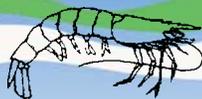
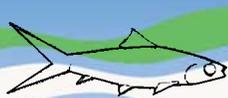


# SEAFDEC Asian Aquaculture



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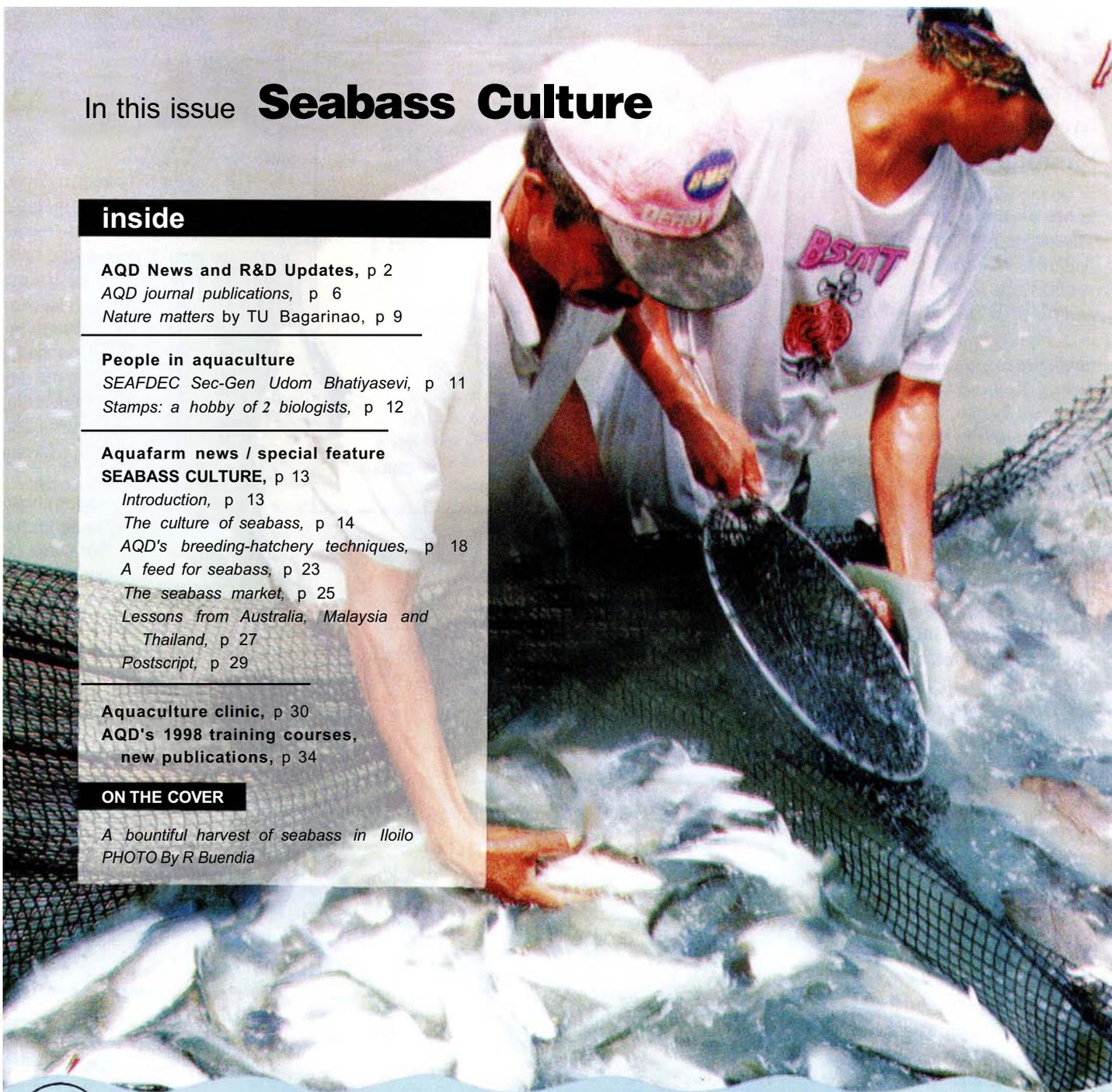
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*A bountiful harvest of seabass in Iloilo*  
PHOTO By R Buendia



## AQD cited for best research

TWO AWARD-WINNING PAPERS EXCERPTED BELOW

### Intensive tilapia cage farming may cause the death of Sampaloc Lake

By **MB Surtida**

The paper by AQD researcher Alejandro Santiago and Rene Arcilla titled *Tilapia cage culture and the dissolved oxygen trends in Sampaloc Lake, Philippines* published in the journal *Environmental Monitoring and Assessment* Vol. 24, No. 3, pp 243-255, won the 11th Dr. Elvira Tan Memorial Award for 1997 in the aquaculture category. The paper discussed Sampaloc Lake vis-a-vis the use of aquaculturists and other users.

The tilapia floating cage culture industry in Sampaloc Lake (for open fishery and tilapia aquaculture, see illustration) has expanded from 6 hectares in 1981 to 28 ha in 1989. But occurrences of fish kills with an estimated loss of 1.2 million pesos aroused national concern over the conditions of Sampaloc Lake and prompted investigations.

Investigations showed that as the tilapia operations intensified, commercial fish feeds were used. Cages measuring 10 x 20 x 5 meters (the most common size) with 3,150 pieces tilapia consume 1.25 tons of commercial feeds for 120 days cropping. The feeds are broadcast or placed in feeding trays. Fish yield at 95% recovery is 0.6 tons with fish averaging 200 g each.

Extrapolated per hectare, the total feeds delivered per cropping is 62.5 tons. Thus the lake receives 187.5 tons per ha



*Sampaloc Lake in northern Philippines: x indicates sampling station, boxes are tilapia cages [map from the *Envi. Monitor. Assess.* 24(3): p. 245]*

or a total 5,250 tons from the 28 ha cage area. Uneaten feeds being unavoidable in intensive cage farming, potential feed loss ranges between 157.5 and 1,575 tons (estimated at 5-30% total feed input).

If the lost feed can be considered as sewage organic matter then the theoretical demand for oxygen is 249 to 2488 tons annually. This estimate does not include the total amount of fish feces and fish respiration which also extract oxygen from the lake.

The pattern of oxygen depletion (<1 milligram per liter) shows the slow biological death of the lake for fishery. What is left in the lake for aquaculture is the upper 2 m because critical oxygen tension for tilapia is around 3 ppm. The present dissolved oxygen level and saturation value

in Sampaloc Lake suggests that growth of fish is confined between the surface and 2 m depth layer. Below this depth, the water quality is unfit for fish culture.

For Sampaloc Lake to recover, the study recommends a moratorium on feeding and reduction of total cage area. Based on the findings that cage area and tilapia growth rate are related, a 5 ha cage area will yield a tilapia growth increment on natural food to be 0.838g per day and 0.699g per day at 10 ha. A 5-gram tilapia fingerling should grow to market size of 150 g and 120 g in 6 months at 5 ha and 10 ha respectively.

The study has two recommendations for the recovery and rehabilitation of the Sampaloc Lake. (1) A master plan should guide the reduction of fish cages in Sampaloc Lake as approved by big and small operators. (2) Powerful aerators in the middle of the lake should be installed to temporarily solve the oxygen depletion. This will break the thermal layering and aerate the water. But a civil or sanitary engineer must first be consulted.

### Soybean oil improves reproductive performance of Nile tilapia

By **ET Aldon**

"Lipid source affects the reproductive performance of Nile tilapia and soybean oil is the best lipid source," reports Dr. Corazon Santiago and Ofelia Reyes in their research

paper titled *Effects of dietary lipid source on reproductive performance and tissue lipid levels of Nile tilapia *Oreochromis niloticus* (Linnaeus) broodstock.*

In their experiment, Nile tilapia were fed diets with one of the following lipid sources at 5% level: cod liver oil, corn oil, soybean oil, a coconut oil-based cooking oil, or a combination of cod liver oil and corn oil (1:1). The control diet had no lipid supplement and had fish meal and soybean as protein sources.

Their results showed that supplemental lipid sources in the diets, corn oil, and the coconut-based cooking oil increased at varying degrees the number of females that spawned, number of fry per spawning, and total number of fry per spawner. The total fry production was markedly high for fish fed the soybean oil diet. This shows that high production in tilapia hatcheries may be achieved not only by increasing spawning frequency but also increasing the number of females that spawn.

Data on gonadosomatic index (GSI), hepatosomatic index (HSI), and weight gain showed no significant differences among treatments. Fish fed the cod liver oil has a poor reproductive performance but is comparable with fish in all treatments in terms of GSI and HSI and gave the highest weight gain.

Fat content of liver and gonads of Nile tilapia broodstock was much higher than that of the muscle. However, fat levels in liver, ovaries and testes as well as the GSIs and HSIs did not clearly indicate which dietary treatment enhanced reproduction. Nile tilapia fingerlings given vegetable oils reportedly had better weight gain and feed efficiency than those given beef tallow or pollack liver oil. However, Santiago reported that broodstock fed vegetable oils influenced reproductive performance of mature fish.

Santiago also noted that supplemental oils may not be necessary if adequate levels of residual oils rich in n-6 fatty acids and n-3 fatty acids can be provided by the major feed ingredients. Among the vegetable oils tested, soybean oil is the best source



The first graduates of the revised Coastal Aquaculture and Resource Management training course pose with AQD Chief Dr. Rolando Platon (seated, 4th from the left) and Training and Information Head Renato Agbayani (seated, 2nd from right).



## AQD improves curriculum of the coastal aquaculture training course

By **AP Surtida**

AQD revised the curriculum of the two-month training course on Coastal Aquaculture, adding a new module on coastal resource management. The changes are in response to the need for reconciling technology with the sustainability of development.

The training course results from the collaboration of the Governments of Japan and the Philippines. AQD conducts the course with the support of the JICA Third Country Training Programme. The course is held once during the Japanese fiscal year 1994 to 1998.

for essential fatty acids and energy for Nile tilapia broodstock diet.

The study was conducted at AQD's Binangonan Freshwater Station where studies on freshwater species are done. Santiago, a scientist, holds a Ph.D. in Fisheries and Allied Aquacultures from Auburn University (USA) while Reyes, an associate researcher, holds an MS in Aquaculture from the University of Ghent (Belgium).

The curriculum changes are:

- discussion of the conceptual framework for coastal resource management
- the new module on coastal resource management includes ten lecture topics: (1) resource assessment and management; (2) coastal ecosystems and biodiversity; (3) mangrove management and silviculture; (4) fish sanctuary and marine reserves; (5) socioeconomic considerations in sustainable aquaculture; (6) community organization and

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This paper published in the *Journal of Applied Ichthyology*, Vol. 9 (1993) pp 33-40 won for the authors a special award during the 11th Dr. Elvira O. Tan Memorial Awards. The award is annually given by the Philippine Council for Aquatic Marine Resources and Development (PCAMRD) in recognition of Dr. Tan's contribution to aquaculture development.

institutional building of fisherfolk cooperatives; (7) management of cooperatives; (8) property rights in fisheries; (9) institutional and policy analysis of coastal resource management; and (10) economic resource valuation.

- addition of abalone to the lecture on mollusc culture. This reflects the strides AQD has taken in abalone R&D. Abalone culture is discussed alongside oyster, mussel and giant clam culture.

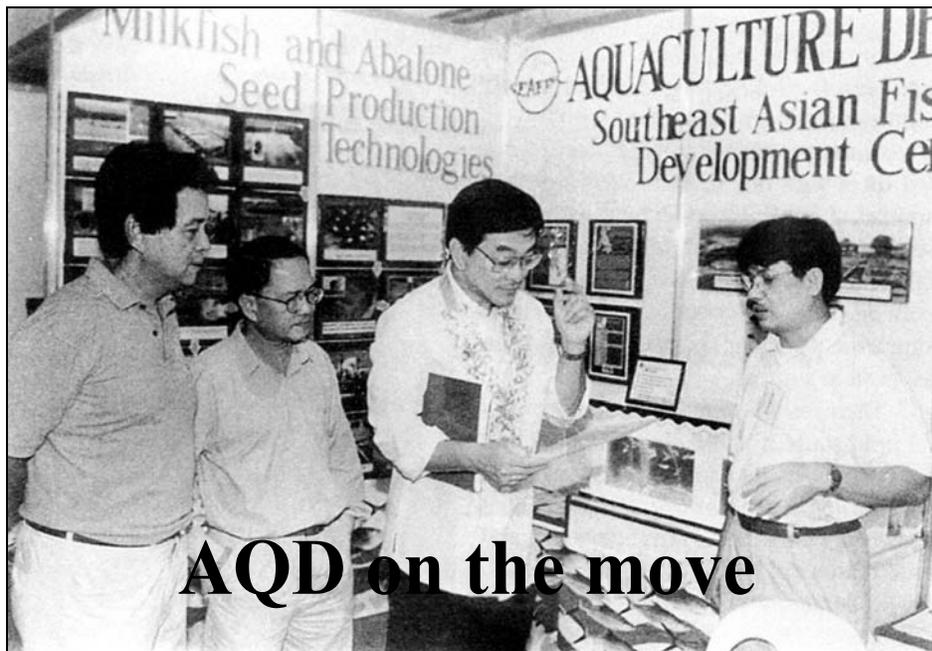
The training course has a new name, Coastal Aquaculture and Resource Management.

