

# SEAFDEC Asian Aquaculture



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**Agrikulturang**



**MakaMASA**

Makapagpabagong Programa Tungo sa Masagana  
at Maunlad na Agrikultura at Pangisdaan



A publication of the Aquaculture Department of the Southeast Asian Fisheries Development Center

Volume XXI Number 1 February 1999

ISSN 0115-4974

## Our cover

PHOTO BY R BUENDIA

A harvest of about 1 ton of 400 g grouper in a 0.25 ha pond area. The owner, also AQD's cooperater, sold the harvest at P 300 per kg live. The farm is situated in Bacolod City.

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in Southeast Asia. Its Member-Countries are Japan, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, and the Socialist Republic of Viet Nam.

Four departments were established in the Member-Countries; the Aquaculture Department (AQD) located in the Philippines pursues aquaculture research and development.

This newsletter **SEAFDEC Asian Aquaculture (SAA)** reports on sustainable aquaculture. It is intended for fishfarmers, aquaculturists, extensionists, policymakers, researchers, and the general public. **SAA** is published six times a year by SEAFDEC/AQD.

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### Contributions

We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs and line drawings must be camera-ready, glossy B&W prints or colored slides. Cut-off date for contributions is every 1st of January, March, May, July, September, or November.

### Gifts and exchanges

Publication exchanges with **SAA** are encouraged. AQD has publications exchange agreements with 800 institutions worldwide.

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Subscription per year (six issues): P300 (local surface mail), US\$ 40 (foreign air mail). Please make remittances in postal money order, bank draft, or demand draft payable to SEAFDEC/AQD. For inquiries about **SAA** subscription and other AQD books and videos, e-mail: [sales@aqd.seafdec.org.ph](mailto:sales@aqd.seafdec.org.ph)

**Nota bene** Mention of trade names in this publication is not an endorsement.



SEAFDEC Aquaculture Department supports the Philippine government's **Agrikulturang MakaMASA** program. This is the banner program of the Estrada Administration for agricultural development and a transitional blueprint for putting the Agriculture and Fisheries Modernization Act (AFMA) to work.

The goals of the program for the fisheries sector are three-fold: (1) sustainable development and management of fisheries resources through food security; (2) socio-economic upliftment of subsistence fisherfolk; and (3) fisherfolk empowerment.

The components are as follows:

- **fisheries production** - increase aquaculture production within ecological limits through technical assistance / extension services, dissemination of appropriate technologies, and improvement / rehabilitation of fishfarms
- **conservation and management** - conduct integrated resource management / rehabilitation and strict implementation of fisheries laws
- **fisheries training and extension services** - provide these services and technical assistance to local government units to ensure that results of scientific studies reach fisherfolk
- **fisheries information and marketing support** - establish an information network and conduct public information and education activities to give fisherfolk access to information on trade / marketing, fisheries laws and technologies

- **research and development in fisheries** - generate or improve appropriate technologies to respond to fisherfolk's need and enhance competitiveness of (the Filipinos') products in the global market
- **fisheries infrastructure** - establish / improve fishports, ice plants, cold-storage, and other post-harvest and marketing support facilities to reduce post-harvest losses
- **rural finance for fisheries**
- **program organization and management for the fisheries sector**

The key institutions involved are: Bureau of Fisheries and Aquatic Resources, Philippine Fisheries Development Authority, SEAFDEC, Fisheries Resource Mgt Proj, Bureau of Agricultural Research, Bureau of Statistics, Fisheries and Aquatic Resource Management Councils, local governments, state universities and colleges, and research institutions.

# Aquaculture Department NEWS

## AQD dialogues with local governments

By **NJ Dagoon**

A dialogue with Aklan local government officials took place last February 23, 1999 at the DENR Training Center in Jawili, Tangalan, Aklan. This paved the way for SEAFDEC / AQD's 3-year (1999-2001) research and development project on Sustainable Aquaculture and Coastal Resource Management (SACRM) in the coastal towns of Tangalan and Ibajay.

AQD Chief Dr. Rolando Platon explained that the dialogue was to make everyone understand the kind of technology the Department extends to end users.

Activities that have already started at the Bugtong Bato, Ibajay site are on mangrove-friendly aquaculture (silvofisheries) — mud crab culture in both ponds and pens within a mangrove area, and searanching with abalone stocked at the nearby fish sanctuary. The latter is to enhance the growth of naturally occurring populations in the area. An identified forthcoming project is grouper culture in floating cages in Dapdap, Tangalan.

AQD Training and Information Division Head Mr. Renato Agbayani stated the project's objective as the attainment of aquaculture development within the context of integrated coastal



*Ibajay Mayor Pedro Garcia (standing) pledges his full support to community-based resource management. Behind him are (from left) Tangalan Mayor Jed Tirol, AQD Chief Dr. Platon, Assistant to the Aklan Governor Mr. Levi Lahaylahay, and AQD's Renato Agbayani*



## High-ranking DA official visits Igang substation



Department of Agriculture Undersecretary for Fisheries Cesar Drilon (center) watches seabass as they feed at AQD's Igang Marine Substation. He visited the substation on January 20. With him is AQD Chief Dr. Rolando Platon (right). The substation, while serving as research site for broodstock of milkfish, seabass, groupers and snappers in cages, also demonstrates low-cost cage farming of various fishes appropriate for coastal communities specifically to address problems of poverty alleviation and food security.

resource management. He said that three developmental strategies are to be used: community based, co-management, and participatory.

Research Head Dr. Clarissa Marte presented preliminary site survey results, particularly on coral reef cover and number of fish species found in the area of the fringing and patch reefs (Pungtod, Tigpuyo, Pangayawan). According to her, there were evidences of coral bleaching, blasting and overfishing. Most areas in the fringing reef had poor live coral cover (averaging 50%), mainly, soft coral (*karne-karne*) which do not contribute very well to reef building. Estimated yields for fish were low (1-6 tons per km<sup>2</sup>).

Other research team members and their topical assessments included: Dr. Jurgenne Primavera, mangroves; Dr. Anicia Hurtado, seaweeds and seagrasses; and Ms. Lilian de la Peña, socio-economics.

Survey data conveyed the need for CRM interventions.

Ibajay and Tangalan municipality and barangay officials agreed to form a joint resource management council. Aklan local government officials who figured prominently in the dia-

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## AQD beefs up its stock of captive milkfish breeders

By **M Castaños**

AQD has been breeding the milkfish in captivity for two decades now. And, given the milkfish industry's fry requirements -- projected at more than a billion fry by the next millennium -- AQD decided to beef up its stock of captive milkfish breeders (*sabalo*). The eggs or fry from these *sabalo* are used in AQD's research, technology verification, and techno-transfer programs.

Around 100 *sabalo* were acquired from San Miguel Foods, Inc (SMFI) on three separate occasions early this year. "The *sabalo* are 4-13 years old, weighing 2 to 7 kg," says Dr. Arnil Emata, AQD's milkfish expert who supervised the transport. "The breeders are part of the broodstock developed by SMFI at their



A San Miguel employee holds one of the milkfish breeders raised in ponds



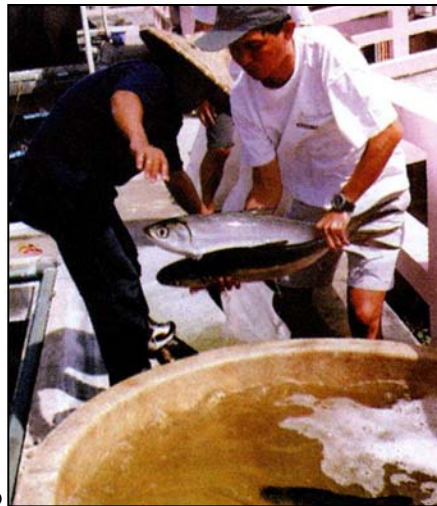
A



B



C



D

former aquaculture station in Calatrava, Negros Occidental. The broodstock has been temporarily held in a 0.5 ha pond in Bago City."

The transport to AQD took 6-7 hours (see photos). Survival rate was 97%, and the fish commenced feeding two days after transport, Dr. Emata noted. At AQD, the *sabalo* were stocked at the Integrated Broodstock and Hatchery Demonstration Complex.

The complex has two broodstock tanks sized 10 × 10 × 2 meters deep. It has a previous stock of 40 females and 60 males that spawned 88 times in 1998. A total of 97 million eggs was produced in 1998.

The demonstration complex is meant to showcase AQD's fish breeding and hatchery technologies, and demonstrate to fishfarmers the commercial viability of such technologies.

Presently, AQD has two technology transfer programs on milkfish. The first — *Accelerated Transfer of Hatchery Technology* -- is intended to encourage backyard shrimp hatchery operators to diversify into milkfish fry production. This is carried out by training the hatchery operators at AQD; after which, they are given milkfish eggs to rear in their respective hatcheries. The cooperators sell the fry they produce while AQD researchers collect the production data.

The cooperators include the hatchery of Luis Rojas in Batan, Aklan; the hatch-

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E

**Transport of *sabalo*:** In Bago City, AQD's milkfish researcher Dr. Arnil Emata first weighed the breeders (A) before placing them in oxygenated plastic bags containing chilled water and anesthetic (B). The bags were packed in styrofoam boxes with ice, loaded onto the Bacolod-Iloilo ferry (C), then transported overland to AQD's 200-ton concrete tanks in Tigbauan. At AQD, the milkfish were allowed to recover in fiberglass tanks (D) before stocking (E)

PHOTOS BY R BUENDIA



# A2D Research Publications

Reprints of papers listed here may be requested from AQD authors.

Compiled by **DATABANK / AQD LIBRARY**

**Alava VR.** 1998. Effect of salinity, dietary lipid source and level on growth of milkfish (*Chanos chanos*) fry. *Aquaculture* 167 (3-4): 229-236

*Abstract.* Six semi-purified micro-particulate diets containing coconut oil (CO), cod liver oil (CLO), and their 1:1 combination (CO + CLO) at 9% and 18% levels were fed to milkfish fry or late postlarvae in freshwater (0 parts per thousand), brackishwater (16 ppt), and seawater (34 ppt) for 30 days. A three-factor factorial design ( $3 \times 2 \times 3$ ) with three replicates per treatment was followed. Sixty-five milkfish fry (5 mg, 6 mm) were stocked per 15-l rectangular glass aquarium and fed with the experimental diets at 20% of biomass daily. Water temperature was  $28 \pm 1^\circ\text{C}$  during the culture period. Survival was not affected by water salinity, and lipid source or level. Among the 18 treatments, freshwater-reared milkfish fry fed with 9% CO + CLO had the highest specific growth rate, but this was not significantly different from those of freshwater-reared fish fed with 9-18% CO and 9% CLO diets or brackishwater-reared fish fed with 9% CO diet ( $p > 0.05$ ). As a main factor, salinity or dietary lipid level, but not lipid source, had significant effects on growth and feed conversion ratio of milkfish fry. Highest growth was observed in fish reared in freshwater and as salinity was increased, growth decreased ( $p < 0.05$ ). Overall, the 9% lipid diets promoted better growth than the 18% lipid diets ( $p < 0.05$ ). Except for the significant interaction between dietary lipid source and level indicating that milkfish fry fed with the 18% CLO was the shortest ( $p < 0.05$ ), no other significant effects of the two- or three-factor interactions were found.

**de Jesus EG, Toledo JD, Simpas MS.** 1998. Thyroid hormone promote early metamorphosis in grouper (*Epinephelus coioides*) larvae. *General and Comparative Endocrinology* 112: 10-16

*Abstract.* The response of grouper larvae to thyroid hormones, thyroxine (T<sub>4</sub>) and triiodothyronine (T<sub>3</sub>), was examined. Two-, 3-, and 4-week old grouper larvae were reared in seawater containing either T<sub>4</sub> or T<sub>3</sub> at 0.01, 0.1 and 1 ppm. T<sub>4</sub> or T<sub>3</sub> induced metamorphosis in all age groups in a dose-dependent manner. Regardless of size of the larvae, metamorphosis was completed in 2 days in larvae treated with 1 ppm of either T<sub>4</sub> or T<sub>3</sub>; 3-4 days in larvae exposed to 0.1 ppm; and 5-6 days in larvae immersed in 0.01 ppm. None of the fish in the control group completed metamorphosis during this period. Compared with control fish, survival rates were higher in groups exposed to 0.01 ppm and lower in those exposed to 1 ppm of T<sub>3</sub>. In 4-week old larvae, T<sub>4</sub> treatment (0.01 to 1.0 ppm) resulted in higher survival compared to the control. These results suggest that a dose of 0.01 ppm is appropriate for acceleration of metamorphosis and improvement of survival in 3- and 4-week old grouper larvae. A lower dose may be appropriate for earlier stages.

**Eusebio PS, Coloso RM.** 1998. Evaluation of leguminous seed meals and leaf meals as plant protein sources in diets for juvenile *penaeus indicus*. *Israeli Journal of Aquaculture-Bamidgeh* 50 (2): 47-54

*Abstract.* The potential of locally available legumes (white cowpea, *Vigna*

*unguiculata*, and green mungbean, *Vigna radiata*) and leaf meals (papaya, *Carica papaya*, and cassava, *Manihot esculenta*) in combination with defatted soybean meal as protein sources was evaluated in juvenile *Penaeus indicus*. The feedstuffs were included in practical diets for *P. indicus*, replacing 9% of the protein in the basal diet. Juvenile *P. indicus* (mean initial weight  $0.08 \pm 0.01$  g) were fed the practical diets for 61 days. Shrimp fed the control diet had the highest weight gain and specific growth rate, which did not significantly differ ( $p > 0.05$ ) from those of shrimp fed white cowpea meal, papaya leaf meal and cassava leaf meal. Survival of the control shrimp was significantly higher ( $p < 0.05$ ) than that of shrimp fed cassava and papaya leaf meals but comparable to that of shrimp fed white cowpea meal. The growth of shrimp given green mungbean meal was comparable to that of shrimp fed papaya leaf meal, however the shrimp fed mungbean meal had the lowest survival. The apparent protein digestibility (APD) of white cowpea meal (87%) was significantly higher ( $p < 0.05$ ) than that of the control (82%) and cassava leaf meal (77%) based diets. However, the APD of the white cowpea meal based diet was comparable to those of the papaya leaf meal and green mungbean meal based diets. Results suggest that, besides digestibility, other factors such as the amino acid balance of the diet and the amount of anti-nutritional factors may influence the growth and survival of *P. indicus*.

