

1999 Highlights



Aquaculture Department
Southeast Asian Fisheries Development Center

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The department chief reports

SEAFDEC/AQD in 1999

The year saw AQD continue to reach out to the aquaculture industry through its technology transfer and demonstration projects and to strengthen its ties with the international scientific community through three international seminar-workshops.

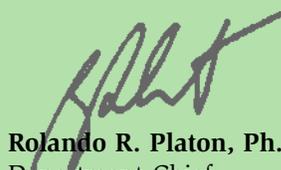
AQD likewise continued to pursue its considerable research efforts into mudcrab, tiger shrimp, milkfish, grouper and snapper, tilapia and bighead carp, marine ornamental fishes, seaweeds, and abalone. The seed production and grow-out culture technologies developed from research were verified as to their commercial viability with the help of private fishfarms and local government units in the Philippines. Packets of technology had likewise been extended by AQD through its training courses and information programs.

This report, *1999 Highlights*, bears the results of our efforts this year. It is worthwhile noting that while most of the sites for technology demonstration is located in the Philippines, this is only the initial step and the program will be expanded to other SEAFDEC Member-Countries in accordance with the new SEAFDEC strategic plan of regional collaboration. The mechanism would be the respective fisheries agencies of SEAFDEC Member-Countries. In addition, we are documenting the process of technology dissemination and collaboration and not just the verification of technologies alone.

The future of aquaculture would mostly include the use of biotechnology with the possibilities of enhancing growth rate and disease resistance, hence, decreasing production costs. AQD is preparing for this challenge by establishing the Advanced Aquaculture Technologies program. The program's facility – the biotech lab – is not yet complete, but it will be operational by year 2000. Collaborative projects would be welcome.

This foray into high-tech approaches would not make us forget the need for basic environment education so we can make wise use of our remaining natural resources and sustain aquaculture, among other human activities. Young minds are so important, and they are the focus of FishWorld, essentially a teaching tool of AQD's environment awareness program. The FishWorld building is nearly finished.

As 1999 drew to a close, we are confident that we did our best in demonstrating that aquaculture can be a tool for eliminating poverty and contributing to the food security in the country and the whole of Southeast Asia.



Rolando R. Platon, Ph.D.
Department Chief
SEAFDEC/AQD

Reaching out to the industry through technology transfer & demonstration projects

Tilapia culture in small freshwater reservoirs



Tilapia netcages in San Julian Dam in Capiz, a joint project of SEAFDEC/AQD, BFAR and CPEU

This is the most popular among the technologies extended and picked up by local government units in the Philippines. Investment in tilapia culture is considerably less, tilapia being a low-cost commodity to culture.

The **Central Panay Economic Unification Inc** (CPEU) was assisted in designing and constructing tilapia cages in San Julian Dam in Capiz. Some 25,000 tilapia fry have been stocked and about 60 tilapia breeders (SEAFDEC strain) are being maintained for fry production. CPEU is a consortium of five municipalities – Altavas, Batan and Libucan of the

province of Aklan and Tapay and Jamindan of Capiz. The Philippine Bureau of Fisheries and Aquatic Resources (BFAR) is also involved in this project.

The **Panay Gulf Development Program** (PGDP) received 250 pieces of SEAFDEC/AQD's fast growing strain of tilapia breeders and 3,000 pieces of tilapia fry for dispersal to operators along the municipalities of southern Iloilo. PGDP is run by the local governments of Oton, Tigbauan, Guimbal, Miag-ao and San Joaquin in collaboration with the Department of Agriculture, Department of Environment and Natural Resources,



Department of Science and Technology, Department of Labor and Employment, the University of the Philippines in the Visayas, and the Land Bank of the Philippines.

Culture of crabs in mangrove areas

This is the most environment-friendly of the grow-out technologies so far developed by SEAFDEC/AQD. Mangroves are not cleared to make way for brackishwater ponds. Instead, aquaculture is conducted within mangrove areas.

The **local government units of Tangalan and Ibajay in Aklan** were extended technical assistance in mangrove-friendly aquaculture and community resource management. The current projects include the raising of mud crabs in ponds and pens with existing mangroves, and the growing of grouper in netcages.

The **Philippine Reef and Rainforest Conservation Foundation Inc (PRRCFI)** was extended technical assistance in mangrove-friendly aquaculture and fish cage culture projects; and in the pen culture of king crab in mangroves. PRRCFI is providing alternative livelihood to local fisherfolk communities in five communities in Negros Occidental, from Cauayan to Sipalay.



SEAFDEC/AQD turned over the management of its mangrove-friendly aquaculture project in New Buswang, Aklan to local government officials. The project is the first model eventually followed by Tangalan and Ibajay, Aklan



Mudcrab culture in pens in mangrove areas: Ibajay model

Grouper culture in cages

This technology is most appropriate in areas with relatively unpolluted marine waters. Grouper is a high-value commodity and is usually marketed live.



SEAFDEC/AQD trained MNLF rebel returnees in marine cage farming last summer

The **Food and Agriculture Organization–United Nations Development Programme (FAO-UNDP)** was extended technical assistance when they searched for alternative livelihood for the rebel returnees of the Moro National Liberation Front. SEAFDEC/AQD provided training in grouper fry procurement, packaging and transport; stocking, sorting, and grow-out activities. AQD also assisted in constructing ten units of floating cages for grouper grow-out in Basilan and Jolo in southern Mindanao.

The **Philippine Business for Social Progress (PBSP)** was extended the same assistance in their livelihood project in Maqueda Bay, western Samar.

The **Conception Polytechnic College** and **BFAR** likewise received technical assistance from SEAFDEC/AQD for verifying and demonstrating in commercial scale the viability of grouper culture and milkfish culture using hatchery-reared seeds.



Rehabilitation of the kapis industry

SEAFDEC/AQD assisted the local governments of Tigbauan and Oton in Iloilo in dispersing seeds of kapis shell (*Placuna placenta*) in their respective territorial waters. The seedstock has been produced from 1,200 wild breeders induced to spawn at AQD's mollusc laboratory. The ultimate aim of this artificial reseedling is the rehabilitation of the kapis industry, a project implemented under PCGR.



Kapis shell provided handsome materials for what was once a thriving shellcraft export industry



SEAFDEC/AQD helped townsfolk of Oton, Iloilo seed kapis breeders near the coast



Government officials of Oton checked out the kapis breeders



Landmark for the kapis reseedling site in Tigbauan, Iloilo



Grouper culture cages in Tangalan



SEAFDEC/AQD conducted a dialogue with Aklan local governments and the local media on sustainable aquaculture and coastal resource management on February 23

Other technologies

The **Western Samar Agricultural Development Programme (WESAMAR)** of the Philippine Department of Agriculture and the European Union got SEAFDEC/AQD's support in establishing a multi-species hatchery, currently under construction. AQD will contribute its seed production technologies for mud crab and grouper.

The **local government of Palawan and BFAR** were assured of AQD's support in constructing an aquaculture demonstration center housed within BFAR's Inland Searanching Station in Puerto Princesa. AQD provided technical assistance in designing and supervising the construction of the center's multi-species hatchery complex which, upon completion, will showcase AQD's technologies.

The **Western Visayas Technology Promotion Center (TPC)** was assured of AQD's support as the center initiates ventures into aquaculture using AQD technologies and financing from LandBank. Site suitability visits has been made in Surigao and Agusan in Mindanao. The TPC is also supported by the University of the Philippines in the Visayas and the Iloilo State College of Fisheries.



A sample harvest of grouper from AQD's ponds



SEAFDEC and WESAMAR agreed on a collaboration establishing a multi-species hatchery



The groundbreaking ceremony for Palawan's aquaculture demonstration center



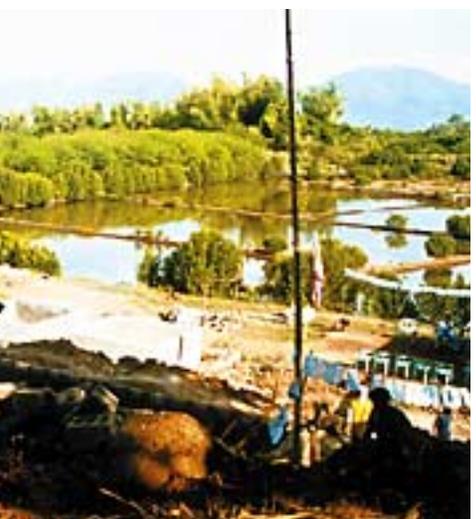
The TPC's multi-species hatchery complex



The first TPC field day was held in AQD's Dumagas Brackishwater Station with representatives of the collaborators in attendance

The **Center for Renewable Resources and Energy Efficiency (CREE), Shell Philippines, the provincial governments of Palawan and Batangas** have likewise been assured of AQD support as they search for livelihood options for displaced residents of Batangas City where Shell has put up an oil refinery. In Palawan, the plan is to set-up a fish sanctuary in Malampaya Sound and provide alternative livelihood for islanders.