The course is aimed at providing participants from Asian countries the opportunity to improve knowledge and techniques of coastal aquaculture and resources management anchored on sustainable development. The increasing pressure placed on coastal resources along the vast waters of Asia and the Pacific has created a need for a comprehensive training on coastal aquaculture and resources management.

This year's two-month course opened August 2 at AQD's Tigbauan Main Station and ended October 2.

Fourteen Asians attended the course: two each from Bangladesh, Malaysia and the Philippines; and one each from Cambodia, China, Indonesia, India, Myanmar, Sri Lanka, Thailand and Vietnam. They are the first graduates of the revised training course.

At the opening ceremony, Mr. Kazuo Sudo, Deputy Training Representative of JICA Philippines, delivered a message to the participants in behalf of Mr. Hiroshi Goto, the JICA Resident Representative.



The first Department of Science and Technology (DOST) Visayas Cluster Science and Technology Fair was participated in by 88 local private small and medium enterprises including research institutions and the academe. AQD's booth shows from left to right: erstwhile Negros Occidental Congressman Bob Gatulao; Mr. Renato Agbayani, Head of AQD's Training and Information; Negros Occ. Governor Rafael Coscolluela and AQD Researcher Mr. Nelson Golez. The fair was held at the Bacolod Convention Plaza, Bacolod City on August 11-16.

#### Most promising technology

Three months ago, AQD shared with the UP Marine Science Institute the most promising technology award when it joined the Fisheries Techno-Forum cum Techno-Mart organized by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) and Marine Technology Foundation, Inc. (MTFI) in Intramuros, Manila. The AQD booth highlighted milkfish and abalone seed production technologies and displayed publications and posters. The forum has the theme "Fisheries Technology - From Research to Market."

#### Some feedback

Meanwhile, two AQD cooperators and a training alumnus expressed their appreciation of AQD's technology transfer and t-verification activities.

Bert Oliveros, the President of Honda Bay Foundation Inc based in Palawan, wrote: "... the overall go out and accommodate ethic was something I did not expect from what I thought before was a snooty organization ..." referring to his recent AQD visit where he was given an impromptu technology consultation by AQD staff.

Claudette Jalandoni, a farm owner in Bacolod City, indicated her satisfaction with AQD's two field studies on mudcrab and milkfish culture conducted in her farm. She urged AQD to "continue technical assistance ... by providing on-call technical (staff)."

Dr. Chukwukadibia Madu of Nigeria's National Institute for Freshwater Fisheries Research wrote of his "...wonderful scientific exposure and experiences ..." in the 1995 marine fish hatchery course which led to "a lot of improvements in our hatcheries due to these experiences." He looks forward to training anew in Aquaculture Management AQD is conducting early next year.

Support  
sustainable  
aquaculture

## AQD renews lease of the Leganes ponds and R&D complex

By **ET Aldon**

AQD will soon reacquire the 24 hectares of brackishwater ponds that partly comprise the Leganes Brackishwater Station which AQD operated from 1973 to 1989.

The contract of lease will be signed next month by Mayor Josil Jaen for the Municipality of Leganes and by AQD Chief Dr. Rolando Platon. The contract for 25 years stipulates that AQD will undertake major but gradual repairs of the Leganes R&D complex.

"We need the Leganes ponds for field verification studies and for hands-on training on brackishwater pond culture," Dr. Platon says. "With experimental ponds beside production ponds in Leganes, AQD will be able to showcase a sustainable integrated aquaculture system that may be operated as a zero discharge facility in the next few years."

The first agreement with the Leganes Municipality for the brackishwater ponds was on March 26, 1974 when AQD Executive Director Dr. QF Miravite and Mayor Esperidion Jagunap negotiated a 7-year contract for 86 hectares of ponds. The contract was renewed for another 7 years in 1981 during the term of AQD Chief Dr. Flor Lacanilao.

In 1989, however, AQD opted not to renew the contract when it redirected its R&D efforts toward seafarming and sea ranching. The Leganes Brackishwater Station was subsequently closed in May 1989 and the experimental ponds and buildings were turned over to the Leganes Municipality. AQD collaborates with private fishfarm owners or uses ponds belonging to the Department of Agriculture and some fisheries colleges for research that needs brackishwater ponds.

When AQD conducted a Visioning Workshop in 1996, the AQD staff and management identified the need for experimental ponds especially in light of AQD's new thrusts of technology verification, t-transfer and t-demonstration.



*During its operation from 1973 to 1989, R&D at AQD's Leganes Brackishwater Station focused on pond culture. The station was also the venue for training on brackishwater pond culture. It was one of the 15 substations and project sites eventually phased out by AQD.*



*The agreement renewing the lease for LBS was signed September 1997.*

Strategically, the acquisition of brackishwater ponds can:

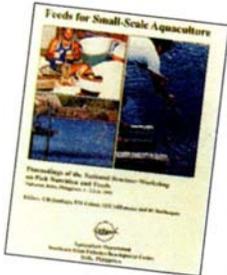
- advance AQD's goal in refining tiger shrimp seed production on a commercial scale;
- provide a take-off ground for technology packaging and transfer for the production of commercially important species;
- benefit local residents and fishfarmers in terms of first-hand knowledge on improving construction methods, pond management and maintenance;
- improve methods of culturing fish; and
- employ a good number of local residents.



# A2D Research Publications

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

Compiled by **DATABANK / AQD LIBRARY**



Below are the AQD papers in the proceedings volume entitled **\*FEEDS FOR SMALL-SCALE AQUACULTURE** edited by CB Santiago, RM Coloso, OM Millamena, IG Borlongan. 1996. 144 pages —

**Millamena OM.** *Review of SEAFDEC/AQD fish nutrition and feed development research.* p 52 - 63.

Research on fish nutrition and feed development at SEAFDEC Aquaculture Department has focused on three major areas: nutrient requirements and their interrelationships, digestive enzymes and digestibility, and practical feed development for important species such as milkfish (*Chanos chanos* Forsskal), sea bass (*Lates calcarifer*), Nile tilapia (*Oreochromis niloticus*), bighead carp (*Aristichthys nobilis*), and tiger shrimp (*Penaeus monodon*). Early studies on essential amino acids and fatty acids, and optimum protein: energy ratio in the diets for cultured species were conducted later. Likewise, requirements for other essential nutrients in shrimps, like phospholipid and cholesterol, were studied. Dietary calcium and phosphorus required to prevent soft-shelled shrimps were determined. Requirements for water-soluble vitamins and bioavailability of stable forms of vitamin C were evaluated. Little is known of the vitamin and mineral requirements.

The major digestive enzymes in milkfish have been studied. The apparent digestibility of common feedstuffs were determined *in vivo* and *in vitro* for milkfish and tiger shrimp, and presently, for sea bass. Development of cost-effective practical feed continues to be a major research undertaking at SEAFDEC/AQD. Diet refinement emphasizes the use of inexpensive and indigenous materials in diet formulations. The feasibility of using legumes, leaf meals, and agricultural by-products and wastes as feed components has been demonstrated. Feed and feedstuff quality control and proper processing techniques were found to improve the nutritional value of low-grade raw materials. Improved feeding techniques and practices have been pur-

sued to minimize feeding costs. Studies on the effect of feeds on the environment are being initiated. Economically feasible grow-out diets for semi-intensive culture of milkfish, Nile tilapia, and tiger shrimp, and diets for broodstock and larvae of these species have been developed.

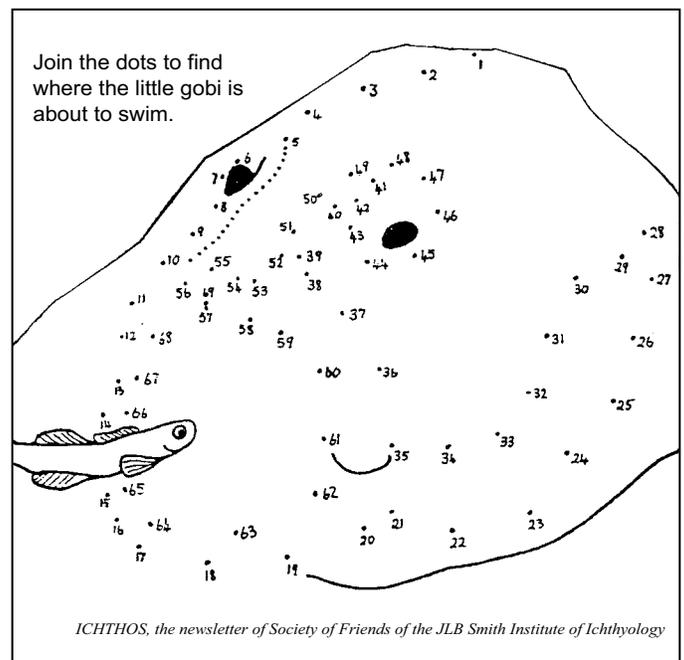


**Quinitio ET, Parado-Esteva FD, Millamena OM, Biona H.** *Reproductive performance of captive Penaeus monodon fed various sources of carotenoids.* p 74-82.

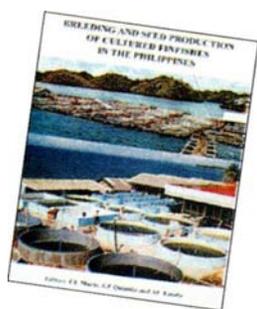
Three groups of pond-reared *Penaeus monodon* broodstock were fed formulated diet in combination with carotenoid-containing natural food: mussel + shrimp broodstock pellet (MBP), crab + BP (CBP), and *Artemia* + BP (ABP). After four months, maturation and spawning rates did not differ significantly among treatments. After eyestalk ablation. MBP-fed shrimps initially spawned 20 days; 34 days for CBP-fed; 50 days for ABP-fed shrimps. The number of eggs per g body weight of spawner (1616-2359 eggs / gBW) did not differ significantly among all groups. Only nauplii from MBP-fed broodstock reached postlarval stage. Rematuration was observed only in MBP- and CBP-fed shrimps. Sperm count was highest in MBP- and lowest in ABP-fed shrimps at the final phase of the test.

**Fermin AC, Bolivar MEC.** *Weaning of the Asian catfish, Clarias macrocephalus Gunther, larvae to formulated dry diet.* p 83 - 86.

Two feeding trials lasting 10 days each were conducted to determine the weaning time in the Asian catfish, *Clarias macrocephalus*, larvae to dry diet feeding. Three-day-old catfish larvae were fed newly hatched *Artemia nauplii* for 2, 4, and 6 days after which ad libitum feeding with a commercial feed (trial 1) or a formulated diet (trial 2) was started. Fish fed exclusively dry diet (0-day *Artemia* feeding) or those fed only *Artemia* for 10 days served as the controls. In trial 1, fish fed at different durations had significantly higher growth and survival than those reared exclusively on dry diet. In trial 2, percent survival was not significantly different among fish with or without *Artemia* pre-feeding. However, fish had significantly higher final body weight and SGR when reared initially on *Artemia* prior to dry diet than those fed exclusively dry diet. Based on the results, catfish larvae can be successfully weaned to dry diet after feeding *Artemia* for a maximum period of four days (ave. BW = 12.25 mg).



\* This volume is available at AQD's Sales / Circulation office. See addresses at the back cover.



Below are the AQD papers in the proceedings volume entitled **\*BREEDING AND SEED PRODUCTION OF CULTURED FINFISHES IN THE PHILIPPINES** edited by CL Marie, GF Qunitio, AC Emata. 1993. 182 pages—

**Garcia LMB.** *A review of SEAFDEC/AQD finfish breeding research.* p 54-64.

Recent progress undertaken by SEAFDEC/AQD in the development of broodstock of a variety of cultured fish in the Philippines is reviewed. Spontaneous maturation and spawning has been achieved among captive breeders of grouper, milkfish, sea bass, rabbitfish, and tilapia. Hormonal intervention methods have been developed mainly to accelerate final gonadal maturation, to synchronize release of mature gametes, and to control sex inversion among hermaphroditic fish such as grouper. These methods entailed the development of gonadal biopsy procedures and hormone administration protocols such as mode of introducing a variety of exogenous hormones to fish, administration intervals, and lately response times.