**Lavilla Pitogo CR, dela Peña LD.** 1998. Bacterial diseases in shrimp (*Penaeus*

 next page

**Note:** Abstracts from journals covered by *Current Contents* are downloaded from the CD-Rom version (Agriculture, Biology & Environmental Sciences; 22 December 1997 - 14 December 1998). 1998. Institute for Scientific Information, Pennsylvania, USA.

*monodon*) culture in the Philippines. Fish Pathology 33 (4): 405-411

**Abstract.** The hatchery system for *Penaeus monodon* evolved from the Japanese community culture system to the modified Galveston method and this shift in culture technique triggered the outbreak of diseases due to opportunistic bacteria. Whereas, sporadic infestation with filamentous bacteria and shell disease were the main bacterial diseases seen in earlier larval culture systems, hatcheries using the modified Galveston method experienced disease outbreaks due to systemic bacterial infection. Although several types of vibrios have been implicated in the epizootics, the dominant species seen were non-sucrose-fermenting vibrios, mainly luminescent *Vibrio harveyi*.

To understand the course of infection, the entry of bacteria in the hatchery was investigated by determining the components and additives which encouraged their growth and dominance. As a result, several approaches to prevent and control bacterial disease have been implemented such as water treatment, hygienic spawning and egg handling, maintaining ecological balance within the system, and chemotherapy.

In shrimp grow-out culture, early reports of bacterial problems were limited to shell disease, filamentous bacterial infestation and tail rot. In the last quarter of 1993, however, mass mortality associated with massive bacterial infection in the digestive organ of shrimp started occurring and contributed largely to the collapse of shrimp grow-out activities. An epidemiological study was conducted to understand the spread of infection. Several approaches to prevent or control the problem have been attempted such as the use of reservoirs, water treatment, chemotherapy, maintaining ecological balance within the system through the application of probiotics, and other system modifications.

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Mharzi A, Tackx M, Daro MH, Kesaulia I, Caturao R, Podoor N. 1998. Winter dis-

tribution of phytoplankton and zooplankton around some sandbanks of the Belgian coastal zone. Journal of Plankton Research 20 (11): 2031 - 2052

**Abstract.** The distribution of phytoplankton and zooplankton around three sandbanks (Gootebank, Westhinder and Buitenratel sandbank) off the Belgian Coast was investigated in February 1994. The abundance of phytoplankton taxa was significantly different between the sandbanks. Community analysis using TWINSPLAN resulted in a clear separation of clusters corresponding to the different sandbanks. The zooplankton community analysis, on the contrary, showed a rather indistinctive division of the sandbank stations. This was due to the omnipresence of three dominant copepod species (*Temora longicornis*, *Pseudocalanus elongatus* and *Centropages hamatus*). When these species were excluded from the analysis, a clearer distinction between the different sandbanks was found. The observed differences in phyto- and zooplankton species distribution could be explained by the position of the sandbanks. Westhinder is positioned further from the coast than Buitenratel, while Gootebank has an intermediate position. Buitenratel and Gootebank harbour typical coastal plankton communities, while the plankton community over Westhinder is clearly influenced by the Atlantic current penetrating the southern North Sea from the English Channel. More phyto-benthic species were found at Buitenratel than at Gootebank, probably because of its limited depth. Thus, the Belgian coastal zone, which is considered as one box in most spatial descriptions of the North Sea plankton, in fact harbours heterogeneous plankton communities at the end of winter.

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**Bagarinao T.** 1998. Historical and current trends in milkfish farming in the Philippines. In: SS de Silva (ed). Tropical Mariculture. Academic Press, San Diego-London-Boston-New York. 487 pp.

Fish, fishing and fish farming are very important to the diet, culture and economy of the people of the Philippines. The milkfish *Chanos chanos* (Forsskal) is so much a part of the way of life that it is the official national fish, as every school child is taught. Milkfish farming started about four centuries ago in the Philippines, the technology apparently having spread from Indonesia. Today, milkfish aquaculture in the Philippines is at a crossroad. Milkfish production has fluctuated sharply between 150 and 250 thousand tonnes, but on average has relatively stagnated over the past decade, partly due to the shrimp boom and the low price of milkfish. But now there is pressure to return to and intensify milkfish farming. Many shrimp farmers want to recoup losses by going back to milkfish and growing it for the export market. But more significant is the rapidly expanding domestic market. The population of the Philippines is already 70 million in 1996, up from 37 million in 1970, and now requires about 3.1 million tonnes of fish. Some 2.74 million tonnes were produced in 1995, but more than 0.5 million tonnes were seaweeds (not eaten), oysters and mussels (mostly shell weight), and snails fit only for duck food. A concerted effort must be made to reduce the large deficit in the fish supply. Milkfish has been, and will continue to be, an important part of the fish supply in the Philippines.

Large investments have been made in the Philippines (as well as in Indonesia, Taiwan and Hawaii) in terms of infrastructure, credit and research in support of the milkfish industry. In the 1970s, various assessments of the industry (e.g. Chong *et al.*, 1982, 1984) identified research, technology transfer and information dissemination as important keys to increased productivity. The SEAFDEC Aquaculture Department, in particular, was established in Iloilo, Philippines in 1973 to find solutions to industry problems through research, training and information dissemination. Government agencies and other fisheries and agricultural institutions were also fielded in the national

## Mangrove-friendly aquaculture workshop

REVIEW PAPERS, COUNTRY PRESENTATIONS  
EXPERIENCE PAPERS FROM SEAFDEC, DISCUSSIONS  
WORKSHOP RECOMMENDATIONS



**THINK TANK FOR SEAFDEC / AQD's MANGROVE-FRIENDLY AQUACULTURE PROGRAM** (from left): **Cesar Drilon**, Agriculture Undersecretary for Fisheries and Legislative Affairs and SEAFDEC Council Director for the Philippines; **Dr. Rolando Platon**, SEAFDEC/AQD Chief; **Udom Bhatiyasevi**, SEAFDEC Secretary-General; **Yasuho Tadokoro**, SEAFDEC/AQD Deputy Chief; and **Dr. Jurgenne Primavera**, mangrove expert and AQD Senior Scientist

Aquaculturists, scientists, environmentalists, and other fishery experts from Southeast Asia and other regions of the world gathered in Iloilo to discuss and map out strategies to counter the threat to the aquaculture industry in the region. A workshop on mangrove-friendly aquaculture was held January 11-15, 1999 at Days Hotel, Iloilo City.

The workshop was the initial activity of the project conceived by the SEAFDEC Council in Bangkok, Thailand. The Council recommended that studies on mangrove conservation be conducted with the Aquaculture Department in Tigbauan, Iloilo as the lead agency.

Acknowledging that there is a loss of 30 to 80% of mangrove cover in Southeast Asia in the last three decades in part due to

the rapid development of aquaculture, the workshop would pave the way for the implementation by AQD of a five-year mangrove-friendly aquaculture program.

The program's goal is to formulate a Code of Conduct for responsible mangrove-friendly aquaculture, which will in turn form part of the Southeast Asian Code of Conduct for responsible aquaculture development.

The workshop assessed the status of aquaculture activities in mangrove areas; identified the problem areas related to aquaculture in mangrove activities; discussed practical technologies on sustainable aquaculture in mangrove areas; and formulated strategies and recommendations for the development of sustainable aquaculture in the mangrove areas.

The mangrove project would address the problems that threaten the industry as militance of some global environmental groups grows. A couple of years ago, it lobbied for an embargo of trawled shrimp that were not using the turtle-excluder device (TED).

The embargo caused millions of dollars in losses among shrimp exporting countries to the United States including the Philippines. The SEAFDEC Council fears that this militant group may also target other aquaculture commodities raised in former mangrove areas.

The workshop was attended by about a hundred participants and observers from the region and the world.

## THE MANGROVES OF SOUTHEAST ASIA

Excerpts of the review paper presented by Dr. JH Primavera, SEAFDEC Aquaculture Department

Southeast Asia has more than a quarter of the world's 18 million hectares of mangroves, and it leads in brackishwater aquaculture production. It is precisely because of its recent aquaculture activities, specifically shrimp farming, that these mangroves are at risk. The phenomenal shrimp production rates coincide with equally high rates of mangrove loss, from 25% in Malaysia, to 50% in Thailand, over the last three decades.

A positive correlation between mangrove area and fish / shrimp landings has been documented for the Philippines, Malaysia, and Indonesia. The mangrove-fisheries correlation has been attributed to (a) trophic subsidy of dissolved and particulate materials from mangroves to nearshore communities, and (b) mangrove nurseries providing food and/or protection to juve-

niles of commercially important fish and crustacean species.

Conventional analysis generally covers only marketed goods and ignores nontraded items because of its subsistence level of use or the difficulty in monetizing regulatory functions, hence, the low values assigned to mangroves. Yet, when complete systems are considered, considerably higher values of US\$1,000-11,000 per ha per year place mangroves at par with profits from intensive shrimp culture.

Mangrove development and conservation should be promoted in the context of coastal zone management that integrates the multiple uses of the coastline (fisheries, aquaculture, forestry, navigation) and that is community-based in cognizance of the fact that fishers are the *de facto* managers of the coastal zone. Mangroves may

be zoned into (a) protective forests - for preservation and conservation, (b) productive forests - for sustained yield, and (c) development zone - for conversion to aquaculture, salt beds, etc, but retaining greenbelts or buffers along shorelines and riverbanks.

Degraded areas should be rehabilitated or replanted. Mangrove-friendly aquaculture integrates forestry and aquaculture uses of the mangrove ecosystem. Such activities are undertaken in the waterways (mariculture of bivalves, seaweeds, fish cages) or pens / ponds for crabs, shrimp, and fish in the intertidal forest. Pond variations of the latter include the traditional *gei wai* of Hong Kong, *tumpang sari*, *empang parit* or silvofisheries in Indonesia, mangrove-shrimp ponds in Vietnam, and aquasilviculture in the Philippines.

## SILVOFISHERY -- AN AQUACULTURE SYSTEM HARMONIZED WITH THE ENVIRONMENT

Excerpts of the review paper presented by Prof. Fumio Takashima, Tokyo University of Fisheries

Reforestation of mangroves has been carried out in some tropical and subtropical countries, but these efforts are not always successful because of conflict of interest in using the areas for human settlement, agriculture, aquaculture or industries. To resolve these problems, a system which attempts to combine utilization and conservation called silvofishery has been introduced.

Silvofishery is a unique method that allows the rearing of both aquatic animals and mangrove trees in the same pond. In Indonesia, this system is called *tambak tumpang sari*, meaning brackishwater pond with multi-crops.

The mangrove usually planted in the silvofishery pond is *Rhizophora* sp. The

animals cultured include milkfish, tilapia, mullet, sea bass, shrimp or mudcrab. These species are euryhaline; they can tolerate large fluctuations in salinity. But there are few data about optimum stocking density of either fish or shrimp.

For raising shrimp, it is better to have more mangrove cover than no mangrove cover at all, as shown below:

Silvofishery model	Shrimp production (kg/ha/yr)
Pond without mangroves	171
Pond with 40-60% mangroves	181
Pond with 70-80% mangroves	355
Pond with >80% mangroves	414

A typical silvofishery pond in Indonesia has an area of 3-8 hectares.

There are less problems at the beginning of the implementation of silvofishery. But when the mangroves grow bigger, fish production can decrease because of shading effect and the appearance of fish predators.

Farmers may have to plant the mangroves gradually. For instance, mangroves are planted in 10-15% of the area every 6 months or one year until the optimal mangrove density is reached.

Among the areas of future research are: site selection, design and construction, mangrove vegetation, selection of cultured species, data on rearing conditions, impact on local community, financial analysis.





Mangrove trees and plants stay where they grow even as natural canals are deepened and stocked with mudcrab, shrimp and seabass. Studies on mangrove friendly-aquaculture are being conducted by SEAFDEC/AQD in this site in Bugtong Bato, Ibabay, Aklan



## INTEGRATED MANGROVE FOREST AND AQUACULTURE SYSTEMS -- INDONESIA

Excerpts of the review paper presented by Mr. William FitzGerald Jr, Oceania-Pacific Rim Consultants Services

There are two basic silvofishery models. One consists of mangroves within the pond with a ratio of 60-80% mangroves and 20-40% pond canal for aquaculture. The second model consists of mangroves outside the pond with similar mangrove to water ratio. There are a variety of designs within these basic models.

These silvofisheries developments range in size from one hectare to thousands of hectares at each site. *Empang parit* (sometimes referred to as *tambak tumpang Sari*) is the traditional application of this integrated aquaculture in the mangrove area. It represents the greatest level of reforestation or maintenance of existing forest.

*Empang parit* usually consists of an unexcavated central platform that alternates between being flooded and exposed and a canal that runs along the pond dikes where fish, shrimp, and crabs are cultured.