The **Philippine government's Agrikulturang MakaMASA Program** was assured of AQD's support. AQD is one of the key institutions involved in this banner program of the Estrada Administration on modernizing agriculture and fisheries. The components of the fisheries sector program include fisheries training and extension services, fisheries information and marketing support, research and development in fisheries, among others.



SEAFDEC/AQD participated in fairs and exhibits in support of the MakaMASA program

Strengthening ties with the international scientific community

Workshop on mangrove-friendly aquaculture

The development of mangrove-friendly aquaculture techniques is a response to the worldwide call for the conservation of Asia's mangrove resources without necessarily sacrificing aquaculture development or precluding the traditional use of mangrove forests by communities. In practice, mangroves may either be found inside or outside the pond. Mangroves inside the pond take up 60-80% while the rest of the area – natural canals – can be deepened and stocked with fish, shrimp, or mudcrab. If mangroves are outside the pond, they act as biological filters for pond effluents before these are discharged to surrounding waters.



Nearly a hundred participants attended the first workshop on mangrove-friendly aquaculture held January 11-15 at Iloilo City. Some visited SEAFDEC/AQD's main station in Tigbauan after the session.

Seminar-workshop on responsible aquaculture development



ADSEA IV was held October 12-14 at Iloilo City. Simultaneous workshops worked out the problem areas in a given culture system

Also dubbed ADSEA IV, this seminar-workshop has set the tone for SEAFDEC/AQD's three year research and development program from 2001 to 2003. Inputs to this program were made by about 150 participants. AQD programs have been redefined according to the major aquaculture activities: openwater mariculture, brackishwater farming, freshwater fish aquaculture and integrated fish farming, coastal resource management and mangrove-friendly aquaculture, intensive aquaculture and farming in marine cages. The participants identified problems areas that AQD can prioritize and work on.

Symposium on diseases in Asian aquaculture

Organized with the Fish Health Section of the Asian Fisheries Society, the symposium had the biggest contributed papers at 152 – 15 plenary presentations by leading scientists in the field of aquaculture, and 79 oral and 59 poster presentations. The shrimp industry was extensively discussed, being one of the worst hit commodities in terms of disease outbreaks. Significant shrimp diseases, and recent findings and developments on the white spot syndrome, vibriosis, crustacean immunity were discussed. Even with solutions like vaccines and high-health organisms bred in laboratories, the participants all agree that, in the final analysis, prevention is still the best cure.



About 240 participants attended the symposium held November 22-26 in Cebu City

Poverty alleviation

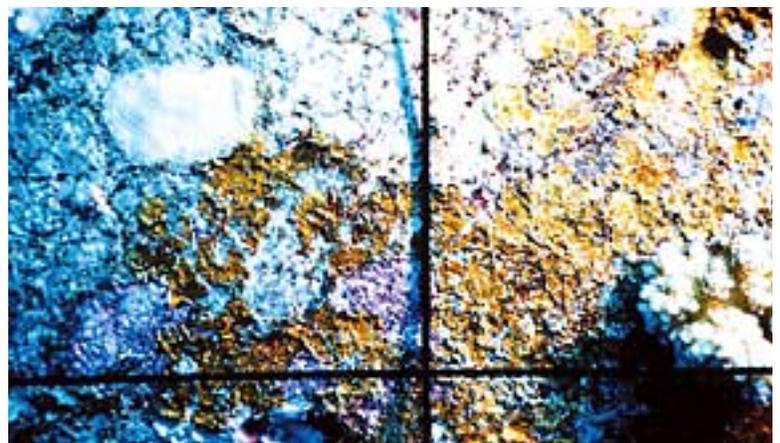
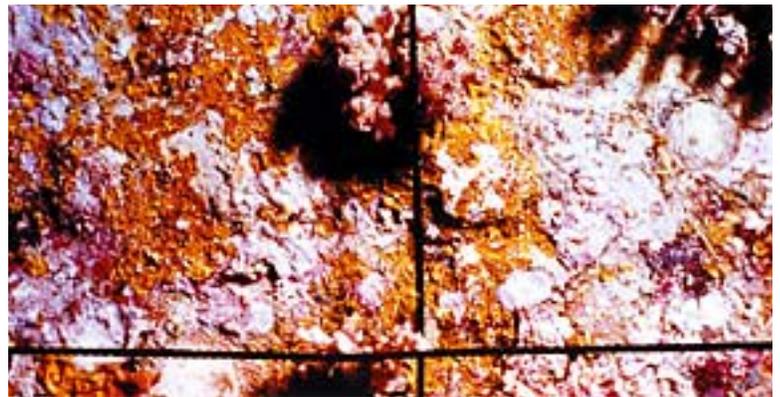
Community fishery resources management project



SEAFDEC/AQD continues to monitor the recruitment of concrete artificial reefs it had deployed with the Malalison community in west central Philippines. These artificial reefs in Guiob have been in protective management with all forms of fishing banned for 3 years beginning 1997. AQD researchers compared Guiob Reef to the island's common fishing ground at Nabltag reef. Fish was 16 times more abundant in Guiob than Nabltag. This was evident among surgeonfishes (21,320 per ha versus 1,040 per ha) and snappers (120 per ha versus 60 per ha). Large sized surgeonfishes (*Naso lopezii*, *N. hexacanthus*, *N. thynnoides*, *Acanthurus mata*, *A. blochii*) measuring more than 30 cm standard length were clearly abundant in the marine sanctuary.

(above)
Surgeonfish and other fishes caught in waters surrounding Malalison Island

(right)
Growth of hard corals in the Nabltag artificial reefs



Food security

Milkfish *Chanos chanos*

FRY QUALITY CRITERIA

SEAFDEC/AQD continues to develop test procedures for evaluating the quality of hatchery-produced milkfish fry. These criteria may set the standard for the industry, and can be used to eliminate “poor quality” stocks. AQD researchers first fabricated a swimming apparatus especially designed to test swimming performance of hatchery-produced and wild fry. In one study, they found that hatchery fry fatigued earlier than wild fry, and that swimming endurance of smaller hatchery-bred milkfish is lower than bigger fish. Researchers have also found correlations among growth, survival, and incidence of abnormalities.

SEAFDEC/AQD holds broodstock of milkfish in 6- and 10-meter diameter netcages in Igang Marine Substation



Broodstock are periodically monitored for growth and gonadal maturation



Milkfish are raised in the hatchery



Apparatus used to test swimming performance of milkfish fry

LARVAL FEED DEVELOPMENT

SEAFDEC/AQD has long developed artificial diets for milkfish larvae. However, these diets can only replace the expensive live feeds, rotifers and *Artemia*, starting day 8 and day 15, respectively, of hatchery operations. This limited success is believed to be due to low digestive capacity of fish larvae at the

early stages of exogenous feeding. To compensate for this weakness, AQD researchers incorporated pre-digested materials such as protein hydrolysates, di- and tripeptides, exogenous enzymes, and free amino acids in artificial diets. The larval development studies are still ongoing.

NURSERY REARING PROTOCOL

SEAFDEC/AQD researchers are developing a nursery rearing protocol for milkfish in netcages. Nurseries can reduce the risk of high mortality while offering new economic opportunities for coastal communities that collect wild milkfish fry. Partial results indicate that milkfish fry (50%) can survive poor weather ►

◀ condition (turbulent waves). It also seems that the successful use of netcages is time- and site-specific. A related experiment on cage sizes showed that milkfish fry stocked at 600 per cage yielded the highest survival (78%) when stocked in a 2x2x0.5m cage, as compared to 1x1x5m (35%) and 1x2x5m (48%) cages.

SOCIOECONOMICS

In line with efforts to promote the use of milkfish hatchery technology, SEAFDEC/AQD is examining the growers' negative perception of hatchery-bred fry. The first phase of this study is assessing the collection and marketing of wild fry. The study site is Hamtik, Antique, one of the richest fry grounds in the country. Results indicate that middlemen have replaced the fry concessionaire. Concession payments from fry grounds constituted 60% of Hamtik's income. Almost 70% of ordinances passed each year by the municipality were on coastal fisheries, half of which were on milkfish fry concession. AQD researchers recommend that fry collectors start other livelihood methods such as growing fry to fingerlings as additional source of income.

OTHER STUDIES

Production of recombinant growth hormone (GH) and insulin-like growth factor-I (IGF-I) is underway. These hormones can eventually be used in enhancing growth of milkfish. A patent application is pending for the milkfish GH cDNA sequence.