Enhancement of reproduction by improving the diet fed to Nile tilapia, rabbitfish, and milkfish breeders has also been achieved in recent years. Protein or lipid enrichment of the diet may enhance growth of broodstock to subsequently increase reproductive performance and fry survival.

Limited success has been achieved with photoperiod manipulation to effect year-round sexual maturation and spawning of milkfish and sea bass broodstock.



**Qunitio GF, Duray MN.** *Review of SEAFDEC/AQD finfish seed production research.* p 119-131.

Research on seed production of several foodfishes has been a continuing activity of SEAFDEC/AQD since 1976. Fry and juvenile production methods of these fish commodities are in various stages of advancement. For instance, advances in the development of hatchery rearing, particularly feeding and water management schemes, have made mass production of milkfish (*Chanos chanos*) seed a reality, resulting further in the application of the technology in commercial hatcheries. Recent studies

now focus on assessing the quality of hatchery seed stocks of milkfish vis-a-vis wild seed during nursery and grow-out culture. Likewise, sea bass (*Lates calcarifer*) seed production has undergone significant improvements since the technology was introduced in the Philippines in 1982. Fatty acid-enrichment of a zooplankton diet can enhance growth and survival of sea bass fry, although other cheaper alternatives and early weaning to formulated diet preparations are currently being tested. Hatchery fry production of grouper (*Epinephelus salmoides* and *E. suillus* syn. *E. coioides*) and snapper is in its infancy, but trials complemented by research on their larval feeding habits and requirements are underway to establish reliable methods of rearing larvae of these species. Although fairly well-established, seed production of rabbitfish (*Siganus guttatus*) requires further improvement in determining an appropriate zooplankton diet to ensure adequate growth and survival of larvae. Hatchery fry production of tilapia (*Oreochromis* sp.), carps (*Aristichthys nobilis*, *Hypthalmichthys molitrix*) and, to a certain extent, catfish (*Clarias macrocephalus*) can already be categorized as a flourishing industry in some parts of the Philippines. Nonetheless, SEAFDEC/AQD continues to conduct research on these freshwater species, with particular emphasis on nutrition and feed development during the nursery production phase. Together, results of past and on-going research studies ensure that seed supply of these important foodfishes become adequate and sustainable for the grow-out.



**Duray MN.** *Larviculture of milkfish (Chanos chanos) in outdoor tanks.* p 150-158.

In the past, larviculture of milkfish depended entirely on the use of rotifers and brine shrimp nauplii and rearing trials were done under roofed facilities. Since the dietary value of live food varies according to culture and feeding conditions, rotifers were enriched with SELCO, a lipid emulsion containing high lev-

els of highly unsaturated fatty acids (HUFA) prior to feeding the larvae. Alternatively, a microbound larval feed (Nosan R-1) was given as a supplement to rotifers during the first two weeks of culture. Larval growth was enhanced and survival was significantly improved when rotifers were enriched or supplemented with these diets. All rearing trials were conducted in 5-10 tons concrete circular/rectangular outdoor tanks.

Verification runs on the use of HUFA-enriched rotifers to milkfish larvae were tried in two nearby private hatcheries. Results from this collaborative work are presented.



**Hilomen-Garcia GV.** 1997. *Morphological abnormalities in hatchery-bred milkfish (Chanos chanos Forsskal) fry and juveniles.* *Aquaculture* 152 (1-4): 155-166 —

Morphological abnormality has been observed in hatchery-bred milkfish juveniles. To characterize and quantify the occurrence of these anomalies, hatchery-bred milkfish juveniles from commercial nursery ponds were sampled, and the development of abnormalities in tank-reared fry and juveniles was monitored. Small specimens were cleared and stained using a KOH-alizarin technique for osteological examination. The occurrence of gross abnormalities in hatchery-bred milkfish juveniles reared in commercial ponds was highly variable (3-26%). These abnormalities were predominantly a cleft on the branchiostegal membrane (CBM) and a deformed operculum (DOp), which was mostly folded. CBM was commonly associated with a deformity or the partial to total absence of its supporting branchiostegal rays (DABr). DOp and DABr, but not CBM, were first detected during the early juvenile stage. Reference samples of wild fry did not develop similar proportions of abnormalities when reared in tanks, indicating that these abnormalities are predetermined or induced before the fry stage. Slow growth and development were observed in fish with opercular and branchiostegal abnormalities. A high mortality rate (70%) of abnormal fish was also observed after handling and transfer of stock. These results demonstrate that

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morphological abnormalities such as CBM and DOp do not only affect the appearance of milkfish but also interfere with its growth and survival.



**Primavera JH.** 1997. Fish predation on mangrove-associated penaeids - the role of structures and substrate. *Journal of Experimental Marine Biology and Ecology* 215 (2): 205-216 -

The effect of habitat structure and substratum on predation of the greasyback shrimp *Metapenaeus ensis* (De Haan), white shrimp *Penaeus merguensis* De Man and tiger shrimp *Penaeus monodon* Fabricius by sea bass *Lates calcarifer* Bloch and mangrove snapper *Lutjanus argentimaculatus* (Forsskal) was evaluated. The shrimp juveniles measured 6-15 mm in carapace length, fish measured 6.5-12.5 cm in standard length; structure types were pneumatophores of the mangrove *Sonneratia griffithii* Kurz and dried coconut leaf bracts; structure densities were 0, 32 and 98 pneumatophores per tank; and sediment particle sizes were pebbles, sand-granules and silt-sand. Predation on shrimp was significantly higher in controls or bare sand (48.7%) than among pneumatophores (29.9%), but not among leaf bracts (43.5%). Shrimp mortality was also significantly higher on bare sand (72.9%) compared to medium-density (54.2%), but not high-density (68.8%), pneumatophores. Fish predation on the burying shrimp *M. ensis* was affected by predator type but not by sediment size. The generally higher predation rates of snapper may be due to their habit of leaving unconsumed pieces of shrimp, whereas sea bass which devour whole prey require fewer shrimp to reach satiation. Moreover, the presence of structures did not affect sea bass behaviour of chasing prey among pneumatophores and under leaf bracts, but reduced predation by the relatively passive snapper. Predation rates among pneumatophores vs. control, and among medium-density pneumatophores vs. bare sand, were lower for *P. monodon* but not *P. merguensis*. This may be related to the greater and more frequent use of (laboratory) shelters by juvenile tiger shrimp compared to white shrimp. The results demonstrate that the effective provision of shelter depends not only on structure type and density but on the behaviour of predator and prey as well. The use of mangrove structures (pneumatophores) by juvenile shrimp as refuge from predation is also documented for the first time.



**Millamena OM. Bautista MN. Reyes OS. Kanazawa A.** 1997. Threonine requirement of juvenile marine shrimp *Penaeus monodon*. *Aquaculture* 151 (1-4): 9-14 --

The threonine requirement was determined for juvenile marine shrimp. *Penaeus monodon* postlarvae, PL20, were stocked in 30-l fiberglass tanks at ten shrimp per tank arranged in a completely randomized design with six replicates per treatment. They were fed amino acid test diets (40% protein) with casein-gelatin as natural protein sources and supplemented with crystalline L-amino acids to simulate the amino acid profile of shrimp muscle except for threonine. Graded levels of threonine were incorporated to obtain 0.72, 1.0, 1.28, 1.56, 1.84, and 2.12 g per 100 g diet or 1.8, 2.5, 3.2, 3.9, 4.6, and 5.3% of dietary protein. Relationship of weight gain with dietary threonine level was analyzed by the quadratic regression method to derive the threonine requirement. Results showed that the quantitative threonine requirement for growth is 1.4% of the diet or 3.5% of dietary protein. This requirement for growth conforms with the threonine level in the shrimp muscle.



**Bautista MN, Subosa PF.** 1997. Changes in shrimp feed quality and effects on growth and survival of *Penaeus monodon* juveniles. *Aquaculture* 151 (1-4): 121-129 --

Five practical shrimp diets were formulated to contain 1, 10, 20, 50, and 100 g tetraethoxypropane (TEP) kg(-1) diet. A diet with no added TEP served as the control. Diets were fed to *Penaeus monodon* (average weight 4.84 +/- 0.11 g) juveniles to determine the level of fat oxidation tolerable to shrimp. Changes in shrimp feed quality were monitored by physical evaluation, thiobarbituric acid (TBA) values, fatty acid composition, and histological examination. Effects of feed quality on growth and survival of shrimp were evaluated. Results showed significant differences ( $P < 0.05$ ) in TBA values among treatments. Animals fed on diet 6, which contained 100 g TEP kg(-1) diet, showed signs of physical deterioration after 6-8 weeks. This diet had a significantly higher TBA value (1262 mg malonaldehyde kg(-1) fat) than the other treatments. The unsaturated fatty acid content of the diet decreased as its TEP content

increased. Weight gains of shrimp fed diet 5 (50 g TEP kg (-1) diet) and diet 6 were significantly lower than those fed the other diets while survival was similar. Hepatopancreatic lesions were not evident in all samples. Fat oxidation levels expressed in terms of TBA values of up to 828 mg mal kg (-1) fat can be tolerated by *Penaeus monodon* juveniles in terms of growth response.



**Duray MN, Estudillo CB, Alpasan LG.** 1997. Larval rearing of the grouper *Epinephelus suillus* under laboratory conditions. *Aquaculture* 150(1-2): 63-76 -

A protocol for rearing orange-spotted rockcod, *Epinephelus suillus* in the hatchery is described. The feeding regime consisted of *Chlorella*, *Brachionus*, *Artemia* and minced fish. With this regime, survival rates at Day 24 were 19.8% in 3-ton tanks and only 7.4% in 0.5-ton tanks. From an initial length of 1.62 mm on Day 0, larvae grew to 10.94 mm on Day 24 and 51.4-65.1 mm on Day 60. Larval growth and survival rate were improved when larvae were fed screened (less than 90  $\mu$  m) *Brachionus* during the first 2 weeks. Survival was even better among larvae fed *Brachionus* until Day 35. *Artemia*, at a density of 3 ml(-1), given once daily to larvae in 24 ppt seawater improved growth and survival.



**Loya-Javellana GN, Fielder DR.** 1997. Developmental trends in the mouthparts during growth from juvenile to adult of the tropical freshwater crayfish, *Cherax quadricarinatus von martens*, 1868 (*Decapoda, parastacidae*). *Invertebrate Reproduction and Development* 32 (2): 167-175 -

The structure and setal armature of the mouthparts of *Cherax quadricarinatus* during development from juvenile to adult were examined using light and scanning electron microscopy. Significant general transformations include increases in the overall size of the appendages and their component segments or processes, and increases in the number and variety of setal types on the margins and surfaces. Conspicuous transformations that occurred on specific sites of the mouthparts were changes in: (a) the size and shape of third maxilliped and mandibular teeth from canine-like to



## Nature matters

the AQD Museum and Biodiversity Garden, and the Environment Action Group

# Museums, gardens, zoos, and wildlife breeding centers in the Philippines

By **Teodora Bagarinao, PhD**  
AQD Scientist and Museum Curator

Non-formal environment education through nature recreation is an effective means toward the 'greening' of the hearts, the minds, and the spirit of the citizens so that they act in favor of biodiversity conservation. This article describes the status of various biodiversity exhibits and conservation centers in the country and urges both the government and the private sector to invest in more of these, especially in programs to reach and involve the people. Good biodiversity exhibits and conservation centers require funds, space, skilled and dedicated technicians, scientists, and artists, and the commitment and support of the government, the local communities, educational institutions, and the private sector.

## Museums

The National Museum of the Philippines was established in 1901 as the primary repository and custodian of cultural treasures and biological collections from all over the archipelago. It is mandated to be a research institution and a showcase for the entertainment and education of the public (Fr. Gabriel Casal, Director, National Museum, personal communication). Aside from the permanent exhibits, film shows, slide presentations, and lectures are provided for children, students, and the general public. Most of the art, anthropological, cultural, and historical collections have their own exhibit rooms, but the natural science collections are just in the corridors, looking old and shabby. The pre-war biological collections of the National Museum were all destroyed, but the post-war materials now include 527

species of birds, 2433 mollusks, 93 corals, 86 crustaceans, 469 fishes, 2945 insects, and many others. The National Herbarium contains about 130,000 mounted plant specimens.