The density of mangrove trees planted in the platform ranges from 0.17 to 2.5 trees per m<sup>2</sup>. The mangrove density influences the quantity of litter production and

organic load. These in turn have an impact on the diversity of non-mangrove flora and fauna growth that may form an important part of the diet of cultured species.

The mangrove tree density also influences the type of aquaculture in *empang parit*. Farmers may opt for less dense mangroves for fish culture (e.g., 0.2 trees per m<sup>2</sup> for milkfish) but not for shrimp and crab culture because these species prefer the shelter afforded by mangroves.

Farmers in Indonesia earn an average gross income of US\$580 per ha per year (range = \$313-946). The net profit averages \$376 per ha per year. The individual farmers operate between 1.5 to 10 ha of silvofisheries ponds. The figures suggest greater production effort per unit area by farmers with smaller farms. Further research is needed to gather a fuller assessment and an evaluation of the different silvofishery models.

The *empang parit* model has a number of disadvantages compared to the brackishwater open pond: (a) greater construction cost per unit area, (b) greater dif-

ficulty to manage, (c) reduced water circulation and greater potential for stagnant areas with low oxygen levels, (d) limitation on species cultured (e.g., seaweed growth), (e) mangrove trees reduce the penetration of sunlight to ponds lowering the productivity of phytoplankton and benthic algae, (f) potential toxicity of tannin from mangroves.

The application of silvofisheries should be approached with reasonable measures of caution as with any development in an environmentally sensitive area as a mangrove ecosystem. The selection of the most appropriate silvofishery model will be site-dependent and influenced by the status of the mangrove ecosystem. It should also be integrated into an area-wide integrated approach to coastal zone management. This approach allows for maintaining relatively high level of integrity in the mangroves while capitalizing on the economic benefits of brackishwater aquaculture. ###

## COUNTRY EFFORTS ON MANGROVE-FRIENDLY AQUACULTURE

Excerpts of papers presented by country representatives

### Japan

Megumi Minagawa

*Seikai National Fisheries Research Institute*

Japan has no aquaculture development in mangrove areas because the area suitable for aquaculture is limited. Japan's total mangrove area is only 553 ha (>80 mangrove communities), mostly in Kagoshima to Okinawa. The mangroves in Iriomote Island account for 80% of the total.

There is strict protection of these mangroves. Some areas are protected as 'natural monuments.' Rather than aquaculture, enhancement and management of fishery resources — sea ranching — are expected to improve the sustainable utilization in mangrove areas. Target species for sea ranching in mangrove areas include mud crab and black porgy.

The mangrove situation in Southeast Asia is different from Japan's. To help the countries in the region, the Japanese government has began a 5-year project with SEAFDEC that will develop mangrove-friendly aquaculture techniques and protect the environment.

### Philippines

Simeona Aypa, *Department of Agriculture*  
Santiago Baconguis, *Dept of Environment and Natural Resources*

Mangrove areas before the 1980s were considered vast tracts of wastelands that had to be developed into other uses. In 1967, there were 418,990 ha of mangroves; 15 years later, 239,387 remained; today, only about 100,000 ha are left.

There are many causes of this destruction. On top of the list is charcoal and firewood utilization, followed by the expansion of agricultural areas, fishponds, urban and industrial development, harbor construction, mining, and housing projects. With the rise in human population comes the demand for agriculture, aquaculture, and industrial development.

The concept of mangrove-friendly aquaculture started as early as the 1970s with the so-called ecological fishponds. The National Mangrove Committee of the Department of Environment and Natural Resources finally implemented aquasilviculture in 1988 in a farm in Ubay, Bohol.

The aquasilviculture concept later spread to the other regions under the Coastal Environment Program, with several modifications and management schemes. A variation has been implemented in Puerto Galera, Oriental Mindoro called the agri-nipa-aquaculture system where agriculture crops are integrated with tilapia culture and nipa production. In Zamboanga del Norte, Silay City, and Banacon Island, there are models integrating fishery activities within mangrove areas.

### Thailand

Sanggontanagit Tanan and  
Anand Tansutapanich  
*Department of Fisheries*

Human activities have reduced the mangrove forest area in Thailand by 50% in the past 32 years (1961-1993), a rate of about 62,000 ha per year. The major causes are political, economic, and social pressures (shrimp farming, mining, among others).

The Thai government has moved to classify the remaining mangroves into three zones: (1) preservation zone — about 36,278 ha — where no development is allowed; (2) economic zone A — about 199,689 — used only for forest products production by communities; (3) economic zone B - about 130,081 ha - where agricultural, industrial, and commercial areas can be developed.

In 1995, the Department of Fisheries initiated a 4-year shrimp culture project incorporating biological waste treatment and other ecological management tools.

Shrimp culture will thus reduce its impact on surrounding mangrove areas.

The Department is also studying silvofisheries. The pond layout is modified by building dikes inside the ponds to get a larger area for growing mangroves. Shrimp or fish culture in the waterways can be intensive or extensive. The supplementary food requirement of the cultured shrimp / fish is expected to be lower because the mangroves are already sources of natural feed.

### Vietnam

Tran Truong Luu  
*Research Institute for Aquaculture*

Vietnam had about 400,000 ha of mangrove forest in the 1950s which was mainly located in the southern part of the country. By the early 1980s, only 252,500 ha remained. The mangrove area had been greatly reduced by chemical warfare, overexploitation for wood-charcoal-firewood, conversion to agricultural land, shrimp ponds, and residential areas.

Vietnam already practices mangrove-friendly aquaculture: (1) shrimp farming model, (2) mangrove forest model, and (3) mudcrab culture.

In the first, a household is allocated 3 ha for mangrove reforestation, mostly *Rhizophora* which are planted at 1,000-2,000 trees per ha. Shrimp are cultured using the traditional, extensive method (no stocking of fry, no artificial feeds).

In the second, a household is allocated 5 ha for reforestation and shrimp farming. Shrimp are stocked at less than 1 fry per m<sup>2</sup> in waterways that occupy about 30% of farm area.

In the third practice, mudcrab culture is done in mangroves or tidal flats mainly in the Mekong Delta. Crabs are also fattened in ponds, bamboo enclosures, and cages located in river and canal systems.

INTERVIEW WITH THE MANGROVE ACTION PROJECT'S ALFREDO QUARTO

## Mangroves and aquaculture development

By **NJ Dagoon**

*Mr. Alfredo Quarto is the Executive Director of the Mangrove Action Project (MAP), a non-government organization formed in 1992. MAP aims to build grassroots networks worldwide to protect and restore the earth's mangrove forests, and support sustainable coastal societies. He shares his thoughts on mangroves and aquaculture development.*

### **How extensive is MAP?**

We have grown from a small organization to a large network of about 900 individual science and non-government organizations from around the world. We have representations in about 58 countries now, including, Africa, Asia, Latin America, Europe and North America.

Originally, I believe there were 32 million hectares of mangrove, but now it is less than 16 million—so less than half the mangroves that once covered the earth still exist. This is a big problem because mangroves, by and large, are important for fisheries. Without the mangroves we are losing a lot of our production for fisheries.

### **Where are most of the mangroves located?**

Most of the mangroves are located in Asia. The largest number of mangrove areas is in Indonesia, about four million hectares. There are also mangroves in Africa, in Latin America. In North America, we have mangroves in Florida in the US. So that is an area that is also endangered by development over the years — population expansion, agricultural expansion, pollution prob-

lems, cutting mangroves for the charcoal industry. But recently in the last 20 years, I would say shrimp farming has been a major contributor to mangrove loss. It could be as much as 20 to 30 percent, depending on who you talk to, but the mangrove loss in modern days is due to shrimp farming. This still happens today. We still see evidence of mangrove loss in Ecuador, for instance, from shrimp farming which is exactly the problem that we have been addressing since 1992 that we still feel is not resolved at this point.

### **How much of the total mangrove loss may be attributed to aquaculture development?**

Well, around 20 to 30 percent...different figures—depending on who you talk too, seem to be attributed to aquaculture development. But it's controversial, some people say it's only about five percent. It depends if you talk to the industry representative or the NGO who is strongly against the industry's expansion to mangrove areas. It also depends on locale. For instance, in Ecuador, over 95% of the mangrove loss is attributable to aquaculture development in shrimp aquaculture. In some areas in Thailand, there is a high percentage of mangrove loss that's been due to shrimp farming. So it depends on the location, it depends on the industry's ability to expand, and regulations and enforcement.

### **Can you recommend some ways to rehabilitate mangroves?**

I think, one of the most important steps in rehabilitating mangroves, is trying to let the system come back on its own—if possible through natural generation which means protecting the land area for one—but also there are replanting programs which we

feel need to be expanded to include other species aside from *Rhizophora*. There has been some kind of plantation approach to replanting mangrove forests. We feel this is not going to work in the long run. We need to basically allow the system to regenerate as a complex system not as a simple one species system. For one thing, we need to also conserve the mangrove forests that still exist—that's one of the problems in our equation for mangrove conservation. There has to be a strong protection of existing mangrove forests and protection of the area where they exist so that they can replant themselves basically.

### **Do you think aquaculture projects can co-exist with mangrove forests?**

I think smaller level, smaller scale aquaculture can exist with mangrove forest. In Africa now is a plan for a large mega project -- 10,000 ha shrimp farm in Tanzania which we personally feel is not a good idea for the surrounding mangrove area which is about 53,000 ha, the largest mangrove area in East Africa. We feel this kind of expansion of a large scale production of shrimp has been and will be a problem for mangrove forests in the future. So we are encouraging aquaculture systems to be less intensive, more friendly to the local population and the local mangrove systems.

### **What kind of aquaculture projects do you think would be mangrove friendly?**

I think low intensity or mangrove-friendly aquaculture projects which are basically extensive systems that are

## SEAFDEC EXPERIENCE IN MANGROVE-FRIENDLY AQUACULTURE

Excerpts of papers presented by SEAFDEC/AQD researchers



### MANGROVE - MARINE FISH CULTURE

Most of the floating netcages in the past were situated in coves or bays protected from typhoons and other adverse weather conditions. But the deep waterways or rivers of mangrove areas offer almost similar qualities, and can be used by communities.

Among the commercially important marine fishes for culture, the mangrove red snapper, the Asian sea bass, and the grouper are good candidates for mangrove areas because they are euryhaline and command high market prices. AQD has started grouper culture trial in netcages in mangrove areas. [For more information, contact: [jdtoledo@aqd.seafdec.org.ph](mailto:jdtoledo@aqd.seafdec.org.ph)]



### INTEGRATED MANGROVE-SHRIMP AQUACULTURE

Most aquasilviculture trials focus on the harvest of fish and crustaceans and forestry products, neglecting the filtering function of mangroves. AQD is testing an integrated mangrove-shrimp culture model in Banate, Iloilo where a shrimp pond is situated beside a mangrove pond, the latter serving as filter for shrimp pond effluents.

Initial results indicate that *Avicemia* and *Rhizophora* may be more suited to integrated farming because they are more resistant to inundation than *Sonneratia*. About 90 kg shrimp were produced from the 1,500 m<sup>2</sup> shrimp pond. [Contact: [jhprima@aqd.seafdec.org.ph](mailto:jhprima@aqd.seafdec.org.ph)]



### MUDCRAB CULTURE IN TIDAL FLATS WITH EXISTING MANGROVES

This technology is ready for commercialization. Mudcrab can be stocked at 0.5-1.5 crab per m<sup>2</sup> in pens (size, 200 m<sup>2</sup>) installed in tidal flats with existing mangroves. Feed for crab can be fish by-catch or mixed diet (mussel meat and fish by-catch). After 160 days, farmers can harvest 17-31 kg of mudcrab (size, 298-305 g). Survival rate is 33-56%, and feed conversion ratio is 5.3-7.6. Farmers can earn gross income of P5,000-9,000 for each pen. Return-on-investment is 65-87%.

The design and operation of the mudcrab pens were tested in New Buswang, Kalibo, Aklan. [[atrino@aqd.seafdec.org.ph](mailto:atrino@aqd.seafdec.org.ph)]



### MOLLUSCS AND SEAWEEDS

Mussels, oysters and seaweeds are good aquaculture options for coastal communities. SEAFDEC / AQD has developed a suitable spat collector for oyster and mussel, and advocates the use of the raft culture method for grow-out culture to prevent siltation of growing areas. A prototype low-cost depuration unit has also been designed.

Among the seaweed species presently cultured, *Gracilaria* can be found in mud flats of mangrove areas. Its culture techniques are well-established. [[decastro@aqd.seafdec.org.ph](mailto:decastro@aqd.seafdec.org.ph) / [hurtado@aqd.seafdec.org.ph](mailto:hurtado@aqd.seafdec.org.ph)]



### SOCIAL TECHNOLOGY

SEAFDEC / AQD implemented an 8-year community-based fishery resources management project in Malalison Island in central Philippines, and the lessons learned regarding the collaboration of community organizations and the research community can be applied to communities opting to practice mangrove-friendly aquaculture. Communities have to be prepared for any co-management schemes. Scientific information to support policy formulation related to coastal management is also very valuable. [[agbayani@aqd.seafdec.org.ph](mailto:agbayani@aqd.seafdec.org.ph)]



### TRAINING AND EXTENSION

SEAFDEC / AQD's training and extension services have expanded from technological viability to sustainability issues. Sustainability includes not only technological feasibility but also economic viability, environmental sustainability and social equity.

AQD has packaged training courses on sustainable aquaculture and coastal resource management for trainees from Asian countries. Several extension materials are also available. [[training@aqd.seafdec.org.ph](mailto:training@aqd.seafdec.org.ph)]

###

## AVAILABLE MANGROVE-FRIENDLY TECHNOLOGIES

The workshop characterized mangrove-friendly aquaculture technologies as benign, with minimal adverse impact on the environment. These technologies also integrate mangrove forestry with brackishwater aquaculture. The following technologies in existence are considered mangrove-friendly. Countries that practice them are indicated.