Review of the national milkfish broodstock-hatchery R&D program and industry has been completed. This effort is motivated by the lack of policy-oriented studies which policy makers can utilize as reference in planning for the national R&D program.



Setup for the larval feed development trials

Tilapias



For selective breeding and broodstock management of tilapia, researchers made reciprocal crosses between an ISRAEL and a NIFI tilapia strain to refine the collimated mass selection procedure. The growth and survival of fingerlings from these crosses were evaluated under communal and separate rearing in tanks and cages. Preliminary statistical analysis showed that fingerlings from the cross between female ISRAEL and male NIFI strain showed a 2.5% higher growth rate than fingerlings from female NIFI strain and male ISRAEL strain under communal rearing in net cages in Laguna Lake. Growth under separate rearing was comparable. High mortality due to aggression was observed in tank reared fingerlings.

In another study, fourth generation selected breeders was compared with that of the fourth generation control group and with that of the parental generation for reproductive efficiency. Initial results after four months showed that the control breeders had the most number of spawning and highest egg production (fry and eggs) in tanks. The selected and control breeders showed the same number of spawning. Fry production of the parental breeders was higher than that of the selected breeders but egg production was higher in the se-



Fourth-generation Nile tilapia breeders at AQD's Binangonan Freshwater Station

lected breeders. In cages, the control breeders showed the most number of spawning and highest seed production (fry and eggs). Lowest number of spawning and seed production were observed in parental breeders.

Quality assessment of Nile tilapia fingerlings is in progress. Performance of ten different batches of Nile tilapia fingerlings were ranked based on their biological index scores on growth and survival in tanks and cages. Preliminary analysis showed some correlation between the biological scores of several fingerling batches and their survival after six weeks of rearing in tanks. A batch of fingerlings scored relatively high at 1.54 (in a system where where 2.0 is the highest score) and had the highest survival percentage in tanks (82.5). However, there is no apparent relationship between the biological index scores and fingerling growth and survival in cages.

A study to compare the reproductive performance of the introgressed red tilapia with a control (non-introgressed red tilapia) was conducted. The breeders were fed with SEAFDEC formulated feed and a commercially prepared feed. Preliminary statistical analysis showed



A batch of Nile tilapia fingerlings stocked in cages in the lake

that the number of spawning and seed production (fry and eggs) were highest in control breeders fed with commercially formulated diet. The introgressed red and control breeders fed with SEAFDEC formulated diet showed comparable number of spawning. However, fry production was higher in the control breeders fed with the SEAFDEC formulated diet while the number of eggs produced was higher in the introgressed red tilapia. The lowest number of spawning and seed produced (fry and eggs) were observed in the introgressed red breeders fed with the commercially formulated diet.



Experiments on red tilapia focused on reproductive performance

Catfish *Clarias macrocephalus*

REFINING NURSERY TECHNIQUES

SEAFDEC/AQD has successfully raised catfish fry in netcages installed in tanks and ponds until the fry have reached 3-4 cm, the size for grow-out culture. Optimum stocking density is from 400 to 800 per m² in tanks and

1200 per m² in ponds. Survival after 28 days ranges 85-89% in tanks and 78-87% in ponds. Results of gut analysis showed that catfish fry feed on zooplankton and detritus, and not phytoplankton although all three were present in water samples.

GROW-OUT CULTURE

Different diets are being tested in grow-out. Results after 120 days of culture showed that catfish grow best – length, weight, production, feed conversion ratio – on diet containing 34% crude protein.



Induced spawning of catfish is routinely done at SEAFDEC/AQD



Catfish fry are raised in netcages in ponds until they are the size for stocking in ponds



The carps

BROODSTOCK DEVELOPMENT

The bighead carp (*Aristichthys nobilis*) mature relatively late (2 to 3 years), a fact that increases the cost of rearing broodstock. But since bighead carp can compensate for stunted growth, SEAFDEC/AQD decided to look into stunting as a strategy in broodstock development. One promising result is that carp stunted in tanks for 6 and 12 months attained sexual maturity when later moved into cages in the lake and reared for 29 months. Carp weigh around 2.2 to 2.6 kg.

FEED DEVELOPMENT

Artemia is expensive, so SEAFDEC/AQD researchers continue to find alternatives. For bighead carp larvae, this could be the free-living nematode *Panagrellus redivivus*. Initial results showed that with high numbers of nematodes given to bighead carp larvae, growth and survival are comparable with larvae fed *Artemia*.

CAGE CULTURE

SEAFDEC/AQD continues to screen carp species as to their culture potential in cages in Laguna de Bay. So far, researchers have determined that the grass carp (*Ctenopharyngodon idella*) is not suitable. Growth rate was generally low.



Bighead carp at SEAFDEC/AQD's Binangonan Freshwater Station

Rabbitfish *Siganus guttatus*



SEED PRODUCTION

The larval rearing techniques for rabbitfish developed at SEAFDEC/AQD were verified once (n=6). Survival rates ranged from 4.5-6.0% at day 40. Researchers also noted that it is possible to increase growth and survival with the use of thyroid hormone (thyroxine, T4). Day 21 larvae treated with T4 by immersion (0.01 ppm) or by feeding *Artemia* enriched with T4 were bigger than the control larvae. T4 treatment was found to hasten dorsal fin resorption.

CLONING OF HORMONES AND FACTORS INVOLVED IN GROWTH REGULATION IN FISH

Growth hormone (GH) was purified from rabbitfish pituitary glands. The weekly injections of this GH to rabbitfish fingerlings at doses of 0.1 and 0.01 µg/g BW resulted in significantly higher increases in body weight and length compared to the control after the fifth week. These results suggest that growth in rabbitfish may be improved by GH administration. On the other hand, cDNAs for rabbitfish GH and insulin-like growth factors I and II were successfully cloned. A patent application is pending for the rabbitfish GH cDNA sequence.

Environment-friendly technologies

Mangrove-friendly aquaculture

STUDIES ON IMBAO, *ANODONTIA EDENTULA*

SEAFDEC/AQD sees the mangrove clam, imbao, as a commodity that can be reared in mangrove areas by coastal communities. The clam is already a popular food in the Philippines. Imbao also harbors sulfur-oxidizing symbiotic bacteria in the gills, making it a potential sediment cleaner in polyculture with shrimp. Hence, AQD researchers started work on imbao in 1997. So far, they have successfully induced the spawning of female and male adults using Serotonin. More work on mass propagation will follow. AQD researchers have also characterized imbao's symbiont. Bacteria observed from plate culture of gill isolates are gram-negative, colorless and spherical to rod shaped. Sulfur analysis showed highly significant amounts of elemental sulfur in the gills. Stable carbon isotope ratio analysis also suggests that clams obtain their carbon through the Calvin-Benson cycle powered by the oxidation of sulfide (chemosynthesis) and do not depend on plankton, sediment or detritus.

SHRIMP CULTURE SYSTEM INTEGRATING MANGROVES

SEAFDEC/AQD researchers are evaluating the capacity of mangrove stands to absorb effluents from tiger shrimp culture ponds. They have established some culture parameters, including the use of *Rhizophora* propagules instead of *Sonneratia* saplings. The former is more resistant to inundation.



Imbao are dug from the mangrove area in Estancia, Iloilo



The spawning of male and female imbao

Cash crops / export crops

Mudcrab *Scylla serrata*

BROODSTOCK MANAGEMENT

After successfully completing the lifecycle of mudcrab in captivity, SEAFDEC/AQD is improving broodstock management to enhance the reproductive performance of mudcrab females. Researchers have found a combination of natural and formulated diet to work well in terms of increasing the number of spawnings, total number of eggs per gram body weight of female, egg fertilization rate, total zoea produced, and larval index.

SEAFDEC/AQD researchers postulated that nutrient profiles of organisms can be used as basis to develop effective feeds. Initial studies focus on eggs and day-old zoea and their levels of free amino acids (FAA) and protein-bound amino acids (AA). Results showed that hatched eggs have 3 to 4 times higher FAA than unhatched ones. Day-old zoea have higher FAA than eggs, at least for three types of FAA. The levels of FAA are small relative to AA.

HEALTH MANAGEMENT

SEAFDEC researchers have found that captive broodstock held for more than two months in tanks developed severe shell disease. Regular scrubbing and disinfection of crab shells, not iodine solution, can prevent the colonization of chitinoclastic bacteria. *Vibrio* count in crab hemolymph has been as much as 8.0×10^3 colony forming units (cfu/ml). Fortunately, the same was not seen in 1999. But crab broodstock recruited during the 1999 rainy season contain various types of bacteria, about 5.3×10^3 cfu/ml in hemolymph, of which 50% is vibrio. The presence of bacteria in hemolymph does not seem to be related to shell disease.