The National Museum has both the cultural and natural treasures to be proud of, but does not have enough political support and funds to carry out scientific research, nor space and technical expertise to properly display its collections. Filipinos who have visited the national museums in other Asian countries and in America and Europe can only feel frustrated, even ashamed, about the dismal state of the National Museum of the Philippines. Recently, a beautifully illustrated book *Treasures of the Philippine National Museum* has been published to build greater public support. Plans have also been announced for a National Gallery of Arts and Culture that will be finished in time for the 100th anniversary of Philippine independence in 1998.

Most museums in the Philippines today are exhibits of the arts, culture, anthropology, and history of the Philippines or its many regions, such as the Metropolitan Museum of Manila, Philippine Museum of Ethnology, Ayala Museum, Museo Iloilo, Museo Dabao, Museo Pambata, and various art galleries in large cities. Banawe Museum houses some of the collections and the personal artifacts including the ornate wooden house of the anthropologist H. Otley Beyer, who married into and lived among the Ifugaos and first brought the Banawe rice terraces to international attention. Several universities operate cultural museums open to the public, for example, the Museum of Anthropology and the Vargas Museum at the University of the

Philippines (UP) in Diliman and the Museo de Oro at Xavier University. Museums about indigenous peoples and cultures are in fact biodiversity displays.

Museums of the natural history type are not numerous and these are mostly run by universities for instruction and research. The Museum of Arts and Sciences at the University of Santo Tomas started in 1682 with the collection and classification of Philippine flora and fauna, and now it is crammed with stuffed mammals, birds, and reptiles. The UP-Los Baños Museum of Natural History is a repository and exhibit of the flora and fauna of Mt. Makiling, including 285 families of insects, 709 genera of fungi, 1200 species of forest plants including rare ferns, and Dioscoro Rabor's collection of land vertebrates. The Marine Science Institute of UP-Diliman maintains the Velasquez Phycological Herbarium. The natural science museums of the UP-Visayas, University of San Carlos, Silliman University, and Visayas State College of Agriculture have sizeable collections of marine animals, vertebrates, and insects, but the displays need to be improved to be appreciated by the public. The Aga Khan Museum of the Mindanao State University has collections of the flora and fauna of Lanao Lake and the surrounding watershed, but does little to promote public understanding of the ecosystem.

The International Rice Research Institute in Los Baños, Laguna opened in 1994 the IRRI Riceworld, a visitors' learning center about rice production and research and the importance of rice to global food production. IRRI Riceworld has exhibits that explain the importance of friendly insects in controlling rice pests, the value of

 next page



The AQD Museum and Biodiversity Garden attract and entertain visitors, mostly students. Museum collection includes deep sea fishes from the Philippine Trench; mangrove fishes from Quezon; coral reef fishes from Pangasinan; and molluscs from Ifugao, Sorsogon and other places.

conserving rice seeds to maintain genetic diversity, and why scientists are looking at the role of methane emissions from ricefields in global warming. Riceworld was designed with children in mind and was made possible with a US\$80,000 grant from the German Technical Cooperation Agency.

The SEAFDEC Aquaculture Department inaugurated in 1993 the AQD Museum, a collection and exhibit of fishes, crustaceans, mollusks, corals, other marine invertebrates, and seaweeds. The AQD Museum holds reference specimens of shrimps, fish larvae and juveniles, and mangrove fishes from completed studies. A botanical garden has been annexed to show off plant biodiversity. The AQD Museum and Biodiversity Garden aims to be an educational exhibit for the public, particularly school children, and a laboratory for undergraduate and graduate students in natural history. But there is not enough room for the displays and hardly any students interested in natural history and systematics. Currently, SEAFDEC AQD is making plans for a larger museum

and aquarium to be called Fishworld.

There are also privately owned natural history museums open to the public. In Cebu, the Julian Jumalon family operates the Butterfly Museum, with butterflies and paintings made of butterfly wings on display, amid a sanctuary-garden of butterflies and food plants. The Carfel Seashell Museum in Manila published the book *Shells of the Philippines*.

An important aid to biodiversity research and conservation efforts is a good computerized database. For example, the International Center for Living Aquatic Resources Management (ICLARM) in Manila has put together FishBase and ReefBase on CD-ROM now available to researchers.

### Botanical gardens, arboretums, and plant nurseries

Botanical gardens are museums without walls whose mission is the cultivation and study of the diversity of plants. The Philippines now does not have a national bo-

tanical garden. UP-Los Baños maintains the Makiling Botanic Garden and Hortorium that preserve the waterways and natural forest growths, and the Microbiological Culture Collection. Many other universities and agricultural colleges in the Philippines have small botanical gardens, plant nurseries, and arboretums, mostly for instruction and research but also for public viewing and enjoyment. The University of Santo Tomas has started a project to turn the campus into a botanical garden that will serve as repository of endemic and endangered flora, a sanctuary for birds and insects, a resource for teaching, research, and recreation for the university, and as 'green lungs' for part of Metro Manila.

The International Rice Research Institute is committed to the conservation of rice genetic resources and maintains a gene bank with 70,000 seed accessions (as of 1991) for both IRRI research staff and outside users worldwide.

The Department of Environment and Natural Resources (DENR) maintains a

INTERVIEW WITH SEAFDEC Secretary-General Udom Bhatiyasevi

## Focus on human resources

*The new SEAFDEC Secretary-General Mr. Udom Bhatiyasevi was in AQD on 4-6 June 1997. His visit allowed him to discuss the SEAFDEC Financial Staff Exchange Program for finance officers of the Secretariat as well as the four Departments. He granted this short interview to writer Marilyn Surtida. Excerpts:*

**Q. SEAFDEC has been around for the past thirty years. In your opinion, what impact has it had on the Member Countries within the region?**

A. SEAFDEC has viewed with some concerns the regional problems in fishery resources depletion, environment degradation, and fishery management. We have been a key regional agency (created) to assist Member Countries in training their people in many disciplines. Above anything else, it is man that can create change. I think that in all these years that SEAFDEC has been training people, these people have created the impact in the region.

**This year is the 30th anniversary of SEAFDEC. What are the highlights of the celebration?**

We have planned several special events. A special publication will be issued to commemorate the Anniversary. It will describe the key milestones and vision of SEAFDEC. We also plan two more publications on marine resources. The first will



*The SEAFDEC Secretary-General:  
There is continuing collaboration among  
Member-Countries although this has not  
received much publicity.*

be pictorial; it will illustrate fishes and other marine life along with their names, description, and geographical locations. The other will deal with the activities in marine resources assessment.

**What is the significance of Indonesia's coming entry as a Member Country?**

I believe that a bigger family is better because we need to have more friends. The good news is that Cambodia and Myanmar have also signified their intention to join SEAFDEC. When Indonesia has joined SEAFDEC, we may have to talk about the

possibility of establishing another SEAFDEC Department dealing with something like marine environment or economics.

**There is a perceived notion that there is little collaboration among SEAFDEC Member Countries. How will you strengthen collaboration?**

We are collaborating with each other on many bilateral programs. SEAFDEC does not have a strong mandate in facilitating collaboration among its members at policy and political level like that of ASEAN. At the technical level, their collaboration has been continuing although this has not received much publicity. We are now doing more to bring them together in collaborative projects of SEAFDEC. In the past few years, researchers from Malaysia and Thailand have been working closely on fishery resource assessment. More of such projects will be planned and implemented by SEAFDEC.

**What is your message to AQD employees?**

As a big Department, AQD has a big mission. To accomplish its aims, the high quality of staff is very important. I am pleased with AQD's incessant efforts in developing its human resources. Their work and the rewards they receive stand behind them as a group of superior professionals. To cope with the challenging work, we need highly qualified staff.

# Stamps: a hobby of 2 biologists

By **NJ Dagoon**

## Aquaculture species as depicted in stamps

Stamps are courtesy of Dr. Doris Bagarinao



One of the oldest stamps in Doris's collection (circa 1952) shows the milkfish *Chanos chanos* L. or *bangus*, the Philippine national fish.



This stamp shows that *Tilapia nilotica* is a foodfish not only in Southeast Asia but also in other parts of the world.



The seahorse is a subject of current AQD research because of its medicinal value.



The successful rearing of tiger shrimp *Penaeus monodon* in aquaculture ponds in Southeast Asia for decades now has been the fruit of painstaking scientific research.

Fish farming is the main occupation of AQD personnel, but even as a pastime, fish and marine life have captured the interests of two of AQD's foremost resident scientists, avid stamp collectors Dr. Teodora "Doris" Bagarinao, a marine biologist and Dr. Emilia "Babes" Qunitio, a crustacean reproductive physiologist.

Stamp collecting as a hobby started in the mid-19th century, just as soon as the first British stamp was circulated in 1840. Philately or stamp collecting has come a long way since then. Collectors may choose to organize their selections by country, geographic region, date, and topic. Currently, there are over 3,000 topics, of which the most popular are music, animals, religious subjects, maps, flags, sports, and mountains.

Babes and Doris's collections on marine life stamps started during their stay at the AQD, although Doris began stamp collecting earlier while still in high school. Babes became especially attracted to the hobby when in Japan she saw her Mexican friend's big stamps.

Doris already has a collection of about 2,000 marine life stamps, while Babes has about 1,000. Both scientists note the stamps' educational and informational worth. Babes even remarked on their therapeutic value.

When asked about their opinions as to what personality does philately appeal most, Doris answered, "the curious, organizer type" while Babes replied, "the patient and inquisitive one." Though not active in philately clubs, they get some of their collections from friends and acquaintances. A large portion of their stamps is also purchased either in the form of newly minted ones from the post office or as used ones that are by the hundreds in souvenir and hobbyist shops. When they travel, they often take time to visit the local P.O.

When the topic shifted from pure stamp collecting as a recreation to its pos-



Dr. Babes Qunitio decorates her office wall with some stamps from her collection.

sible link to resources conservation and their careers as aquaculture scientists, these were their responses.

### How does stamp collecting relate to your career as scientist?

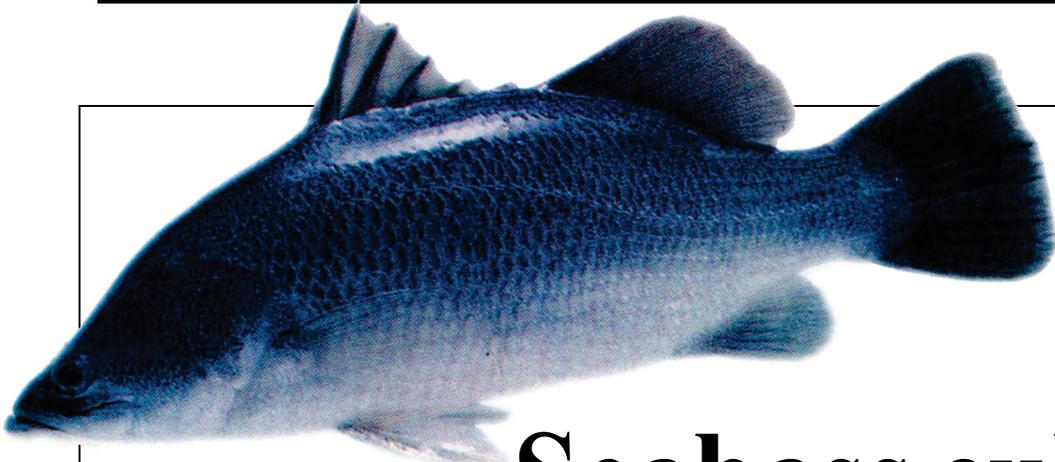
**BABES:** *It does not relate to my career. I do this as part of my hobby / therapy.*

**DORIS:** *It does not... it's a hobby.*

### Do you feel that stamp collecting builds interest in resources conservation? In aquaculture?

**BABES:** *Not really... But there's a regular issuance of stamps featuring wild life. When you put these wonderful stamps on letters, cards and packages, you are reminding people to conserve our wildlife resources.*

**DORIS:** *No, stamp collecting does not necessarily build interest in resources conservation. Many stamp collectors have no concept of resources conservation. Perhaps collecting fossils, rocks, skulls, shells, and*



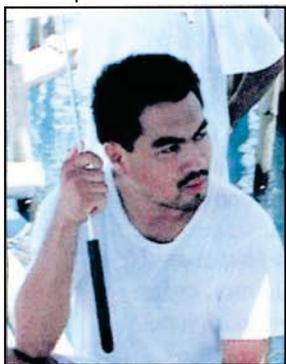
## Seabass culture

The seabass industries in Thailand, Malaysia, Singapore, Indonesia, Hong Kong and Taiwan are well-established. In the Philippines, however, farmers are hesitant to venture into seabass culture despite the ease of grow-out culture and established breeding and hatchery techniques. The farmers' two main reasons are low market demand and difficulty in getting a steady supply of trashfish.

