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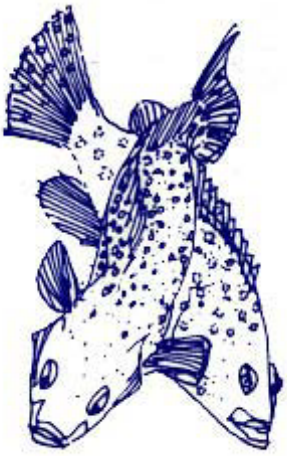
Farming Lapu-lapu

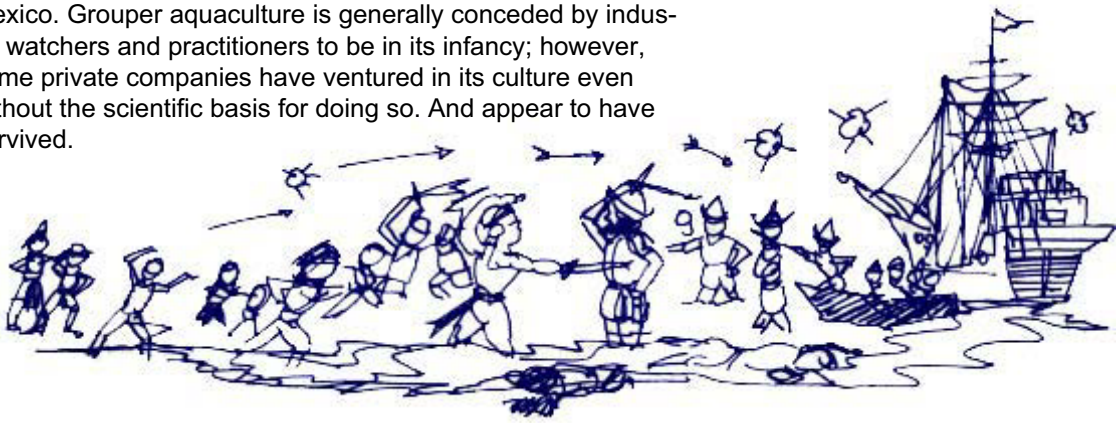


There are two Lapu-lapus who figured significantly in the social and economic history of the Philippines.

Lapu-lapu, the man, was a Mactan (Cebu) chieftain who stood his ground against the first Spanish conqueror, Magellan, in 1521. He opposed the intrusion of foreign beliefs and way of life.

Not so Lapu-lapu, the fish, which is farmed so docilely under controlled conditions and so successfully it seems, although reports of its culture appeared only in the late 1970s.

The Lapu-lapu fish is known to the scientific community as grouper with the genus *Epinephelus* as the most abundant. Groupers are some of the country's delicious and highly priced foodfish. They are also popular in Kuwait, Indonesia, Malaysia, Thailand, Hongkong, Taiwan, Republic of China, Japan, and Mexico. Grouper aquaculture is generally conceded by industry watchers and practitioners to be in its infancy; however, some private companies have ventured in its culture even without the scientific basis for doing so. And appear to have survived.



This issue presents a review of grouper aquaculture in Southeast Asia. It also reports studies on grouper conducted at SEAFDEC Aquaculture Department, some industry trends, and technology tips from research and academic institutions. Grouper biology is also discussed as well as grouper markets.

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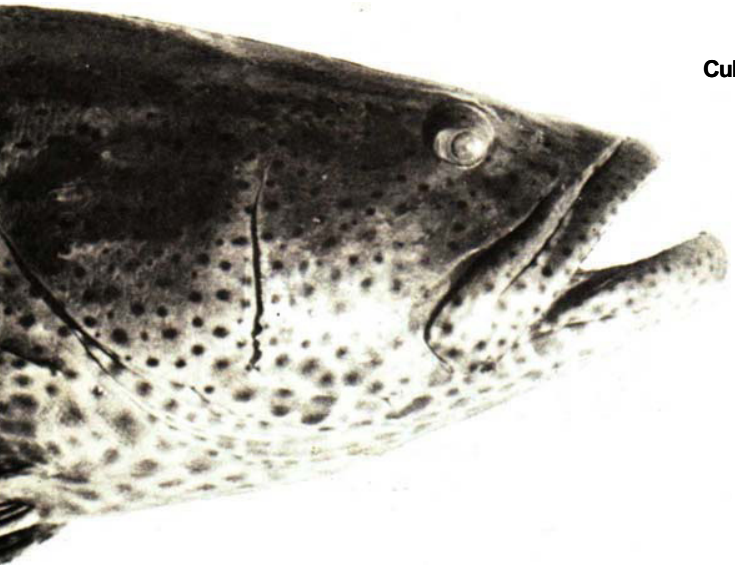

Grouper aquaculture in Southeast Asia

Some species of groupers such as estuarine grouper, black-spotted grouper, brown-spotted grouper, red grouper, and red-spotted grouper have been found to be suitable for aquaculture. Grouper culture can be conducted both in cages and in ponds. However, cage culture is more popular than pond culture in many countries. The major constraint to large-scale development of grouper culture is the shortage and uncertain supply of fingerlings from the wild.

Artificial breeding has been done in many countries such as Singapore, Thailand, Kuwait, and Japan. The hatchery techniques are still under experiment. However, research efforts have been directed at larval rearing techniques aimed at achieving sufficient supply of fingerlings.

Culture species and methods

Culture species. Groupers have been cultured in Southeast Asia for more than 10 years. *Epinephelus tauvina* was the first recorded species for culture in Kuwait, Singapore, and Thailand while *E. salmoides* have been cultured in Penang, Malaysia. At present, many species of grouper are cultured in Asia (Table 1). However, only *E. tauvina, E. salmoides,* and *E. malabaricus* have been cultured in commercial scale in Southeast Asia and Middle East. *E. akaara* have been cultured in Japan and China.

Culture methods. Cage culture has been practiced in many countries such as Thailand, Malaysia, Singapore, Philippines, Indonesia, and Hongkong, while pond culture has been reported in the Philippines. Cage culture has some advantages like:

- Cages are set in sites with better aquatic environmental condition. Therefore, cages can be stocked with more fish than ponds;
- Cost of cage preparation is less than the cost of pond construction;
- Cage culture does not need water changing and elaborate preparation, thus, its operation is less costly than pond culture.

Floating cages

Galvanized iron or wooden parts are used for the cage frame in Thailand, Singapore, and Malaysia. The cage is kept afloat by styrofoam drum, plastic carbuoy, or bamboo. In the Philippines, wooden parts are used for the frame. Styrofoam drum, plastic carbuoy, or

Table 1. Species of grouper cultured in some countries in Asia.

Species	Common names	Countries
1. *Epinephelus*		
E. malabaricus	Black spotted grouper	Thailand, Philippines
E. salmoides	Estuarine grouper	Malaysia, Thailand
E. tauvina	Brown spotted grouper	Singapore, Kuwait
E. akaara	Red spotted grouper	Japan, Hong Kong, China
E. amblycephalus	White-spotted green grouper	Hong Kong, Philippines
E. bleekeri	Yellow-spotted grouper	Philippines, Hong Kong
2. *Plectropomus leopardus*	Leopard grouper	Indonesia, Singapore
3. *Cromileptes altivelis*	Hump-backed grouper	Thailand

Table 2. Suitable water quality for cage culture of grouper.

Parameter	Range
pH	7.5-8.3
Dissolved oxygen	4-8 mg/l
Salinity	20-32 ppt
Temperature	26-32°C
Ammonia-nitrogen	< 0.2 mg/l
Current	normal

bamboo are also used for supporting the cage frame.