Researchers have shown that hatching of mudcrab normally occurs 6-12 days following spawning at 26-29°C in 1.5-10 ton tanks. But the egg mass of some



Mudcrab (above) are fed a combination of natural – mussel meat and fish by-catch for example – and artificial diets to enhance reproductive performance

Megalopae (below) are grown in netcages set in ponds with survival rates of 60%. The source of crab megalopae is AQD's captive crab broodstock



females were attacked by fungal disease. Low survival (0.5 to 5%) from zoea to megalopa has also been attributed to another disease agent – luminous bacteria. But survival rates of

megalopa to crab juveniles is much higher, from 26 to 89%. Weekly sorting of crab juveniles apparently reduces cannibalism.

Tiger shrimp *Penaeus monodon*

REFINEMENT OF SHRIMP CULTURE SYSTEMS

SEAFDEC/AQD has established the optimum salinity range for tiger shrimp reared in hatcheries at 28°C. For post-larvae 1 (PL 1), it is 24-32 ppt; PL 5, 24-40; PL 10, 16-40; and PL 15, 16-40. Researchers have also established that oxygen consumption of shrimp weighing nearly 30 g raised at 28°C is 7-13 mg/h at 32 ppt, 6-7 mg/h at 4-20 ppt, and 4-6 mg/h at 0 ppt. All shrimps died after one week at 0 ppt. These parameters are useful in providing the optimum conditions for shrimp in culture.

SEAFDEC/AQD continues to determine the impact of semi-intensive shrimp culture on the environment. Researchers have so far determined the nitrogen fractions of rearing water where tiger shrimp have been fed two diets. For AQD-formulated diets, NH₃-N ranges 0.003-0.01 ppm, NO₂-N ranges 0.001-0.02 ppm, and NO₃-N ranges 0.002-0.006 ppm. These values are lower – and better – than those from a commercial diet (0.04-0.10 ppm, 0.02-0.13 ppm, and 0.02-0.06 ppm, respectively for NH₃-N, NO₂-N and NO₃-N).

HEALTH MANAGEMENT

Researchers continue to monitor vibriosis in shrimp culture. About 189 bacterial isolates from various locations (shrimp rearing water and near-shore seawater) have been characterized biochemically. Results show that the isolates are luminous bacteria like *Vibrio harveyi* (nearly 66%), *V. logei* (7%), *V. orientalis* (1%), and *Photobacterium* (6%). The characteristics of other isolates merit their clarification into non-



luminous *Vibrio* groups like *V. campbelli* (16%), *V. mediterranei* (3%), *V. fluvialis* (0.5%), *V. cholerae* (0.5%), and *V. splendidus* II (0.5%). Agglutination tests also indicate that 72 of these isolates are serologically heterogenous or different.

SEAFDEC/AQD has started studies on antibiotic-resistant bacteria isolated from shrimp farms which now use or have previously used antimicrobials. Initial results indicate that vibrios show varying degrees of resistance to oxytetracycline (OTC) and oxolinic acid (OXA). OTC-resistant bacteria are more readily recovered from the water than the soil. Higher percentage of resistance to OXA was recorded in bacteria isolated from ponds that have a history of OXA use compared to ponds that have not used OXA. Sensitivity tests by disc diffusion method showed highest incidence of

resistance to OTC followed by furazolidone (F), OXA, and chloramphenicol. Resistance to these antibiotics does not reflect the pattern of antimicrobial use. However, incidence of bacteria with multiple antibiotic resistance is associated with antimicrobial usage. Incidence of resistance to both OXA and F was highest compared to other antibiotic resistance profiles.

Tiger shrimp will always sell but the industry is troubled by disease problems brought about by deteriorating environmental conditions in shrimp farms

FINDING ENVIRONMENT-FRIENDLY ALTERNATIVES TO ANTIBIOTICS

Pseudomonas may have vibriolytic properties. "Bacteria can fight bacteria" is the premise of SEAFDEC/AQD's studies on naturally occurring and com- ▶



SEAFDEC/AQD shrimp research is mostly focused on diseases

Mangrove red snapper *Lutjanus argentimaculatus*

BREEDING AND SEED PRODUCTION

This year, SEAFDEC/AQD completed the life cycle of snapper in captivity after 6 years. This happened when the second generation of the offspring of red snapper reared from fry in floating net cages and concrete tanks spontaneously matured and spawned.

Reproduction, however, is seasonal. Spermiating males are observed as early as January and females possess mature oocytes in March. The number of mature males and females continue to increase until June when almost all of the stock are mature. The percentage of mature fish begins to decline by October. In the absence of natural spawning from March to June, SEAFDEC/AQD researchers induce the spawning of snappers with 1000 IU human chorionic gonadotropin per kg body weight or 100 µg luteinizing hormone-releasing hormone analogue (LHRHa) per kg body weight. Successful spawning, however, is low in March and high in June. Natural spawning begins in July and lasts until December.



Snappers are kept in floating net cages, and are induced to spawn with hormones, hCG and LHRHa. This year, SEAFDEC/AQD completed the life cycle of snapper in captivity



A spermiating male (note the whitish milt, arrow, when the belly is pressed)



Spawned eggs in the cages are collected by rotating the egg collector gear

Seven females and eight males kept in 2 units of 150-ton concrete tanks produced 3.38 million eggs from 25

spawns. Total egg production of 8.44 million (23 spawns) was collected from 10 females and 16 males kept in 2 units



◀ commercially available probiotics for shrimp culture. In the first study, four isolates of *Pseudomonas* were grown and tested against luminous *Vibrio harveyi*. Vibriolytic activity based on

Pure culture of luminous vibrio, which causes shrimp to light up like fireflies in the dark. Vibriosis is a big problem, hence the efforts to find antibiotic alternatives that can fight the luminous bacteria in ponds and hatcheries

the decrease in the optical density of a standard *V. harveyi* suspension was shown by the pseudomonads during the logarithmic phase of growth. Five extracellular vibriolytic factors were isolated from one iso-

late coded JP4. Two of these also possessed vibriolytic activity. The vibriolytic factors show optimum activity at 30°C at pH 7.0 and are heat-sensitive.

In the second study, the bacterial content of 15 probiotic or bioaugmentation products available in the Philippine market for aquaculture was determined. Bacterial colony-forming-units (cfu) obtained on agar spread plates ranged from 10⁴ to 10⁹ per gram or milliliter of product. The same number of cfu was obtained on culture media with or without salt, indicating a wide range of salinity tolerance of the bacterial

of 6-m diameter cages. The frequency of producing viable eggs (those with embryo) and normal (straight and without deformities) larvae is higher for natural spawning than induced spawning. Nevertheless, induced spawning can produce eggs and larvae when needed for hatchery operation and can supplement natural spawning.

Hatchery technology is currently being refined, with studies on stocking density and feeding. Results showed that survival is low (2-4%) in the first 5 weeks of culture at stocking densities of 1500, 3000 and 4500 larvae per ton and high at the later stage of culture when densities have been lowered to 33, 66 or 100 larvae per ton. Day 21 larvae can be fed *Artemia* alone, supplemental (Lansy A2) diet, or the combination of *Artemia* and supplemental diet.

FEED DEVELOPMENT

Higher growth is obtained when snapper is fed a practical diet with more animal protein. Growth is similar in snappers fed diets containing cod liver oil or soybean oil with or without vitamin/mineral mix.

components in the products. Colonies obtained by pour plate were always ten times higher than those obtained by spread plate method.

Results also indicate that high live cell content (from 10^9 to 10^{10} cfu/g or ml) is one of the desirable traits of probiotics or bioaugmentation products. Low cell counts, especially those from liquid products, indicate a loss of viability during transport and storage. Bacterial products that are supplied in liquid form have a shelf life of less than 3 months, while products in granular or pelleted form maintain their viability from 6 months to more than one year in storage.

Grouper *Epinephelus coioides*

SEED PRODUCTION

Studies on refining seed production techniques continue. Researchers have examined the microflora of naturally spawned grouper eggs, and noted that good eggs harbor 10 to 100 times less *Vibrio* and other bacteria than bad eggs. To reduce bacterial load by a factor of 10, researchers recommend disinfection of eggs with 2 ppt Argentyne.

The use of thyroxine to improve metamorphosis and larval survival continues to be considered in intensive seed production. Grouper eggs were directly stocked in 5 ton circular tanks. Average survival after 5 days of thyroxine treatment from day 21 was 53% by immersion and 59% by feeding. Larval survival from hatching to Day 35 ranged from 5.4 to 29.8%. Survival rate at harvest (Day 55; ≥ 2 " size) was 3%.