Low market demand can perhaps be attributed to the preference of most Filipinos for low-cost fishes. Poor market strategy may also play a role. Prices of seabass cannot compete with less expensive fishes like milkfish, tilapia, among others, because of production cost due to feeds. Neither can seabass compete with high-value fishes like grouper and red snapper with already well-established markets.

In this special feature for aquaculturists, we take a look at the seabass markets in Asia, Europe and Australia. We also discuss culture techniques in the Philippines, Australia, Malaysia, and Thailand; also AQD's seabass research and development, covering breeding-hatchery techniques and feed substitutes to trashfish (for grow-out culture) and *Artemia* (for larval rearing).

*Two seabass growers share their experiences: Bernard Oabe of Ivisan, Capiz uses floating netcages and Florito Pudadera of Oton, Iloilo watches over cage nurseries and ponds. Images from their farms accompany our special feature.*





# The culture of seabass

By **ET Aldon** PHOTOS **R Buendia**

Seabass are raised in ponds and cages in Southeast Asia. The development of artificial propagation and hatchery techniques contributed to the large-scale development of seabass culture. The report of Baldia and Vasudevan in 1996 showed that culture of this high-value species gave a 74% return-on-investment and 1.4 years payback period for hatchery and cage grow-out.

Seabass culture is done in two phases: **nursery and grow-out.**

*Seabass are raised in ponds and cages in Capiz.*



## POND NURSERY

Kungvankij recommends pond size ranging from 500 to 2000 m<sup>2</sup> with water depth of 50-80 cm. Ponds must have separate inlet and outlet gates for water exchange and a flat bottom that slopes towards the drainage gate. A 1-mm size screen net is installed in gates to prevent predators and competitors from getting into the pond.

Stocking density in pond nursery is 20-50 fry per m<sup>2</sup> for fry size of 1.0-2.5 cm.

Standard pond preparation and management techniques are followed. Fry are acclimatized to pond salinity and temperature before these are stocked in early morning or early evening.



## NURSERY

Seabass fry are raised in the nursery (1.0-2.5 cm until 8-10 cm) in either ponds or cages. This minimizes competition for space and food, thus controlling cannibalism. The use of tanks, though common, is not recommended because excess feeds can accumulate on the bottom and bacterial disease can become a problem. But this problem can be minimized with proper and frequent water change. Handling of stock during sorting is easier done in tanks than in ponds or cages.

If stocked directly in grow-out ponds, seabass may be difficult to size-grade. Regular sorting of fry is best done during the nursery phase.

About 30% of water is changed daily to prevent deterioration of water due to uneaten food or excess growth of natural food.

## CAGE NURSERY

The rectangular net cage attached to wooden frames is either kept afloat by styrofoam, plastic or metal drum, or fastened (stationary) to a bamboo or wooden pole at each corner





ner. The cage size varies from  $3 \times 1 \times 1$  m to  $5 \times 2 \times 1$  m with net mesh of 1.0 mm. The cages may be installed in the river, coastal area or in a pond. Sites should be free from biofoulers and strong currents. Cages should be checked regularly of leaks and clogs. Water exchange is by natural wave action.

Stocking density is 80-100 fry per  $m^2$ . After 30-45 days or until fingerling stage (5-10 cm), the fry are graded into different size groups before they are transferred to grow-out ponds or cages. This, Kungvankij noted, gives better growth and survival than those stocked directly into

## CAGE CULTURE

Kungvankij recommends these criteria for site selection:

- protected bays, lagoons, sheltered coves or inland sea
- an area where influence of tidal fluctuation is not pronounced. (Avoid installing cages where the current velocity is strong.)
- an area where salinity ranges from 13-30 ppt
- far from biofoulers; sources of domestic, industrial and agricultural pollution; and other environmental hazards

## Design

Square and rectangular cages with sizes from 20 to 100  $m^2$  are preferable for easy management and maintenance. Cages are made of polyethylene netting with mesh size ranging from 2-8 cm depending on fish size. There are two types of cages used in seabass culture:

*Floating cage.* The net cage is attached to a wooden, GI pipe or bamboo frames and is kept afloat by plastic, styrofoam drum or bamboo floaters. Concrete weights attach or anchor the corners of the netcage to the bottom. The most manageable size is  $50 m^3$  ( $5 \times 5 \times 2$  m); nets of this size are easy to change once clogged with fouling organisms.

*Stationary cage.* The cage is fastened to the bamboo or wooden poles installed at its four corners. Stationary cages are usually installed in shallow bays.

Stocking density in cages is usually between 40-50 fish per  $m^2$ . This is reduced to 10-20 fish per  $m^2$  after 2-3 months, when the fish attain 150-200 g in weight. Farmers must provide spare cages for easy grading of stock.

Cages are checked regularly of clogs and leaks. Damaged net should be cleaned, repaired or replaced since clogging could reduce water exchange. Low oxygen and accumulation of wastes may stress the seabass and likewise affect its feeding and growth.

## Feeds and feeding

Feeding of trash fish is done twice daily (morning and afternoon) at a rate of 10% of total biomass in the first two months of culture. Fish are fed to satiation. The artificial feed which AQD has formulated still needs to be verified in large-scale cages and ponds. Also, its economic profitability has yet to be established. The formulation is shown on page 23.

A cage nursery in Oton, Iloilo

grow-out ponds and cages. Parazo (1991) suggested that stocking density be regulated to minimize cannibalism. This is supported by Victor Billanes of Capiz Institute of Technology who claimed that he did not encounter cannibalism in his stock of 400 seabass in the school's experimental pond ( $1,000 m^2$ ). He said he feeds the seabass twice a day with trash fish. AQD researcher Fermin, however, reported that occurrence of shooters is neither a result of the differences in stocking density nor the lack of supplemental feeds.

## GROW - OUT

The grow-out phase involves rearing seabass from juvenile to marketable size (300-400 g). Culture period varies from 3-4 months.

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## POND CULTURE

There are two culture systems employed in pond culture of seabass. *Monoculture* is a culture system where a single species of fish is produced. *Polyculture* is the system where two or more fish species are produced. Forage fish like tilapia are combined with the main species - like seabass - in the pond. They feed on natural food and will not compete with the main species for food. Forage fish should also continuously and sufficiently sustain the growth of seabass throughout the culture period.

Kungvankij recommends that seabass ponds, whether for mono- or polyculture, be situated in suitable sites. The parameters normally considered as suitable water supply are:

pH	7.5-8.5
dissolved oxygen	4-9 ppm
salinity	10-30 ppt
temperature	26-32°C
NH <sub>3</sub> (ammonia)	< 1 ppm
H <sub>2</sub> S (hydrogen sulfide)	< 0.3 ppm
turbidity	< 10 ppm

Seabass farms should also have moderate tide fluctuation of 2-3 meters for complete draining during low tide and tidal entry during spring tide. The soil should have enough clay content to hold water. Acid sulphate soil should be avoided.

Other considerations are accessibility of site to transportation and communication, availability of seed, labor, technical assistance, market demand and social condition.

Seabass ponds are generally rectangular with size ranging from 2,000 m<sup>2</sup> to 2 ha and depth of 1.2-1.5 m. Pond bottom is entirely flat but slopes toward the drainage gate.

Pond preparation is similar to other monoculture systems. In polyculture system, however, organic fertilizer (chicken manure) is applied at the rate of 1 ton per ha alter the pond acidity is neutralized. Then water depth is gradually increased to grow natural food.

Seabass juveniles (8-10 cm) from the nursery are stocked in grow-out ponds at a rate of 10,000-20,000 per ha in monoculture and 3,000-5,000 per ha in polyculture. Prior to stocking, juveniles are acclimatized to pond water temperature and salinity. Stocking in uniform sizes is done at cooler times of the day.

In monoculture (where supplementary feed is given daily and excess feeds may pollute the water), daily water

*Seabass and red snapper are reared in a farm in Oton, Iloilo.*



replenishment is necessary. In polyculture, a 50% water replenishment can be done once in three days; this is enough to maintain natural food in ponds.

In monoculture, the same feeding regime as in floating cage is applied. In polyculture, supplementary feeding is not required as the seabass feed on forage fish in the pond. Polyculture can hence reduce the farmers' dependence on trashfish. Several reports suggest the viability of seabass polyculture with other species.

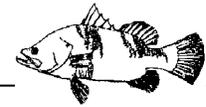
### Seabass with milkfish and tilapia

Jessie Banno (1984) studied the culture of seabass combined with milkfish and tilapia in brackishwater ponds. He noted the best stocking density as follows: 5,000 seabass + 1,500 milkfish + 4,000 tilapia per ha. The size range for sea bass should be uniform: 10-20 g, 20-30g, or 30-50 g. Banno noted that culture should not be more than three months because growth rates of milkfish and seabass are affected adversely by wild tilapia spawnings.

### Seabass with groupers

Alcantara et al. (1995) reared seabass with the groupers *Cromileptis* and *Epinephelus* in 2.5 x 2.5 x 1.5 m cage for five months at Tinguiban Cove, Pto. Princessa, Palawan. Trashfish required during culture was supplied by the catch of the lift net installed at one side of the cage. The lift net is operated twice daily. Trashfish were given twice daily chopped or whole depending on size. The growth of seabass is faster (4.0 g per day) than *Epinephelus* (2.3 g per day) or *Cromileptis* (1.59 g per day). Seabass fry were





first reared in nursery ponds and grown as juveniles before stocking in cages.

### Seabass with seaweed

AQD scientist Anicia Hurtado-Ponce noted the possibility of seaweed — *Kappaphycus alvarezii* var. *tambalang* — polyculture with carnivorous fishes or molluscs in cages.

Seabass are fed trashfish twice a day. A 1 kg seabass can be harvested after 8 months of culture. Pudadera harvests seabass according to the size and volume requirement of his clients. The farm supplies restaurants in Iloilo City with live seabass.



Grouper and tiger shrimp, both high-value species, may be cultured with seabass.

Individual cuttings of seaweed (150-200 g wet weight) were tied to a 3-m nylon monofilament cord and to two ends of a bamboo frame (3 × 3 m). The bamboo frame was installed inside a 4 × 4 m floating cage of seabass broodstock. Seabass-seaweed culture can make better use of marine resources, reduce impact of intensive aquaculture, minimize grazing and maximize production.

### Seabass with tilapia

Dr. Romeo Fortes and Jerome Genodepa of the University of the Philippines - Visayas studied the potential of seabass as predator on young tilapia and determined the most effective seabass-tilapia combination. A 1:5 seabass-tilapia ratio is suggested. Tilapia are first allowed to grow in the ponds before seabass are stocked.

### Seabass with snapper, grouper, shrimp

Florito Pudadera, a farm technician in the Robles Farm in Oton, Iloilo, reported a 90% survival of seabass cultured with red snapper, grouper and tiger shrimp in brackishwater ponds. (Pudadera stocks 500 seabass + 2,000 grouper + 500 red snapper + 600 shrimp in a 0.5 ha pond.) Wild fry are first stocked in tanks and fed with copepods. Survival rate in tanks is about 50%. The fry are next transferred to hapa netcages (survival is 75%) then to grow-out ponds when they are around 12 cm in length.

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# AQD's breeding-hatchery techniques

By **M Castaños** PHOTOS **R Buendia**

It took a lot of experiments before AQD researchers settled on a standardized method to spawn seabass and to develop a method of rearing seabass fry in the hatchery. In all, nearly 40 papers were published out of these experiments (some are on the reference list, pages 21-22) since AQD started working on seabass in the early 80s.

## **1** TO SPAWN SEABASS IS EASY

*Inject wild spawners (weighing 2-8 kg each) with a fresh solution of LHRHa (the luteinizing hormone releasing hormone analogue available from drug companies). The dose is 20-100 (µg of LHRHa per kg of seabass body weight.*

*An alternative to direct injection is implantation of pelleted hormone but this needs more preparation.*

There are certain caveats to the above technique that AQD researchers urge fishfarmers to take note:

- (1) that the seabass spawner be in good condition - without wounds, disease-free, body parts intact, strong and active upon capture;
- (2) that the farmers be familiar with preparing fresh hormone solutions. This only needs simple calculation based on the amount of LHRHa packed commercially by the manufacturer. The LHRHa is usually in powder form and needs to be dissolved in salt solution. Farmers can easily follow the manufacturer's instructions.
- (3) that the farmers maintain a 1:2 sex ratio (female:male) in the spawning tank or cages after hormone injection. Seabass will spawn on the second night.
- (4) that the female spawners have eggs averaging at least 0.40 mm in diameter; the male spawner should give out a milky white substance (this is the milt) when its abdomen is gently massaged in a head-to-tail direction. Otherwise, farmers should wait until the gonads of sexually immature adults

ripen. Breeders, researchers say, may also be obtained after 3-5 years from fry or juveniles reared in cages, tanks or ponds.

