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AQUA FARM NEWS

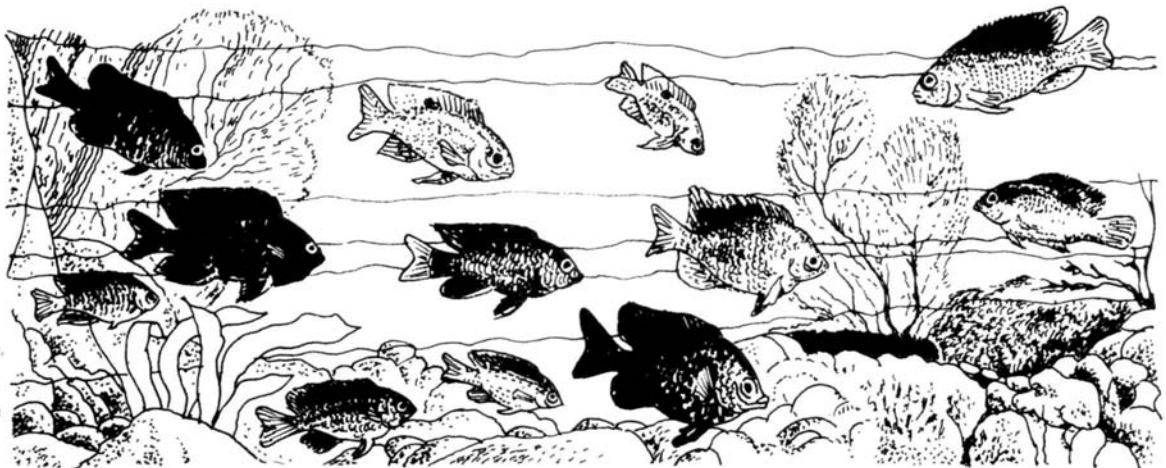
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Marine Ornamental Fish

A new commodity prioritized in the SEAFDEC Aquaculture Department for research in the next three years is **ornamental fish** (marine and freshwater). This was identified by representatives of SEAFDEC Member Countries - Japan, Philippines, Singapore, and Thailand - during the *Second Seminar-Workshop on Aquaculture Development in Southeast Asia* in August 1991 (see *AFN*, Vol. IX, No. 4, July-August 1991). Further, broodstock development and genetic improvement of some marine ornamental fish will be pursued this year, as planned during the *Roundtable Discussion on 1992 SEAFDEC/AQD Research Activities* last 23-24 January at Tigbauan, Iloilo. The roundtable discussion was attended by SEAFDEC/AQD researchers, some faculty members of the University of the Philippines in the Visayas, representatives from the Department of Agriculture (both Bureau of Agricultural Research and Fisheries Sector Program), Philippine Council for Aquatic and Marine Research and Development, and the private sector (see related stories, pp. 18-19).



This issue takes a look first at the economics of the world trade of ornamental fish. Virtually, no complete statistics are known to have been compiled on world trade in tropical aquarium fish other than the assessment made by the International Trade Centre UNCTAD/GATT in 1979 with the eight largest tropical aquarium fish markets: United States, Germany FR, United Kingdom, Netherlands, Belgium, Sweden, France, and Switzerland. These countries then accounted for 70% of total world imports of aquarium fish. Detailed statistics on the trade and industry are not generally available because of the low volume (though high value) of the commodity.

And then, the status of the Philippine industry and a concern on conservation - particularly of the **marine ornamental fish** - as well as some management aspects are discussed. (to page 2)

World Trade

During the last four decades, there has been considerable growth and diversification in the international trade in ornamental fish. Global retail sales of fish, plants, and associated accessories for the hobby were estimated in 1971 at US\$4 billion, although these had then increased to US\$7.2 billion in 1986.

Very few reliable data are available on the number of fish involved in the ornamental fish trade. Conservative estimates suggest that at least 150 million ornamental fish are now sold on a world-wide basis each year.

A huge range of fish species are available through the ornamental fish trade, and one major European importer lists 700-800 species of freshwater and marine fish as "commonly available." Barbs, danios and related carp-like fishes, characins and tetras, catfish, toothcarps, and cichlids and coral fish are particularly popular. Although precise supporting data are lacking, current opinions agree that 90% of the freshwater fish available in the trade are captive-bred and virtually all of the marine fish are removed from the wild.

Source: C. Andrews. 1990. *The ornamental fish trade and fish conservation*. **Journal of Fish Biology** 37 (Supplement A): 53-59.

Demand characteristics. The value of world trade in tropical aquarium fish is estimated at about US\$600 million annually at wholesale level, or US\$200 million in terms of imports.

Demand for aquarium fish has grown since the 1960s at an average annual rate of 10-15%. Owing to adverse economic conditions, it has slackened since 1974, but is expected to pick up with economic recovery and reduced unemployment in the importing countries.

The largest markets for tropical aquarium fish are the United States, Japan, the Federal Republic of Germany, the United Kingdom, and the Netherlands. Saltwater fish account for only about 10% of the total market in terms of volume, and 20% in terms of value.

The bulk of demand, in terms of population groups, appears to be accounted for by skilled industrial workers. The hobby is also reported to be particularly popular among apartment dwellers in large towns, as well as among persons living in areas where winters are relatively long and severe.

Supply pattern. On a regional basis, exports of tropical aquarium fish originate as follows (by value): Asia, 60%; South America, 30%; Africa, the Caribbean and other areas, 10%. Although Africa has vast natural resources of aquatic life, its exports of fish are estimated at only 2% of the total, and the potential market for West African and Central African species is only beginning to be explored. The same is true of a large number of potential sources of supply in other parts of the world.

The condition of the aquarium fish trade and industry in developing countries, with the exception of a few countries in Southeast Asia, is as yet far from satisfactory. This is due primarily to lack of technical know-how concerning breeding, collection and packaging methods, and lack of adequate market information; lack of suitable air transport to the target markets is another limiting factor for some countries.

Most of the freshwater species exported from Southeast Asia are bred in captivity. Exports from Hongkong and Singapore, for example, include native species and varieties raised from breeding stock imported from other parts of the world. Freshwater species from South America (e.g., Brazil, Colombia, and Peru) are usually caught wild.

Saltwaterfish, however, cannot normally be commercially bred in captivity. One Florida company has successfully bred a few varieties of saltwater aquarium fish, but their colors are much less vivid than those of the same varieties when caught in their natural habitat.

Some 40-50% of all tropical aquarium fish sold, and virtually all marine fish, are caught wild.

Tropical aquarium fish are also bred in industrialized countries. Domestic supplies of aquarium fish meet about 20% of total demand in the United States, and about 10% in several European markets.

However, the breeding of tropical aquarium fish in industrialized countries has become

relatively uneconomical in recent years owing to the drastic increase in costs, especially for heating. Domestic supplies in all major markets are therefore declining fairly rapidly, a situation that offers growing export opportunities to developing countries.

Fish losses. Fish losses during capture in natural habitat and in transit to importing countries are reported to be still alarmingly high; on a world-wide basis, the loss ratio is estimated at not less than 50%. Some 20-30% of exported fish die through mishandling of consignments during air transport; the balance are lost through lack of care and knowledge on the part of collectors, exporters, and importers.

The lowest loss ratio occurs in exports from Southeast Asia. The average loss in transit from Singapore and Hongkong is 5%, whereas the corresponding figure for supplies from South America, particularly to European markets, may be up to 30%. For supplies from certain African countries, losses are reported to be even higher.