Cage is usually 5 m × 5 m × 5 m in Thailand. However, 3 m × 3 m × 3 m cages are used in the Philippines.

Stocking density

At present, grouper fry are collected from the wild. Fry of size 7.5-10 cm are usually collected by fish trap from coastal water near mangrove areas. The fry are first stocked in nursery cages. Stocking is done separately for each size group to prevent cannibalism. Suitable water quality for cage culture of grouper is presented in Table 2.

The stocking density up to the marketable size varies from 10 to 100 fish per m^3. This is due to insufficient supply of fry.

Feeding

Groupers are carnivorous and voracious, taking live fish and crustaceans as food. However, it is not difficult to train the grouper to feed on trash fish. For the first two months of culture, feeding rate is 10% of body weight. After that, it can be reduced to 5%.

Supply of trash fish is always insufficient and expensive in some seasons and areas. Artificial diets can be recommended for feeding. It is easy to train grouper to feed on artificial diet. Growth rate is similar to fish fed trashfish (Table 3).

Table 3. Growth of grouper at different stocking densities in cages

Culture period (days)	Stocking density	
	*58/m^3	**100/m^3
0	83.7	26.9
30	158.7	45.6
60	186.5	65.9
90	243.9	98.7
120	283.7	137.0
150	296.8	217.1
180	355.8	312.4
210	433.9	387.6
250	-	586.6

*Fish fed trashfish; **fed artificial diets.

Market size and rearing period

Market- sized fish varies from 0.5 to 1.3 kg. In the Philippines, fish of high demand ranges from 0.5 to 1.0 kg. In Thailand, 1.3 kg fish are usually exported live by air to Hongkong.

Fish cultured in net-cage can reach 0.6 kg in 8 months.

Polyculture of grouper and other fish

Polyculture of grouper and tilapia have been reported in the Philippines. A ratio of 1 grouper to 20 tilapia proved to be the most effective in earthen ponds. Grouper yield is higher since they fed on tilapia fingerlings.

The basic construction of the polyculture pond is similar to milkfish or shrimp ponds. A suitable site with salinity higher than 10 ppt is preferred. However, feeding techniques, water management, growth rate, and food conversion ratio should be studied in more detail.

Marketing

Grouper is more expensive than most other fish species in Thailand. The local demand is rather limited. At present, production from cage culture in Thailand is exported live by air to Hong Kong. The demand is year-round. Therefore, the income from grouper could be more than the other species. In Singapore, production from cage culture is only sold live in the local market.

Source: S Tookwinas. *1989. Review of knowledge on grouper aquaculture in South East Asia.* In: **Proceedings of Advances in Tropical Aquaculture**; 20 Feb - 4 Mar 1989; Tahiti. AQUACOP IFREMER, Actes de Colloque: 429-435.

Grouper studies at the SEAFDEC Aquaculture Department

Recent reviews of grouper aquaculture in the Philippines like that made by SEAFDEC researchers Gerald Quinitio and Joebert Toledo had noted these constraints in the industry's expansion: (1) inadequate knowledge of biology and ecology of the species, (2) insufficient supply of fry, (3) absence of appropriate techniques for culture, (4) lack of trained personnel, and (5) inadequate support from financing institutions.

The researchers noted that the present culture techniques used in the grouper industry have mostly evolved from experiences of operators with little support from research institutions. Available fast-growing species with high market value should be identified and the appropriate culture techniques for. these species developed.

Also, grouper production in the country is hampered by inadequate supply of fry for stocking. This shortage is aggravated by the absence of appropriate techniques in handling, transport, and storage of fingerlings collected from the wild. Local farmers have to compete for the available supply with those engaged in the foreign market. Research on seed production should, therefore, be intensified.

There is also lack of appropriate techniques for efficient culture of the fish. Optimum stocking density and feeding regime in ponds and cages should be determined. To minimize dependence on trash fish for feeding, a low-cost practical diet for culture should be developed and the polyculture system with tilapia actively pursued.

To date, lack of skilled manpower for hatchery and grow-out culture plagues the industry. Government and other institutions should consider sponsoring training programs or undertaking intensive information campaigns to disseminate available techniques.

At the SEAFDEC Aquaculture Department's Tigbauan Main Station, little research on grouper* was conducted prior to 1987. In this year, grouper was officially included as a priority species for research. Since then, rapid progress has been made.

1984. The Aquaculture Department first studied grouper in 1984. However, this lone study on the induced spawning of grouper using human chorionic gonadotropin (hCG) and Chinese carp pituitary achieved very limited success. Little milt was obtained from males, hence only 4% of the eggs were fertilized. Subsequently, only 50% of the eggs hatched.

1986. A follow-up study in 1986 using hCG + pituitary gland and luteinizing hormone-releasing hormone-analogue (LHRHa) succeeded in spawning grouper. Lower dosages of the hormones, however, only allowed artificial fertilization by stripping. Larval rearing

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*It has been clarified that grouper studied by AQD is of the species *Epinephelus suillus* and not *E. malabaricus, E. salmoides,* or *E. tauvina* as previously reported.

trials gave 9% survival until day 30 of larvae reared on the plankton *Isochrysis,* sea urchin eggs, and the rotifer *Brachionus.*

1987. Work on the taxonomy and identification of epinepheline fishes in the Philippine archipelago was published by Hiroshi Kohno, a visiting JICA expert on finfish aquaculture. In the same year, ADSEA I *(Seminar-Workshop on Aquaculture Development in Southeast Asia;* 8-12 Sept. 1987; Iloilo City) included grouper among the finfish prioritized for research. Specific areas for study included:

- development of breeding techniques;
- development or adaptation of nursery and grow-out techniques;
- development of practical diets;
- investigation of disease agents in grouper culture systems.

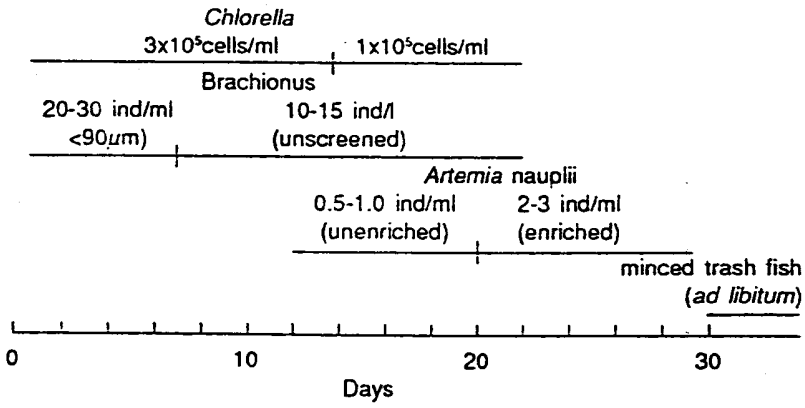
1988. As a result of ADSEA I priorities, a lone study, again on induced spawning and larval rearing was implemented in 1988. This study ran through 1989 and particularly focused on sex inversion of females to males, the number of male grouper being a constraint in spawning trials. The use of 17 α-methyltestosterone (MT), however, did not induce adult female spawners (3-9 kg body weight) to invert sex. A single implantation of LHRHa also did not trigger spawning.

1987. Two studies on sex inversion showed promising results. In the first study, female grouper showed signs of sex inversion three months after biweekly injections of 0.5-5 mg MT/kg fish weight. Only fish weighing 1.2 kg underwent spermatogenesis; milt was expressed after six months, or less for higher hormone doses. In the second study (continued in 1990), preliminary histological observations of gonads indicated no differences between fish fed diets with or without the hormone mibolerone.