AQD researcher Joebert Toledo has reported that seabass spawn spontaneously between 0.4 to 60 million eggs in a month (this is total from 13 females paired with 28 males in a netcage). These spawners are part of the wild juveniles reared by AQD since 1982.

Toledo noted that spawning appears to be related to the phases of the moon. It took place within 4 days before or after the first quarter moon, or 3-5 days before or after the last quarter moon. Spawning time is between 5 pm to 1 am.

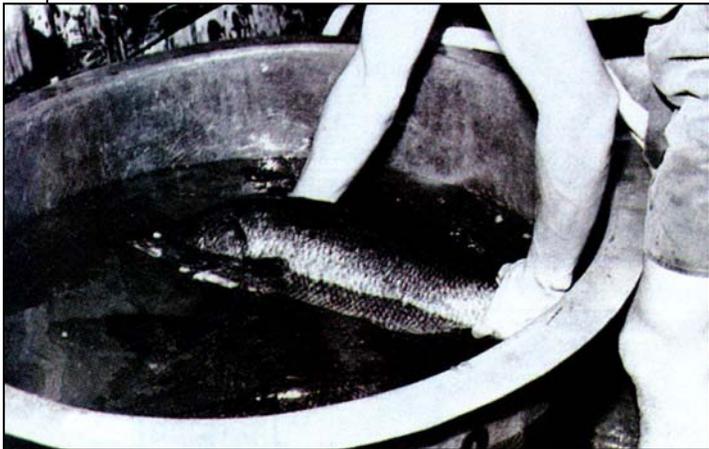
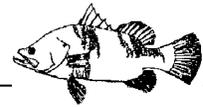
Seabass are what researchers call multiple spawners. Each fish spawns 2-3 times consecutively. AQD scientist Luis Ma. Garcia has found that the number of spawnings can depend on the amount of LHRHa given to seabass.

AQD researchers have also tried to lengthen the spawning days of seabass, increase the number of multiple spawnings, induce the seabass to spawn outside its breeding season, or work on alternative spawning agents like hCG (human chorionic gonadotropin) and 17- $\alpha$  methyltestosterone. But all these are issues of increased production of eggs out of the breeders available to fishfarmers.

The more critical problem is brought by the seabass itself. Seabass are protandrous hermaphrodites — they first mature as males then invert to being female (see page 19). The implication is that we might be getting less and less males for artificial propagation. Seabass males need to be replaced at some point.

 page 20

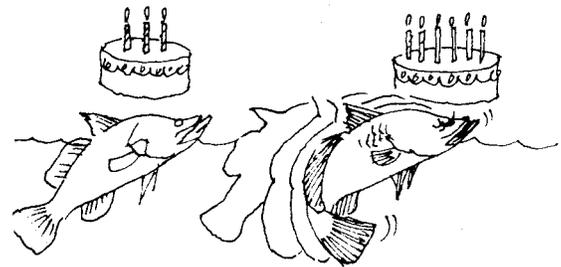
***EASY DOES IT.** seabass are induced to spawn by AQD researchers at the Igang Marine Substation in Guimaras, Iloilo. Top to bottom: seabass under anaesthesia are injected with the hormone LHRHa, allowed to recover in a holding tank, then left in peace to spawn; a beakerful of eggs.*



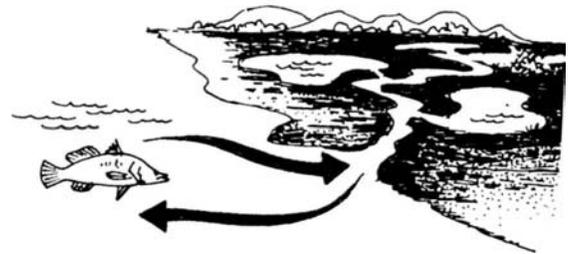
# Who, me?

## INTERESTING FACTS ABOUT SEABASS

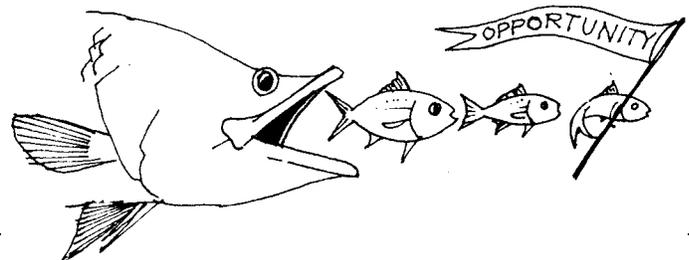
*Young seabass mature initially as males after 3-4 years but invert to females on the 6th year. This condition is called protandrous hermaphroditism. But, not all males become females. There are the so-called primary females (seabass that never mature as males).*



*Seabass appear to breed during the monsoon months (late June until late October). The eggs are spawned and fertilized at sea, and the larvae enter brackishwater swamps and mangroves. Seabass also inhabit estuaries, rivers and lakes. They return to the sea to spawn.*



*Seabass are opportunistic predators. Young ones (<4 cm in size) feed on "microcrustacea" almost exclusively; bigger ones (30 cm) have diets of "macrocrustacea" and fish. The really big ones prey mostly on fishes.*





After the spawning attempts became successful enough to allow experiments on larval rearing, AQD researchers began working on hatchery techniques. In 1990, AQD extended its hatchery technology by publishing the first seabass manual authored by MM Parazo et al. The more important details are noted below.

## 2 SEABASS FRY CAN BE EASILY RAISED IN THE HATCHERY

*Incubate seabass eggs in fiberglass tanks (1,200 eggs per liter). Eggs hatch 14 hours after fertilization (28°C; 32 ppt).*

*Stock 30 seabass larvae per liter, but reduce this density to 15 per liter on day 10, then to 6 per liter on day 21. The reduction in density gives seabass more "space" to grow. It also minimizes cannibalism.*

*Add and maintain 1-3 x 10<sup>6</sup> Chlorella cells per ml to maintain water quality and to serve as food to the rotifers. It is best to introduce live food before the seabass larvae begin feeding 50 hours after hatching.*

*Take care of seabass larvae by daily feeding — 15-20 Brachionus per ml on days 1-12, 0.5-2 Brachionus+Artemia per ml on days 12-15, and 5-10 Artemia per ml on days 15-26 or until harvest.*

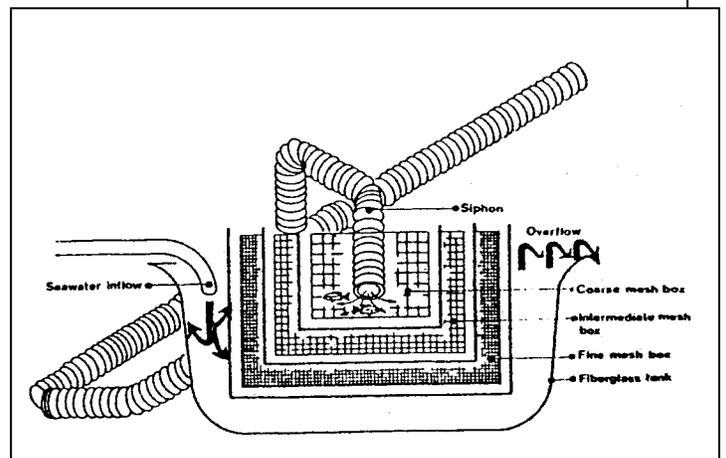
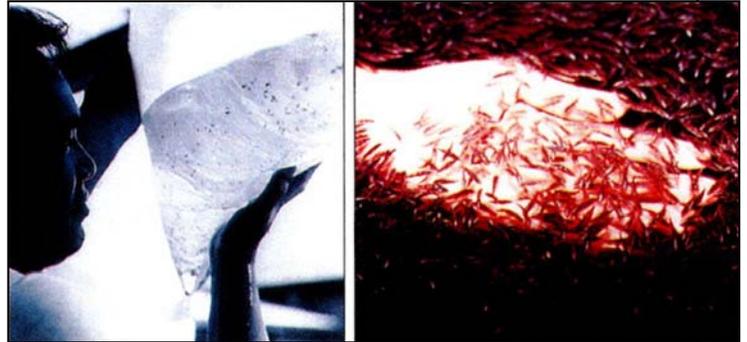
*Make sure the tank is cleaned daily and the water changed.*

A survival of 90% is common in the hatchery (until 21 days old). (In its heyday, tiger shrimp hatcheries record 30-40% survival.)

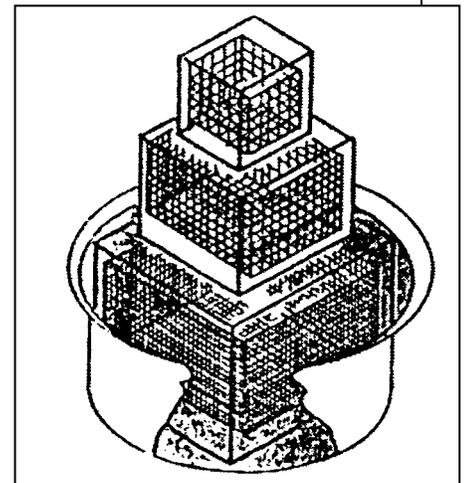
The critical issues in the hatchery remain to be cannibalism and the need to size-grade fry. AQD researchers advise that there should be no more than 33% size difference of seabass in the same tank, otherwise, cannibalism will get out of hand. Hatchery operators must separate the "shooters" or the fast-growing seabass from the smaller ones.

AQD researchers have designed sorter boxes to aid in size-grading seabass (see illustration). These boxes are fitted with different net mesh: coarse mesh, intermediate mesh, and fine mesh.

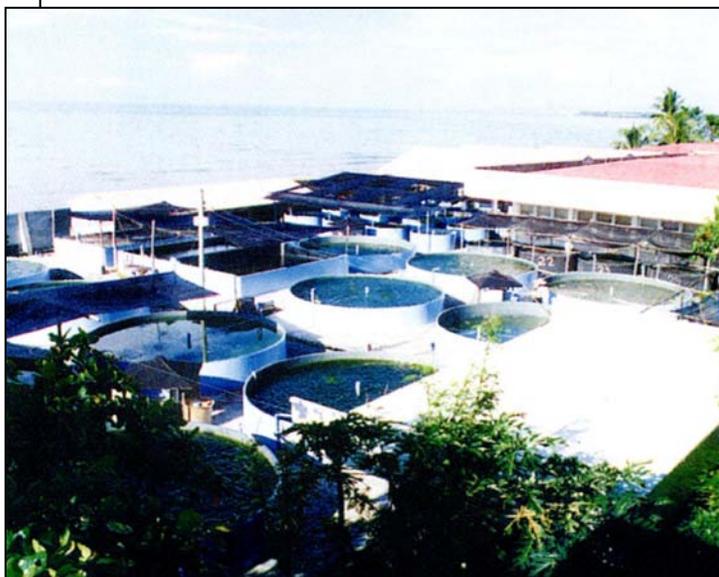
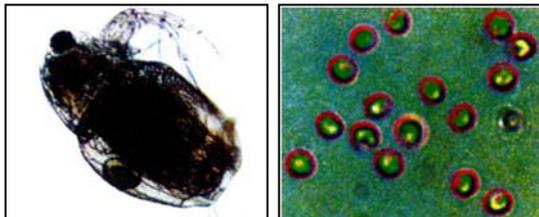
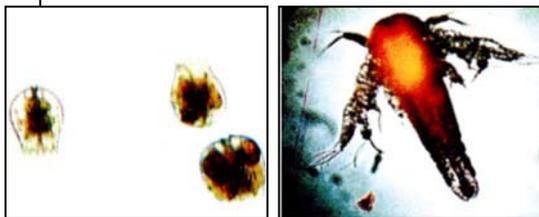
Newly hatched seabass larvae and 30-day old fry



*AQD researcher M. Parazo has found that cannibalistic seabass swallow its prey whole. Since the maximum size of prey that a cannibal may ingest is 2/3 of its length, seabass with length differences of 33% or more must be separated. A series of sorter boxes can facilitate in size-grading sea bass fry. (cross section above, box arrangement in a fiberglass on the right; from Parazo et al. 1990).*



The boxes are arranged serially in a fiberglass tank (coarse mesh box inside the intermediate mesh box; fine mesh box is outermost). Hatchery operators can siphon all the fish into the coarse mesh box. To separate fish, the



Different live food that are fed to seabass larvae: (clockwise) the rotifer *Brachionus*, *Artemia*, the phytoplankton *Chlorella*, and the cladoceran *Moina*.

