and the Southeast Asian Fisheries Development Center (SEAFDEC), the forum will bring together scientists, farmers, processors and policy makers from different regions of the world to assess the progress achieved in tilapia farming in the 20th century, and to chart directions for its sustainable development in the 21st century. It will attempt to “benchmark” and identify “best practices” of tilapia farming industry on a worldwide scale.

The first day of the forum will be for the opening and presentation of papers on tilapia farming in the Asia-Pacific, the Americas, Europe and Africa by distinguished speakers. The second day will be for panel discussions on breeding/genetic improvement, culture systems, processing/marketing and national/international policies. The last day will be for the presentation of the panels, final discussion and closing.

A registration fee of \$150 will be charged for foreign participants and P1,500 for local participants. Hotel reservations can be arranged by the Secretariat on request.

Inquiries may be directed to: *The Secretariat, Informational Forum on Tilapia in the 21st Century, c/o PCAMRD, Los Baños, Laguna, Philippines 4030 / Tel. (063)(49) 536-5579 / Fax (063)(49) 536-1582 / E-mail: <dedo@laguna.net>*

reviews & invites

Call for papers

The Philippine Association of Marine Science (PAMS) is calling on researchers to submit abstracts of articles or researches on marine science. This is for PAMI's 6th National Symposium in Marine Science which will be held 20-21 October 2001 in Silliman University, Dumaguete City, Philippines.

PAMS aims to promote the growth of marine science, and recognize and give importance to the role of Philippine scientists in furthering knowledge on tropical ecosystems.

Papers on various aspects of marine science in the Philippines may be presented at the symposium. The Dean Francisco Nemenzo Award will be given to the best oral and poster papers among the student presentations during the symposium. This award honors the late Dr. Nemenzo, Father of Philippine Coral Taxonomy. Symposium proceedings may be published as a special issue of the *Silliman Journal*.

The symposium will update the participants on the current state of knowledge in the marine sciences, focusing on the following themes:

- Aquaculture/mariculture: contributions and consequences
- Marine environmental impacts: natural and human induced
- National programs: Pacific Seaboard, FRMP and AFMA
- Connectivity and marine protected areas
- Participatory approaches to coastal resources management
- Institutions, policies, and regulations
- Natural resources economics
- Marine products
- Evolution, biogeography, and conservation

For inquiries, interested parties may contact: Janet Estacion, Silliman University Marine Laboratory, Dumaguete City. Fax (035) 225-2500; 225-2008 / E-mail: <mlsucrm@mozcom.com>

Where are the milkfish breeders ... from page 31

Owner / location	Rearing facility	No. of brood-stocks	Age	Remarks
SANTOS FARM , Pagbilao, Quezon	Pen	200	3 yrs	No spawning facilities
BFAR Region V Tabaco, Albay	Cage	100	11 yrs	Low fry production
JALANDOON FARMS Ajuy, Iloilo	Pen	400	5 yrs	No spawning facilities
RETCEM RESOURCES INC Dumangas, Iloilo	Pond	300	3 yrs	No spawning facilities
SEAFDEC/AQD Tigbauan, Iloilo	Tanks, Cages	292 846	6-19 yrs 3-23 yrs	Consistent fry production
JAMANDRE HATCHERY INC San Joaquin, Iloilo	Tank	200	6 yrs	Consistent fry production
MARANON FARMS Sagay, Negros Occidental	Pond	1 700	6 yrs	No spawning facilities
BFAR Region VI Himamaylan, Negros Occidental	Pond	800	4 yrs	No spawning facilities
BAYSHORE AQUACULTURE Pulupandan, Negros Occidental	Pond	190	7-8	No spawning reported
CENTRAL VISAYAS POLYTECHNIC COLLEGE Bais, Negros Oriental	Cage	200	7-8 yrs	Low fry production
NEGROS ORIENTAL FISHERIES DEMO COMPLEX Bais, Negros Oriental	Pond	500	7-8 yrs	No spawning facilities
OVERSEA FEEDS INC Minglanilla, Cebu	Tank	150	5 yrs	Spawning reported
SOUTHWESTERN AQUA Calape, Bohol	Cage	280	6 yrs	Consistent fry production
BFAR Region VII Calape, Bohol	Pond	700	4 yrs	No spawning facilities
BFAR Region VIII Tacloban, Leyte	Pen	500	4 yrs	No spawning facilities
FORSTER FARM Dapitan, Zamboanga del Norte	Pond	1 000	5 yrs	No spawning facilities
DUPA ENTERPRISE Mati, Davao Oriental	Cage	300	5 yrs	No spawning facilities
FINFISH HATCHERIES INC General Santos City	Pond	4000	6 yrs	Consistent fry production