NURSERY AND GROW-OUT CULTURE

A series of experiments were conducted to determine the apparent protein digestibility (APD) of selected feed ingredients in grouper diets. White fish meal based diet had the highest APD value (95%) followed by the control

(Chilean fish meal and defatted soybean meal). The APD values for squid meal, local meal and bone meal, Protamino Aqua, HP 300, and rice bran were 99.3%, 91.8, 101.8%, 95.8% and 91.2% respectively.

The efficacy of low fishmeal-based diets was determined for grouper juveniles. Processed meat solubles (Protamino Aqua) was tested to replace fish meal at increasing percentage (0, 10, 20, 30, 40, 60, 80, 100%) in an isonitrogenous diet. Results after 60 days of feeding showed a weight gain of 300 to 554%. Best survival and percent weight gain was highest at 100% replacement.

Pond-reared and cage-cultured grouper collected from Panay were examined for parasite fauna. Fish reared in floating net cages harbored more species of parasites with higher prevalence and intensity of infection than pond-reared grouper. Among the parasites recovered are: the ciliates *Trichodina* sp., *Vorticella* sp., and *Ribosyphidia* sp.; the monogeneans *Dactylogyrus* sp. and *Pseudorhabdosynochus* sp.; didymozoid digenean; and two species of nematode. The life cycle of *Pseudorhabdosynochus* sp. was examined.



Groupers are bestsellers in the live reef fish market in Asia. This is the *Epinephelus coioides*, and one of the breeders being held at SEAFDEC/AQD



SEAFDEC/AQD has developed technologies for seed production and grow-out culture



A diet low in fish meal – an expensive ingredient – is being tested for grouper juveniles

Tropical abalone *Haliotis asinina*

DIATOM CULTURE AND LARVAL SETTLEMENT

Researchers continue to investigate suitable substrates for diatom culture. Initial results showed that “hardiflex” boards (made of fiberglass and cement) harbored the highest numbers of diatoms such as *Navicula*. However, for *Nitzschia*, plexiglass boards were the most suitable for growth. When cultured together on plexiglass as substrate using the F-medium, combined cell density counts of *Navicula* sp. and *Nitzschia* sp. reached 0.45 to 0.66 million cells per cm² after 4-5 days.

In a related study, a 25% settlement rate was obtained after 10 days in diatom-filmed plates with addition of diatom slurry, but no postlarvae survived without diatoms. The best settlement results occur with diatom density of 200-300 cells per cm². Settlement rates



An AQD researcher checks abalone broodstock maintained in concrete tanks

of abalone were also significantly higher when rearing tanks are aerated 2-4 days after stocking.



Abalone still grows best when fed seaweeds but efforts are underway to study artificial feeds

ARTIFICIAL FEEDING OF ABALONE FOR GROW-OUT TANK CULTURE

Formulated diets were used to improve the reproductive performance of aba-

Marine ornamental fishes

BREEDING AND SEED PRODUCTION OF SEAHORSES

After successfully producing second generation broods of the seahorses *Hippocampus kuda* and *H. barbouri*, SEAFDEC/AQD researchers are now looking into broodstock diets to enhance reproductive performance. Partial data indicate that seahorses fed a combination diet – DHA Selco-enriched *Artemia* adults and/or mysids – have the most parturition events and the greatest broodsize.

The hatchery rearing protocol is also being worked out. So far, the best stocking density of newly born seahorses in 60

liter tanks is ≥ 5 fish per liter. Seahorses are fed a mixed diet of copepods, rotifers, and DHA Selco-enriched *Artemia* nauplii. But when seahorses reach day 20, better growth has been observed at stocking density of 1 fish per liter than at 5 or 10 fish per liter.

SEAFDEC/AQD researchers note that nursery and grow-out culture of seahorses in floating net cages and marine ponds would require transport of young seahorses from the hatchery to culture sites. From results of simulated transport experiments, it appears that almost all seahorses (age, 12-15



Two species of seahorses are bred at SEAFDEC/AQD – *Hippocampus kuda* and *Hippocampus barbouri*



Tiny seahorses are fed a mixed diet

Seaweeds *Gracilaria*, *Gracilariopsis*, and *Kappaphycus*

SEEDSTOCKS FROM THE LABORATORY

SEAFDEC/AQD researchers studied the life history of four agarophytes – *Gracilaria coronopifolia*, *G. firma*, *G. salicornia* and *Gracilariopsis bailinae* – in an effort to produce seedstock from the laboratory. Results indicate that these mature agarophytes can liberate spores which germinate to sporelings and grow healthily up to about 1 cm long in four months.

Similar trials are being conducted for *Kappaphycus alvarezii* under ambient light and temperature at different levels of ammonium phosphate (1, 5, and 10 ppm).

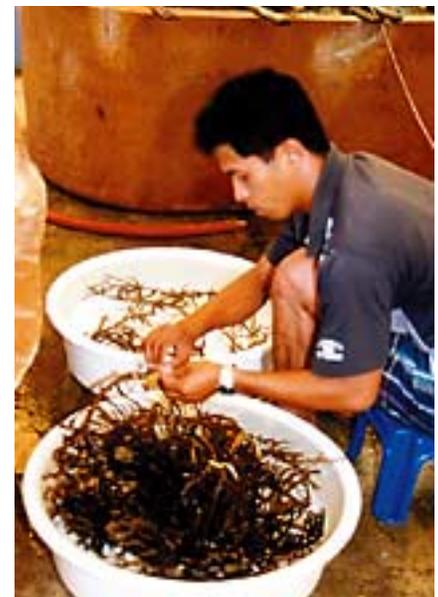
GROW-OUT CULTURE IN TANKS

SEAFDEC/AQD continues to develop culture techniques of *Gracilariopsis* in tanks. Researchers have so far determined that *Gracilariopsis* prefer (1) 25 ppt salinity; (2) $\text{NH}_4^+\text{-N}$ over $\text{NO}_3^-\text{-N}$ as nitrogen source; (3) 40 ppm ammonium chloride concentration; (4) 1 ppm phosphate level in the form of disodium phosphate; and (5) stocking density of 2 kg per ton. Researchers also observed that healthy plants have slightly higher gel strengths than unhealthy plants after the culture period. Higher concentrations of $\text{NH}_4^+\text{-N}$ (≥ 20 ppm) eliminate rotter thallus syndrome.

For *Gracilariopsis bailinae*, growth rate is high in the filter tank of a recirculating water system, about 10% per day. The seaweed is able to decrease ammonia concentration in the tank. Tissue nitrogen is saturated by the 5th day, and growth started thereafter. Agar quality of *G. bailinae* was 2000 g per cm^2 .

SEAFDEC/AQD is currently modifying some concrete tanks for the integrated recirculating culture of seaweed, abalone and grouper.

Gracilariopsis bailinae (right) and *Kappaphycus* (pictures below): growth experiments by SEAFDEC/AQD



alone broodstock. Results showed that a combined formulated diet and seaweed gave the highest number of spawning and egg fertilization rate. However, broodstock fed only seaweed gave the highest survival.

For hatchery-bred abalone broodstock, the feeding of seaweed also yields the best survival compared to the use of formulated diet or diet-seaweed combination. But the latter gave the highest number of spawning (62-67 times) and egg fertilization rate (51-67%). The result may be explained by the similarity in n-3/n-6 fatty acid ratio or profile between the formulated feed and a mature abalone ovary.

days) can survive a 12-hour transport time when packed in oxygenated bags (28-29°C, 32 ppt). Older seahorses (age, 35-69 days) also do as well. Generally, total ammonia levels in transport water were elevated as loading densities and transport duration increased.

BROODSTOCK DEVELOPMENT OF BLUE TANG

SEAFDEC/AQD researchers continue to monitor the gonadal development of blue tang *Paracanthurus hepatus*. Of the 35 broodfish monitored, 15 are females with pre-vitellogenic or vitellogenic oocytes (yolky eggs), while 11 are milting males. Females generally are smaller than males. Females injected 0.2 μl Ovotide per g body weight have spawned 24 hours post-injection. In subsequent months, natural spawning occurs for 5-12 consecutive days with 1-10 days interval between spawning periods. About 5000 to 30000 eggs have been collected per day. Larviculture is still being worked out.



Larval Food Project

SEAFDEC/AQD continues to evaluate phyto- and zooplankton species for their potential use in the hatchery. Three species are under study - *Pseudodiaptomus annandalie*, *Navicula* sp. and the thraustochytrids found on fallen mangrove leaves.

For *P. annandalie*, production of eggs, nauplii and copepodite is highest at 24-27 ppt; abundance is greatest if fed *Chaetoceros calcitrans* maintained at 100,000 cells per ml; hatching is most efficient at lower salinities of 15-25 ppt.