AQD's marine fish hatchery where seabass larvae are reared until these can be stocked in cages or ponds for grow-out culture.

innermost (coarse) box is moved gently until only the big fish remain inside. The box and the fish are removed; they constitute one size class of seabass. The middle intermediate box is next and the fish that can't go through the box is another class size. The fine box will hold the smallest sized fish. AQD researchers note that shooters usually develop several days after *Artemia* feeding. They advise that the first size grading be done around this time.

Needless to say, spawning and hatchery rearing of seabass cannot be this simple. Although the main ingredients so-to-speak have been described, fishfarmers are urged to maintain contact with AQD's research staff for technical support.

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(Our AQD Library has a Document Delivery Service; for inquiries / addresses, see page 36)

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- 
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# A feed for seabass

By **ET Aldon**

One of the major constraints in seabass culture is feed supply. Trashfish (for grow-out culture) is expensive and its supply is limited. *Artemia* (for larval rearing) is also expensive.

This problem led AQD researchers to formulate a "standard" feed suitable for carnivorous species like seabass and grouper. Their success would be good news to consumers and entrepreneurs. Reduction of feed cost will consequently lower the price of seabass.

## FEED FOR SEABASS GROW-OUT

Available data on nutrient requirements of seabass were used to formulate the seabass diets. AQD scientists Mae Catacutan and Dr. Relicardo Coloso determined the optimum levels of protein, lipid and carbohydrate. Dr. Coloso worked out the essential amino acids required by seabass. Scientist Ilda Borlongan determined the lipid sources and fatty acid composition.

To formulate a practical diet for seabass (see table), Dr. Coloso first tested 11 formulations and a control diet in 500-liter tanks for 8 weeks to screen for the most cost-effective diet to be used in cages and in ponds. Locally available protein sources were used: fish meal, shrimp head meal, scrap squid meal, blood meal, poultry feather meal, leaf meals, soybean meal, and mung bean meal. The diets which contained combinations of animal and vegetable protein sources had essential amino acid compositions similar or close to that of seabass muscle tissue. Crude protein was 43% and fat was 10%.

Based on the results of the tank experiments, 2 of the 11 diet formulations were chosen to be tested in cages (at AQD's Igang Marine Substation) and in brackishwater ponds (at the Iloilo State College of Fisheries in Barotac Nuevo, Iloilo). These 2 diets contain *kangkong* or ipil-ipil leaf meals.

In floating netcages, seabass with initial average body weight of 5 g were stocked at 10 or 15 fish per m<sup>3</sup>. Four formulated diets containing *kangkong* and ipil-ipil leaf meals and a control diet were fed *ad libitum* to seabass for 16 weeks. It seems that the control diet promotes the best growth, survival and feed efficiency ratio (FER), but the diets containing *kangkong* or ipil-ipil are more cost-effective.

### Practical diet formula for juvenile seabass (grow-out)

Ingredients	Amount (g/100 g dry diet)
Fish meal	42.0
Soybean meal	9.0
Shrimp meal ( <i>Acetes</i> sp.)	10.0
Squid meal	5.0
Breadflour	7.7
Cod liver oil	2.9
Soybean oil	2.9
Vitamin mix	4.0
Mineral mix	2.0
Rice bran	14.5

Proximate composition	(% dry matter)
Crude protein	43
Crude fat	9
Crude fiber	12
Nitrogen-free extract	25
Ash	11

The same diets were tested in brackishwater ponds (10 ppt). Seabass were initially stocked at 4 fish per m<sup>2</sup>. Stocking density was reduced to 1 per m<sup>2</sup> when the fish became bigger. The same feeding regime was applied. Results indicate that seabass generally grow better in floating netcages than in ponds. Dr. Coloso, however, recommends further economic analysis. He also noted that protein digestibility of these feeds be determined and then improved.

Results of his experiments showed that:

- locally available agricultural and marine by-products may be used in feeds for juvenile seabass
- seabass reared in floating netcages and in brackishwater ponds may require lower amounts of added vitamins and minerals in the feed
- seabass growth was generally better in floating netcages than in ponds as environmental conditions (e.g., dissolved oxygen and ammonia levels) in ponds were sub-optimal
- in floating netcages and ponds, the control diet seems to promote the best growth, survival and FER, but the diets containing *kangkong* or ipil-ipil are more cost-effective.

 next page



*Almost all seabass growers still use trashfish as feeds.*

Meanwhile, AQD researchers Perla Eusebio and Dr. Coloso evaluated some leguminous seeds as protein and energy sources for seabass. They determined the effect of processing on the nutritive value of different legumes using growth, survival and digestibility coefficient as indices. Preliminary results showed that soybean protein was the most digestible to seabass whereas ricebran was the least digestible regardless of the processing method used. The dehulling process gave the highest protein digestibility followed by solvent extraction and boiling. Roasting gave the lowest digestibility.

In another study, Eusebio and Dr. Coloso showed that leguminous seed (cowpea and mungbean) can be potential sources of protein that can replace the fishmeal component at 18% of the seabass diet without affecting their growth. Specific growth rates of fish fed leguminous seed meal-based diets were comparable with that of control diet containing defatted soybean meal. Feed conversion ratio for leguminous seed-based diet was 1.17-1.20 while control diet was 1.12. Leguminous seed meal can also be a good source of energy because of its high carbohydrates content.

### FEED FOR LARVAL REARING

In larval rearing of seabass, AQD scientist Armando Fermin (1991) demonstrated that *Moina* can partially replace *Artemia* as live food. *Moina* are sieved to obtain smaller-sized individuals for younger larvae (day 15) while unsieved *Moina* can be fed to older larvae to ensure efficient utilization. *Moina* is an inexpensive yet excellent food source for hatchery rearing of freshwater and brackishwater fishes.

In Fermin's experiment, 15-day old seabass larvae were acclimated and fed to satiation with *Moina*, *Artemia*, or *Moina*+ *Artemia*. After 20 days, specific growth rates of fish ranged from 9-13% per day and did not differ significantly among the treatments. Fish fed *Artemia* or *Artemia* and *Moina* had a higher survival rate than fish fed *Moina* alone.

Fermin determined the amount of *Moina* ingested in the presence of *Artemia* by 15-, 20-, 30-, and 35-day old seabass. Thirty-day old seabass fry ingested the highest number of *Moina* with or without the addition of *Artemia*,





# The seabass market

By **M Surtida**

The seabass *Lates calcarifer* (bulgan, apahap in the Philippines) are high value fish occupying a market niche with the snappers (mangagat, maya-maya) and groupers (lapulapu). Recently, its skin has been found to be a suitable leather material with unexpected resiliency and durability, not to mention its attractiveness.

Seabass are cultivated in both fresh- and brackishwater ponds as well as in cages in coastal waters.

## PHILIPPINES

At present, the culture of seabass is not popular in the Philippines. Although it can be grown side by side with grouper and snapper in floating cages, fish growers rarely grow seabass for market. Bernard Oabe, a fish grower from Basiao, Ivisan, Capiz says that he grows seabass for home consumption and for gifts to friends and business associates. He has a booming grouper trade, but with seabass he says "I brought a sample of seabass to Manila to test its market, but there were no takers." He further says "seabass of sizes 500-700 g are marketable; these sizes are grown in ponds for 8-12 months but are expensive to feed and fetch a meager P 110-120 per kilogram (chilled) in Panay restaurants. It is not profitable. Possibly, seabass demand in Manila is supplied by growers in Luzon or Mindanao."

Being a high value fish, seabass consumption is limited to specialized restaurants and occasionally, the domestic users. Florito Pudadera is a pond technician at an Oton, Iloilo fishpond that grows grouper, red snapper, seabass, shrimp, and milkfish. He sells live seabass at P 200 per kg (sizes of 1-2 kg), but orders are few and far between. Thus, his seabass production is limited to the restaurants the pond-owner owns. This set-up makes seabass culture profitable, but limited.

Seabass production in the Philippines must be negligible. The Bureau of Agricultural Statistics (BAS) does not include seabass in the top 35 fish species or products it listed from 1991 to 1997.

*Infofish* Malaysia (August 1997) also does not mention the Philippines as a producer of sea bass. Mentioned producers are Taiwan, Malaysia, and Thailand:

### Seabass production in 1996

Taiwan	10,000 tons
Thailand	2,800 tons
Malaysia	2,600 tons

The Food and Agriculture Organization in 1996 showed a decreasing seabass production after 1991. After peaking at 4,698 tons in 1991 (from 779 tons in 1990), seabass production further decreased to 36 in 1992, 14 in 1993, and 3 tons in 1994. It further decreased to 2.92 and 3 tons in 1995 and 1996 (BAS 1997).

Perhaps this is what the paper of Uwate and Tumaliwan (1985) meant when they said that the "short term (1-2 years) prospects for the development of a seabass culture in the Philippines are bright with increased consumer awareness, high market prices, availability of seedstock and established pond and cage culture technology. But medium term prospects (5-10 years) may see market saturation with numerous producer entrants and market adjustment with lower market prices."

Uwate and Tumaliwan further said that one aspect of market demand is consumer characteristics. With a population growth rate of 2.3% per year, the potential market for seabass is growing. But seabass is a high value fish more expensive than milkfish or tilapia. Thus, a high value fish, although preferred, is not purchased during difficult economic times.

## Other markets in Asia

### MALAYSIA

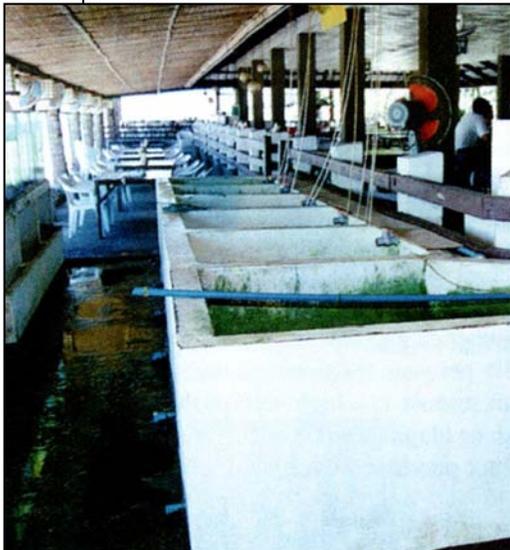
Market for fresh or chilled seabass is small. The September 1997 wholesale price of chilled seabass is RM 11-14 per kg (US\$4-5 per kg). Seabass are normally sold in wet markets and in supermarkets. Home consumption is very limited. Although Malaysia imports some fish, there are hardly any for seabass as domestic production is enough to cover the local demand.

Malaysia even exports live seabass to Singapore (by truck) where the market offers higher prices.

 next page



Seabass are mainly marketed in restaurants (top photo) in Iloilo City. One restaurant has holding tanks for live fish and crustacean display.



### HONG KONG

The local seabass production of Hong Kong is negligible but local demand for it (restaurants) is high. Thus, live seabass together with other fish are imported from Taiwan, Indonesia, or Malaysia.

Current live, wholesale price in Hong Kong is HK\$ 42.90-57.80 per kg. Thus, the live fish trade goes almost entirely through wholesalers to restaurants. Seabass is not a popular household product.

The weather also plays an important role in the seabass market. When few people dine out during inclement weather, it dulls the restaurant trade.

### SINGAPORE

Singapore imports seabass from Malaysia and Indonesia. *Infofish* reports that almost 95% of the total seabass supply in Singapore goes to restaurants. The live, ex-farm prices range S\$7.50-12.00 per kg.

### THAILAND

Thailand is one of the major producers and consumers of cultured seabass in Asia. Production caters to the domestic market. But when supply exceeds local demand, seabass are exported to Malaysia.

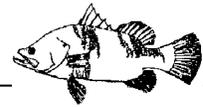
In Asia, seasonal demand dictates the high value fish market including seabass. Festive seasons mean high sales. During the Chinese New Year, the largely ethnic Chinese population of Hong Kong, Taiwan, Singapore, and Malaysia spend lavishly on ceremonial food regardless of price. Any live fish is popular to Chinese families because of the belief that it brings prosperity.

### Australia

In 1995, Australia produced 311 tons of seabass worth AUS \$3.4 million. Australia's main producer is Queensland. Whole plate-sized fish are preferred (250-400 g) but filets are getting popular. Seabass are grown in freshwater ponds or sea cages.