Prices. The prices obtained by exporters of tropical aquarium fish on a free-on-board basis have remained virtually static over a number of years. This is due primarily to the lack of adequate market information generally available to exporters, the excessive number of exporters in certain countries, the abundant supplies available from a few key sources (particularly in Southeast Asia), and the heavy losses in transit. In addition, air freight rates have risen sharply in recent years, and the economic recession has depressed wholesale and retail prices in the importing countries. Certain changes in the distribution system, in particular the emergence of casual importers, trans-shippers and forwarding agents, have also contributed to holding down the prices paid to exporters.

Clearly, therefore, the revenue obtainable from this trade will increasingly depend on economies in the breeding and collection of fish for export as well as on a determined effort to reduce losses in transit, in other words, on the more effective organization of the aquarium fish trade and industry in the exporting



countries. Certain corrective measures are also required in the importing countries to promote the healthier growth of the trade, and hence of the hobby.

Seasonal pattern. Sales of aquarium fish slow down substantially during the summer months, especially in July and August. It is estimated that 60-70% of total annual fish imports take place in the seven-month period from October to April.

The volume of trade reaches a peak in December and January. January, according to many of those interviewed, is the busiest month of the year, because parents often give aquarium tanks as Christmas presents to young enthusiasts. An unduly long winter or a bad summer also tends to help the trade.

Role of airlines. Airlines play a pivotal role in world trade in tropical aquarium fish, and it is primarily owing to the expansion of civil aviation that the export trade in aquarium fish from developing countries has reached its present level. For an exporting country, the selection of export markets is largely dictated by the availability of suitable flights to the appropriate destinations.

Airlines, mainly the national carriers of industrialized countries, earn an estimated US\$80 million annually in freight charges from this trade. On average, freight represents 40% of landed cost; actual freight charges vary with distance, the size of the consignment, and the carrier.

Environmental considerations. There is growing concern among environmentalists that the large-scale capture of tropical fauna

for commercial purposes will lead to gradual extinction of such fauna and consequent damage to the environment.

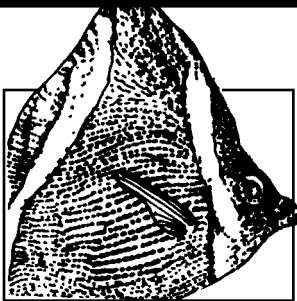
Importing countries are concerned that the trade may result in damage to their local biotope. They are therefore taking a number of measures to prevent the introduction of species which, if allowed to proliferate, might spread disease among domestic livestock (including poultry), or even among humans.

Hence, national authorities responsible

for export development would find it useful to establish a joint body to assist, guide, and supervise the aquarium fish export trade and industry. Such a body would be composed, for example, of officials of the fisheries department and the export promotion agency, and of representatives of the trade.

Source: **International Trade Centre UNCTAD/GATT**. 1979. *International trade in tropical aquarium fish*. Geneva.

The Philippine Industry



The tropical ornamental fish industry, both freshwater and marine, is the least known and recognized in the fisheries sector. Its devel-

opment is not as good as the other branches of fisheries.

Regardless of this shortcoming, the tropical fish industry continues to grow steadily. As a hobby, it is fast gaining popularity and many hobbyists are switching to aquarium fish because of its advantages. Unlike other pets, tropical fish does not occupy a lot of space. For small homes, a mere 30 × 60 cm area will suffice. Tropical fish is also less messy compared to dogs, cats, birds, and other pets. It is an interesting and beautiful house decor, too. Tropical fishes do not eat much, so they are economical to grow. Also, many professionals' offices and doctors' clinics have aquarium displays because watching fish swimming gracefully calms the nerves of waiting clients and patients. Modern equipment now available makes the culture of tropical fish less complicated. For travellers, this is also the easiest pet to keep because food required can actually be measured and placed in an automatic dispenser attached to the tank.

In short, tropical aquarium fish can be a flourishing industry.

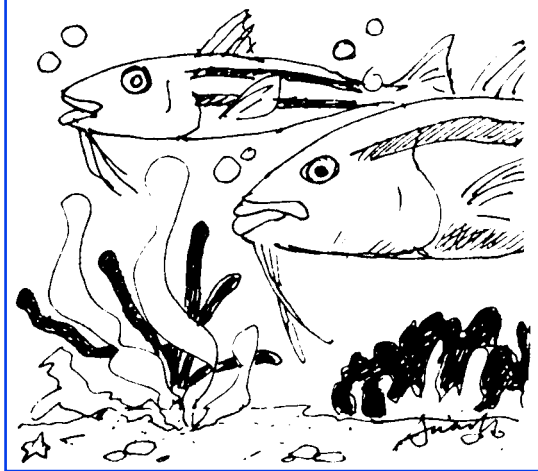
Marine tropical fish

The Philippines is the biggest exporter of marine tropical fish. The industry has been in existence for 20 years or so. During the first five years, only a few people engaged in the trade. In the '70s and '80s, more people realized its potential, thus increasing the number of people involved in this trade.

The Philippines supplies 70% of the world's marine tropical fish requirement, comprising 340 known species of fishes. In the United States alone, it is estimated that 80% of their imported aquarium fish comes from the Philippines. The country has an advantage over others in producing and shipping aquarium fishes - advance technology in handling and packing, modern equipment, and variety. Other Asian countries like Singapore, Taiwan, and Hongkong have to import from the Philippines to supplement their own limited supply and variety. Export markets include United States, Canada, England, West Germany, Belgium, Italy, Spain, France, Australia, Sweden, Switzerland, Australia, Japan, Thailand, Singapore, Taiwan, and Hongkong.

The aquarium fish industry is fast becoming a major source of dollars for the country. Hence, it is of utmost importance to develop this trade. Unfortunately, government attention to the industry is inadequate. One

Grazers? What do you think they call us goatfish for?



important contribution though is the launching of the "Bantay Dagat" Program of the Department of Agriculture. Under the program, the Bureau of Fisheries and Aquatic Resources "plants" thousands of artificial reefs in various Philippine seas. Although this program is not exclusively for the benefit of the aquarium industry, it actually helps increase the supply of fish. Many suppliers and collectors confirm that these artificial reefs are now inhabited by all forms of marine life, especially the coral and rock-dwelling species.

Today, industrialized countries are dumping more wastes in the seas. Pollution, compounded by siltation and illegal fishing, is rapidly destroying coral reefs and killing marine life. If not stopped now, this will result in the destruction of marine life and consequently spell the end of the aquarium fish industry.

At the *National Export Congress* held on 24-25 May 1989, Secretary Jose Concepcion, Jr. of the Department of Trade and Industry announced the total export target of US\$15 billion by the year 1992. This may signal the realization of the dream to become a newly industrialized country by the year 2000. In answer to the call of Secretary Concepcion, the tropical fish exporters are working very hard to increase the volume of their export.

The country's tropical fish export has steadily increased over the years. Recently, however, some setbacks occurred. An airline

is slowly killing the business by reducing air transport space. In fact, confirmed shipments have been unloaded in several instances. Thus, a reduction in export volume. Also, afternoon flights to the United States arrive too late for regular customs clearance.

It is hoped that the government can help in this regard. Then, the industry can help make economic progress a reality for the Filipino people.

Source: Lolita Ty. 1990. *Overview of the Ornamental Fish Industry*. In: **Status of the Ornamental Fish Industry in the Philippines; Proceedings of the 1st National Ornamental Fish Symposium and Exhibition in the Philippines**; 17 October 1989; Metro Manila; PCAMRD and TLRC.