Technology	Country
<b>SILVOFISHERIES (POND)</b>	
• mangrove+fish	Indonesia, Vietnam, Philippines
• mangrove+shrimp	Indonesia, Vietnam, Thailand, Myanmar, Cambodia
• mangrove+mudcrab	Indonesia, Myanmar, Philippines
• mangrove+seaweeds	Philippines
<b>SILVOFISHERIES (PEN)</b>	
• mangrove+mudcrab	Vietnam, Malaysia, Indonesia, Brunei, Philippines, Myanmar
<b>BIVALVE CULTURE</b>	
	Thailand, Malaysia, Philippines, Indonesia, Vietnam
<b>CAGE CULTURE</b>	
• mudcrab in cages	Vietnam, Philippines, Indonesia
• fish cage culture	Thailand, Malaysia, Brunei, Vietnam, Philippines, Indonesia
<b>OTHERS</b>	
• rearing of sea horses	Philippines
• rearing of sea cucumbers in pens	Indonesia

###

## WORKSHOP RECOMMENDATIONS

The workshop participants identified the problems affecting mangrove-friendly aquaculture and the strategies in solving these problems.

### I. Problems associated with mangroves

MORE RESEARCH WORK ON THESE AREAS:

- biodiversity: biomass, mangrovetum / gardening, mortality, tree density for optimal detrital production, cost-benefit analysis or valuation
- zonation of mangroves: carrying capacity studies
- silviculture practices: pruning and thinning, appropriate spacing between trees
- management for sustainability

FOR POLICY ENFORCEMENT:

- reversion of abandoned/underdeveloped ponds for aquasilviculture
- rehabilitation: financial / technical guidelines and support

### II. Problems associated with aquaculture practices

MORE RESEARCH WORK, SCIENTIFIC EXCHANGE ON:

- shortage of seed supply from the wild, spawner quality, fry quality
- management aspects: optimum stocking density for crab culture in canals in mangrove areas, feeds and feeding, water quality management (drainage and sedimentation), diseases and disease outbreaks (fast diagnostic tests), farm pollution
- engineering aspects: farm layout, design and construction
- refinement of appropriate / promising technologies for possible funding / loans from banks
- ecological footprint or the support area needed for mangrove-friendly aquaculture

MORE TRAINING AND EXTENSION PROGRAMS, COLLABORATIVE WORK WITH NON-GOVERNMENT ORGANIZATIONS, AND INFORMATION DISSEMINATION ON:

- economic viability of mangrove-friendly aquaculture practices
- non-acceptance of technology, lack of awareness and knowledge, if not misinformation

## Special report • mangrove-friendly aquaculture workshop

The participants of the first workshop on mangrove-friendly aquaculture held January 11-15, 1999 at Iloilo City, Philippines



The participants visited AQD's Tigbauan Main Station, 25 km south of Iloilo City, and AQD's project sites on mangrove-friendly aquaculture in the province of Aklan

*workshop recommendations continued from previous page ...*

### III. Socio-economic and cultural issues

#### POLICY ENFORCEMENT FOR:

- property rights: ownership, informal use rights, access, tenurial rights, equal opportunity use, conflict over potential areas for aquaculture, financial constraints, poaching, tree farm leasehold
- other legal issues

#### CO-MANAGEMENT REGIMES / COMMUNITY-BASED APPROACH / COMPLEMENTARY LIVELIHOOD /

- integrated/overall development of an area must include all sectors
- gender issues

#### SCIENTIFIC EXCHANGE

- regional cooperation, institutional development

###

## INTERVIEW

### William FitzGerald and Sukristijono Sukardjo

By **MB Surtida**

Both interviewees were invited to participate in the Workshop on Mangrove - friendly Aquaculture held at the Days Hotel in Iloilo City January 11-15, 1999. Mr. FitzGerald was invited to present a paper titled Integrated mangrove forests and aquaculture systems: Indonesia while Dr. Sukristijono Sukardjo participated as Officer of the Directorate of Fisheries Resources Management, Indonesia. Mr. Sukardjo is also responsible for the continued implementation of FitzGerald's Mangrove Rehabilitation and Management Project in Sulawesi as Senior Scientist of the Department of Forestry.



*Mangrove experts Mr. FitzGerald (left) and Dr. Sukardjo share their experiences with M. Surtida of AQD*

**Q.** Please tell us about your work on mangroves in Indonesia.

**Mr. FitzGerald:** My portion of the project (Mangrove Rehabilitation and Management Project in Sulawesi) was to look at the artisanal fisheries and to identify the different aquaculture activities and interaction with the subsistence fisheries in the mangrove forests. We also identified resources, potentials, and problems and made recommendations. The project was with the Ministry of Forestry of the Indonesian government.

**Dr. Sukardjo:** My duty now is to evaluate the result of the project in Sulawesi, specifically in the rehabilitation of mangroves. We are looking into an integrated approach to mariculture-aquaculture. The first choice is

silvofishery. We all know that silvofishery is not really aquaculture and the forestry approach is not also fishery approach. So we are looking into the real situation of our country where people living in the coastal zone especially those below the poverty line level can increase their capacity to earn and improve their quality of life by imposing rehabilitation projects of mangroves. In this way they can benefit from the resources in the mangroves and gain experience in implementing silvofishery projects. But in the virgin mangrove forests, there can be no silvofishery activities because they are considered as forest reserves.

*How long has this project been going on? Was there a long historical background?*

**FitzGerald:** I worked on the project over a two-year period (6 months in Sulawesi). It ended in September 1997. A preliminary assessment sometime in 1992 was done by an ADB-assisted project that led to the project that I worked on. They assessed the needs of the area and the scope of the project.

**Sukardjo:** The ADB result was very important because we were made aware of the mangrove in our country especially in Sulawesi. There are *tambak* and construction is going very fast and lots of mangrove to be converted to *tambak* without considering the ecological function in the mangrove area. So our mangrove areas will be degraded very fast. By knowing the situation, my country is thinking of how to rehabilitate the mangroves. This is not easy. This is also very costly. We are looking at the possibility of taking a loan from the ADB to finance the projects. But we are also hoping that with implementation of the project, we would get a realistic view of our mangrove resources. We are also looking at the continuation of the project, thus, we are now into rehabilitation. We will consider special tax for silvofishery activities as a result of the success of our demonstration project in West Java. This means that other areas may be suitable for such projects. The species characteristics should be considered carefully for the benefit of the environment, of silvofishery, and the people living in the area.

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*Do you see some problems in terms of ownership or tenure in these silvofishery projects?*

**FitzGerald:** Ownership is an important issue especially for silvofisheries in the mangrove area. For individual investors or owners of the private lands in the mangroves, silvofisheries is not that attractive economically at this point. To have them adapt silvofisheries practices, incentives for the private owners to go into silvofisheries will probably be needed. That is why it is important that the government maintains ownership of the mangroves as a common resource and then policies must be developed *vis-a-vis* utilization and conservation. They can then maintain better control over the mangroves. A conditional use lease could be utilized for individuals or community silvofisheries operations. If it is privately owned, it is harder to implement various policies. So ownership is an important issue.

**Sukardjo:** Based on our regulations, all forest lands belong to the government. All public lands may be used for agriculture or aquaculture for the benefit of the people. People cannot own forest lands.

*Prior to your Indonesian project, were you involved in similar projects globally? How successful were they?*

**FitzGerald:** Not so much in mangroves but in the development of agriculture industries in Guam, Micronesia, and Palau. In Guam, the project on the hatchery industry started essentially from nothing. In Palau, I worked with a regional organization (Pacific Aquaculture Association) on establishing marine shrimp specific disease free broodstock and on spawning groupers.

*Southeast Asia is the leading region in silvofisheries globally, considering that Indonesia's mangroves comprise 1/4 of these resources. In what part of the globe is there a similar scenario?*

**FitzGerald:** I think the Philippines is similar in the sense that it has a large area of mangroves.

Sukardjo: In Indonesia, we have

many natural resources. These include mangroves. Biodiversity projects have been established by some government agencies in preparation for the policies that would be formulated for the rational use of mangroves and other natural resources.

*A speaker in this workshop said that the moneyholder looks at the profit while the local community looks at the stomach. Do you see this as a conflict? Please comment.*

**Sukardjo:** This is a special case in Indonesia because our economy is weak. In the coastal zones, people live below poverty line level. From outside of these villages, moneyed people come in and manipulate the people. The people do not have a choice. They have no alternatives. In Indonesia, a method of compromise must be arrived at between the hungry people and the moneyed people. Both groups must understand the ecological function of the mangroves and their sustainable use for the benefit of the people in the country and the world. We are eager to generate earnings for the people from the resources of the mangrove ecosystem. So if we can harmonize the hungry people and the moneyed ones, we can rehabilitate and conserve our natural resources. We have extension projects not only for the hungry people but also for the moneyed ones. This is not easy. In some provinces, projects that last for two or three years are abandoned, benefitting the moneyed people and leaving the hungry people nothing.

**FitzGerald:** I agree that there should be a compromise. I think the government should provide the people with the basic opportunity to live meaningful lives and have adequate food. That is a definite priority. There should be room for industries to make profit but they should be governed by certain guidelines and codes of conduct that do not allow for the abuse of the environment. It should also be in coordination with the local community and consider social issues effected by such development. If it is done properly, it can be a win-win situation for the industry which earns a profit and the community which benefits from it.

*Can mangrove-friendly projects be commercially profitable?*

**Sukardjo:** Silvofishery is the only approach to share resources. We want silvofisheries to be scientifically sound and acceptable in all places. I think the moneyed people would be interested in this approach, especially in the northern coast of Java where a demonstration project has been established. A private company has put up a seafood fishery processing plant. But I know everything depends on compromise as this project is between the moneyed and the forestry people. I am sure if an understanding is arrived at between them, it is only a matter of time for us to achieve equity.

**FitzGerald:** At the individual level, projects have been shown to be profitable but not on the corporate level. Small-scale, family level or community type of projects would be effective. Governments might want to emphasize mangrove-friendly aquaculture to assist farm families to provide adequate income for them. At the same time, the environment is not destroyed.

*Do you have any last words for our readers?*

**FitzGerald:** The workshop was a great help in identifying issues in mangrove-friendly aquaculture practices and hopefully new ideas and direction for research will be formulated. The subject is still at its very early stage in development and still a lot of issues have to be resolved including environmental, technical, social, and economic issues. There's a lot of room for improvement in silvofisheries practices, and at workshops like this, the ideas presented will be valuable in developing research programs and future development of mangrove-friendly aquaculture practices.

**Sukardjo:** I hope the proceedings of this workshop will be finished soon as this is in line with my government's program on land use. I hope that in the spirit of cooperation, our mangrove-friendly projects would be successful. I invite everyone to come to my country. ###



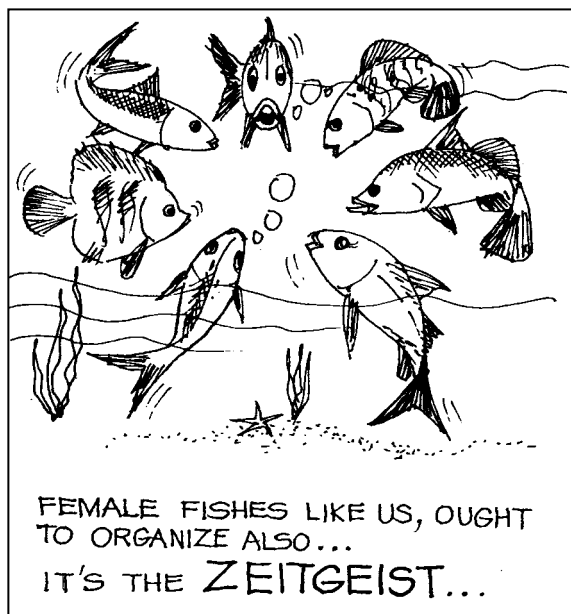
## Women do fish!

Women and children make highly significant but undervalued contributions to fisheries aquaculture, fish processing, retailing and fisheries sector services, according to the experts who gathered on November 13, 1998 in Chiang Mai, Thailand at the first *International Symposium on Women in Asian Fisheries*.

Appropriately, the Symposium was conducted in Thailand which is the biggest exporter of seafood in the world today. Women play a big role in the Thai fisheries sector, including holding 33% of professional positions in the Central Directorate of Fisheries, according to the Director General of Fisheries, Mr. Dhammarong Prakobboon, who spoke at the opening ceremonies.

Men and women from diverse specialist backgrounds gathered for the Symposium. They included rural bank managers, non-governmental organization staff, university chancellors, research managers, international and regional bureaucrats, fish product inspection experts, biologists, social scientists and fisheries information specialists. The keynote address was delivered by Senator Helena Benitez, who is renowned internationally and in her home country, the Philippines, for her contributions to women's rights, rural development and environmental conservation. Presentors came from Bangladesh, Cambodia, India, Italy, Indonesia, Malaysia, Philippines, Taiwan, and Thailand.

Knowledge of the contributions of women in the fisheries sector is only evolving slowly and still lags behind that of other rural sectors in Asian countries. The experts concluded that one way to help rectify this situation would be for the governments in Asia to cover gender questions on fisheries and aquaculture in their regular agricultural censuses. Participants were urged to go back to their ministries



of agriculture and alert them to this vehicle for data collection. Despite the lack of comprehensive data, the Symposium learned from several programs and studies in India, Bangladesh and the Philippines that agricultural banks and non-government organizations are already helping hundreds of thousands of women entrepreneurs and fish producers through technical assistance, loans and credit and fostering self help groups.