It was in 1989 that a study on feed development for grouper fry was initiated. This baseline study showed that practical diets with 30% soybean meal, 25% squid meal, and 25% squid liver meal produced fry with the highest survival rate and maximum increase in body weight.

Another study implemented was identification of bacterial disease affecting grouper. *Vibrio* was isolated in cage and tank-held grouper broodstock. Infected fish responded well to oxytetracycline-hydrochloric acid treatment.

1990. A landmark AQD achievement in research was the first spontaneous spawning of tank-held grouper broodstock, yielding close to a million eggs of which 97% hatched. The spawners were six females (3-5 kg) and four males (7-12 kg). Spawnings occurred for 12-21 consecutive days every month from July to December. Indeed, grouper broodstock technology advanced by quite a distance, and hopes are high that soon to follow is hatchery technology that would solve the problem of grouper fry supply. More significantly, the spawning success would in the long run establish grouper culture as another alternative to shrimp culture. This study on broodstock development for seed production which is continued to the present has consistently given 6-15 spawnings per month from Jan to Dec. Daily egg collection hit the 2 million mark and fertilization and hatching rates rose to 87-94%. Hundreds of metamor-



Feeding scheme for larval rearing of Epinephelus suillus presently employed at SEAFDEC/AQD.

phosed larvae are now being reared at the Tigbauan Main Station. The feeding scheme is shown above.

Other studies in 1990 which also showed promising results were: (1) induction of sex change in juvenile grouper by intraspecific interaction - 4% of juveniles possessed ovotestes 11 wk after different-sized fish were stocked in communal tanks; and (2) development of a dry diet for grouper fry - among the dry diets, that with fermented soybean meal as attractant showed the best result; fish fed minced fresh fish gave close to 100% survival.

1991. A survey of grouper fry in the northeastern coast of Panay Island is ongoing and this noted that fry started to appear in July until Nov. Other studies still in progress include:

- Grouper culture in ponds given artificial diets; started 1990
- Egg quality evaluation; 1991
- Development of larval rearing techniques: food and feeding; 1991
- Biological studies on seed production: (1) effect of light intensity and food coloration on growth and survival and (2) comparison and importance of dietary value of live and artificial food; 1991

1992. Approved studies are as follows:

- Reproduction of hump-back grouper (*Cromileptes altivelis*)
- Effect of salinity on survival of *Epinephelus suillus* fry
- Development of larval rearing techniques for *E. suillus:* food and feeding
- Biological studies on seed production of *E. suillus.* II. Comparison and improvement of dietary value of live and artificial food
- Metabolic energy requirements of selected finfish larvae
- Survey of finfish fry in the coastal areas of Capiz.

Grouper research priority for 1992-1994

(1) inventory and taxonomy
(2) identification of suitable species for culture
(3) development of breeding techniques
(4) broodstock development
(5) development of rearing techniques for hatchery and nursery
(6) development of artificial feeds for nursery and grow-out
(7) induction of sex inversion

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Industry Trends

As BFAR sees it...

Aquaculturists of the Bureau of Fisheries and Aquatic Resources (BFAR) told newsmen that the agency has been encouraging fishpond owners to shift to grouper culture.

"Prospects are very bright for grouper culture in ponds," said Lutgarda Penolio, Chief of the brackishwater section of BFAR and grouper culture consultant at the Technology and Livelihood Research Center (TLRC).

"Pound for pound, live grouper today commands a price in the international market almost as high as that of shrimps. So, we should consider that growing lapu-lapu is far simpler and less costly than growing shrimp. Grouper is also sturdier and has bigger chance of survival in captivity," she said.

Grouper is raised in ponds and cages in many areas of Bulacan, Quezon, Mindoro, Pangasinan, and Iloilo.

Small-scale grouper culture started in the mid-70s, but it was only two years ago that its dollar potential was realized. At present, local grouper culture is not as widespread as shrimp and milkfish and its technology, especially cage culture method, is not as advanced as in Hongkong, Singapore, and Taiwan.

"The labor and feed-intensive nature of cage culture method compelled us to concentrate more on improving the traditional method of pond culture, which, as in the case of lapu-lapu ponds in Binuwangan, Obando, Bulacan, has already proved to be successful," said Penolio.

She said BFAR is now trying to shorten the culture of the species and develop other lapu-lapu feeds.

Source: AG Chua, *"Lapu-lapu" is potential dollar earner.* **The Manila Times.** 4 Mar 1989.

According also to BFAR, grouper fisheries production in the Philippines increased from 13 817 t in 1978 to 24 403 t in 1984. Although this contribution is very low in volume, grouper fisheries is significant in terms of both domestic income and export earnings. For over seven years, 85.52% of grouper production was contributed mainly by the artisanal fishermen, using the hook and line, longline, handline, gill net, fish corral, fish pot/trap, and spear gun as his fishing gears. The export value of this fish, both live and frozen, has increased tremendously from P10 915 to P4.6 million, with Hong Kong and Singapore as the major markets. Other markets include USA, France, Germany, Italy, Japan, Australia, Taiwan, and Malaysia.

in Samar...

In Guiuan, eastern Samar, there are seven genera and 25 species of groupers that have so far been identified and three more species whose identification has to be confirmed. The fishermen are encouraged to catch more than what they could consume because of a ready market in the town's public market or in buying stations.

A trading company buys live grouper from fishermen every day and stocks them in floating net cages for shipping to Hongkong. Another source of livelihood for Guiuan fishers is the sale of small fishes which serve as food for live grouper of the trading company.

Source: CR Pagdilao. *Harnessing grouper fishery for the small fisherman.* **The PCARRD Monitor**, V.15(1), Jan 1987.

in Bulacan...

Grouper culture in ponds in Obando, Bulacan was spearheaded by Alfredo Santos, one of the eight fishfarmers in the area currently engaged in the activity.

The grouper farm is located in the Binuanganlsland along Dampalit River. Five hectares are devoted to grouper culture, 1 ha for polyculture of milkfish and prawn, and 0.3 ha for the production of salt. The ponds range from 0.3 to 1.5 ha each. The dikes of the ponds are reinforced with bamboo stakes and nets to ensure that clay and rocks do not slide back into the pond area.

Mr. Santos and other farmers obtain grouper fingerlings and juveniles from Manila Bay, Bataan, and Cavite. Length of grouper for stocking range from 7.6 to 15.2 cm. The export quality fingerlings cost 25 for 12.7 cm in size and -17 for < 5.1 cm size.

Grouper is fed tilapia fingerlings purchased from tilapia farmers in Malabon, and with marine fishes locally known as *kapag.* The frequency of feeding depends on the amount of the remaining tilapia in ponds. Usually 5-10 *bañeras* (1 *bañera* = 45 kg) of live tilapia are broadcast into a 1 -ha pond every 2 wk. For one cropping cycle (6-8 months), 100-200 *bañeras* of tilapia (200/*bañera*) are required per hectare. The culture period lasts for 6-8 months, wherein the fish attains 0.5 -1 kg weight. Out of 5000 fingerlings stocked, at least 4000 attain marketable sizes. Survival rate ranges 80-96%.

In harvesting market-sized grouper, Mr. Santos either drains the pond completely or scoops out the fish by using hook and line or nets: The fish are placed in plastic cages for transport to the market. Grouper can stay alive for about an hour out of water.

Mr. Santos sells the live grouper to hotels and restaurants or in the Aranque market where the family owns a stall. He usually delivers 200-300 kg/day of grouper in selected hotels and restaurants in Metro Manila. He sells grouper for P180-220/kg.

Source: DL de Guzman. *Grouper farm in Obando: A bright prospect.* **PCAMRD Waves**. V. 1 (1), June 1988.

in Dagupan...