Resources

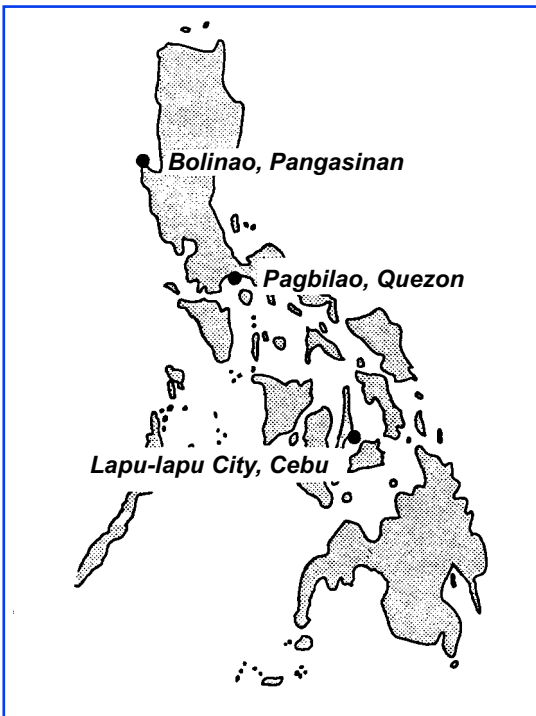
Fish groups. There are 25 groups of fish comprising 243 species (and 32 others not included below) that can be found in the Philippines for aquarium purposes. The groups and their corresponding number of species are as follows:

- | | |
|--------------------------|------|
| 1. Angel fish | - 28 |
| 2. Angel fish | 4 |
| 3. Anthias fish | 8 |
| 4. Batfish | 3 |
| 5. Bleeny | 4 |
| 6. Butterfly fish | - 35 |
| 7. Cardinal fish | 4 |
| 8. Clown fish | 9 |
| 9. Damsel fish | - 15 |
| 10. Eel | 6 |
| 11. File fish | 6 |
| 12. Goat fish | 3 |
| 13. Goby | - 20 |
| 14. Grouper | 16 |
| 15. Grunt fish | 6 |
| 16. Hawk fish | 4 |
| 17. Lion fish | 7 |
| 18. Parrot fish | 5 |
| 19. <i>Pseudochromis</i> | 3 |
| 20. Puffer fish | 7 |
| 21. Shark | 4 |
| 22. Snapper | - 5 |
| 23. Tang fish | 9 |
| 24. Trigger fish | - 10 |
| 25. Wrasse | - 19 |

Aside from these, there are also 66 known species of invertebrates being exported, namely:

- | | | |
|------------------|---|----|
| 1. Anemone | - | 12 |
| 2. Crab | - | 6 |
| 3. Lobster | - | 3 |
| 4. Seahorse | - | 3 |
| 5. Shrimp | - | 9 |
| 6. Sponge | - | 2 |
| 7. Starfish | - | 8 |
| 8. Urchins | - | 2 |
| 9. Featherduster | - | 3 |
| 10. Live shell | - | 7 |
| 11. Sea slug | - | 4 |
| 12. Octopus | - | 2 |

Other invertebrates number five species each.



Trading zones. There are three major trading zones in the Philippines for marine aquarium fishes, namely: Pagbilao, Quezon; Bolinao, Pangasinan; and Lapu-Lapu City, Cebu (above map).

Pagbilao, Quezon

This is the biggest trading zone of aquarium fishes. Barangay Polo, Sitio Ibaba, is

the base of 25 managers (middlemen) and 300 or more collectors. Almost all are migrants and descendants from the Visayan region, specifically Sta. Rosa, Olango Island in Cebu. Pagbilao has the most extensive collecting grounds, covering the areas of Panambok, Talaw-talaw shoal and Dalahican, Quezon. And what makes this zone more extensive is that most of the big suppliers from this area operate in far flung places like Palawan, Mindoro, and other known reefs in the Visayas. One fishing expedition with 15 divers lasts for 10-15 days. Coral reef area most often explored by Pagbilao collectors are Agdangan, Gen. Luna, Catanuan, Padre Burgos, Aurora, and Polillo Island in Quezon; Burias in Masbate, part of Marinduque, and Mindoro Oriental; and Caramay, Bugsuk, and Quiniluban group of islands in Palawan.

Lapu-Lapu City, Cebu

Cebu in general is considered the second biggest trading zone. The traditional collecting grounds are the southern part of Cebu, Bohol, Siquijor, Negros Oriental, Leyte, and some parts of Davao and Surigao del Norte. The double-barrier reefs of Dajanon Bank, the fringing reefs of the nearby islands of Olango, north and northeastern parts of Bohol are also their favorite collecting areas.

There are about 116 species of fishes, 34 genera, representing 33 families and 39 species of invertebrates coming from Cebu.

Bolinao, Pangasinan

The smallest trading zone is Bolinao. There are only six legitimate aquarium fish middlemen and about 30 or more collectors. Collection of fishes is done in the shoal reefs of Pangasinan Gulf, Fagg Reef, Poro Pt. in San Fernando, La Union, and part of Olanin Bay in Pangasinan.

Other trading zones fast catching up with the three traditional zones include Sta. Cruz, Masinloc, and Matain, all in Zambales; Bicol; Sulu and Zamboanga.

Production. Bolinao, Pangasinan produces a maximum of 239 *bayongs* or *cara-*

gumoy bags of assorted tropical fishes every month. One *bayong* contains about 2-10 rare or expensive fishes and 100-200 ordinary or less expensive fishes, like damsels, etc. There is no known tally as to the actual number of fishes delivered from this area to Manila, nor is there an accurate record of the total cost of fish delivered. However, based on interviews made with several collectors and middlemen in the area, it was established that the daily income of one collector is about P60 a day or P1500 per month based on 25 diving days a month. A middleman makes an income of P3200-8000 per month.

Pagbilao, Quezon produces a maximum of 725 *bayongs* per month, three times more than the production of Bolinao. Earnings of collectors and middlemen are almost the same as their Bolinao counterparts.

Lapu-Lapu City, Cebu, produces a maximum of 506 *bayongs* per month, which is a little less than the production of Pagbilao. The difference could be attributed to selective collection of species ordered by middlemen or exporters. Income of collectors and middlemen is about the same as those in other areas.

Existing technology

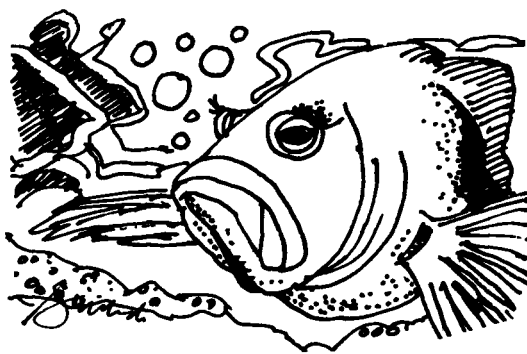
Gears. There are only a few gears used in collecting marine aquarium fishes in the Philippines, namely:

1. *Hookah* or *kapandra*
2. Gill nets
3. Scoop nets
4. Spear needle gun
5. Goggles
6. Squirt bottle

Methods. Most collectors in the country still resort to the free dive method. This is very common in shallow reefs while collecting ordinary or less expensive fishes. However, in deep areas where most of the rare and expensive fishes are found they use *hookah* or *kapandra*.

As gathered from divers in different areas, less expensive fishes are caught with the use of gill nets. This gear is set around a stone coral where most of these fishes seek

Wanted exotic tropical fish ...Hmm... That's me! Tokyo, LA, NY here I come ... I can dream, can't I?



sanctuary. The divers will then stir the fish until they come out and swim directly to the waiting gill nets. From there on they collect the trapped fish by using scoop nets.