Year 2001 AQD TRAINING COURSES

Responsible Aquaculture Development (Third Country Training Program funded by JICA), *by invitation, Sept 4 to Oct 29*
Fish Nutrition, *Oct 10 to Nov 15 (5 wks)*
Marine Fish Hatchery, *completed June 5 to July 13*
Management of Sustainable Aquafarming Systems (includes module on Aquaculture Management), *completed May 9 to June 14*
Freshwater Aquaculture, *completed April 18 to May 17*

For application forms and further information, please contact:

Training and Information Division
SEAFDEC Aquaculture Department
Tigbauan, Iloilo 5021, Philippines
Tel/fax: 63 (33) 336 2891, 335 1008
E-mail: training@aqd.seafdec.org.ph

For local applicants who wish to apply for fellowships, contact:

Hon. Cesar Drilon, *SEAFDEC Council Director for the Philippines*
Office of the Undersecretary for Fisheries and Legislative Affairs
Department of Agriculture, Elliptical Road, Diliman, Quezon City 1104
FAX: (02) 927 8405

For fellowship applicants from other countries,
please contact your respective SEAFDEC Council Director.

SEAFDEC websites on the internet

- **www.seafdec.org**
maintained by the SEAFDEC Secretariat and SEAFDEC Training Department in Samut Prakan (Thailand) with contributions from the various SEAFDEC departments. Regional programs are highlighted
- **www.seafdec.org.ph**
all about the SEAFDEC Aquaculture Department based in Iloilo, Philippines
- **www.asean.fishnet.gov.sg/mfrd1**
all about the SEAFDEC Marine Fishery Research Department based in Singapore
- **www.agrolink.moa.my/dof/seafdec**
all about the SEAFDEC Marine Fishery Resources Development and Management based in Kuala Terengganu, Malaysia

NEW!



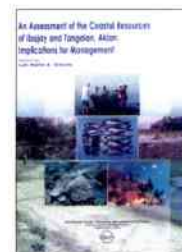
Use of chemicals in aquaculture in Asia, edited by JR Arthur, CR Lavilla-Pitogo and RP Subasinghe, 235 p

Responsible aquaculture development, edited by LMB Garcia, 275 p



Conservation and ecological management of Philippine lakes in relation to fisheries and aquaculture, edited by CB Santiago, ML Cuvina-Aralar and ZU Basiao, 187 p

An assessment of the coastal resources of Ibayay and Tangalan, Aklan: implications for management, edited by LMB Garcia, 60 p



The farming of the seaweed *Kappaphycus*, written by AQ Hurtado and RF Agbayani, 25 p

2000 Highlights, a 27-page annual report which present AQDs accomplishments in 2000, especially in technology verification and extension, cage culture of milkfish and grouper, and environment-friendly schemes in shrimp culture. FREE UPON REQUEST





ASEAN-SEAFDEC CONFERENCE 2001 ON SUSTAINABLE FISHERIES FOR



**“Fish for the People”
19-24 November 2001
Bangkok, Thailand**

In the Southeast Asian region, the rapid population increase and economic growth have accelerated the pace of exploitation of fisheries resources. It is therefore urgently required for the region to re-evaluate current fisheries practices and exploitation patterns, formulate appropriate policies and strategies to reconcile the current practices, and promote the development of sustainable fisheries. Under these circumstances, the Association of Southeast Asian Nations (ASEAN) and the Southeast Asian Fisheries Development Center (SEAFDEC), in collaboration with the Food and Agriculture Organization of the United Nations (FAO), will jointly organize a Conference on Sustainable Fisheries for Food Security in the New Millenium: “Fish for the People” from 19 to 24 November 2001 in Bangkok, Thailand. It will be hosted by the Department of Fisheries, Thailand. As part of the Conference, the Millenium Fisheries Exhibition will be concurrently organized from 21 to 24 November. The Exhibition will provide seafood traders and suppliers of goods, services and ships to the fishing and aquaculture industries with a unique opportunity to make valuable contacts and sales with various parties.



Detailed information on the Conference can be obtained from the announcement in the SEAFDEC home page: www.seafdec.org.
For other inquiries, please contact conference@seafdec.org.