Lapu-lapu culture has greater money-making potential than you think, it could rival, if not surpass, the phenomenal shrimp industry. That's the opinion of Joe de Guzman who has been growing lapu-lapu in floating cages in Barangay Salapingao, Dagupan City during the last five years.

Joe has been operating a 2500 m^2 area where he has set up 100 floating cages of 2 × 2 m each. Each cage has a double net. The structure includes styropore raft and wooden planks measuring 5 cm × 25 6 m. 6 m. The materials are costly so a cage normally costs about P2000 to build. The cage has a service life of at least one and a half years.

Can you recover the high cost of the cage?

Easy, according to Joe.

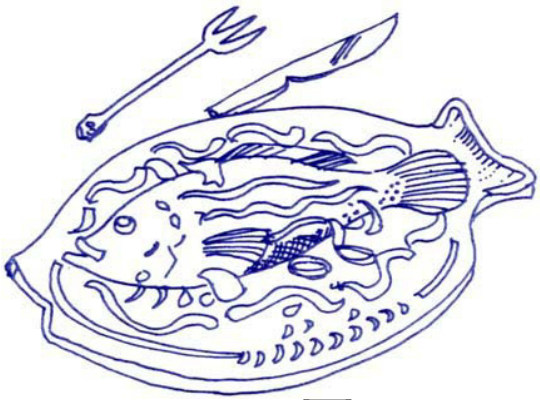
Here's how. Usually, 13-cm fingerlings costing P30 each are used for stocking. In the early stage, one cage will contain 300 to 400 fingerlings. Three months after stocking, some will have to be transferred so that there will be more room for the growing fish, leaving 200 per cage.

Six to seven months from stocking, *lapu-lapu* is usually ready for sale. One live fish normally fetches P120 ex-farm. Expenses in-

clude P30 for the fingerling and another P30 for feeding and care.

From one harvest, therefore, the 200 lapu-lapu will give you a gross of P24 000. Subtract the fingerling cost (P6000) and the cost of feeds and care (another P6000) and you will have P12 000 left. Deduct the entire cost of the cage (P2000) and you will still have P10 000 left. And you can use the cage without repair for two more croppings. Very clear, isn't it? Multiply that by a hundred if you have 100 cages and you'll really be impressed.

Source: Z Sarian. *Lapu-lapu is a sleeping giant.* **Agribusiness Weekly**, 7-13 Apr 1989.



In Taiwan...

Greater profits made C.H. Shieh switch from tiger shrimp *(Penaeus monodon)* to grouper cultivation eight years ago. Mr. Shieh has 25 years of aquaculture experience in Yang An, located in Kaohsiung, southern Taiwan.

The selling price for 1 kg of grouper is $500 New Taiwan (NT) dollars (US $18.50) compared to NT $270 (US $10.00) for one kg of tiger shrimp (NT $27= US$1). Grouper is considered a delicacy throughout Asia. Grouper cultivation has also spared Mr. Shieh from the deadly disease that plagued many Taiwanese shrimp farms in 1988.

The 5-ha farm has 11 earthen ponds measuring 100 m × 50 m × 2 m deep. Seawater is pumped through the ponds at 20% of pond volume per day. Using 32 1-hp aerators increase yields by 30% and add to profits for this veteran farmer.

Grouper fingerlings (4.6 cm) are stocked at 30 000-40 000 pieces per pond. Harvest size varies with customer demand. A 1 -yr grow-out produces 0.6-kg size; a 19-month grow-out yields 2-kg size. Production is 30 000 - 40 000 kg/ha/yr with 80% survival.

Source: *Greater yields, profits and more.* **Aqua - O_2 News,** V.2(1), May 1989.

Diseases of Penaeid Shrimps in the Philippines

This manual by SEAFDEC/AQD senior fish health researchers is available under a **new** cover.

First printed in 1990, the manual is considered to be AQD's best seller. It notes the viral, bacterial, fungal, protozoan, and nutritional-toxic-environmental diseases of the three major species of shrimps cultured in the country: *Penaeus monodon, P. merguiensis,* and *P. indicus.* The manual also details the common names of the diseases, causative agents, species affected, stages affected, gross signs, effects on the hosts, and methods of prevention. Illustrations are in full color.

It costs P200. Write to Sales/Circulation, SEAFDEC/AQD, Tigbauan, Iloilo 5021.

Technology TIPS

from Bicol University (BU) College of Fisheries in Tabaco, Albay

Pond requirements. Any traditional milkfish or tilapia pond can be utilized in grouper culture. For maximum productivity the following considerations must be met:

1. Good water quality with a salinity of >10 ppt.
2. Water depth of at least 1 m.
3. Pond structure that can be easily flooded or drained.

Pond preparation

1. Drain the pond.
2. Cultivate (upturn or plow) the pond bottom.
3. Prepare the pond bottom and make it slope gradually towards the gate.
4. Repair the dikes and gate.
5. Install screen in the gate.
6. Eradicate pests and competitors. Apply any of the following on the pond bottom.
   a. Tobacco dust or shavings at 500-2000 kg/ha or commercial nicotine at 12-15 kg/ha, depending on density of pests.
   b. Commercial saponin at 10-15 kg/ha or teaseed cake at 150-200 kg/ha.
   c. Derris root at 40 kg/ha. The roots are cut into small pieces and soaked overnight in water. Remove the roots from the water to crush them. Then put back in the water in which they were soaked and squeeze to extract rotenone. This solution is applied directly to the pond.
   d. All the above applications must be done with the water depth kept at 10 cm and the application should be made during sunny days between 9:00 a.m. to 2:00 p.m.
7. Apply lime to pond bottom to raise soil pH to its optimum level (6.0-9.0). This will prevent abrupt change in water pH during heavy rain.
8. Place used tires, PVC pipes, dried tree stumps, etc. in scattered locations throughout the pond to serve as shelters.

Culture methods. Grouper is cultured in two ways: monoculture and polyculture.

In monoculture, grouper is stocked at 5000/ha and fed chopped trash fish or live tilapia fingerlings. In polyculture, the combination is 1000 grouper and 15 000 tilapia per ha. Tilapia is stocked at a sex ratio of 1 male to 5 females.

Tilapia is stocked two months ahead of grouper to give them enough time to spawn and produce young ones that become the live food of grouper. The presence of young tilapia will prevent the original tilapia stock from being devoured by grouper as the young ones become easy prey. To enhance tilapia reproduction, it is fed formulated diets.

Stocking fingerlings. Grouper fingerlings should be at least 8 cm or 20 g. They should be of uniform size to avoid cannibalism, i.e., bigger ones eating smaller fingerlings.

The preferable time for stocking is the cooler parts of the day. Proper handling is necessary to minimize stress on fish.

Feeding stock. The ideal feed for grouper is live tilapia fingerlings. If not available, chopped trash fish is a good substitute. Volume of feed should be at least 10% of fish body weight contained in feeding trays placed near the shelters.

One thing to remember in feeding is to remove and take out excess or unconsumed feed. This will prevent pollution caused by decomposing feeds.

If feed is consumed within an hour after it is given, the amount of feed may be increased.

Water management. Change the pond water as frequently as possible to maintain at least 3 ppm dissolved oxygen.

To maintain salinity at 10 ppt, partially change the water after heavy rains. This can be done by getting the surface water out of the pond and replenishing it with tidal water.

Harvesting. Stocks are harvested in 8-10 months. Fish should normally weigh 500-900 g each.

Water is totally drained in harvesting. The gate is provided with bamboo screens. Grouper can be easily collected since they congregate in the shelters.