The same procedure is applied to a variety of some expensive fishes. However, these fishes like angel fish are difficult to catch with gill nets because of their habit of seeking refuge in the inner portion of the corals or stones. Hence, sodium cyanide in squirt bottles is used as anaesthetic. This method, however, is being discouraged because of its adverse effects on the natural habitat and on the fish itself.

Spear needle gun is a very specialized device used for collecting a certain species (Mandarin fish). This kind of fish, according to divers from Cebu, cannot be caught by any other method. The process is quite tedious but very effective.

Value

Export of marine aquarium fishes has increased twenty-fold in a span of 10 years. In 1970 the marine aquarium fishes exported made P1 000 263; in the early '80s, it increased to over 20 million. However, slight decrease in the mid-'80s was attributed to the bad publicity the country's marine aquarium fishes got in the buying countries, particularly the United States. Demand for Philippine

fishes declined because of mortality on account of the use of sodium cyanide. Aquarium enthusiasts and hobbyists are now opting for fishes certified hand-caught (net method) which attain a high degree of survival in the aquarium.

Recommendations

1. Attempts should be made at resource management to protect the industry's future.

2. Alternative catch methods which are not hazardous to fishes and not habitat-debilitating must be introduced. The net method (as against the use of sodium cyanide) should be encouraged.

3. Supply problem being felt during typhoon and cold months could be offset by tapping non-traditional or unexplored fishing grounds unaffected by natural elements. Areas like Mindanao, Sulu archipelago and northeastern Luzon.

4. A massive re-education program among the people involved in the industry with emphasis on the conservation of the coral reef ecosystem should be conducted.

5. The idea of a marine reserve should be looked into to ensure sufficient gene pool to serve as a recruitment source for population being actively collected in adjacent areas.

6. Depleted areas due to overfishing and areas where dead corals abound should be pinpointed for a massive planting of artificial fish habitat.

Source: Lolita Ty. 1987. *Tropical Fish Aquarium Industry in the Philippines*. In: **National Conference on Fisheries Policy and Planning**; 16-20 March 1987; Baguio City; UNDP-FAO-DA-BFAR.

7. (National authorities) should support the development of the industry by the provision of credit facilities and technical assistance, as well as by the promotion of joint ventures with dealers in importing countries. Owing to rising domestic breeding costs, many such dealers are interested in establishing breeding stations in tropical countries either in partnership with organizations in the private or public sectors or independently.

Training is another prerequisite for the development of the industry.

By the adoption of such measures, a developing country would be able to increase the supply and variety of species available for export, and at the same time reduce the risk of overexploitation of its natural resources and resultant damage to the environment.

Source: **International Trade Centre UNCTAD/GATT**. 1979. *International trade in tropical aquarium fish*. Geneva.

in the news

Aquarium fishermen go back to school

Aquarium fishermen from Palawan, Quezon and Zambales received a ₱3.25 million grant from the International Marine Life Alliance (IMA), Canada, and ₱1.7 million from World Wildlife Fund (WWF-US) to implement the *Netsman Training Project*.

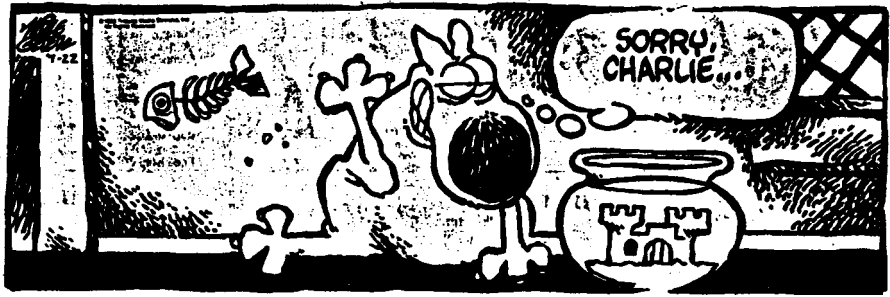
The objective of the project is to train marine aquarium fish collectors to use small nets instead of cyanide in catching aquarium fishes. The long-term objective is to stop one Cause of coral destruction.

The grant was released through the Haribon Foundation, a non-profit organization concerned with environmental conservation. The Philippine Council for Aquatic and Marine Research and Development (PCAMRD) of the Department of Science and Technology (DOST) provided technical assistance.

The training, headed by Steve Robinson, an American tropical fish expert and IMA training coordinator, was conducted in different regions of the country. Initial sites identified were

(p. 9, box)

Mike Peters. *Mother
Goose and Grimm.
Pacific Start and
Stripes.*



in the news...from p. 8

San Salvador, Zambales, Puerto Princesa, Palawan, and Pagbilao, Quezon. A series of 2-wk training sessions started in January 1990. About 20 collectors were trained at each session.

Using lecture-demonstrations, slides and videotapes, the training imparted basic ecology, importance of coral reefs, social cost of coral loss (economic evaluation of corals), the aquarium fish industry, benefits and profits from using nets instead of cyanide, and better packaging and shipping methods. Laboratory work included net making and underwater techniques in catching fish with nets.

The aquarium fish industry is practically coral-based. The export value of the Philippine aquarium fish from 1979-1987 rose from ₱2.9 to ₱100 million. The industry, however, is beset with the problem of the use of cyanide which results in the early death of fish and destruction of corals.

Although the practice is illegal, cyanide fishing is used to capture the brightly colored clown fish, butterfly fish, angelfish, and gobies that are highly prized by collectors/hobbyists. It generally does not kill the fish but it is believed to weaken them and shorten their life span. It does, however, kill the coral reefs where the fish breed and live. Cyanide is also harmful to the fishermen who swim through clouds of cyanide and to their families if they eat fish that have ingested the poison.

The *Netsman Training Project* is expected to raise the income of aquarium fish collectors and protect their health, as well as reduce the death of non-target fish (including eggs and larvae) and the corals which provide important habitat for Philippine food fishes.

Source: *Aquarium fishermen go back to school*, **Philippine Journal**, 12 Feb. 1990.

Reef fishes reared In captivity

For the first time, Hawaiian ornamental reef fish for the aquarium trade have been successfully raised in captivity at the University of Hawaii's Institute of Marine Biology on Coconut Island in Oahu (Hawaii).

The damselfish, *Dascyllus albisela* from Hawaii and *D. arunus* from Guam, were reared to marketable size in the laboratory in just 10 wk. In the wild, these fish take a full year to reach market size.

Up to 250 000 fish are collected from Hawaiian reefs each year for the ornamental reef fish trade. This has caused serious depletion of the wild population. The achievement of the University of Hawaii offers hope for restoring the wild reef fish population and sustaining the ornamental fish industry.

Source: **INFOFISH International** (November-December) 6/91.

Conservation: A Concern

Practically all species of marine fish used in the aquarium fish business - an industry valued at US\$20 million a year - inhabit the coral reefs. It therefore follows that for the industry to become sustainable, coral reefs must be protected from human disturbances.

The common strategy for protection is the establishment of reserves, sanctuaries, or fishery replenishment areas. These protected areas should be managed ideally by the fishing communities that stand to benefit from the protection scheme. There are at least half a dozen protected areas in the country; two other areas are being set up.

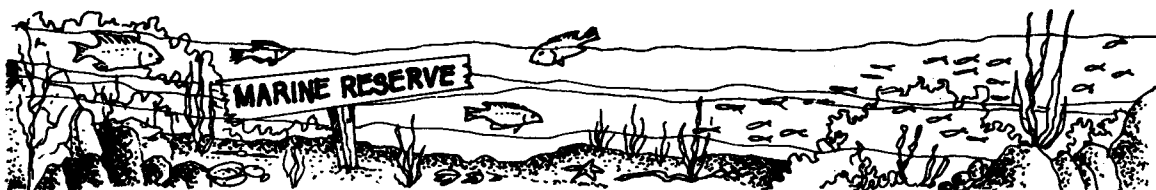
These reserves are expected to be the source or reservoir of recruits for areas that are being fished by fisherfolk. Since the environment of the reserves is not disturbed, they are usually ideal habitats of marine aquarium fish, and thus expected to continuously supply the exploited areas with fish for the fisherfolk. Reserves, therefore, work to sustain the aquarium fish catch.