Researchers have also established the 5-day scale-up production of *P. annandalie*, as follows: about 250 individuals per liter in 250-liter tanks, 600 per liter in 500 liter tanks, 1000 per liter in 1-ton tanks, 1500 per liter in 5-ton tanks, and 2000 per liter in 10-ton tanks.

For the local *Navicula* sp., researchers studied the effects of light intensity and

three fertilization schemes. Preliminary results show that cultures exposed to 1 light tube grow unpredictably regardless of fertilizer used. It seems best to culture *Navicula* indoors to avoid contamination.

SEAFDEC/AQD researchers have found that thraustochytrids populations are dominated by *Shizochytrium* spp. (>90%) and few *Thraustochytrium* spp. Two *Shizochytrium* isolates were identified as *S. magrovei* using pine pollen culture. Abundant thraustochytrids are found on the leaves of the mangroves *Avicennia lanata*, *A. officinalis*, *Xylocarpus granatum* and *Sonneratia* spp. collected from Ibajay (Aklan), Banate (Iloilo) and Dumaguít (Aklan). Axenic cultures are presently maintained in the laboratory for species identification and physiological screening with regards to growth and DHA production.



SEAFDEC/AQD's larval food laboratory (above).

Amount of natural food in larval tanks can be visually estimated (below). A light color usually indicates less food



On-farm trials and verification runs

Shrimp culture systems

SEAFDEC/AQD continues to find ways to increase shrimp farm productivity using environment-friendly techniques. In Aklan, multi-species cropping in ponds is being tested. One pond was stocked with small shrimp *Metapenaeus* spp., the second with tiger shrimp (*Penaeus monodon*) and milkfish, and the third with mudcrab. In another site, shrimp and mudcrab culture were likewise tested in coastal tidal flats with existing mangroves. These trials are in progress.

In Bacolod City, SEAFDEC/AQD assessed the use of probiotics as bio-manipulators in shrimp culture. The farm trial also included the use of sludge collector at the center of the pond; stocking of milkfish, tilapia and oysters in reservoir ponds to act as bio-filters; cleaning of pond bottom; and the use of a specially formulated, less polluting SEAFDEC feed. Results showed that after 157 days of culture, tiger shrimp attained an

Pond culture of other brackishwater species

The Dumangas Brackishwater Station is SEAFDEC/AQD's brackishwater pond facility where fish pond technologies are first demonstrated on commercial scale. Newly acquired, the facility is being rehabilitated for the trials in shrimp farming systems (as described above), the high-density culture of milkfish and grouper in ponds, and the polyculture of mudcrab, and milkfish.

Initial results in high-density milkfish culture – 2 fish per m² – are encouraging with an ABW of 143 grams after 98 days of culture with 90% survival of stock, and an FCR of 1.6 when fed with commercial pellets.

Grouper, on the other hand, did as well. Stocked at 1 piece per m², grouper attained an average body weight of 144 g after 120 days with 85% survival. In another pond, grouper attained 76g on average after 92 days with 90% survival. Grouper were fed tilapia fry and freshwater snails with trash fish given as supplemental feeds. Paddle wheels have been installed for additional aeration, and PVC pipes placed for shelter.

Polyculture of mudcrab with milkfish was also verified. Mudcrab were stocked at 0.5 per m² and after 118 days of culture, they weighed an average 250 g with 53% survival rate. Another species – the king crab – are stocked in three of the six newly constructed pens in the station's mangrove area, and are being fed freshwater snail. The study is still in progress.



The shrimp pond in SEAFDEC/AQD's brackishwater station in Dumangas, Iloilo

average body weight of 33g. The formulated feed worked well but its stability in ponds needs to be improved.

At SEAFDEC/AQD's Dumangas Brackishwater Station, an environment-friendly shrimp farming method is being developed. Reservoirs are stocked with bio-manipulators – in this case, tilapia and siganids – to provide green water in the shrimp ponds. Tilapia have been stocked at about 2 pieces per m² and siganids at 0.5 piece per m². After 70 days in the reservoir, tilapia attained an average 80g with 85% survival; siganids, 71g also with 85% survival. Inside the prawn pond, a sludge collector has been installed and 3,000 pieces of tilapia has been stocked to condition the pond water. About 130,000 shrimp fry were later added (stocking density of 20 per m²) and the level of luminous bacteria monitored. The trial is still in progress.

Seaweed culture

The trials on the longline and the hanging methods to culture the seaweed *Eucheuma* are in progress at SEAFDEC/AQD's Igang Marine Substation. The former seems to be a more successful method than the latter. About 25-30g of seaweed stock has been tied to 20m ropes at 25-30 cm intervals. Each rope has been tied to the side of cages which have grouper stock. A total of 20 long lines are being maintained.

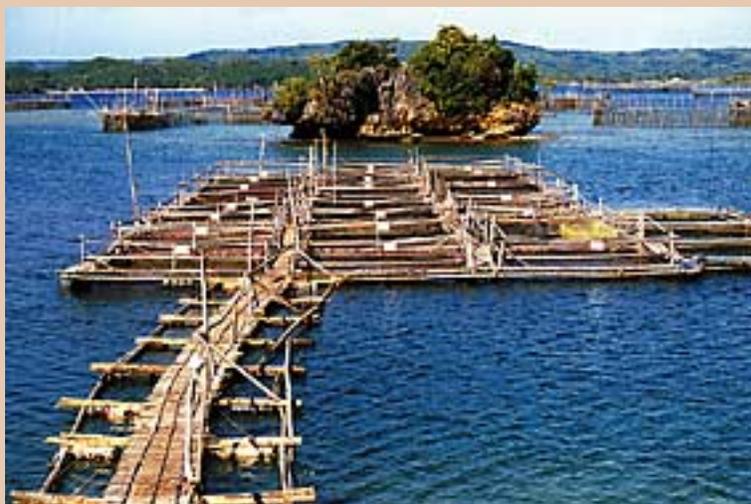
Seaweed and grouper culture in SEAFDEC/AQD's marine substation in Igang, Guimaras



Nursery and cage culture of marine and freshwater fishes

The nursery is an important phase in aquaculture as it increases the likelihood of a successful commercial run. For this year, SEAFDEC/AQD continues work on the nursery techniques for milkfish, tilapia, grouper, red snapper, crabs, siganids, scats or "kikiro," and the catfish native to the Philippines (*Clarias macrocephalus*). On the other hand, the cage culture of red snapper, grouper, siganids, scats and tilapia were also verified.

Produced at Igang Marine Substation around 380 pieces of small sized snappers (105g) and 80 pieces of big snappers (320g); a total of 336 kg of grouper weighing an average 435g each after 180 to 210 days of culture; and around 200 pieces of scats ("kikiro") weighing 120g after 110 days of culture. A stock of siganids – 30 pieces per m² – is being held in five cages.



Nursery cages for marine fishes at Igang



Broodstock development

In anticipation of the needs of private sector cooperators for snapper and grouper fry, SEAFDEC/AQD is maintaining several broodstocks. There are four of red snappers of sizes 2-5 kg, and another stock of size 300g. For grouper, there are 40 pieces of sizes 5-15 kg, and a new batch of undetermined ages. All these broodstocks are maintained in cages at Igang Marine Substation, and fed with trash fish at 5% of the total biomass every other day.

Multi-species hatchery

The emerging trend is of hatcheries that can be used for many aquatic species. SEAFDEC/AQD's multi-species hatchery at the Igang Marine Substation has already produced a total of 400,000 tiger shrimp fry during the preliminary runs. In addition, four larval rearing tanks (size, 10 tons) have been stocked with grouper and milkfish larvae at 10 larvae per liter. The hatchery's algal tanks has already produced natural food for the growing fish larvae.