The Symposium recognized that Asian women in fisheries usually carry multiple roles in their lives and careers, thus making time allocation a critical issue to address when developing assistance programs. Men's and women's sense of confidence and self-worth were intrinsically linked and embedded in their culture. Therefore, social support systems need to be organized to help bring about changes that may be resisted at first. Gender relations should not be seen as competitive but rather as complementary and mutually reinforcing. Support systems should also help to raise the aspiration levels of women. More generally, formal service

and delivery agencies are realizing that they can only do their jobs if they are gender sensitive and more participatory with their clients, such as involving fish farmers in designing curricula for field schools. In most cases, this means a major internal effort in organizational transformation. The workshop learned how some non-governmental organizations have already embarked on these internal cultural changes.

Women in the sector are marginalized in planning and policymaking and unless this is changed, they will continue to suffer inequalities and discrimination. Even some Asian women fisheries scientists and academics rated their chances of making a significant

policy contribution as 'hopeless'. Several speakers stressed that community-based coastal resource management was one activity related to fisheries that would only be successful if both men and women are active. Although such management was becoming more inclusive of stakeholder groups generally, women were still rarely involved.

Women frequently participate in the fisheries sector under conditions of great inequality, bordering on blatant exploitation, even through they do gain economically from their participation in the labor force. Young and unmarried women were often preferred because they were cheaper to employ and have fewer family responsibilities. Studies showed that women laborers in some offshore fisheries in the Philippines and in fish processing plants in India were paid below minimum wages, received little in basic health and welfare benefits and, because they lacked power and legal protection, could even be exposed to sexual harassment on the job.

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Such labor and personal discrimination was often well hidden because the women could not speak out and their basic human rights were not adequately protected.

Speakers at the symposium revealed the results of studies that showed women were productive and efficient when they had access to the right technologies and opportunities. Studies in Malaysia and other countries showed, however, that more than 80% of rural women's activities were carried out in or close to the home. New technologies and modernization in the sector tended to marginalize these backyard activities. The new development included the introduction of large scale, centralized fish processing aimed at high quality export markets and the mechanization of fishing vessels. However, small scale aquaculture, low capital fish processing, value-added fish products, rice-fish farming and rearing of fingerlings from fry were examples of fisheries activities which were suited to cottage industries. In addition, complementary activities such as tourist lodging, handicrafts and seasonal

farming were showing promise for diversifying, stabilizing and raising family incomes.

Some general recommendations from the Symposium are as follows:

- Training and extension programs in fisheries should specifically target women in areas where they contribute to fisheries activities
- Microcredit programs, along the lines of the successful programs in Bangladesh and India, should be tried to benefit women in other countries
- Networks should be formed at the national and regional levels with the active participation of all the actors. A notable example is the effort of Mekong River Commission to form networks in four countries in the Indo-China region

The Symposium was organized by the Asian Fisheries Society. For more information, contact: ICLARM@cgiar.org (Dr. Meryl Williams) or anrcare@Bangla.Net (Dr. MC Nandeesh).  
###

### milkfish breeders ... from p4

ery of Aquaculture Specialists, Inc. in Guimbal, Iloilo; and other small-scale hatcheries operating near AQD.

The second — *Pond Cooperators' Program* — is intended to encourage milkfish grow-out farms to use hatchery-reared milkfish fry instead of wild-caught fry. The cooperators are given up to 100,000 pcs of hatchery-reared fry for free.

The cooperators include the Gatuslao and Jalandoni farms in EB Magalona, Negros Occidental; Naranjo farm in Carles, Iloilo; Hautea farm in Iloilo; and the BFAR station in Pagbilao, Quezon.

Trial runs in these farms also looked at the issue of higher incidence of malformed stock when hatchery-reared fry are used compared to wild-caught fry.

Initial results from the cooperating farms showed very few malformed fry in the nursery phase (0.23%), semi-intensive grow-out culture (0.05%), and modular grow-out system (0.003%).

### mangrove-friendly country ... from p 10

Farmers also raise blood cockle and clam; the seaweed *Kappaphycus*; Nile tilapia, mullet, milkfish, seabass.

## Malaysia

*Choo Poh Sze and Raihan Sh. Hj. Ahmad  
Department of Fisheries*

Malaysia has 641,172 ha of mangroves, mostly found in Sabah (57%), Sarawak (26%) and peninsular Malaysia (17%). Of these, 440,400 ha are reserve forests. About 20% of the total mangrove area has been lost to various development activities in the last two decades.

The area under brackishwater aquaculture (ponds) constitutes less than 1% of the total mangrove area; another 30% is utilized for various purposes — human settlements, ports, jetties, airports, tourist resorts, industries, and agriculture. Despite the small hectareage converted to prawn farms, its conversion has taken the

blunt of the criticism on mangrove destruction. This is perhaps due to some of the spectacular reports on the collapse of unsustainable farms all over the world.

Malaysia's mangrove management is focused on the conservation of forests for wood production (fire, charcoal, poles).

The culture of cockles in mangrove mud flats in Peninsular Malaysia is the most important brackishwater culture in terms of production, and contributes to over 90% of the mariculture production. Around 4,700 ha of mud flats are utilized for this culture and the production in 1995 was 100,276 tons. The method and time of collection, as well as the permitted spat size for collection and size of cockle that can be harvested are regulated by the government. The culture of oyster and mudcrab contributes around 1% of total mariculture while fish cage culture contributes 5%.

While it is recognized that the mangrove ecosystem plays an important role in sustaining aquatic resources, it may not be pragmatic to advocate a no-use policy to prevent the loss of this important habitat. It may not be realistic to put a total ban on aquaculture (example, shrimp farming) in the mangroves. It is more realistic to advocate sustainable practices that are not harmful to the environment.

## Brunei Darussalam

*Hajah Laila Haji Abdul Hamid  
Department of Fisheries*

The mangrove area utilized for aquaculture is minimal. Out of the 18,418 ha, only 190 ha are developed for shrimp farming. The other aquaculture activity is cage culture of marine fishes.

The late development of aquaculture in Brunei is a blessing because the prob-



# Grouper culture

Groupers (*Epinephelus*) are high-value commodities for the urban and export markets. Their demand are mostly in countries with high seafood consumption or with high economic growth rate. According to the Bangkok-based Network of Aquaculture Centres in Asia (NACA), grouper demand is currently centered in Hong Kong. NACA is currently teaming up with the Asia-Pacific Economic Cooperation (APEC) in establishing a regional grouper R&D cooperation.



Aquaculture can supply part of the demand for groupers. SEAFDEC Aquaculture Department for instance is developing technologies for grouper hatchery and grow-out culture. Grouper spawn readily in captivity but larval survival is somewhat low. At present, the grow-out industry relies on fry taken from the wild.

This issue presents the progress of SEAFDEC / AQD in grouper hatchery production, and in brackishwater pond culture. The latter is a good substitute crop for tiger shrimp whose industry is still slowly recovering from production losses due to diseases resulting from unsustainable farming practices.



Also in this issue: the natural sources of grouper fry and the experiences of some netcage operators in the Philippines; the markets for reef fishes -- Hong Kong and Singapore - and some live transport tips.



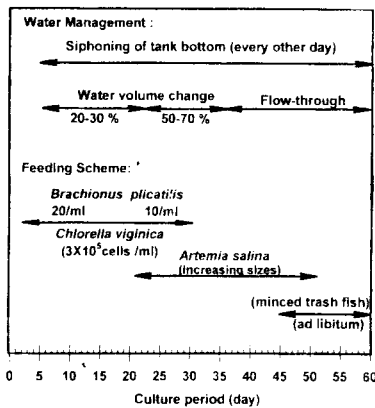
*FROM THE TOP* - Market-sized grouper harvested from a brackishwater pond that used to have tiger shrimp stock; a grouper pond in Bacolod City; netcages for grouper grow-out in Capiz; logo of 65 grouper farmers in Capiz who formed a cooperative for easier marketing and exchange of information; lifting of netcage to check grouper stock

## SEAFDEC/AQD's R&D on grouper

By **M Castaños**

Aquaculture in the long term can not really depend on seed supply from the wild because this supply is highly seasonal and erratic; hence, the efforts being made to establish hatchery techniques.

For the grouper *Epinephelus coioides*, SEAFDEC / AQD has made significant strides in R&D in the last ten years. It has established a working technology for grouper hatchery although there are still a few kinks to be ironed out. AQD researcher Marietta Duray has worked out the feeding and water management protocol in rearing grouper larvae as shown below.



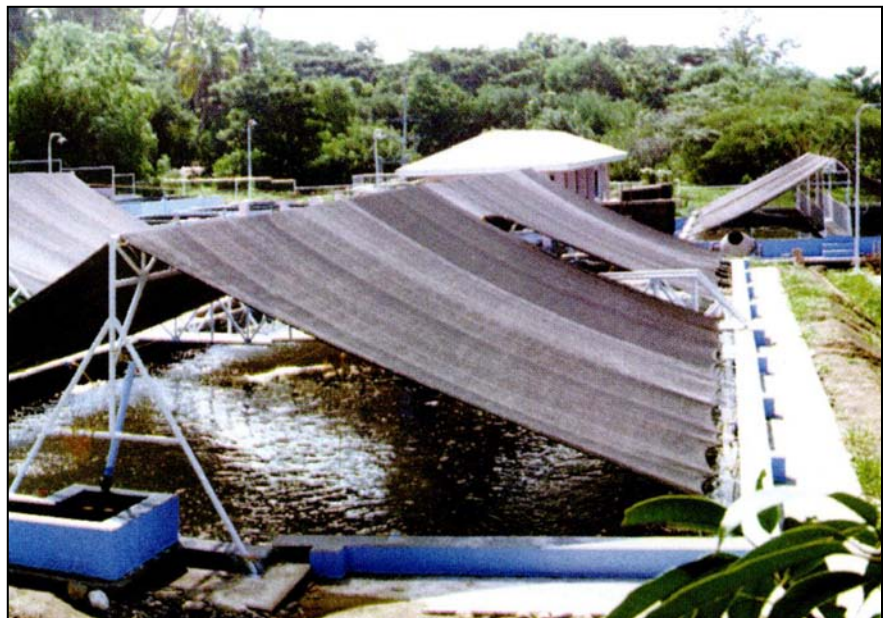
cf. *Aquaculture* 150 (1997): 63-76

A stocking density of 20 larvae per liter of seawater is recommended. In trials (6-8 runs), survival rate using this scheme was about 20% on Days 0-24, and 16% on Days 25- 60. Day 0 larvae measured 1.6 mm, Day 24 about 11 mm and Day 60 between 51-65 mm.

Ms. Duray noted that it is better to use large tanks (>3 tons) and water salinity of 24 ppt. It is also better to feed small-sized *Brachionus* (a screen may be used to select only less than 90 µm rotifers) during the first feeding period because the mouth of newly hatched grouper is small and grouper can not yet go after bigger prey.



Grouper juveniles produced from AQD's fish hatcheries



The Integrated Fish Broodstock - Hatchery Demonstration Complex where grouper are held. At present, the complex and the netcages at AQD's station in Igang hold more than 100 grouper broodstock

### SEAFDEC/AQD's research milestones for the grouper *Epinephelus coioides*

YEAR	RESEARCH ACCOMPLISHMENT
1988	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
1994	completion of the grouper life cycle in captivity, intensive hatchery techniques, fry production
1995	sex-inversed males in natural spawning
1996	improved larval survival by use of copepod nauplii
1997	larval metamorphosis advanced by thyroid hormones

## Known sources of grouper and snapper fry / fingerlings in the Philippines

After the hatchery protocol has been worked out, AQD researchers are studying ways to refine it and increase grouper survival so that entrepreneurs can get into the hatchery business.

The source of eggs or newly hatched larvae reared in the hatchery is usually captive broodstock. AQD has around 100 grouper breeders sourced from the wild in 1988 to early 1990.

According to AQD researcher Joebert Toledo, the grouper spontaneously spawn year-round (except in May) in concrete tanks and from July to October in floating netcages. A 5-kg female grouper can produce between 2.3-3.9 million eggs per month.

Mr. Toledo noted that of the eggs produced, 72-89% were fertilized; and of the fertilized eggs, 67-88% hatched into larvae. These figures can still be improved. For one, AQD researchers are studying broodstock nutrition as it relates to reproductive performance. Several other studies are on-going.