After collecting the fish, they are sorted and stocked in *hapa.*

Marketing. For maximum profit, grouper is marketed live, since live grouper commands a price 300% higher than frozen ones.

To keep grouper alive, it is placed in oxygenated plastic bags placed inside styrofoam containers. Each bag contains 3 l water and packed with 3-5 pieces of fish weighing 3 kg total.

To regulate temperature and maintain the proper coolness during transport, ice is placed inside the styrofoam containers where the plastic bags are contained.

With such proper handling, the survival rate should normally be 90-100%.

Source: JV Manzano and VB Manzano. *Pond culture of Lapu-lapu.* **Outreach,** V. 13(1), Mar 1990.

BU on pen/cage culture

Fish culture in pens or cages could bring more income to small-scale rural farmers especially when traditional low-investment materials are used.

Site selection. It is important that the cultured fish in cages or pens are provided with: enough oxygen in the water, plenty of food and favorable environmental conditions (moderate currents and waves and minimum pollution).

The basic principles in selecting sites for floating cage culture are good water quality, adequate water exchange, and freedom from predators and natural hazards.

Bays, lagoons, straits and open coasts protected from strong monsoonal winds and rough seas are good sites for cages. These locations are usually affected by tidal flushing. Except in lagoons, salinity change in these sites is low and the environmental conditions are stable.

It is also important to examine the degree of nutrient enrichment of the water since too much enrichment may encourage the growth of destructive organisms.

Cage design. For pelagic species such as threadfin bream (Polynemidae) and the jack (*Carangoides*) which swim continuously near the surface, bigger nets in circular or hexagonal cages may be more suitable.

For demersal fish such as grouper (Serrankfae) and marble goby (Gobidae) which are less active and stable in habits and which prefer to hide under any structure, square or rectangular cages are advisable.

The practical size of the cage for estuary grouper is 3-11 m^2 where the stocking can range from 360-1320 fish at a stocking rate of 60 fish/m^3 for size less than 1 kg.

The parts of a floating net cage are: the floating unit, the framework, the net cages, and the anchorage facilities. (For details of such construction, the interested party may inquire from BU College of Fisheries in Tabaco, Albay).

Once a site has been selected, the physical facilities established and the cage stocked, the farm manager has to ensure that: (a) the fish grow at expected rate, (b) loss of fish due to disease and damage to nets from predators or foulers are minimized, (c) nets are regularly maintained and cleaned, (d) feeding is optimized through provision of suitable feeds for different sizes of fish at the right time of the day and at the right amount and frequency, and (e) regular grading of the stocked fish and routine checking of the water quality throughout the operating periods are carried out.

Cage maintenance. The nets are changed once a week for smaller mesh size of 0.635 cm, once every two weeks for mesh size between 1.27 cm and 2.54 cm, and once a month for those above 3.81 cm.

Regular checking of the conditions of the nets for wear and tear is most important since the netting might be torn by predators like the puffer fish or by the sharp edges of barnacles.

Stocking and grading. The highest stocking density per cage for each species in mono- or polyculture should be carefully determined. In order to reduce the effect of the dominant fish in the culture population, grading by size is necessary. This would not only contribute to rapid growth but also ensure uniform sizes. Grading is usually done by hand every two weeks.

Predators and poaching. The hairy-nosed otter is the most common predator that may attack the cultured fish in cages. They have sharp teeth and strong claws which can easily tear the polyethylene netting and can kill the cultured fish in a short time. Fencing the cultured site with galvanized wire mesh prevents the otter from entering. Watch dogs can also drive away otters. Trapping otters is also a solution.

Source: VB Manzano and JV Manzano. *You can raise fish in pens or cages.* **Outreach** V. 12 (1). March 1989.

from Cagayan State University

Given the fishery resources of the region, Cagayan State University researchers conducted a study of grouper culture in Buguey Lagoon, Cagayan, and a survey of grouper fry grounds in selected rivers of Cagayan.

The grouper cage culture was done in a lagoon along the coastal barangays of Buguey, Cagayan, covering a total area of 120 m^2. The growth of three species of grouper, *Epinephelus bleekeri, E. tauvina,* and *E. sexfasciatus* was evaluated at stocking densities of 45 and 60 fish/cage. The fish were reared for 5 months in 1 m x 1 m x 1 m net cage (3-mm mesh size).

Grouper was fed chopped trashfish twice a day at 15% of fish biomass and sampled at 30-day intervals. While there was no significant difference in weight and length among the three species, weight gains were significantly higher at 45 than at 60 fish/cage. The highest average weight gain of 101.53 g/month was achieved by *E. tauvina.* Average final weights of 609.2 and 529.4 g at 45 and 60 fish/cage, respectively, were attained.

On the other hand, a 9-month survey of fry gatherers and buyers was undertaken by CSU researchers headed by R.C. Culasing to determine the production and seasonality of grouper fry, and the catch per unit effort of fry gatherers in the rivers of Buguey, Gonzaga, Baua, Abulug, Pamplona, Pata, Cabicungan, and Cagayan.

Grouper fry were found in Buguey River and Gonzaga River in January to September, with the peak catch in February and August. Buguey River had the highest number of grouper fry collected, followed by Gonzaga River and Baua River. Fry catch was estimated at 894 200 in Buguey River and 578 500 in Gonzaga River from January to September 1989.

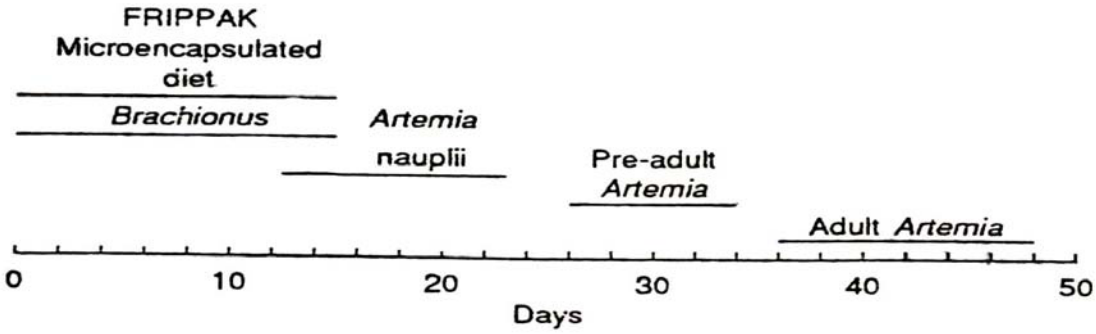
With the area's fishery resources and the R&D efforts of CSU, Cagayan's grouper industry - one of the country's leading edges in fisheries - may be on its way towards full development to boost the local economy.

Source: **Currents,** PCAMRD, 6 Aug 90; **The PCAMRD Waves,** V.3(3), July-Sept 1990; **Philippines Journal**, 31 Oct. 1990.

from a private hatchery

Attempts to spawn grouper have also been conducted by the private sector. A mature male (15 kg) and female (6.5 kg) *E. malabaricus* injected with 100 μg LHRHa/fish twice at 24-h interval spawned naturally in a canvas tank. Approximately 120 000 spawned eggs were collected of which 44 800 hatched.

This private hatchery had also successfully used FRIPPAK microencapsulated diet in combination with *Brachionus as feed* for early larval stages (Day 1-10) of *E. malabaricus. Brachionus* was solely used from Day 11-15, *Brachionus* + *Artemia* nauplii from Pay 12-24, pre -adult *Artemia* from Day 25-34, and adult *Artemia* from Day 35-50 (figure on p. 13). A sur-



Feeding scheme for larval rearing of Epinephelus malabaricus followed by a private hatchery.

vival rate of about 14% was obtained on Day 50 using this feeding protocol.