The variety of species that might be observed in a reserve is multiple. Several fish families can be represented, including those that are quite rare.

The Apo island Reef in the Mindanao Sea has been protected for five years. Coral cover composed of a variety of species is 80-100%. This is in contrast to most Philippine reefs which have barely 25% cover. The coral reef fishes of the area are represented by several species which are abundant in number. When they become too many for the reef to support, some individuals spill over to the fishing areas where they are caught by fisherfolk. In this particular reef, only food fishes are caught; aquarium fishes are left alone for tourists to see and photograph. Recent reports by fisherfolk indicate that their catch has increased as a result of the establishment of reserves or sanctuaries.

In catching aquarium fishes, we need to use non-destructive methods and adopt some forms of protection to be able to sustain the aquarium fish industry.

Source: Angel C. Alcala. 1990. *Conservation and Management of Marine Aquarium Fishes*. In: **Status of the Ornamental Fish Industry in the Philippines; Proceedings of the 1st Ornamental Fish Symposium and Exhibition**; 17 October 1989; Metro Manila; PCAMRD and TLRC.



Starting a Home Aquarium

Basic equipment for a home aquarium includes a tank and tank cover, a filter, and an air pump.

A rectangular 40-80 l tank makes a good aquarium for a beginning aquarist. One

popular type of tank has a plastic frame, glass sides and ends as well as a glass bottom. Most covers include an incandescent or fluorescent lamp that shines down into the tank. Make sure that the lamp is for aquariums and not the ordinary incandescent lamp. Such covers, called light reflectors, make it easy to see the fish. Lids that cover the entire top prevent fish from jumping out of the tank.

There are two types of filter - an aquarium filter and an undergravel filter. The aquarium filter removes dirt suspended in the water

and keeps the water clean. Most filters are connected to an electrically operated air pump which produces a stream of air that pushes water through the filter. Trap-type filters pass the water through a sponge material which removes particles and some impurities. On the other hand, the undergravel filter sucks wastes into the gravel at the bottom of the tank. Filters also provide water circulation that helps disperse harmful gases.

Before setting up the aquarium, the tank should be washed inside and out with luke-warm salty water and then rinsed thoroughly. The tank should be placed in its permanent location on a level, strong surface near an electrical outlet and located away from direct sunlight to prevent the formation of algae.

The gravel or sand should be rinsed thoroughly then boiled to kill the bacteria. Cool the gravel or white sand before putting into the tank in a layer 5 cm in front and 10 cm at the back to support the filter, and other decorations like rocks and plants. Undergravel filters should be placed in the tank before the gravel is added.

Water used for the tank should be "aged" for at least 12 h.

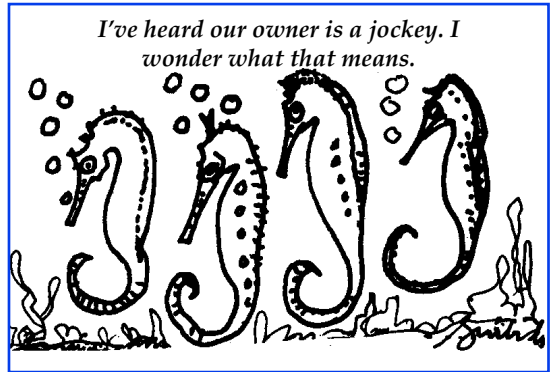
It is best to fill the tank with water a little at a time and to watch for leaks that might show up. Plants that root in the gravel, rock, driftwood, or aquarium decorations should be placed in the tank when it is about two-thirds full. These makes the aquarium more attractive but uncrowded with plants and decorations. Remember, the fishes should have enough room to swim around.

Just before the tank is completely filled, install the filter or aerator. Lastly, dissolve a capsule of antibiotic in the aquarium (250 mg for 80 l) to disinfect the water. The antibiotic should be placed everytime water is changed and new fish is added.

The water will be cloudy at first due to unsettled particles of dirt but this will clear up within 12 h.



Source: *Starting a home aquarium*, Malaya, 1 November 1988.



Ornamental Fish Breeding

There are probably several thousand species of fish suitable for the tropical aquarium. About 600 are known to aquarists. There is a great variety of fishes; some are rare and expensive, while others are too large to rear in an aquarium. It is advisable to start with the common, attractive, easily bred, and less expensive species, before attempting the more challenging ones.

Goldfish

"Lionhead oranda" goldfish are the most popular variety of goldfish (*Carassius auratus*). They have short, round bodies, double tail and anal fins, and a broad head covered with a bumpy, fleshy hood.

Goldfish mature at the age of about one year. Size is usually not a good measure of sexual maturity. A male that is ready to spawn usually has tubercles or "pearl organs." The tubercles commonly appear on the operculum and first ray of the pectoral fin and feel rough to the touch. The female's body becomes rounded with a firm belly. Live food, such as *Tubifex* worms and blood worms, is excellent for conditioning goldfish for breeding.

Goldfish spawn easily and the fry are among the most hardy and easy to raise. A

ratio of two male fish to one female is used. Aquatic plants such as water hyacinth with long dense roots can be used as spawning substrate. Spawning takes place with a sudden change in temperature. Goldfish normally spawn shortly after dawn.

Spawning is usually accompanied by much splashing with several eager males pursuing a ripe female. The males fertilize the eggs immediately by spraying milt over them. A good sized female will lay 5000-6000 eggs per spawn. The eggs are adhesive, about 1 - mm dia. They will hatch in about 24 h. Due to the strong egg-eating tendencies of the adults, these should be removed.

The water containing the fertilized eggs should then be treated lightly with methylene blue (one drop of 1% methylene blue per liter of water) and relatively strong aeration introduced. The aeration will not only ensure a plentiful supply of oxygen in the water, but will also tend to keep small particles of food moving, thus encouraging the fry to eat. The live food given is *Moina*.

Dwarf gourami

The dwarf gourami, *Colisa lalia*, is hardy, adaptable, peaceful, easy to breed, and an ideal fish for beginners. Dwarf gourami males in breeding condition rival the most colorful of reef fishes. They are banded in red and blue-green of the most intense iridescence imaginable. The throat and belly are also bright blue-green. A number of new color variations of this fish have recently appeared in the market.

To condition gourami for breeding, the sexes are kept separate for 3-4 wk and fed live food. When ripe, females will have extremely bulging abdomens and the colors of the males will be more intense. Each pair is placed in a 12-l tank with floating plants. After a period of acclimation, the male begins his courtship, with outspread fins and intensified coloration. Soon afterwards, he begins to build the bubble nest. While he is building the nest, the male drives the female away every time she approaches. Eventually, the nest may reach 6-8 cm dia. and 1-2 cm thick.

Once the nest is completed, the male will entice the female beneath it by extending

his fins and displaying his colors. When the female approaches, the spawning embrace begins. The male nudges the female gently into position, wrapping his body tightly around her. There may be a few "false starts" before the pair attains the correct position. A few dozen eggs are expelled beneath the nest and fertilized by the male. The mate picks them up and places them in the foamy nest of bubbles at the surface.

The pair will then sink to the bottom and separate. Soon, they are beneath the nest again, and the embrace is repeated. This cycle will continue until the female's supply of eggs is exhausted. About 1000-2000 eggs will be produced. When spawning is completed, the female should be removed, as the male may begin to attack her as he defends the nest.