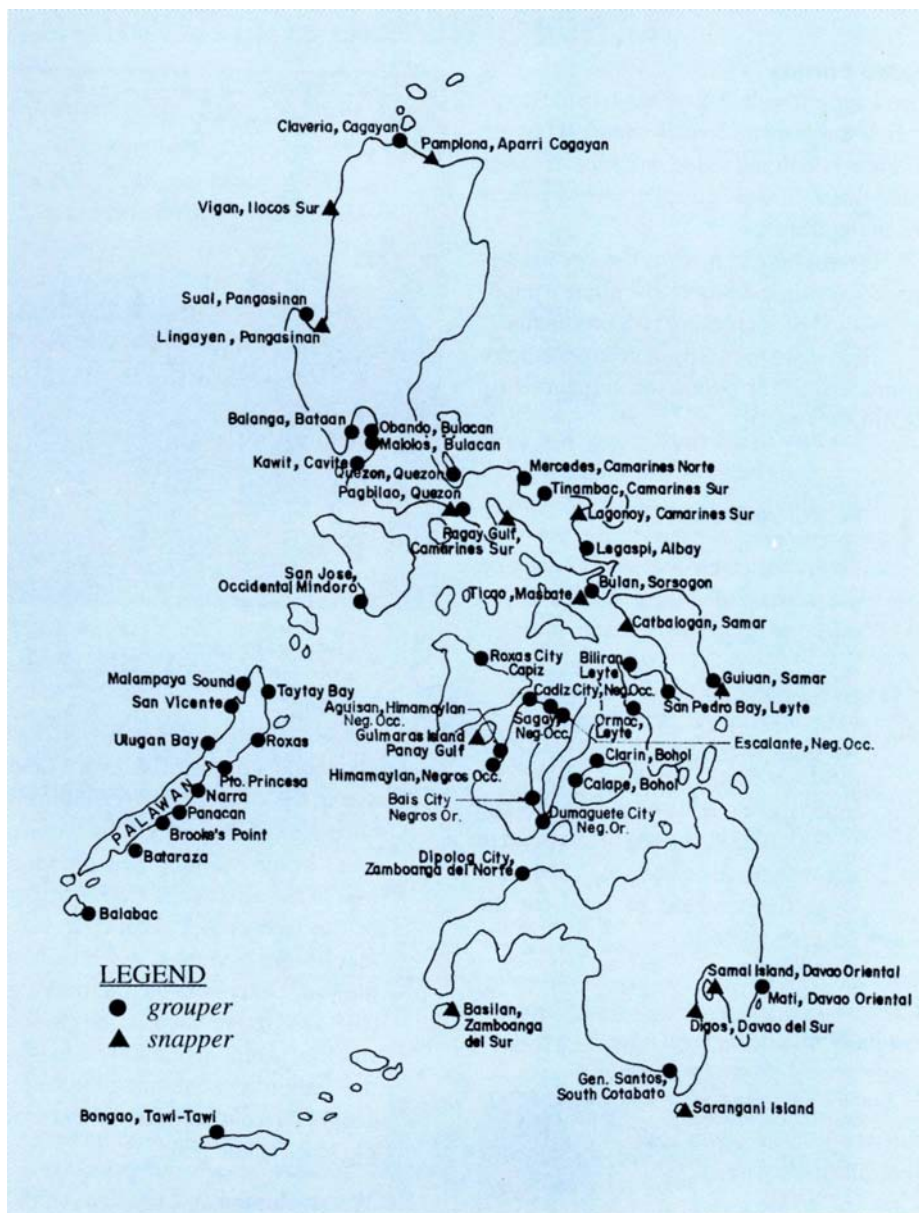
### RECENTLY PUBLISHED WORK ON GROUPER BY SEAFDEC / AQD

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# Grouper culture I. In ponds

By **MB Surtida**

Groupers are widely distributed in the tropical and subtropical coastal waters. They are of great economic value and form a major component of the coastal artisanal fisheries in the tropics.

Declining catch from the oceans has made grouper and other fish culture a popular method of increasing fish production.

Below are the steps in grouper culture in brackishwater ponds recommended by SEAFDEC / AQD:

## 1 POND PREPARATION

Ponds for grouper grow-out may be prepared following protocol for milkfish pond preparation.

## 2 STOCKING

Stock grouper fingerlings (7.2 cm or more) at 5,000 per ha. Do this one month after releasing adult tilapia (5,000-10,000 per ha) in the pond to allow them to reproduce. The tilapia fingerlings would be food for the grouper juveniles.

*When stocking, gradually acclimate fry to pond conditions by adding pond water slowly to the plastic bags holding grouper fry*



## 3 CARE OF STOCK

### **Feeding**

Aside from the tilapia fingerlings, give chopped trash fish every other day at 5% of total grouper biomass. Give half of the daily feed requirement in the morning and the other half in the afternoon. Place one part of the feed onto a feeding tray for monitoring purposes and broadcast the rest. Determine the biomass and daily feed requirement of the grouper stock by sampling monthly. Measure the length and weight of grouper caught by a cast net. Return the sample stock to the pond.

### **Water change**

Change 50% of pond water twice weekly. Constantly monitor the water parameters: water depth, 0.6-1.3 m; water temperature, 24-31°C; salinity, 21-41 ppt; and dissolved oxygen, 4.9-9.3 ppm (values from AQD runs in Bacolod City).

Groupers take 5-7 months to attain the marketable size of 400 to 800 g.

## 4 HARVEST

Selective harvesting when most of the stock reach 400-600 g is best for grouper culture. A drag net is placed at the farthest end of the pond and dragged slowly towards the other end in the early morning. For a 0.5 ha pond, four men may drag the net.

As the net is drawn towards the opposite side of the pond and groupers have already been encircled, the fish are transferred to a holding net. Grading starts here. Groupers that do not reach the required size for the market are placed back in the holding tank to be later released in the pond.

In case there are no immediate buyers, the grouper may be kept in production net cages at 20 fish per m<sup>2</sup>. The grouper may be kept for not more than one week in the production netcages. The grouper may be fed with trashfish at 5% of biomass every other day while waiting for buyers.





PHOTOS BY R. BUENDIA

## II. In cages

**To harvest grouper:** A net is dragged across the pond (A) and the fish caught in the drag net are placed in a holding hapa net (B-C) where the fish are size-graded. To keep the grouper alive while preparations for packing and transport are being made, groupers are temporarily held in conditioning wooden tanks (D). A market-sized grouper weighs 400-800 g (E)

### Packing

Groupers are marketed live, hence packing is critical.

From the ponds, groupers are placed in conditioning tanks for at least one hour. Gradually reduce the water temperature to about 18°C by gradually adding packed ice.

Place 3-5 (depending on size) groupers inside double sheet plastic lined styrofoam boxes (30 x 30 x 20 cm) and place just enough water to cover the nostrils. Close the plastic lining and place crushed ice on top of the plastic bags to maintain coolness during transport. ###

Grouper may be cultured in net cages in sheltered coastal waters, particularly in areas where there are fishing villages. Two commercially important species are cultured in the Philippines -- *Epinephelus malabaricus* and *E. coioides*. There are very slight differences between the two species in appearance. *E. malabaricus* has smaller, dark blackish brown spots than *E. coioides* which has reddish brown or brownish orange spots. *E. malabaricus* has irregular white spots on the head and body while *E. coioides* has none.

Groupers are popularly known as *lapu-lapu*.

### 1 CHOOSING THE SITE

Place your grouper cage farm in areas with good water quality and adequate water exchange, no predators, and protection from strong wind and waves.

### 2 MATERIALS FOR CAGES

In the Philippines, floating cages are more popularly constructed with wood, bamboo poles and polyethylene netting material at 25-50 mm diameter. The net cage is formed by two types of net panels; 4 side panels forming the walls of the netcage and one bottom panel. The net is se-

cured to the raft structure (bamboo poles) by ropes. The rope system holds the bamboos together onto which the nets are attached. Buoyancy is provided by empty plastic drums attached to the wooden and bamboo frames.

### 3 STOCKING

Grouper fry/fingerlings (2.5-7.2 cm) can be stocked into the nursery net cages. Density can range from 100-150 fish per m<sup>2</sup> net bottom area. A net of 2 x 2 x 2 m would be able to hold 400-600 fingerlings. Sorting must be done every week and stock sampling every 15 days. Grouper should be held there until they reach about 16 cm when they are thinned out and transferred to transition nets at about 44 fish per m<sup>2</sup>. A transition net 5 x 5 x 5 m can hold 1,100 fish. The fish are finally transferred to a production net after 2-3 months.

### 4 CARE OF STOCK

#### Feeding

Grouper juveniles are fed chopped trash fish (to be chopped as finely depending on the size of fish) once or twice daily at 10% of total biomass. Feeding must be done in the morn-

➡ next page



A grouper cage farm in Capiz (top) where the grouper grow-out industry started, led by pioneering fishfarmers Elmer Blasurca (lower left) and Policarpio Altamia Jr.

ings and towards evening and at slack tides so that minimal feed are swept away by the tidal current.

The amount of feed given to the fish depends on fish size. Each fingerling may be given up to 10% of its body weight daily; a 50 g fingerling should receive 5 g trash fish daily; a 100 g fish should receive 8% of body weight daily; 300 g fish should be given 5% of its body weight; and 500 g fish, 3% of its body weight daily.

Fish conversion ratio is estimated at 4.5:1 ratio.

#### Yield

Groupers reach 400 - 600 g in 6 - 8 months.

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## Some problems of the grouper grow-out industry in the Philippines

The grouper industry in Capiz started in the early 1980s. Two grouper cage farmers were interviewed regarding the operation of their farms in Cagay and Aguho, Capiz in central Philippines. They both raise groupers in net cages.

Cagay has the most number of grouper cages in the Philippines, occupying a 1.2 km stretch (28,000 m<sup>2</sup> area of grouper cages) of coastal area. The cages are owned by 65 small operators who formed a grouper growers cooperative in 1991, the Bangbang Inland Fishfarmer Multipurpose Cooperative.

Mr. Policarpio Altamia, Jr. is the cooperative's farm manager. He said that in his experience, *Epinephelus malabaricus* grow fast but are not tolerant to salinity changes. If salinity dips to 10-15 ppt for more than 24 hours, the fish die. He also experienced fish kills in June and July, 1996 (70% of stock perished). The affected fish had tail rot, red lips, and melting fish scales. He later learned that bacterial count rose because of high temperature. He has also learned that it is not correct to assume that the water can clean itself and that the farm must not exceed the carrying capacity of the area. Aside from these considerations, he follows the protocol described above in rearing his groupers.

But he says that the government is still neglectful of the fisherfolk. He says that 75% of the population of Capiz are fisherfolk and yet they do not have insurance in case of destruction due to natural causes such as storms or too hot weather. He also wants the government to maintain some sort of a seed bank for aquaculture and fisheries. He said this would help the industry a lot.

Mr. Elmer Blasurca has been operating his grouper cages since 1990. The first problem he identified is the absence of cargo planes to ship his stock to the market live. Saying that grouper production in the country has only supplied 10% of market demand, he cannot increase his production because he would pay a lot for shipping if he hires his own transport facilities. He said there used to be cargo planes in the early 90s but it stopped operating.

He offers a few innovations. He says he feeds once daily at 6 in the morning. The fish grow as fast as those fed twice daily. He says, however, that dried pellets are not good for tiny grouper fry.

He relates of a seasonal occurrence (during very hot weather annually) that has baffled him. He says that for almost 4 years now in April and May, very tiny jellyfish ("lobo-lobo" type) appear in his area. They are as small as a mung bean. If it appears during very hot weather followed by rains, the grouper in his cages would die the next day. He has yet to figure out what the jellyfish are and why they cause mortality.

He also thinks that the Land Bank of the Philippines should offer credit facilities for fishery and aquaculture. He says this will improve the industry and improve the quality of life of the fisherfolk.

Bobby Sanson, also a grouper grower in Negros Oriental, cannot be too pleased. He converted his tiger prawn ponds to grouper ponds since 1996 and has been continuously increasing his production. He says that the market should first be established before one thinks of expanding production. He operates nine hectares of grouper ponds, gets a return-of-investment of 60% and a 2 years payback period. So far he has not had problems in trash fish supply, fry supply, and even market. In the beginning of this operation, SEAFDEC / AQD extended technical assistance.

-- By MB Surtida



# Markets for reef fishes

By **AP Surtida**

Groupers and snappers are categorized as reef fishes together with sea breams, rock cods and coral cods in the major Asian markets — Hong Kong, Singapore, Japan and the US.

## Hong Kong

The live reef fish market in Hongkong accounted for about US\$35 million of live fish imports in the mid-1990s. The average wholesale price was about US\$23 per kg. This makes Hongkong the major importer in Southeast Asia, accounting for about 60% of the total annual regional trade of 25,000 tons. Live reef fishes are flown in from Indonesia, the Maldives, Australia and the western Pacific.

Groupers were also among the most valuable species. For example, in 1996, several large giant groupers (45-90 cm) were sold for about US\$10,000 each, a price comparable to silver. But majority of the live reef fish largely fall within sizes of 0.5 to 2.0 kg or 35 to 50 cm. Grouper price vary according to species. Red grouper (*Epinephelus akaara*) and spotted grouper (*Plectropomus* spp.) sell for US\$42 per kg; the rest around \$20 per kg.

In 1997, Hong Kong consumed 28,000 tons of live fish. About 35% by weight and 50% by value were groupers.

## Singapore

Singapore with a population of only about 3 million does not constitute a significant market for fishery products. But it is important as a transshipment base for fishery products within and outside Southeast Asia. A substantial portion of the imports constitute reef fishes, including groupers and snappers. Imports are mostly delivered at Jurong Market.

Licenses for imports, exports and transshipment have to be obtained from the Fisheries Division of the Primary Production Department.

## Market study

Australia's Queensland Department of Primary Industries assessed the potential of developing the reef fish aquaculture industry in Queensland in 1995-1996. Its major conclusions are found below:

- With increasing population and growing affluence in Hongkong and southern China, the market for live seafood, including groupers and snappers, seem set to increase. Prices are forecast to increase steadily in the next six years. It appears unlikely that this demand can be fully met by capture fisheries, particularly in view of the widespread environmental damage caused by unsustainable fishing techniques. Increasing demand for live reef fish will have to be met by aquaculture
- R & D costs for development of reef fish aquaculture industry are high, but returns are also likely to be higher, and the industry should be highly profitable. The main constraint is the difficulty associated with producing large numbers of fingerlings for grow-out. This aspect is specifically targeted in R&D programs

The market analysis, which concentrated on Hongkong and southern China, estimated Hongkong's total seafood market at over 220,000 tons per year. The current market for high quality live reef fish is estimated at 1,600-1,700 tons per year.

Assuming that the Hongkong and the Chinese economies continue to expand at the current rate, both demand and price will expand in the immediate future. Compound growth rates in excess of 12% are forecast, indicating that the market is expected to double every six years.