Feeding scheme for larval rearing of *E. suillus* followed by the SEAFDEC Aquaculture Department is noted on p.6.

Source: GF Quinitio and JD Toledo. 1990. *Mariculture Techniques for Epinephelus sp. in the Philippines. In:* RD Guerrero III and MP Garcia Jr (eds). 1991. **Advances in Finfish and Shellfish Mariculture; Proceedings of the 1st Phil.-French Technical Workshop on Advances in Finfish and Shellfish Mariculture;** 24-26 Oct. 1990; Los Baños, Laguna.

SEAFDEC/ AQD's *1991 Report* is available

The 1991 Report of SEAFDEC Aquaculture Department, *Better life through aquaculture,* is available in July. The Report notes achievement in research, training, and information; it also contains AQD's program for the next three years (1992-1994).

Write to: Sales/Circulation, Training and Information Division, SEAFDEC/AQD, Tigbauan, Iloilo 5021.

GROUPER STUDIES AT SEAFDEC... FROM P.6

(8) fish health control, and
(9) international market.

The AQD research team for sea bass - grouper - snapper that will closely follow the above priorities are:

Marietta Duray, team leader, with team members: Arnil Emata, Josefa Fermin, Luis Ma. Garcia, Joebert Toledo, Gerald Quinitio, Ruby Bombeo, Demetrio Estenor, Armando Fermin, Fe Estepa, Junji Imayoshi, Antonio Castillo, Mae Catacutan, Relicardo Coloso, Renato Agbayani, Eduard Rodriguez, Noel Solis, Norio Yasunaga, Soichiro Shirahata.

It is hoped that within the decade, grouper technology will be developed.

Sources: (1) GF Quinitio and JD Toledo. 1990. *Mariculture Technique for Epinephelus sp. in the Philippines.* In: RD Guerrero III and MP Garcia Jr (eds). 1991. **Advances in Finfish and Shellfish Mariculture; Proceedings of the 1st Phil.-French Technical Workshop on Advances in Finfish and Shellfish Mariculture;** 24-26 Oct. 1990; Los Baños, Laguna. (2) **1987-1991 SEAFDEC/AQD Annual Reports.** (3) Brackishwater Aquaculture Information System. 1987. **Grouper Abstracts**. SEAFDEC/AQD, Tigbauan, Iloilo.

BACK TO BASICS

Grouper reproductive biology and larval rearing

Reproductive biology

• Groupers are protogynous hermaphrodites, i.e., females transform into mares when they grow larger and older. The age and/or size at sex inversion so far reported are as follows: *Epinephelus akaara,* 4-5 years and 0.5-1 kg in body weight; *E. diacanthus,* 2-6 years and 70-200 g; *E. tauvina,* 7-11 kg; E. *mario,* 2-4 years and 1 -8 kg.

• Results of (1) induced sex inversion by oral administration of methyltestosterone (MT) for several consecutive months and/or (2) induced spawning by giving several intramuscular injection of human chorionic gonadotropin with or without salmon pituitary extract have been reported for *E. tauvina, E. akaara, E. fario,* and *E. malabaricus* or *E. suillus.* Induced sex inversion by intramuscular injection of MT is possible for *E. suillus.* However, fertilization rates in these experiments were variable and generally low.

• Spontaneous spawning was recorded as early as 1965 for *E. akaara.* Since then, this species has been made to spawn naturally at many fisheries stations in Japan, though the conditions to obtain quality eggs are still to be investigated.

Records of natural spawnings of other grouper species were very few until recent years and known only for *E. tauvina* at the Kuwait Institute for Scientific Research, Kuwait. Since mid-1980's, natural spawnings other than *E. akaara* have been reported for the following species: in Southeast Asia, *E. malabaricus* at the National Institute of Coastal Aquaculture, Thailand; *E. fuscoguttatus* at the Bojonegara Reseach Station for Coastal Aquaculture, Indonesia, and at the Marine Aquaculture Research Station, Singapore; and *E. suillus* at SEAFDEC, Philippines; in Japan, *E. fasciatus, E. salmoides, E. moara, E. microdon,* and *Plectropomus leopardus.*

• Spawning seasons of groupers in Asian waters are estimated to be as follows:

E. tauvina - around Aug in Singapore
E. diacanthus - Apr to May in Taiwan
E. akaara - June to Sept in Japan
Apr to June in Hongkong
E. malabaricus- Sept to Nov in Thailand
E. microdon - May to Sept in Japan
E. *salmoides* - Apr to June in Japan

Larval rearing

• Newly hatched larvae are inactive, passively flowing with the current created by aeration. They drift in the water with their heads down for 1 -2 days after hatching and, if aeration is stopped, they tend to sink to rest on the bottom and float up again.

Grouper larvae undergo morphological transformation, characterized by elongation of dorsal and pelvic fin spines from 10 to 40 days after hatching.

• The larvae of *E. malabaricus,* until 2 wk after hatching, produce mucus all over their bodies. So, they are very adhesive to one another when they group together by phototaxis. Sudden mortality was sometimes observed due to suffocation in the group.

Some researchers adjust aeration at a low level, less than 10 ml/min, to minimize physical shock to the larvae of *E. akaara* reared in 1-ton tanks. On the Other hand, others recommend stronger aeration at 200 ml/min for *E. tauvina* larvae reared in 0.5-t tanks to ensure even distribution of the larvae.

• The mouth of grouper larvae is so small that rotifers are possibly too large for their initial feeding. Several kinds of small food organisms, such as fertilized eggs and larvae (trochophores) of oysters, screened small rotifers, nauplii of copepods, and diatoms have been tested as initial larval feeds for *E. akaara.* However, larval rearing using these organisms has not yet resulted in remarkably successful larval survival. Several researchers have observed that larvae feed well on rotifers when tank is provided with green water.

• Researchers also reported the "point of no return" for *E. akaara* larvae as 9 h after the opening of the mouth. This period is very short compared to red seabream (2 days), yellowtail (1 day), etc. They obtained fairly good survival

during this period by applying illumination at night to accelerate initial feeding.

• Researchers also reported that, in *E. tauvina* larvae, the survival and growth of larvae reared in salinities between 25-39 ppt were not significantly different at the early larval stage, but those parameters were higher at a constant salinity of 25 ppt at more advanced larval stages. Best survival and growth were observed at 27-29°C for larvae from hatching to the 12th day and at 30-31°C for 19- to 33-day-old larvae.

• The larvae of *E. tauvina* were observed to die after they gorged themselves with *Artemia* nauplii. *Artemia* may be detrimental if consumed in large quantities.

• When larvae become juveniles, they show cannibalistic behavior.

• Due to the difficulties in larval rearing explained above, coupled with the difficulty in obtaining quality eggs, the survival of grouper larvae and juveniles so far reported was generally very low, the rate being < 10% on day 7 and 1% on day 50-60, even in rearing trials which were reported to be successful.

In 1989, remarkable results have been reported on survival rate and quantity of larvae produced. The Tamano Station of the Japan Sea-Farming Association produced about 400 000 juveniles of *E. akaara* in 60-t tanks with an average survival rate of 34.1% from day 1.

Source: Masanori Doi, Munir bin Hj. Mohd Nawi, Nik Razali bin Nik Lah, and Zulkifli bin Talib. *Artificial propagation of the grouper, Epinephelus suillus at the marine finfish hatchery in Tangong Demong, Terengganu, Malaysia.* Dep't of Fisheries,
Ministry of Agriculture, Malaysia 50628. Jan 1991.