The eggs hatch in about a day. After 3 days, the fry are free-swimming. The male is removed as he may eat the fry.

The first food for the fry should be live *Brachionus* sp. After 2 wk, the fry will be large enough to take sifted *Moina*. Growth is typically slow, but most fry will reach 1-cm length in a month if given sufficient food. Frequent partial water changes (about 25%) and a bigger tank are also needed.



Angelfish

The angelfish, *Pterophyllum scalare*, originated in the Amazon basin in South America. It is relatively easy to breed and produces a substantial number of eggs and fry. It tolerates a comparatively wide range of water quality conditions and displays pronounced parental care.

It is best to keep the breeding pair in a tank 60-cm long, 30-cm wide, and 30-cm deep. Readiness for spawning is indicated by vigorous cleaning of the aquarium glass. When the fish is ready for spawning, the female's breeding tube descends from the urogenital pore. The male's breeding tube descends on the actual day the spawning will take place.

The female then passes over the cleaned portion of the glass a few times with her genital papilla almost touching it. The eggs are deposited in this manner in a dozen or so strings, with the male following behind fertilizing them. After each string of eggs is laid, the female will circle around and get into position for placing the next string, usually in close proximity to the last. Again, the male fertilizes them. Spawning lasts 2-3 h.

The number of eggs deposited varies according to the size of the female parent and her age. Usually, between 300-1200 eggs are laid per spawning. After spawning, the parents will "fan" the eggs with their fins, creating currents of water that flow over them, carrying off the carbon dioxide that is released in respiration and providing an abundant supply of oxygen. The parents will defend the eggs from intruders and will remove any eggs attacked by fungus. The eggs will hatch 2 days later. Within this time, one or both of the parents may select another spot to clean and, soon after hatching, move the fry to this clean, new spot.

After 7-9 days, the fry become free-swimming and start to look for food. They can be fed with the live cladoceran, *Moina micrura*. Once the young are about one month old, they should be transferred to a large aquarium as additional space would ensure normal, steady growth. The fry are then fed floating pelleted feed.

Rearing the fry

There are three basic important requirements for successful rearing of the fry, namely:

Sufficient space. A 1 m³ tank can hold about 1000 newly hatched fry. However, once the fry are about 1-cm long, they should have more space to grow and half the number must be transferred to another tank.

I wonder whether we're included in the list of exotic tropical fishes ... We can provide enough foliage in an aquarium, you know ...



Clean, fresh water. For the first few weeks, just siphon off the dirt twice weekly; then top up with the same amount of water. When the fry are about a month old, the tank needs to be siphoned every alternate day.

Suitable and sufficient food. The amount and type of food to be given depends on the size of the fry. During the first two weeks, the fry can be fed with *Brachionus* sp. A half teaspoonful of drained *Brachionus* per day will be enough. At about 2 wk, the fry can start to take sifted *Moina* given twice a day.

With proper selection and conditioning of broodstock and provision of suitable spawning substrates, there is no reason why these popular aquarium fish cannot be bred successfully. By observing the three basic principles of providing suitable and sufficient food, ample space and good, clean water, the average hobbyist should soon have many beautiful fish to enjoy and share with friends.

Source: *Ornamental fish breeding* by Wong Chee Chye, *Infotish International* 5/91.

Faces of the Industry

Aquarium fish: high value, low volume

More and more Filipino businessmen are exporting Philippine aquarium fishes to the United States due to the increasing popularity of the hobby there.

However, to tap its multi-million dollar potentials, Philippine aquarium fish exports must be competitive in terms of quality, price, supply, and consistency.

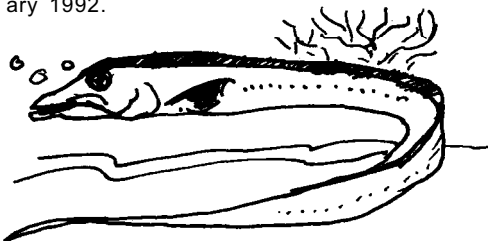
According to Rosalino Perez, Deputy Director of Market Information Dissemination, a project of the Philippine Chamber of Commerce and Industry, "this can be done through closer government-private sector cooperation." He also disclosed that the Aquarium Fish Industries of the Philippines conducts technical lectures, on species as well as financial analyses.

Perez also said that a buyer in the US is interested in acquiring 10 000 pieces per week of various fish species from the Philippines, if suppliers can offer competitive prices and deliver on a regular and consistent basis.

He said that even small fishermen and cooperatives can enter the export market by forging alliances with established breeders and exporters who are looking for contract suppliers for volume.

Perez said that given the high freight costs and the growing global demand, the country should export high value but low volume products which can compete even with the high transport costs.

Source: *More aquarium fish exporters to US noted*, **Manila Bulletin**, 7 January 1992.



*Hope to God I won't mistaken
for an arowana!*

Asia's costliest fish regarded lucky

What is the most expensive fish in Asia?

Metro Manilans have found that it is the *arowana*, a fish native to Malaysia, and supposed to bring good luck.

The *arowana* has silvery fins that glitter against the light, with red-tipped fins lining its elongated body. It looks like an eel at maturity or somewhat like the native *espada* (sword fish). Its distinctive feature is its large mouth.

It is the red tips of the fins that make this fish special for collectors. Malaysians ascribe good fortune and prosperity to this trait, indeed a rarity among the fish kingdom.

True enough, the *arowana* is a lucky fish in itself: a full-grown 30-cm *arowana* costs P35 000.

Source: *Asia's costliest fish regarded lucky* by Aldric C. Dalumpines, Philippine Daily Inquirer, 17 October 1988.

'Yes' to a leading edge?

The single most telling advantage of the Philippines over other countries exporting marine fishes is its vast resource base. With more than 7000 islands, the country hosts seemingly countless coral reef species, more than 200 of which are exported to about 30 countries around the world.

But "vast" is not limitless and, even if it were, environmental degradation would already have put constraints to the productivity of the country's marine resources. Warned (Science and Technology Secretary) Follosco: The industry is facing some problems which we have to address immediately. The absence of a resource-

(p.15,box)

Faces... from p. 14

use and management conservation policy has become the industry's main problem. This problem particularly concerns marine or saltwater fishes captured in our coral reefs. If our fishermen continue to use cyanide in catching marine aquarium fishes, we may lose our export market sooner than we expect because fishes caught in this manner do not last long. Cyanide also destroys our fish coral sanctuaries. In fact, 80% of the country's coral reefs are already damaged.

The second problem involves the use of destructive fish harvesting techniques and the resultant siltation or sedimentation of the sea waters due to deforestation.

The third problem is the lack of organization among small ornamental fish producers and the need for the government to establish a one-stop center for the processing and marketing of aquarium fishes for local and export markets."

(The 4-term president of the 13-member Philippine Tropical Fish Exporter

Association and Aquascapes Philippines' Lolita Ty expressed this concern): The market is big, but supply is tight.." Indeed, this is the reason why the industry cannot expand. "We have to rely on what nature can give us."

But something more needs to be done to meet increasing demand for ornamental fish. Marine fish breeding has been suggested. There are only two companies in the whole world - one in the United States and another in Europe-that have been successful in marine fish breeding, but... their production costs are very high. To make a profit, says Ty, they will have to sell at a price many times over that quoted for wild-caught fish, so "how can they compete?" They cannot - at least not yet and maybe not for a long time - for which reason local ornamental fish traders are not keen on exploring marine fish breeding as an option.