High-ranking officials visit the broodstock cages at Igang: SEAFDEC Secretary General Panu Tavarutmaneeagul (leftmost) and SEAFDEC Council Director for the Philippines and DA Undersecretary for Fisheries Cesar Drilon (with glasses)

Research publications

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Collaborators

Research

- **Australian Center for International Agricultural Research (ACIAR)** – for research on the mudcrab *Scylla serrata* (development of broodstock diet and hatchery techniques) and the grouper *Epinephelus coioides* (development of practical diet for juveniles; determining the environmental factors affecting embryonic development, hatchery, and survival of early larval stages of grouper; tracking the development of larval digestive system)
- **European Union (EU)** – for research on the ecosystem approach to sustainable management of Laguna de Bay, the largest freshwater lake in the Philippines (effect of different nitrogen-phosphorus ratios on phytoplankton and their utilization by Nile tilapia; kinetics of dominant algal species in reply to different nutrient conditions) and the development of bioencapsulated feed based on nutritionally enriched nematodes for carp, catfish, grouper and milkfish larvae
- **Japan International Cooperation Agency (JICA)** for research on the culture of grass carp in cages in Laguna Lake
- **Department of Agriculture (Philippines)** for three projects – *Oplan Sagip-Sugpo* (shrimp task force) which aims to rehabilitate the shrimp culture industry; the *Accelerated Transfer of Milkfish Hatchery Technology* project which aims to intensify adoption of technology developed at AQD; and the *Community-based Coastal Resources Management* project which aims to achieve equitable, efficient and sustainable use of coastal resources
- **SEAFDEC Secretariat and SEAFDEC Departments** for two projects – *Management for Sustainable Coastal Fisheries in Southeast Asia* which involves an integrated, multi-disciplinary approach to resource management and the *Mangrove-Friendly Aquaculture Program* which aims to reduce the adverse impact of aquaculture on the mangrove resources. The latter has been endorsed for implementation under the SEAFDEC-ASEAN Fisheries Consultative Group collaborative mechanism

Mudcrab ◀ Page 14

NURSERY AND GROW-OUT

Trials on crab nursery are being conducted in 20 m² hapa nets installed in brackishwater ponds. SEAFDEC/AQD researchers are recommending a stocking density of 30 crab megalopae per m². Survival rate up to juvenile stage is nearly 60%.

A diet for nursery rearing is being developed. Initial results indicate that trash fish as protein source gives the best weight gain for crab megalopae reared in tanks for 9 days although a commercial shrimp feed gives the highest survival. Protein sources tested include fish meal, meat solubles, and processed soybean meal.

In another study, mudcrab juveniles stocked in 60 liter tanks were fed formulated diets for 6 months. It took crabs 92 to 170 days to molt 3 times. Final carapace length ranged 58-88 mm. Weights measured 30 days from each molting ranged 32-116 g. Analysis of crab flesh showed moisture content of 63-72%, protein of 84%, and crude fat of 34-43%. The exoskeleton had 19-22% calcium and 0.6-0.8% phosphorus.

Training and extension

- **FAO/UNDP** for training and extension of alternative livelihood options to Moro National Liberation Front regulars and rebel returnees in Mindanao
- **Research Institute of Marine Products of the Ministry of Fisheries (Vietnam)** for the training on mangrove-friendly aquaculture in Hal Phong, Vietnam. The training also received special funds from the Government of Japan and Canada-ASEAN Centre based in Singapore

Information

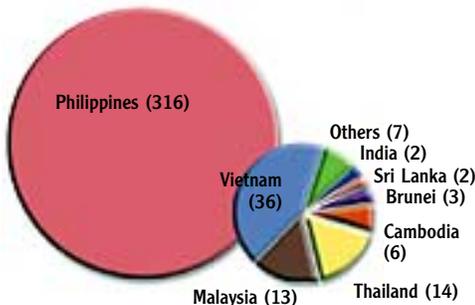
- **Various people's organizations**, the private sector, government and non-government organizations
- **SEAFDEC Secretariat** for the publication of the quarterly SEAFDEC Newsletter and the maintenance of the SEAFDEC website in the internet

Training Program

SEAFDEC/AQD continues to develop human resources for the region's aquaculture industry. It runs three kinds of training program: regular (classroom and laboratory type), special (tailor-made based on the need of requesting party), and individual (for fisheries students and new aquaculturists).

In 1999, over 450 industry, academic, government and non-government personnel were trained. Most were from the Philippines and Vietnam.

ATTENDANCE IN TRAINING PROGRAM, BY COUNTRY:



There are more practical sessions and laboratory work in AQD's regular training courses than classroom discussions



On-site training in Vietnam on mangrove-friendly aquaculture

Regular training course	Duration	Number of participants
Aquaculture management	March 16 to April 6	21
Management of sustainable aquafarming systems	May 4 to June 9	15
Fish health management	May 19 to June 24	16
Marine fish hatchery	June 15 to July 23	14
Freshwater aquaculture	August 17 to September 15	16
Fish nutrition	October 19 to November 24	18

Special training program	Duration	Number of participants
Seaweeds, grouper and marine cage farming ¹	March 10-13	28
On-site training on mangrove-friendly aquaculture (Vietnam) ²	April 19 to 30	25
Roundtable discussion on aquaculture and coastal resource management ³	February 23	38
Shrimp hatchery operation ⁴	April 5 to May 5	1
Grouper culture in cages and ponds ⁵	July 20 to 22	38
Seed production of native catfish ⁶	September 14 to 17	9
Turn-over ceremony on mangrove-friendly aquaculture project ⁷	February 28	47
Planning workshop on mangrove-friendly aquaculture and coastal resource management project ⁷	November 25	37
Sustainable aquaculture and coastal resource management ⁸	October 25 to 29	30
Mollusc health management ⁹	November 29 to December 3	16
Forum on culture and post-harvest management of <i>Kappaphycus</i> ¹⁰	December 17	30

Individual training program	Number of participants
On-the-job or practicum	38
Internship	26

¹ In collaboration with FAO-UNDP for MNLF rebel returnees in southern Philippines

² In collaboration with Vietnam's Research Institute of Marine Products, Ministry of Fisheries; venue was Hai Phong City, Vietnam. Funded by the Government of Japan and ASEAN-Canada Fund

³ With the local government units and people of two of Aklan's towns

⁴ Specialized course for an Indian national working for a hatchery at Chennai, India

⁵ In collaboration with LandBank of the Philippines; venue was Bohol

⁶ In collaboration with the provincial government of Iloilo in reseeding Iloilo with native catfish

⁷ The project is a collaboration with the local governments of Ibayay and Tangalan, Aklan

⁸ In collaboration with the local governments of the first district of Iloilo and Guimaras

⁹ AQD hosted the first phase of the training as part of the Regional Molluscan Health Management Program initiated by FAO and NACA in collaboration with NIWA of New Zealand, DFO Canada, and IFREMER of France

¹⁰ Conducted for fishers from Ajuy, Iloilo belonging to the Binangon-an Upac Nabaye Fisherfolk Association

Information dissemination

Activities in 1999 continue to focus on producing extension materials, maintaining the SEAFDEC/AQD website in the internet, instituting an aquaculture news service, and maintaining an aquaculture library.

Extension materials production

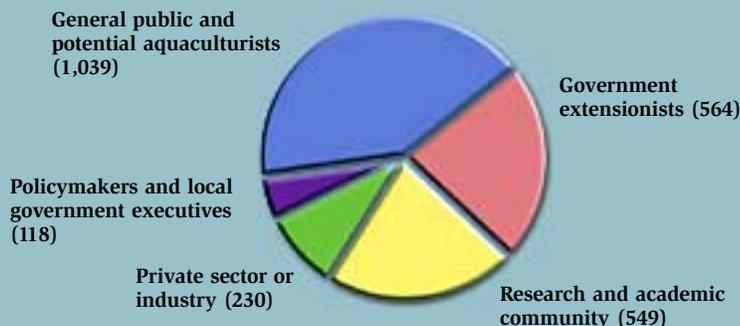


SEAFDEC Asian Aquaculture, the bimonthly newsletter on aquaculture technologies:

ISSUE	SPECIAL FEATURE
Vol. xx No. 6	The Malalison story
Vol. xxi No. 1	Grouper culture and mangrove-friendly aquaculture
No. 2	Marine ornamental fishes
No. 3	Milkfish culture
No. 4	Giant tiger shrimp
No. 5	Bighead carp and ADSEA '99

Around 2,500 copies of the newsletter are circulated every two months. There were 105 new paying subscribers in 1999.