## Transport tips

Since transport of live fish to markets hundreds of miles away is stressful to the fish,

it deserves special attention. Below are some tips in transporting and marketing live groupers.

- Plan operation to minimize delay in transit
- Select only healthy animals
- Keep the animals well aerated, the higher the density, the higher the need for oxygen
- Condition the fish prior to transport to reduce stress. Fish should be starved at least 24 hours prior to transport. The larger the fish the longer it needs to clear its gut. Water temperature in the holding tank should be reduced by adding ice. Temperature reduction should be ideally less than 5°C per hour and should be brought down to not less than 18°C. Ice should be contained in a plastic bag to prevent dilution of seawater when it melts
- Use sealed double polyethylene bags for packing live groupers. Put just enough water in each bag to avoid extra weight. Place bags in an insulated styrofoam box where sufficient ice are added to control rise in temperature
- Determine airline requirements for shipping or air freighting live fish. Generally, gross weight of the pack should not exceed 20 kg
- Label the packages properly: LIVE ANIMALS, THIS SIDE UP.

(Thanks to Nazri Bin Seman of SEAFDEC, Malaysia; and Florito Pudadera of Oton, Iloilo, Philippines for providing some of the information included in this article.)

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effort to intensify milkfish farming (Schmittou et al., 1985). The work of these institutions focused mainly on production constraints and ignored market constraints in milkfish farming. During the Second International Milkfish Aquaculture Conference in 1983, Smith and Chong (1984) and Samson (1984) presented industry trends but made very different projections. Since then, there has been no examination of the national and local (Iloilo) trends in milkfish production and research has not kept up with the industry practices.

This chapter considers the trends in milkfish production in the Philippines and shows how these were affected by research and development and by the market forces in the private sector. Presented here are statistics on the economic value of the industry and the milkfish production and yields over the past 70 years. Several sections then discuss the seed supply, farming practices, other inputs, costs and constraints in milkfish farming in ponds, pens and cages. The characteristics of milkfish farmers illuminate some industry trends. Special focus is given to high-intensity milkfish farming, the verification of improved farming methods, and the fry supply from hatcheries. The chapter concludes by reiterating that milkfish farming, as all aquaculture, should be undertaken (and intensified) as part of integrated coastal resources management.

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**Primavera, J Honculada.** 1998. Tropical shrimp farming and its sustainability. In: SS de Silva (ed). Tropical Mariculture. Academic Press, San Diego-London-Boston-New York. 487 pp.

In December 1996, the Supreme Court of India ordered the closure of all semi-intensive and intensive shrimp farms within 500 m of the high tide line, banned shrimp farms from all public lands, and required farms that closed down to compensate

their workers with 6 years of wages in a move to protect the environment and prevent the dislocation of local people. If the 1988 collapse of farm across Taiwan provided evidence of the environmental unsustainability of modern shrimp aquaculture, the landmark decision of India's highest court focused attention on its socioeconomic costs.

This chapter briefly describes shrimp farming, discusses its ecological and socioeconomic impacts and recommends measures to achieve long-term sustainability including improved farm management, integrated coastal zone management, mangrove conservation and rehabilitation, and regulatory mechanisms and policy instruments.

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**Borlongan IG, Coloso RM.** 1996. Use of metaldehyde as molluscicide in milkfish ponds. In: IF Henderson. Slug & Snail Pests in Agriculture: BCPC Symposium Proceedings No. 66. British Crop Protection Council. p 205-211

*Abstract.* META™ metaldehyde formulations were tested under laboratory and field conditions against brackishwater pond snails (*Cerithidium* sp.). Under laboratory conditions the LC<sub>50</sub> and LC<sub>90</sub>, 3 days after treatment ranged from 2-3.5 and 4.8- 5.4 kg/ha, respectively. However, these levels proved ineffective when applied directly under actual pond conditions. In ponds with snail population of about 300/m<sup>2</sup>, a higher application rate of 30 kg/ha is recommended. Application of META metaldehyde concentrations of 0-175 kg/ha did not affect milkfish juveniles (1-3 g body weight) 7 days after treatment. Results suggest that the META metaldehyde formulations were effective for pond snail control without detrimental effect on juvenile milkfish.

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**Capinpin EC Jr.** 1995. Growth of donkey's ear abalone, *Haliotis asinina* Linne,

fed an artificial diet and macroalgae. In: Zhou Yingqi, Zhou Hongqi, Yao Chaoqi, Lu Yi, Hu Fuyuan, Cui He, and Din Fuhui (eds.). The Fourth Asian Fisheries Forum, China Ocean Press, Beijing, p 158.

*Abstract.* Growth of *Haliotis asinina* fed three different food items was evaluated over a 120-day period. Abalone juveniles fed with *Gracilariopsis heteroclada* and an artificial diet grew better in terms of total weight and shell length than those fed *Kappaphycus alvarezii*. Juveniles fed with the artificial diet had higher total weight than those fed with *G. heteroclada* from day 15 to day 90 but abalone fed with *G. heteroclada* grew better from day 105 to day 120. In terms of shell length, the artificial diet provided better growth than *G. heteroclada* from the start to day 75 but from the day 105 to 120, better growth was observed in juveniles fed *G. heteroclada*. Juveniles fed with the artificial diet and *G. heteroclada* showed some reductions in daily growth rates during the latter part of the growth trial which were attributed to channeling of energy in gonadal development. Histological observations of gonad sections revealed that abalone fed with the artificial diet and *G. heteroclada* were sexually mature, suggesting a possible shift in metabolic energy from somatic to gonadal growth while those fed with *K. alvarezii* were still sexually immature at the end of the 120-day feeding experiment.

Extending the culture period to 360 d indicated that *G. heteroclada* is a suitable food item for long term culture of *H. asinina*. When fed solely on *G. heteroclada*, *H. asinina* grew well, reaching a mean total weight and shell length of 23.96 g and 45.77 mm, respectively during its first year of growth. Likewise, *G. heteroclada* has a high protein content, abundant in nature, farmed commercially, and is available year round.

The fast growth of *H. asinina* and the availability of good quality feed algae demonstrate the potential of commercial abalone farming in the Philippines.





**Catacutan MR.** 1995. Protein and dry matter digestibility of feedstuffs in complete diets for *Penaeus monodon*. In: Z Yingqi, Z Hongpi, Y Chaoqi, L Yi, H Fuyuan, C He and D Fuhui (eds). The Fourth Asian Fisheries Forum. China Ocean Press, Beijing. p 490-494.

*Abstract.* The digestibilities of animal and plant protein sources were determined for *P. monodon* (30 ~ 40 g wet weight). Protein sources were incorporated in complete diets containing the indicator, chromic oxide at 1.8%. Casein (APDC=97.9 %) was highly digested. The APDC values of shrimp meal (*Acetes* sp.) and squid meal were 95.4% and 96.0%, respectively. These values did not differ from those for plant protein sources such as soybean meal (93.4%), yeast (93.0%) and wheat germ meal (91.9%). Fish meal (60.75%), meat and bone meal (73.8%) and copra meal (75.2%) had significantly lower APDC values while shrimp head meal and testis meal were digested at 89%. The TPDC of feedstuffs were generally higher by about 5% than the APDC. A highly positive correlation was observed between APDC and TPDC ( $r=0.97$ ) and between APDC and ADMDC ( $r=90$ ). Protein content of all diets which ranged from 12.9% ~ 60.18% showed no correlation with APDC, TPDC, ADMDC and U'. This study showed that the shrimp has the capability to similarly digest plant and animal protein sources.

**Caturao R, Tackx M, Daro N, and Sanares R.** 1998. Zooplankton distribution during winter using Two-way Indicator Species Analysis (TWINSPAN) and Canonical Correspondence Analysis (CANOCO). In: 7th National Convention on Statistics. Phil. Statistical System & NSTCB, Manila. Vol. II, p 87-103

*Abstract.* Spatial distribution and community structure of zooplankton species and its relationships with the environmental parameters (temperature, salinity, and turbidity and phytoplankton distribution) in

some sandbanks of the Belgian coastal zone was carried out by the use of Two-Way Indicator Species Analysis (TWINSPAN) and Canonical Correspondence Analysis (CANOCO). There were 49 zooplankters identified all over the three sandbanks. Crustaceans were the most dominant sub-phyla represented mostly by copepods. Other members of plankton community were also present like cladocera, appendicularia, pteropoda and the larger omnivores and carnivores such as hypyriid, amphipod, caetognath, ctenophore and fish larvae. TWINSPAN did not show a distinct division of the sandbank stations because of the presence of three dominant copepod species (*Temora longicomis*, *Pseudo-calanus elongatus* and *Centropages hamatus*) in the three sandbanks. Canonical correspondence analysis (CANOCO) showed that species distribution of zooplankton was significantly affected by the environmental variables. This was due to lower salinity values observed around Buitenratel sandbank than Gootebank and Westhinder sandbanks.

Two-Way Indicator Species Analysis analyzed spatial distribution and community structure of zooplankton species over the three sandbanks of the Belgian coastal zone based on species abundance. Canonical Correspondence Analysis (CANOCO) on the other hand, gave an idea on how far these subgroups were related to environmental variables.

**Duray NM, Estudillo CB, and Alpasan LG.** 1995. Optimum stocking density and tank size for larval rearing of the grouper *Epinephelus coioides*. In: Z Yingqi, Z Hongqi, Y Chaoqi, L Yi, H Fuyuan, C He, and D Fuhui (eds). The Fourth Asian Fisheries Forum, China Ocean Press, Beijing. p 48-52.

*Abstract.* The effect of stocking density and tank size on early growth and survival of grouper *Epinephelus coioides* (= *suillus*) larvae were determined. In one experiment, larvae were stocked in 500 L tanks at den-

sities of 5, 10, 20 and 30 per liter and fed rotifers at 15 ind/ml. After 21 d, larvae attained best growth (9.6 mm) and highest survival (32.2%) at 20/L. In another experiment, larvae were stocked at 30/L in 40 L, 200 L and 500 L circular fiberglass tanks. Survival was highest in 500 L (22.3%) and lowest in 40 L tanks (0.5%), but larvae in 200 L tanks were larger (8.2 mm total length, 1.5 mg dry weight) on day 21. Thus in small tanks, 20 larvae / L is the optimum stocking density. In larger tanks of 500 L, 30 larvae / L is feasible.

**Emata AC.** 1993. Maturation and induced spawning of the mangrove red snapper (*Lutjanus argentimaculatus*) reared in a floating net cage in the Philippines. In: F Arreguin-Sanchez, JL Munro, MC Balgos and D Pauly (eds). Biology, fisheries and culture of tropical groupers and snappers. ICLARM/EPOMEX, University of Campeche, Mexico. p 378-384.

*Abstract.* Wild-caught mangrove red snapper (*Lutjanus argentimaculatus*) were reared in a floating net cage at SEAFDEC/AQD's Igang Marine Substation at Guimaras Island, central Philippines. In 1993, monthly samplings and induced spawning trials were conducted as part of a project on seed production. Gonadal development began in February for males and April for females, reached a peak in September and declined in December. Males and females had ripe gonads for up to 5-6 consecutive months. Spawning occurred in the evening (2000-2300 hours), 32-36 hours after a single intramuscular injection of 1 500 IU human chorionic gonadotropin  $\text{kg}^{-1}$  body weight (BW). About 0.53-2.14 million eggs were collected per female (2.5-4.4 kg BW) with fertilization rates of 21-97% and hatching rates of 42-80% resulting in 30-85% normal larvae (straight and without deformities). The results strongly suggest the feasibility of breeding mangrove red snapper in floating net cages. ###



lems and mistakes encountered by neighboring countries have been avoided in planning for aquaculture development.

The aquaculture practices in Brunei are generally mangrove-friendly. Aquaculture is only allowed in identified or zoned areas, and a license is mandatory for fishfarms. Initially, a farmer is granted 4 ha, with the government building the access road, main water supply and discharge canal, and supplying electricity. Two areas are involved in this scheme: the 100 ha farm in Maura district, and a 90 ha farm in Tutong.

These farms have "bio-ponds" which receive effluents from the shrimp pond. Effluent water is allowed to settle before it is discharged back to the main canal, minimizing the loading of surrounding areas with polluted farm water. Research studies are still being conducted to evaluate the effectivity of the bio-ponds.

A silvofishery model is also employed in mangrove crab culture. There is only one farm, and it has 4 modules of crab pen (30 x 30 m). The pen is made of locally available palm tree. Inside the pen are small trenches 30-50 cm wide and 20-30 cm deep where mudcrab juveniles are stocked.

## Indonesia

Sukristijono Sukardjo  
Indonesian Institute of Sciences

The extent and exact limits of mangroves in Indonesia are continually changing because of accretion (deposition of silt and subsequent colonization by pioneer plant species) or erosion (reduction through changes in sea currents). Various sources and methods of assessments have put the total figure between 2.17 and 4.25 million ha. The latest official estimate in 1995 is about 3.5 million ha. These forests are concentrated in Irian Jaya (probably half of the total), East and South Kalimantan, Riau and South Sumatra. The government is committed to conserving 10% of the country's land area and eventually 20 mil-

lion hectares of coastal and marine habitats (mangroves included).

Mangrove use varies from site to site on each island depending on the ethnic population or mangrove dwellers. Generally, mangroves are used for wood and energy production. Around 12 million people live in and around the forests and many more are dependent on coastal resources for subsistence.

The conversion of mangroves to aquaculture (*tambak*), agriculture, coastal infrastructure such as ports, and for industrial, business and housing development has put a severe strain on the remaining mangrove forests. In 1960, it was estimated that *tambak* covered about 145,000 ha. By 1994, this had risen to 270,000 ha.