Source: *The ornamental fish industry: "Yes" to a leading edge* by AE Sia, **Aquaculture Watch**, November 1990.

SEAFDEC/AQD 1992 research ...from p. 19

Molluscs

Studies on stock assessment, seed production, grow-out culture, transplantation, and economics of bivalve culture systems will continue.

Oyster (Crassostrea sp.) and green mussel (Perna viridis): resource evaluation and socioeconomics.

Window-pane oyster (Placuna placenta) and saddle-shaped oyster (Placuna sella): site identification and resource evaluation, spatfall forecasting, seed production, and transplantation.

Seaweeds

Gracilaria: inventory and selection of productive strains, seed production, culture, economic studies of culture methods. An inventory of *Gracilaria* species and selection and development of productive strains with high quality agar will continue. Seed production studies will be conducted. Pond culture in ponds will be investigated. Refinement and studies on economics of culture techniques will be undertaken.

Other Studies

Natural food culture. Improvement of culture systems for various phytoplankton and strains of *Brachionus* sp. will be conducted. Studies on *Artemia* biomass production, and improvement of nutritional quality of brine shrimps as food for shrimps and finfish larvae will be continued.

Seafarming and searanching project The following ongoing projects in Malalison, Antique Province, will be continued: (a) resource assessment of selected marine communities; (b) economic studies on utilization of resources; and (c) studies on traditional marine boundaries and territorial rights in fisheries. Studies on construction and placement of artificial reef modules for habitat enhancement will be considered.

Epizootic Ulcerative Syndrome (EUS). Studies on predisposing factors, etiology, and epidemiology of EUS as well as histopathological characterization of the disease will continue.

In addition, some researches had been suggested during the two-day *Round-table Discussion on 1992 Research Activities*.



On MBV and the Shrimp Postlarvae

Facts

1. Monodon baculovirus (MBV) is the most prevalent disease in hatchery-reared and pond-cultured shrimp (*Penaeus monodon*) in the Philippines which accounted for 67.1% of the 372 diagnostic cases examined from October 1989 to December 1990 at the DA-Bureau of Fisheries and Aquatic Resources. Of 9100 shrimp samples, 5085 (55.8%) were MBV-infected.

2. There is a high positive correlation between host age and incidence of MBV in hatchery-reared shrimp postlarvae (PL). This indicates that incidence of MBV increases with increasing age of host.

3. MBV is consistently diagnosed in all provinces every month. However, there is low correlation between occurrence of MBV and time (month). Therefore, MBV epizootics are basically hatchery and/or pond management related problems and do not specifically relate to certain geographical distribution or seasonal variations.

4. MBV is very resistant to chemical agents such as 150 ppm iodine, 10 ppm calcium hypochlorite at maximum exposure times of 6 and 8 h, respectively. Likewise, MBV is resistant to environmental parameters such as freshwater (0 ppt) and 37°C at maximum exposure time of 4 h. This resistance is probably due to the tough proteinaceous material (polyhedrin) of MBV occlusion bodies which act as a protective matrix.

Note: *Aqua Farm News*, Vol. VIII, No. 5, September-October 1990 featured *Disease Prevention in Shrimp Hatcheries*. Also, *Recommended Practices for Disease Prevention in Prawn and Shrimp Hatcheries*, an extension pamphlet, has been published by SEAFDEC/AQD. Write to: Sales/Circulation, SEAFDEC/AQD, P.O. Box 256, Iloilo City, Philippines 5000.

Drugs in Aquaculture

Using drugs in aquatic animals for both curative and preventive purposes may not only initiate environmental pollution but also affect human health due to drug residues. To protect human health, drug residues in marketed fish or shrimp are monitored in some major importing countries. Japan has begun such a monitoring program in seafood imports; the USA and European Economic Community may follow suit in the near future.

A withdrawal period is needed for complete removal of drug residues from the animal. This period can be determined according to the temperature of the water. Recommended withdrawal periods for various drugs are shown below.

Recommended withdrawal periods (number of days) for various drugs [*The Fish Inspector* (INFOFISH), Aug/Sep 1991, quoting *Asian Shrimp News*, ASCC, 1st Quarter '91, Issue 5.]

	Temperature (°C)		
	<12	12-22	>22
Oxytetracycline	60	40	15
Oxolinic acid	60	40	15
Furazolidone	40	20	10
Sulfamonomethoxine	60	30	15
Sulfadimethoxine	60	30	15
Neomycin	40	30	15
Nalidixic acid	40	20	10
Piromidic acid	40	20	10
Nifurpirinol	40	20	10

Source: Naga, *The ICLARM Quarterly*, October 1991.

5. Direct sunlight exposure for 4 h completely inactivates MBV in infected hepatopancreatic tissues. MBV, being a virus of an aquatic species, might be far less resistant to drying and sunlight exposure when compared with other insect baculoviruses.

6. In pond culture, MBV infection results in low production. These observed differences in average body weight between MBV-negative and MBV-positive populations decreased as the stocking density decreased; hence, MBV infections may not be a problem in extensive culture where the stocking density ranges 1-2 shrimps/m².

7. Shrimp populations with MBV infections at stocking may harbor the virus throughout the whole culture period. However, the severity of infection (SOI) may decrease as the culture period increases. This decrease in SOI is probably due to the rapid regeneration of hepatopancreatic tissues in infected shrimps.

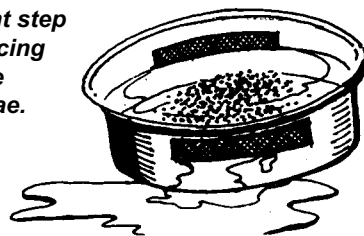
8. Transmission of MBV in hatchery reared shrimp larvae/PL can be by wild MBV-infected broodstock. During spawning, these infected broodstock may continuously shed tremendous quantities of MBV occlusion bodies and free virus via their feces before and during spawning. MBV-contaminated feces remained in the water until the eggs were hatched and may have infected the shrimps when they began feeding.

9. Production of MBV-free PL can be achieved by means of strategic egg prophylaxis as described below. The principle involved in this method is to eliminate all possible egg contaminants, including free MBV virus and occlusion bodies, by means of egg prophylaxis using iodine, benzalkonium chloride, calcium hypochlorite, or ozone-treated seawater.

Producing MBV-free postlarvae

Egg prophylaxis by washing and rinsing spawned eggs is the most important step towards the production of MBV-free shrimp PL. Regardless of the type of disinfected seawater used to wash the eggs, MBV-free postlarvae are produced up to PL-15. However, there exist significant differences among the types of disinfected seawater used in

Egg prophylaxis - washing spawned eggs - is the most important step in producing MBV-free postlarvae.



comparison to the hatching rate of the eggs and the survival rate in their larval and postlarval life stages.

Overall, the eggs washed with ozone-disinfected seawater gave the highest survival rate of 67.6% in PL-7 animals. This high postlarval survival can be attributed to the substance itself, having a rapid rate of decay in the water with low level ozone residuals. Ozone residuals are believed to cause genetic damage to developing embryos and larval forms of marine species; hence, activated carbon filtration is recommended to eliminate ozone residue in ozonized seawater. On the contrary, the unwashed eggs exhibited the highest hatching rate, but gave the lowest survival rate of only 30.6% when the animals reached PL-7. This low survival rate can be attributed to microorganisms, such as bacteria and fungi, that may have attached to the eggs and may have infected the larvae after hatching. It can also be noted in the unwashed eggs that the average survival rate at Zoea-2 stage was 86% but abruptly dropped to 54% at Mysis-2. In contrast, eggs washed with ozone-treated seawater gave a relatively higher survival rate (89.3%) at Z-2 and gradually dropped to 78.5% at M-2 and 67.6% PL-7. Survival of the postlarvae (PL-7) hatched from eggs washed with ozonized seawater was more than twice the survival of PL-7 hatched from the unwashed eggs which was 30.6%.