NEWSLETTER READERSHIP



The modular method: milkfish pond culture, an 18-page manual that describes a better way of raising milkfish in brackishwater ponds



Pen culture of mudcrab in mangroves, a 10-page manual that details the operation of net enclosures in mangroves for mudcrab culture



Mudcrab, a 32-page manual that gives a general overview of mudcrab species of commercial value and their grow-out monoculture in ponds; polyculture with milkfish; and fattening in ponds, mangroves, and cages



Mudcrab *Scylla* spp. production in brackish-water ponds, a 14-page manual that covers the specifics of grow-out operation, including costs-and-benefits analysis and a list of useful references



Ecology and farming of milkfish, a 117 page monograph that discusses the life history and ecology and various aspects of the farming industry in the Philippines



Promoting appropriate aquaculture technology for more fish in Southeast Asia, a 24-page report that discusses the commercial trial runs of SEAFDEC/AQD-developed technologies on (1) milkfish hatchery, pond culture using hatchery-raised fry, and polyculture of milkfish and seaweeds; (2) the use of environment-friendly schemes in tiger shrimp culture; (3) mudcrab culture in ponds and net enclosures in mangroves; (4) cage culture of hybrid tilapia; (5) catfish

hatchery technology; and (6) oyster and mussel culture in rafts



1998 Highlights, a 31-page report of SEAFDEC/AQD's research and development activities for 1998

Milkfish breeding and hatchery fry production, a reprint of the 2-page flyer that summarizes the integrated milkfish broodstock and hatchery operation technology developed by AQD



Milkfish breeding and hatchery technology at SEAFDEC/AQD, a 2-page flyer that describes the techniques already adopted by the private sector: broodstock management and artificial diet, commercial fry production, live transport, and larval diet



The commercialization of SEAFDEC/AQD's milkfish fry production technology, a 2-page flyer that illustrates AQD's newest hatchery facility – the Integrated Fish Broodstock and Hatchery Demonstration – and the extension program that go with it – Accelerated Transfer of Milkfish Fry Production Technology



Mudcrab culture, a 2-page flyer that summarizes the available technologies on mudcrab grow-out – monoculture in ponds and in tidal flats with existing mangroves, polyculture with milkfish in ponds, and mudcrab fattening



Seed production of native catfish *Clarias macrocephalus*, a 2-page flyer that describes SEAFDEC/AQD's work on artificially propagating the catfish



The farming of *Kappaphycus*, a 2-page flyer that introduces the red seaweed with notes on the types of culture systems, the environmental factors required, initial investment needed, and crop management



Binangonan Freshwater Station, a 2-page flyer on SEAFDEC/AQD's R&D on freshwater aquaculture and lake ecology, primarily for Laguna de Bay

Reaching out through technology verification and extension, a 2-page flyer that presents the efforts of SEAFDEC/AQD to fast-track commercialization of aquaculture technologies developed



Aquaculture training program, a 20-page brochure that introduces SEAFDEC/AQD's short-term regular courses



Training module on sustainable aquaculture and coastal resource management, a 2-page flyer that describes the new SEAFDEC/AQD training course, including course content, qualification of participants, and enrollment process



Grouper cage culture, a 16-minute video documentary describing site selection, cage construction and grow-out culture

A CFRM experience: the Malalison story, a 30-minute video documentary that shows the processes and lessons gained in SEAFDEC/AQD's 7-year project in Antique

Milkfish hatchery operations, a 12-minute video describing SEAFDEC/AQD's recommended mode of operations for a milkfish hatchery

Ang palaabuton sang kapagangan, a 12-minute video documentary on coral reefs

Three news feature shorties on the FAO-UNDP and SEAFDEC/AQD training for MNLF rebel returnees, the LandBank-AQD training in Bohol, and the ADSEA gathering in October

The year that was, a 7-minute video that described 1999 in terms of AQD's major activities



Booklaunching ceremonies: the first in July for three of AQD's manuals, and the second in November for the monograph on milkfish. Three authors helped Dr. Platon distribute the first copies (top); milkfish author signs complimentary copies (bottom)

Coverage in the mass media and the internet

SEAFDEC/AQD appeared in about 255 articles in national daily newspapers (27%), local sheets (56%), and specialized publications (16%) in the Philippines. The increase in AQD coverage and interest by the mass media may be attributed to the aquaculture news service instituted during the year.

AQD continues to maintain a website in the internet (www.seafdec.org.ph) whose server is in Iloilo. AQD activities can also be accessed through the SEAFDEC main website www.seafdec.org maintained by the SEAFDEC Secretariat in Bangkok.



A booth in one of the 5 fairs attended by AQD. Ten of AQD's researchers were also sent to lecture on various topics around the Philippines upon the invitation of local governments and other institutions



A textbook writing workshop was held by SEAFDEC/AQD on November 4 to 5, and attended by 45 AQD senior staff involved in the proposed aquaculture textbook project



SEAFDEC's Deputy Secretary-General Mr. Shogo Sugiura visited SEAFDEC in summer (right) while Dr. Platon, DA Undersecretary Mr. Cesar Drilon, and SEAFDEC Secretary-General Panu Tavarutmaneeagul faced the Iloilo media during a press briefing in July (above). Around 10,500 other dignitaries, fishfarmers, teachers, and students visited AQD in 1999



Dr. Herminio Rabanal (above, on the right), foremost Filipino scientist and aquaculture expert, donated his personal collection of nearly 5,000 materials to SEAFDEC/AQD, including rare titles like the 1900 *Manual on Fish Culture*, the 1929 *Contributions to the Biology of the Philippine Archipelago and Adjacent Regions*, and the 1939 *Fish Fry Industry of the Philippines*

Forget the old stuffy image of a library. The AQD Library (left) has become a dynamic place where information can be accessed faster and more comprehensively through the use of computer databases and the internet

Library services

SEAFDEC/AQD's present library collection includes 14,848 monographic volumes; 7,791 pamphlets; 3,159 SEAFDEC publications; and 4,657 bound journal volumes. The Library served an average of 7 readers per hour in 1999, and replied to 148 queries for materials on milkfish, shrimp, seabass, seaweeds, siganids, crabs, among others. It also served 191 requests for online searching of databases like ASFA, Fish & Fisheries Worldwide, and Life Sciences on CD-Rom.

Celebrations

SEAFDEC/AQD welcomed the new SEAFDEC Secretary-General Panu Tavarutmaneegul during its 26th anniversary celebration in Tigbauan, Iloilo. Mr. Panu expressed his appreciation for the Philippine government's support of SEAFDEC.

AQD also celebrated the 1st anniversary of the Dumangas Brackishwater Station. Dr. Platon gave thanks to the fishfarmers who are AQD collaborators in its technology transfer and commercialization program, calling them AQD's partners and external infrastructure.

The third celebration was the 23rd anniversary of the Binangonan Freshwater Station where bighead carp was given much publicity through a foodfest to generate interest in carp culture and marketing. AQD has developed broodstock and hatchery technology for bighead carp.

Top: Dr. Platon and, to his left, Deputy Secretary-General Masao Shimomura, Secretary-General Panu Tavarutmaneegul and SEAFDEC Council Director for the Philippines Cesar Drilon

Right: Mayor Rolando Distura of Dumangas, Iloilo receives a certificate of appreciation from SEAFDEC

Below: The "karpistahan" during AQD's celebration of 23 years of freshwater aquaculture research



Facilities & infrastructure

The biotechnology laboratory – formally known as the Laboratory for Advanced Aquaculture Technologies – is being set-up.

On the other hand, the construction of FishWorld – the small eco-park dedicated to the environment education of the general public – is nearly complete. Visitors will walk through a large permanent ecosystems exhibit that will show the interrelations and interdependence of land and water ecosystems. FishWorld will also feature an Aquaculture Hall with major types of aquaculture systems and methods shown.



The beginnings of a biotechnology laboratory

The nearly completed FishWorld (below, right)



Personnel & management

As of 31 December 1999 the total number of AQD permanent staff totalled 314 with 143 in Research, 35 in Training and Information, 93 in Administration, 21 in Finance, and 22 in the Office of the Chief.



Rolando Platon, PhD
DEPARTMENT CHIEF



Susumu Ito
DEPUTY CHIEF



Clarissa Marte, PhD
RESEARCH HEAD



Renato Agbayani
TRAINING &
INFORMATION HEAD



Dan Baliao
ADMINISTRATION &
FINANCE HEAD

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in the region. Its member countries are Japan, Malaysia, the Philippines, Singapore, Thailand, and recently, Brunei Darussalam and the Socialist Republic of Vietnam.

Representing the member countries is the Council of Directors, the policy-making body of seafdec. The chief administrator of seafdec is the Secretary-General whose office, the Secretariat, is based in Bangkok, Thailand.

Created to develop fishery potentials in the region in response to the global food crises, seafdec undertakes research on appropriate fishery technologies, trains fisheries and aquaculture technicians, and disseminates fisheries and aquaculture information. Four departments were established to pursue the objectives of seafdec.

- The Training Department (TD) in Samut Prakan, Thailand, established in 1967 for marine capture fisheries training
- The Marine Fisheries Research Department (MFRD) in Singapore, established in 1967 for fishery post-harvest technology
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines, established in July 1973 for aquaculture research and development
- The Marine Fishery Resources Development and Management Department (mfrdmd) in Kuala Terengganu, Malaysia, established in 1992 for the development and management of the marine fishery resources in the exclusive economic zones (EEZs) of seafdec Member-Countries.

SEAFDEC /AQD is mandated to:

- promote and undertake aquaculture research that is relevant and appropriate for the region
- develop human resources for the region
- disseminate and exchange information on aquaculture



Tigbauan Main Station



Igang Marine Substation



Binangonan Freshwater Station



Dumangas Brackishwater Facility

SEAFDEC SECRETARIAT

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<http://www.asean.fishnet.gov.sg/mfrd1.html>

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