Another serious threat is the perception among the general public and many government officials that mangroves are worthless and suited only as recipient of urban wastes if not converted to other uses.

The government is currently engaged in a national rehabilitation programme for mangroves which involves replanting of 150,000 ha in areas where mangroves have been cleared and along shorelines that have not been colonized -- Java, Bali, Lombok, South Sulawesi, North Sulawesi, Southeast Sulawesi, South Kalimantan, Lampung, South Sumatra, Riau, and North Sumatra. These areas are the provinces most seriously affected by *tambak* construction. Mangroves may be planted for hazard prevention alone or for a form of sustainable economic use. In the latter case, a basic system of dealing with mangrove-friendly aquaculture called *tambak tumpangsari* or *empang parit* (silvofisheries) was developed. Silvofisheries combine wood and fish output.

The silvofisheries model is being promoted in Indonesia through a national program by the Office of the Directorate General of Fisheries. Two project sites dealing with silvofisheries have been established for demonstration purposes. There are also large scale silvofisheries programs in Cikiang (6,600 ha with 1,508 farmers) and Blanakan (5,300 ha with 2,060 farmers) in West Java under the Perum

Perhutani (State Forestry Corporation).

The culture system used at the farms is mainly polyculture while monoculture is practiced in 24-32% of the farms. The cultured species include milkfish, shrimp, the seaweed *Gracilaria*, and mudcrab. Production and profit vary depending on the site. Further research is needed to assess and evaluate the different silvofisheries models.

Generally, the silvofisheries model is a labor intensive technology appropriate for an individual or family operation. It has been shown as a viable alternative to brackishwater pond culture.

## Cambodia

So Sreymom  
Ministry of Agriculture, Forestry and Fisheries

Cambodia has 85,100 ha of mangrove forests mostly found in Koh Kong province (63,700 ha), Sihanouk Ville city (13,500 ha) and the Kompot province-Kep resort city (7,900 ha). The activities which threaten the mangrove forests include: charcoal production, shrimp farming, establishment of salt pans, rice farming and gathering (and export) of firewood and construction materials.

Intensive shrimp farming covered an area of 850 ha in 1994 with production of 450 tons a year. But disease outbreaks have since reduced the culture area to 20%, with estimate of national losses amounting to US\$28.6 million a year. A moratorium on further licensing of shrimp farms has been enforced.

The government restrictions on aquaculture include: non-encroachment of farms on mangrove forests, waste treatment of water from shrimp farms before water is discharged to the sea, and construction of ponds 150 m away from the shoreline. However, these restrictions are not followed though shrimp farmers are aware of the negative impact on the environment.

Other aquaculture activities such as oyster / green mussel culture are not significant in terms of production and economics.





In general, Cambodia does not have mangrove management / conservation activities such as inventory and reforestation. But there are already many efforts and attempts by non-government organizations and international organizations to collaborate with the government to improve environmental protection.

## Myanmar

U Tin Win

Department of Fisheries

Myanmar has extensive mangrove forests, 382,032 ha, distributed in Ayeyarwady (46.4%), Tanintharyi (36.7%) and Rakhine (16.9%). But there has been substantial reduction of forest cover in all areas over the years mainly attributed to the demand for fuelwood / charcoal production.

Neither intensive nor semi-intensive shrimp farming has developed, and Myanmar is fortunate to have learned from the mistakes of shrimp producing countries like Thailand and the Philippines. But there are plans to develop 40,000 ha of ponds for semi-intensive shrimp culture because the government considers shrimp a potentially large generator of foreign exchange (US\$400-500 million).

As yet, shrimp farmers still practice the traditional, extensive method. About 12,000 ha are operated in Rakhine state, near the border of Bangladesh. The yields are very low, about 100 kg per ha per year. Fish culture of seabass, grouper, milkfish and mullet is still in pilot-scale.

At present, there is no well-developed arrangement for managing the country's coastal and marine zone. Much of Myanmar's coastline is sparsely populated and features natural ecosystems which have suffered relatively little exploitation except in Ayeyarwady Delta.

In the future, integrated coastal zone management approaches will be considered in establishing the policy, planning and regulatory framework to ensure that the coastal zone is managed sustainably.

###

### AQD dialogues ... from p 3

logue were: Hon. Jed Tirol, Tangalan mayor; Hon. Pedro Garcia, Ibajay mayor; Norberto Soliva, Bugtong Bato barangay captain; Cesar Ureta, Aklan BFAR provincial director; Levi Lahaylahay, provincial planning and development officer and the Aklan governor's representative.

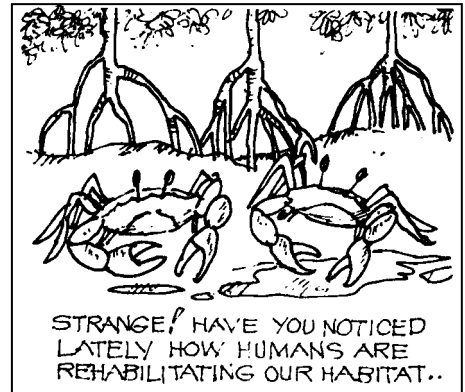
Local and national media based in Aklan were also present. ###

### Quarto / MAP... from p 11

small scale, that aren't using lots of inputs, for instance, chemical inputs and antibiotics, pesticides and don't require the clearing of mangroves to exist and silvofisheries. These have proven themselves in different countries, for instance, Indonesia, Malaysia. The local people can afford to actually implement these systems in their areas. These are what we're looking for. The kind of solution to help the local communities, basically not replace their livelihood.

### Any final, encouraging note on mangroves?

I do think if we replant mangroves and conserve our mangrove forests, we'll find enough fish in our oceans to feed the increasing populations. If we properly manage our fishing techniques, and help preserve and get back the ocean's health, the ocean will be the best place to raise fish for the future. And aquaculture will be used as a supplement, not as a replacement for ocean production of fish products for the future. ###



### Grouper R&D ... from p 21

Israeli Journal of Aquaculture - Bamidgeh 49: 77-83

Tan-Fermin JD. 1992. Withdrawal of exogenous 17 $\alpha$  methyltestosterone causes reversal of sex-inversed male grouper *Epinephelus suillus* (Valenciennes). Philippine Scientist 29: 33-39

Tan-Fermin JD, Garcia LMB and AR Castillo Jr. 1994. Induction of sex inversion in juvenile grouper *Epinephelus suillus* (Valenciennes) by injection of 17 $\alpha$  methyltestosterone. Jap. J. Ichthyol. 40: 413-420

Toledo JD, A Nagai and D Javellana. 1993. Successive spawning of grouper, *Epinephelus suillus* (Valenciennes), in tank and a floating net cage. Aquaculture 115: 365-367

Toledo JD, SN Golez, M Doi and A Ohno. 1997. Food selection of early grouper, *Epinephelus coioides*, larvae reared by the semi-intensive method. Suisanzoshoku 3: 327-337

Toledo JD, SN Golez, M Doi, RS Bravo and S Hara. 1996. Preliminary studies on the rearing of the red-spotted grouper, *Epinephelus coioides* larvae using copepod nauplii as initial food. UPV J. Nat. Sci. 1: 119-129

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## NEW VIDEOS, BOOKS from SEAFDEC Aquaculture Department

NEW VIDEO RELEASES FROM SEAFDEC

### Culture of oyster and mussel using raft method

A 9-minute documentary that depicts the AQD favored method of using the environment-friendly hanging raft for oyster and mussel culture. Scenes show construction of the raft, the site selection process, the two farming phases (spat collection and grow-out), and harvest. Most of the shots were taken at AQD's technology and extension project in Capiz and Aklan, two provinces in west central Philippines. **Price (including postage): P350 in the Philippines; US\$35 for other countries.**

### Grouper culture in brackishwater ponds

An 8.5-minute video documentary that was based on AQD's 17-page manual of the same title authored by AQD's technology verification team headed by Dan Baliao. It shows the different stages of grouper culture: grow-out, harvest, and post-harvest, as well as site selection and pond preparation. It also describes the economics of one grouper crop, and marketing and transport techniques. **Price (including postage): P350 in the Philippines; US\$35 for other countries.**

### Conserving our mangrove resources

A 12-minute video documentary that describes the plight of mangroves in the wake of the fish-pond boom and efforts to sustain them is now on sale. It is suited for science and environment class viewing and for the use of awareness seminars on coastal resource conservation.

**Price (including postage): P400 within the Philippines; US\$40 for other countries.**

### NEW PUBLICATIONS

#### Grouper culture in ponds

A 17-page manual discussing basic information about groupers and detailing brackishwater pond culture: sourcing fry and fingerlings, site selection, pond preparation, nursery operation, grow-out culture, harvest, and post-harvest. It also describes the economics of one grouper crop, marketing and transport techniques and diseases. **Price (including postage): P80 in the Philippines, US\$ 30 other countries.**

#### Sea bass hatchery operations

A 42-page manual updating AQD's 1990 publication of the same title. It details the activities in the seabass hatchery, from breeding until the harvest and transport of fry to fishponds. New section on the propagation of natural food *Moina* and *Diaphanosoma* has been added. **Price (including postage): P100 in the Philippines, US\$ 30 other countries.**

### Biology and culture of siganids

A 53-page monograph updating AQD's 1990 publication of the same title. The book includes siganid morphology, distribution and ecology; reproduction; fisheries; diseases and parasites; genetics. It also covers larval culture; fry and fingerling production; nutrition and feeds; and problem areas in aquaculture. **Price (including postage): P100 in the Philippines, US\$ 30 other countries.**

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Since June 1997, we have merged our two newsletters -- *Aqua Farm News* and *SEAFDEC Asian Aquaculture* -- into a new *SEAFDEC Asian Aquaculture*, the newsletter you're reading now. Update your newsletter subscription (use form below).

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Papers presented at the *Second international conference on the culture of penaeid prawns and shrimps* held 13-17 May 1996 at Iloilo City, Philippines appear in a special issue of the journal *Aquaculture*, volume 164, 374 pages. This journal volume is edited by AQD researchers ET Quintinio and JH Primavera.



## Flyers

*The farming of Kappaphycus*. Introduces the red seaweed *Kappaphycus* with notes on the types of culture systems, the environmental factors required, initial investment needed, and crop management.

*Milkfish breeding and hatchery fry production*. Summarizes the integrated milkfish broodstock and hatchery operation technology developed by AQD.

*Binangonan Freshwater Station*. AQD's R&D on freshwater aquaculture and lake ecology, primarily the Laguna de Bay, is conducted in this station. Species prioritized for research include tilapia, carp and catfish.

These flyers are free upon request. If interested, send request to [sales@aqd.seafdec.org.ph](mailto:sales@aqd.seafdec.org.ph) or fax (63-33) 336 2891, 335 1008.

## Field guide

*Field guide to important commercial marine fishes of the South China Sea*, 284 pages with color photos. Published by SEAFDEC in Malaysia. Also available from SEAFDEC / AQD in Iloilo, Philippines. **Price including postage: US\$48** (may be paid in pesos for local orders). E-mail: [sales@aqd.seafdec.org.ph](mailto:sales@aqd.seafdec.org.ph)

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- [www.agrolink.moa.my/dof/seafdec](http://www.agrolink.moa.my/dof/seafdec)  
all about the SEAFDEC Marine Fishery Resources Development and Management based in Kuala Terengganu, Malaysia.

# Aquaculture can be friendly to mangroves

Contrary to the perception of radical environment lobby groups, the aquaculture sector does not neglect the environmental safeguards in fish production.

The proof is in the efforts of researchers and communities to develop mangrove-friendly aquaculture techniques.

"Our mangrove program," SEAFDEC/AQD Chief Dr. Rolando Platon says, "is a response to the worldwide call for the conservation and preservation of the mangrove resources in Southeast Asia without necessarily sacrificing aquaculture development or precluding the traditional use of mangrove forests by communities."

AQD's mangrove program is one of the topics discussed in the recently concluded *Workshop on Mangrove-Friendly Aquaculture* held at Iloilo City in January.

The workshop gathered almost a hundred participants and observers from the fisheries community in southeast Asia.

Experts say there are several technologies that utilize the mangroves for fish production. Foremost of these is the silvofisheries model exemplified by Indonesia. This model is low input aquaculture that is sustainable.

In silvofisheries, mangroves may either be found inside or outside the pond. Mangroves inside the pond may take up 60-80%, while the rest of the area -- natural canals -- can be deepened and stocked with fish, shrimp, mudcrab or seaweeds. If mangroves are outside the pond, they usually act as biological filters to pond effluents before these are discharged to surrounding waters.

The experts also note that unlike early aquaculture development projects, clear cutting of mangrove trees are no longer allowed by most governments in South-



PHOTOS BY R. BUENDIA

An example of mangrove-friendly aquaculture is this site in Tangalan, Aklan (west central Philippines) where mangrove trees are left alone to grow inside pens that hold mudcrab stock.



east Asia. Environment impact assessments are usually necessary in getting approval for development projects. Most countries also

decree by law a certain percentage of total mangrove cover as conserved / preserved sites.

In the Philippines, communities are pioneering the culture of mudcrab in pens installed in mangrove sites (a variation of silvofisheries). AQD alone has 4 projects with different communities and local governments (in New Buswang, Tangalan, and Bugtong Bato all in the province of Aklan and in Brgy. Manalo, Puerto Princesa in Palawan province).

Mangroves serve as spawning and nursery grounds to fishes and crustaceans which are also important to aquaculture. The fishfarming community has not forgotten that its own survival depends on the mangrove resource.

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Entered as second class mail matter at  
PPC Tigbauan, Iloilo 21 July 1995

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