Although ozonized seawater appeared to be the best disinfectant based on high egg hatching rate and larval/postlarval survival, its use in small and medium scale hatcheries would be a critical factor in terms of its capital and operational costs. Benzalkonium chloride-treated seawater gave the second highest hatching rate of 60.3% making it an alternative choice, especially in small scale hatch-

eries. Benzalkonium chloride is a quaternary ammonium compound used as a surface disinfectant, as a detergent, or as a topical anti-septic.

The iodine-disinfected and chlorinated seawater showed low hatching rates - 37.8% and 48.3%, respectively. One of the drawbacks of using chlorinated seawater was the neutralization process with sodium thiosulfate. In freshwater environments, sodium thiosulfate is non-toxic, but in seawater, 1 mg/l sodium thiosulfate has been shown to be toxic to larval penaeid shrimps.

Summary. Although the use of ozone-treated seawater gave the highest hatching and survival rates, the use of benzalkonium chloride-tested seawater appeared to be a better choice for medium and small-scale hatcheries due to high capital and operational costs of ozone generators.

Source: *The Epizootiology of Penaeus Monodon Baculovirus (MBV) in the Philippines* by Dr. Jose M. Natividad of DA-Bureau of Fisheries and Aquatic Resources. Paper presented at the **2nd Prawn Congress**; 23 Nov. 1991; Bacolod City.



SEAFDEC/AQD R&D

Alternative Farming Systems

"AQD's general objective is generation of technologies that (1) have no ecological effects, (2) give equitable benefits to end-users, and (3) are sustainable," SEAFDEC Aquaculture Department Chief Dr. Flor Lacanilao stressed in his opening remarks during the *Roundtable Discussion on 1992 Research Activities* held 23-24 January at Tigbauan, Iloilo.

As the three criteria characterize real development, the Chief noted, AQD will not support these two farming systems: intensive shrimp culture and milkfish pen and tilapia cage cultures in Laguna Lake. These two systems he termed "wrong development [concepts] for the country" and which he criticized as:

	Intensive shrimp culture	Milkfish pen culture and tilapia cage culture in Laguna Lake
1. Ecological effects	Antibiotics pollution; development of drug-resistant pathogens	Reduction of natural food in surrounding waters; pollution
2. Social consequences (unequal benefits)	Endangers public health	Reduced catch of small fishermen
3. Sustainability	Stopped by low prices	Stopped by pollution, social unrest

AQD will hence gear its R & D towards these alternative farming systems: semi-intensive/extensive systems (low stocking density to prevent disease) and the use of the more extensive coastal waters (seafarming and searanching).

SEAFDEC/AQD 1992

RESEARCH ACTIVITIES

Most of the research projects on 13 important commodities conducted in 1991 will be continued in 1992, and new studies on priority species identified during the *2nd Seminar-Workshop on Aquaculture Development in Southeast Asia* will be initiated. As in previous years, studies are geared to support seafarming and searanching projects. Emphasis of research will be on the improvement of seed production and nursery culture techniques for species suitable for seafarming and searanching; technology verification and refinement; practical feed development for marine and freshwater finfishes; economic analysis of various culture systems; and socioeconomic studies of coastal communities.

Site-specific and verification studies will be implemented in collaboration with public and private sectors, and academic and research institutions.

The following studies will be undertaken:

Marine finfishes

Grouper: inventory and taxonomy, broodstock management, seed production, culture, fish health control. Studies to develop induced breeding and seed production techniques will continue. Hatchery and nursery techniques will be improved, and studies on inventory, taxonomy, and fish health control will be conducted.

Milkfish: broodstock management, hatchery system, feed development, culture. Broodstock management and hatchery techniques will be refined. Verification and economic assessment of hatchery and nursery techniques will be initiated in collaboration with private cooperators. Practical feed development for various life stages will be continued. Studies on nutritional requirements and bioenergetics of larvae and juveniles, and on nutrient cycles in ponds will be continued.

Snapper: inventory and taxonomy, broodstock management. Inventory and identification of suitable species for broodstock development and culture will be continued.

Sea bass: broodstock management, hatchery techniques, feed development, fish health control, economics and marketing. Broodstock development and management will be continued. Hatchery, nursery, and grow-out culture techniques will be refined and verified. Practical feed development for various life stages will be continued. Fish health

control, economics, and marketing for juveniles and table-sized fish will be investigated.

Rabbitfish: stock assessment, economics and marketing. Studies on stock assessment, socioeconomics of existing industry practices, and marketing will be undertaken.

Mullet: broodstock management, seed production. Broodstock management and development of hatchery/nursery techniques will continue.

Freshwater finfishes

Tilapia: strain comparison and evaluation, selective breeding, feeds and feeding techniques. Procedure for strain comparison and evaluation will be refined. The ecological effect of new strains will be investigated. Selective breeding will be undertaken. Feeding techniques will be improved.

Catfish: induced breeding, hatchery and nursery techniques, feed development. Induced breeding, hatchery and nursery techniques will be refined. Practical feed development for juveniles will be continued.

Bighead carp: induced spawning, feed development, fish health control. Induced breeding and hatchery techniques will be refined. Practical feed development for juveniles and adults will be continued. Fish health control in hatchery, nursery, and grow-out will be undertaken.

Red tilapia: selective breeding, hatchery techniques. Selective breeding will be conducted and hatchery techniques will be refined.

Ornamental fish

Marine ornamental fish: broodstock development, genetic improvement. Broodstock management techniques will be developed for some marine ornamental fish.

Crustaceans

Mudcrab: pond and cage culture. Verification studies on pond and cage grow-out cultures will be conducted.

Tiger shrimp: broodstock management, culture, feed development, fish health control. Broodstock management and genetic selection studies for better fry quality will be undertaken. Verification of hatchery techniques with emphasis on disease and standardization of criteria for fry quality will be continued. Practical feed development for juveniles and adults will be continued as well as the assessment of quality of artificial feeds. Pond culture systems will be improved.

Other shrimps (P. merguensis and P. indicus): ecology, broodstock development, culture. Broodstock development will continue, and hatchery and grow-out culture techniques will be verified.

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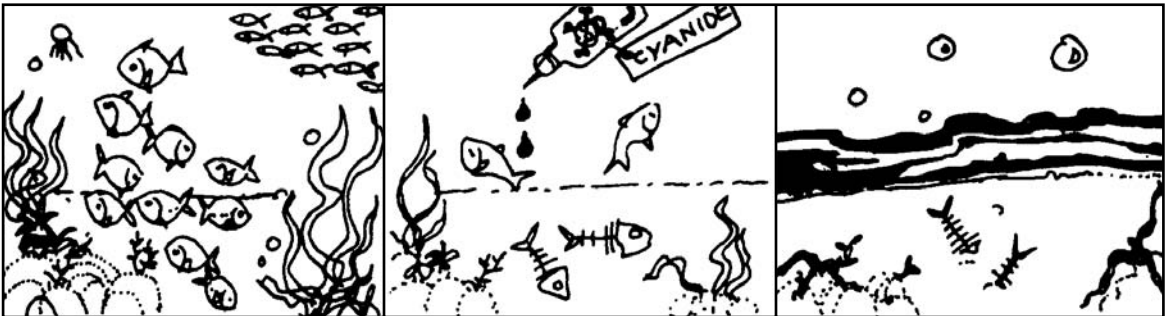
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Ten little fishes ...and then there were none.



by I. Tendencia



Better life through aquaculture