Asian markets for reef fish

Reef fish comprise a variety of species such as grouper, snapper, bream, rock cod, and coral cod. Although able to command high prices in international markets, they are presently underutilized in many parts of the world. The four major markets for reef fish worldwide are Japan, Singapore, Hong Kong, and USA. Two important Asian markets, Singapore and Hong Kong, are described.

Singapore

With a population of only 2.6 million and a per capita fish consumption of 36 kg, Singapore by itself does not constitute a significant market for fishery products. Its importance lies in the fact that it serves as an export market for fishery products from Southeast Asian countries and also as a transshipment base for these products both within and outside the region.

From Jan to July 1988, Singapore imported 18 118 t of fresh/chilled marine fish and 10 8611 of frozen marine fish. Fresh/chilled fish are mainly imported from Malaysia and Thailand to augment local supplies as consumption of whole fresh fish is the most popular form of utilization in Singapore. Although import statistics are not classified by species, it can be safely said that a substantial portion of the imports constituted reef fish such as grouper, snapper, rock cod, coral cod, and seabream. Grouper and red snapper are two popular high value fish in this market. Red snapper sells at a wholesale price of about S$2.60 (approximately US$1.34) per kg while rock cod and coral cod are being sold at S$13.00/kg (approximately US$6.70/kg) and S$9.50/kg (approximately US$4.65/kg), respectively.

Imports are mostly delivered directly to the Jurong Market which was established in 1969 to facilitate the importation of fresh fish to

meet increasing domestic demand as well as to capitalize on Singapore's position as one of the world's major ports.

Apart from being a fairly big importer of fish for domestic needs, Singapore also plays a major role as a re-exporter of marine products. Exports doubled from 30 000 t in 1976 to 60 000 in 1986. As labor is getting more and more expensive, processed products such as fish fillets are imported to meet the growing domestic demand. In 1987, 2498 t of frozen fish fillets were imported into Singapore. Frozen red snapper fillets are sold at wholesale level, at around S$2.20/kg (approximately US$1.13/kg). These are mostly Indonesian products.

There are no tariffs for the import of fish and fishery products into Singapore. However, licences for import, export, and transhipment of fish have to be obtained from the Fisheries Division of the Primary Production Department.

Hong Kong

Hong Kong is one of the most important markets for fish and fishery products. With a population of 5.5 million and an annual per capita consumption of seafood of about 4&kg, domestic demand is high.

The country is also an important trading center engaged in both the import and re-export of fish and fishery products. Imports of fresh, chilled, and frozen fish have increased from 57116 t in 1982 to 68 538 t in 1986 while exports of the same show an increase from 13 408 to 28 421 t.

The market for reef fish such as snapper, grouper, bream, and coral cod in Hong Kong is of growing importance, as is evident from the imports and re-exports of these fish.

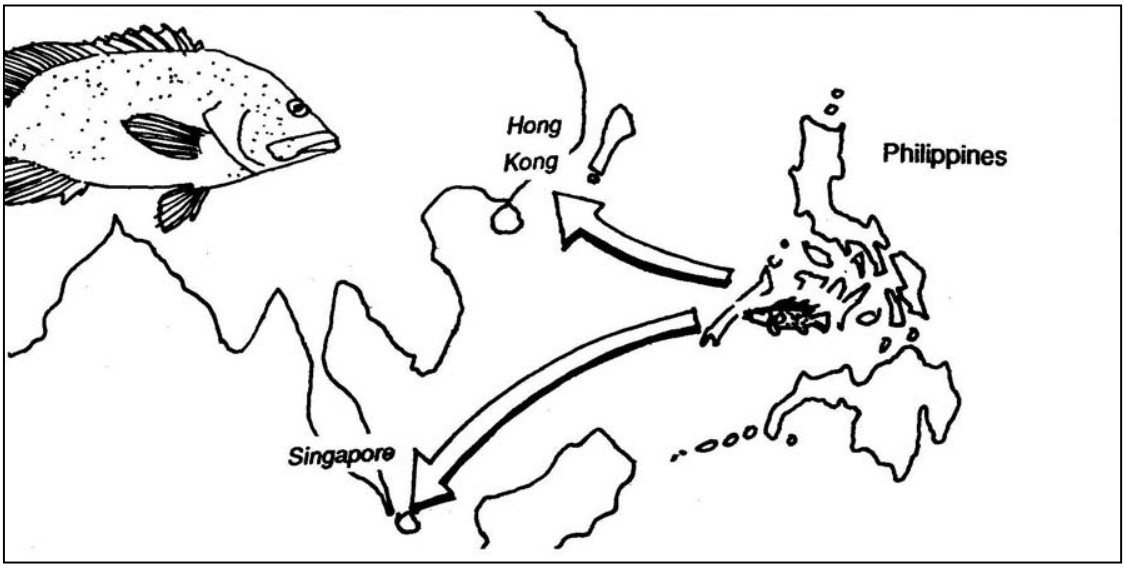
The Aberdeen wholesale market handles the bulk of the wet fish and frozen fish landed. The market is owned and operated by the Fish Marketing Organization (FMO), a government marketing arm. Prices of reef fish at the Aberdeen wholesale market, though fluctuating according to economic and market forces, still maintain high levels.

Domestic catch is almost entirely sold in fresh form to restaurants. Imported frozen products are sold for household consumption through retail shops, restaurants, supermarkets, and the catering trade.

Live red snapper and grouper are sold at US$18.73/kg. The species are mostly used in restaurants and hotels.

Hong Kong is a free port and there are no customs duties or quantitative restrictions on marine products. However, these are subject to statutory control governing the sale of food under the Food and Drugs Section of the Public Health and Urban Ordinance and its subsidiary legislation.

Source: *Markets for reef fish in Singapore and Hong Kong.* **INFOFISH International 1/89.**



Aquaculture clinic

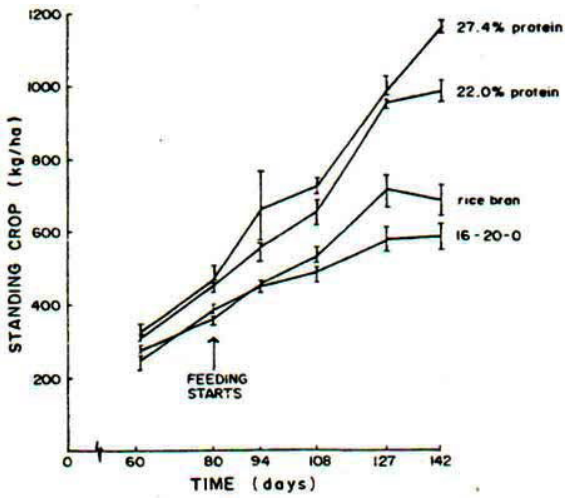
[Technical queries of this column are referred to SEAFDEC/AQD researcher(s) knowledgeable on that particular topic. - Ed.]

QUERY

Some fishfarmers are reportedly feeding *Cheez Curls* and other human "junk" food to milkfish. Is there a scientific basis for doing so? Is it recommended?

REPLY

An effective way of ensuring food supply for milkfish is to grow natural food. And when natural food is depleted, supplemental feeding can be given. Supplemental feed is formulated to include specific nutrients that are limiting in the pond at certain standing crop or biomass (see figure below).



Different feeding schemes may be Implemented as the standing crop or biomass in milkfish ponds changes [Modified from Aquaculture 93 (2): 183.]

Low biomass ponds. Most fishfarmers rely on natural food present in ponds. This natural food is grown using organic or inorganic fertilizers. But as culture progresses, natural food may no longer supply the nutrient requirements of milkfish. Research has shown the it is energy that is generally the first limiting factor when biomass in ponds is still low (500-700 kg/ha). In which case, most fishfarmers give rice bran, bread crumbs, and corn bran (and yes, *Cheez Curls* and other "junk" food). These supplemental feeds serve primarily as energy sources because of their high carbohydrate content. Also, some fishfarmers use *Cheez Curls* to fatten milkfish during the final days of culture.

High biomass ponds. But as biomass increases to 800 kg/ha and above, it is dietary protein and other essential nutrients (e.g., vitamins, minerals) that become limiting. Pelleted feeds containing 22-27% protein were found to be economical in attaining higher yields.

Example. In low productivity ponds, rice bran was found to support production up to 680 kg/ha at a stocking rate of 8,000 fish/ha. If 22% protein diet and/or a 27% protein diet with vitamin supplement is used, yields increased to 980 and 1150 kg/ha, respectively.

Is feeding human junk food recommended? From the point of view of human food production, it may not be advisable to feed to fish the feed of man. This is not only unphilosophical but also expensive. There is also the question of recycling resources. The use of rice bran, corn bran, and other by-products of agriculture can go a long way towards optimizing our limited resources.

The reply was made by Ms. Neila S. Sumagaysay, one of AQD's Research Associates based at the Tigbauan Main Station. She has published on supplemental feeding of milkfish in ponds.

SEAFDEC/AQD NEWS

Seaweeds of Panay launched

A practical book on the seaweeds of Panay by AQD researchers Dr. Anicia Hurtado-Ponce, Ma. Rovilla J. Luhan, and Nicolas Guanzon, Jr. was launched by AQD Chief Dr. Efren Ed. C. Floreson 11 June 1992 at Tigbauan, Iloilo.

In a ceremony that symbolically transferred knowledge from research to its end-users, Dr. Flores requested the author to hand over the first three copies of the 115-page book to Dean Prudencia Conlu of U.P. Visayas (to represent the academe), Engr. Ramon Hechanova of the Regional Agricultural and Fisheries Council -VI (to represent the private sector), and Director Vicente Majaducon of the Department of Agriculture -VI (to represent the government).

The seaweeds of Panay are diverse and abundant, but there is little information on their taxonomy, distribution, ecology, and economic importance. The book *Seaweeds of Panay* lists the species of seaweeds in Panay and Guimaras Islands as surveyed by the seaweeds team in April 1988 to February 1989. The common names, descriptions, habitats, economic importance, and collection sites are given for 100 species of green, brown, and red algae of which 41 are new records for Panay.

The book is especially relevant to the academic and research community, policy makers, fishermen, and businessmen. The emergence of western Visayas as potential site for *Kappaphycus* and *Eucheuma* farming makes the book particularly useful.

Copies are available at Sales/Circulation, SEAFDEC/AQD, Tigbauan, Iloilo 5021. It costs P-200/copy.

Better service from AQD Library

The newest and fastest information retrieval technology was recently acquired by AQD's Library and Documentation Services. The CD-ROM drive (compact disc-read only memory) is a device attached to a microcomputer (e.g., IBM-PC) which reads data contained in a CD (an optical or laser disc).

Author Dr. Hurtado-Ponce hands over the first three copies of her book to Director Majaducon of DA-VI (partly hidden), Engr. Hechanova of RAFC-VI, and Dean Conlu of UPV College of Fisheries.

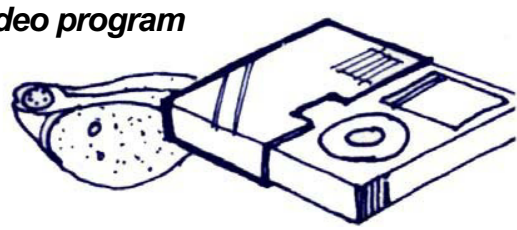
One CD can hold 10 000-20 000 pages of text. Hence, "CD-ROM drive enhances speedy retrieval of information," Library Head Marubeth Ortega explained.

The Library is subscribing to the CD version of ASFA or the *Aquatic Services and Fisheries Abstracts* data base, the coverage of which is 1988 to December 1991. Updates for 1992 will be received from ASFA beginning this quarter. Ms. Ortega also said that other data bases on CD format shall soon be acquired, for example, *Fisheries Review* published by US Fish and Wildlife Services.

Non-AQD researchers can avail of this service; however, payment for copies of search results will be charged (P3/page/citation) to defray overhead costs.

CD-ROM drive was acquired through the equipment fund courtesy of the Government of Japan.

New video program



Caring for milkfish larvae, a 14-min instructional video on milkfish larval rearing, is now available. It demonstrates the four primary hatchery activities: hatching of milkfish eggs, stocking of newly hatched larvae, larval rearing, and harvest. These techniques have been successfully practiced in AQD experimental hatcheries, private cooperators, and the National Bangus Breeding Program pilot projects in the different regions of the country.

Write to: Sales/Circulation, SEAFDEC/AQD, P.O. Box 256, Iloilo City 5000. The tape costs P420.

SEAFDEC Training Programs

The following are SEAFDEC's training programs - dates, topics, host Departments - for the second half of this year:

July	Lecture-cum-Demonstration Course for Fish Processors and Technologists	MFRD
12 Aug-1 Oct	Marine Finfish Hatchery	AQD
30 Sept - 29 Oct	Aquaculture Management	AQD
Sept-Oct	Regional Training Course in Fish Quality Preservation	MFRD
22 Oct - 2 Nov	Fish Nutrition	AQ
mid-Oct	Short-term Training Course on Fisheries in General	TD
mid-Oct to early Dec	Regional Training Course for Fishery	TD

For more information, write to: Marine Fisheries Research Department (MFRD), Changi Fisheries Complex, Changi Point, Singapore 1747; Tel. 542-8455/6/7; Fax: 545-1483. Orto Training Department (TD), P.O. Box 13-4, Phrapradaeng, Samut Prakan 10130, Thailand; Tel: 425-8040-5; Fax: 425-8561. AQD's address is on p. 20.

Last quarter, SEAFDEC implemented *Advanced course for fishing technology graduates* hosted by TD 15 May-14 June; *Marine finfish hatchery* is ongoing at AQD 3 June -24 July so with *Regional training course in fish processing* hosted by MFRD June.

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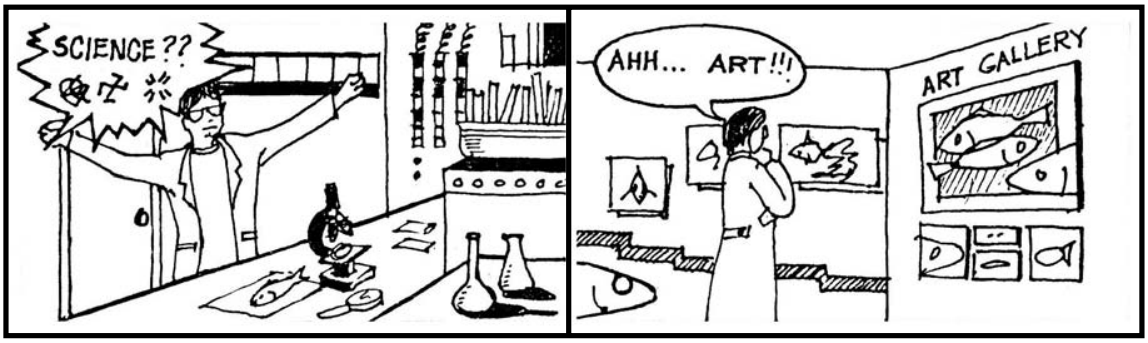
The science behind the art...



by E. Ledesma

Better life through aquaculture