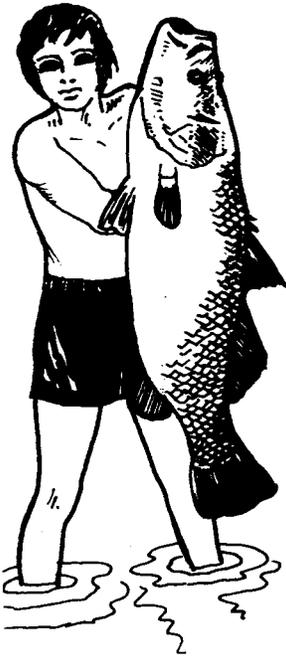
### The European markets

The seabass *Dicentrarchus labrax* are usually traded whole, mainly fresh and sometimes frozen in the European Union. The top producers in 1995 are Greece (4,000 tons),



# Seabass grow-out and marketing: lessons from Australia, Malaysia, and Thailand

By **R Buendia**



## A U S T R A L I A

Seabass, popularly known as barramundi in Australia, are highly valued foodfish throughout its range. Research work on seabass culture began in the mid-1980s to develop commercial and recreational fisheries.

There are three different methods used for growing barramundi in Australia. The first is brackish-water or freshwater pond culture. Usually, the fish are maintained in cages in ponds because of the difficulties in stock management and harvesting. Cage culture in estuarine waters is considered when large-scale production is envisaged. However, relatively few companies are using this technique primarily because of the difficulties in obtaining government approval to establish fish farms in

public waters and, to a lesser extent, biofouling and predation. The third method is intensive production in an indoor, controlled-environment building, using underground water (pathogen-free) and a high level of recirculation through a biological filter. Using this method, year-round production is possible and environmental concern associated with the release of nutrients to open waterways is avoided.

In Barramundi Waters, Australia's largest producer of cultured seabass, the fish are grown in floating cages in freshwater ponds. Fingerlings (15 cm) are stocked in  $2 \times 2 \times 1.5$  m or  $10 \times 5 \times 1.5$  m net cages at 100 kg per  $m^2$ . Barramundi are fed by hand to satiation twice a day, every morning and evening. Floating pellets is generally given to minimize wastage and monitor the feeding activity of the fish. In other farms however, seabass are "reluctant" to feed at the surface when water clarity is high, hence sinking pellets are used. Fish are graded every two months during the 8-month rearing period. The high turbidity in ponds minimizes foul-

ing of mesh nets. Good aeration is maintained in the ponds using aerators and paddlewheels. Regular monitoring of water quality is undertaken and whenever necessary, water is exchanged. As quoted from the owner Chris Phillips, "the barra are tough and don't need large water exchange."

Harvesting and processing of the fish takes place at Barramundi Waters twice a week. Dip nets are used to catch the fish in cages while escapees from the cages are gillnetted from the ponds. Draining of the ponds is done once a year to make sure that no larger fish are present before the next crop is stocked. Harvested plate-size seabass (350-600 g) are killed by slitting the throat and letting the fish bleed in an ice brine. After gilling and gutting they are packed with ice in polystyrene boxes and airfreighted to the marketplace. The late 1995 selling price of gilled and gutted fish is US\$12.50 per kg and that of gut-in fish is US\$10-10.50 per kg. With increasing domestic demand of larger barramundi (2-3 kg) at an estimated price of US\$5-6 per kg for fish fillet, the seabass industry in Australia seems to have a bright future.

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## M A L A Y S I A

Seabass are the most predominant fish cultured in cages in Malaysia. Although ponds are used, the bulk of seabass production comes from floating netcages because these are easy to construct, investment cost is low, farm management is easy and cages are versatile.

Most of the floating cage farms in Malaysia consist of wooden platforms supported by floats made of steel drums, fiberglass-coated styrofoam or plastic containers. The netcages themselves are usually made of polyethylene netting, the mesh size of which varies according to the size of





the fish stocked. The common size of individual net cages used is 3 x 3 x 2 m. The cages are anchored to the seabed by means of concrete blocks, wooden pegs driven into the seabed, or by long metal or wooden poles.

Seabass are usually grown in calm and protected bays and lagoons where water current does not exceed 0.5 m per sec. A tidal range of around 1-2 m allows sufficient water exchange through the cages to wash away the feces and uneaten food and ensures an adequate supply of dissolved oxygen. The dissolved oxygen content of the water at the chosen location should not be less than 3 ppm. Clear water is an advantage as the nets will not be easily clogged by fouling organisms and silt particles. Seabass can grow well in 10-30 ppt salinity range. The depth of the water should be such that at no time are the cages touching the sea bottom.

Fingerlings of 2-3 inches in size are initially stocked at 15-23 per m<sup>3</sup>. As seabass grow, they are periodically graded and transferred to larger mesh size cages with stocking density reduced to 10-12 per m<sup>3</sup>. Trashfish are given once a day. The nets are cleared regularly of fouling organisms such as barnacles and seaweeds to ensure a clear flow of water through the cages. Seabass usually attains marketable size (500-600 g) in about 6-8 months with a survival rate of 60-80%.

Most of the seabass produced is consumed domestically, with high demand in seafood restaurants and five-star hotels. Home consumption is very limited. The ideal market size ranges between 600-700 g apiece. Ex-farm price of live seabass in 1994 is RM 15 apiece. In a restaurant, the price of live fish (later cooked) may range between RM 28-30 apiece.

The market for fresh or chilled seabass in Malaysia is comparatively smaller. The September 1997 wholesale price of chilled fish is RM 11-14 per kg (see also preceding article). Fresh or chilled seabass is normally sold through supermarkets and wet markets with prices ranging between RM 17-18 per kg.

Despite the high domestic demand, Malaysia also exports live seabass to neighboring Singapore as the market offers a better price. Live fish are transported by truck or by boat from the northern states of peninsular Malaysia to Singapore.

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## THAILAND

Commercial-scale farming of seabass was made possible by research on artificial propagation by the Thai Department of Fisheries in mid-1970s. Seabass then became one of the most widely cultured and marketed fish in Thailand.

Seabass are reared in 5 x 5 x 2 m floating cages in coastal waters or stationary cages in shallow bays. Stocking of 25 cm fish varies from 12 to 300 per m<sup>3</sup> depending on water quality and the environmental conditions of the culture site. More fish are stocked in floating cages than in stationary cages because they are usually in sites with deeper water, smaller fluctuation of salinity, more rapid circulation and further away from sources of pollution.

Fresh and clean sardines and other marine trashfish are the main feed of seabass. Trashfish are chopped to fit the mouth of seabass. Seabass are fed to satiation twice a day, in the morning and afternoon. Food conversion rates range from 4 :1 to 10:1. Normal growth and survival rates are 1 kg per yr and 80-95%, respectively.

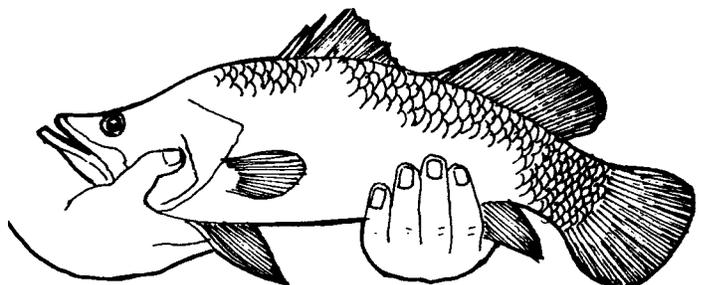
The cages are checked once or twice a month to ensure that these are not damaged and to monitor fish number and health. Cleaning or changing of the cages is done every month. Cover nets are used to prevent fish from jumping out, especially when the sea is rough, and to prevent predation.

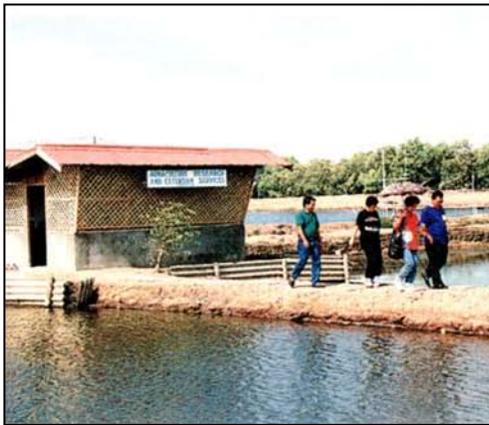
Seabass are reared for 5 to 20 months until the marketable size of 700-900 g and 2,000-3,000 g are reached. However, 700-900 g fish is preferred by the local market.

Thailand is a major consumer of cultured seabass. Domestic production is sufficient to cater to increasing demand. Thailand also exports seabass particularly to Malaysia when there is shortage of the fish in the Malaysian market.

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## POSTSCRIPT

There are successful seabass growers in the Philippines who note how easy it is to culture seabass in cages or ponds. Their real difficulty is finding markets (only restaurants and even then, not really in big numbers).

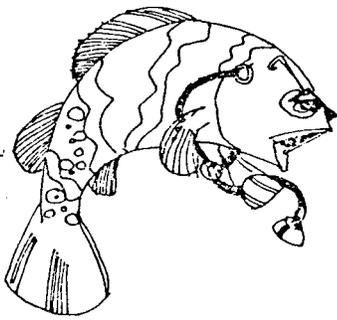
Other markets outside the Philippines can be explored by fishfarmers. Another possibility is to sell seabass with high-value fish with already established markets coupled with aggressive advertizing. Polyculture may increase profit.

If the aim is to make seabass affordable to a greater number of people, AQD has made progress in finding feed substitutes that can lower production cost. AQD has also developed breeding and hatchery techniques.

Seabass may be a good choice for fishfarmers who will opt for the high-value foodfish market.



*Seabass cage nursery at AQD's Igang Marine Substation in Guimaras.*



# Aquaculture clinic

**QUERY** A year ago until early this year, newspapers in the Philippines have reported fishkills. What did happen and what were the causes?

**REPLY** The fish kills were reported in milkfish pens and cages in rivers and shallow marine waters in Pangasinan (in northern Philippines). The carrying capacity of these farm sites may have been exceeded. In other words, the pens and cages were overstocked. One farm, for example, stocked 5,000 fish in each cage that measures 7 meters x 12 m x 6 m deep. Feeds were also added in large amounts to sustain the large number of fish stocks. About 45,000 bags of feeds (25 kg per bag) were used each month in the pens and cages in Pangasinan.

AQD researchers say that high fish stocking rates and high feeding rates in water bodies with limited flushing and water exchange can bring the oxygen so low at night that fish kills happen. All living things need oxygen to live. Fishes and other aquatic animals with gills take oxygen (dissolved oxygen or DO) from the water where they swim, eat and put out wastes.

AQD researchers also point out that:

- dissolved oxygen comes from the air by diffusion across the water surface, and from the photosynthesis of aquatic plants. Shallower, more turbulent waters with plants contain more oxygen than deep static waters without plants.
- tropical and salty waters contain less oxygen than cold and fresh waters
- oxygen consumption of all living things is faster in warmer waters
- oxygen consumption of all living things increases with size and number
- organic wastes like feeds and feces and substances like ammonia and sulfide consume oxygen during decomposition and oxidation. Thus, polluted waters contain less oxygen than clean waters.
- when the dissolved oxygen is used up, toxic substances like sulfide come out of the sediments and may poison the fish.
- when dissolved oxygen is always low, the fish are more stressed, they grow slowly, and are more likely to get sick and die.

*Newspaper reports of fishkills in the Philippines.*

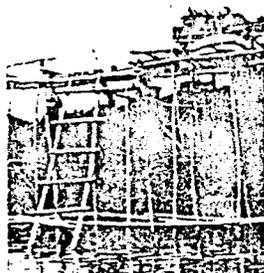
PHILIPPINE DAILY INQUIRER ~~JANUARY 27, 1994~~

## Fishkill blamed on fishpens

BY YOLANDA FUERTES  
PDI Northern Luzon Bureau

LINGAYEN, Pangasinan — This is a case of which came first: the egg or the chicken.

Fishkill has affected both the fish-



THE PHILIPPINE STAR

PANGASINAN fishpens are being

## Pangasinan bangus industry dying due to fishkills

PANGASINAN—The local bangus industry faces bankruptcy amid the series of fishkills which have wrought damages placed at P120 million since January.

The latest fishkill, which struck last May 2, is affecting fishpens and

owners to harvest their bangus prematurely and sell them at a very low price. A kilo of bangus now fetches P30 from a high of P60 to P70, while malaga is sold at P80 per kilo from P150.

Fishpond operators are now

By EVA DE LEON

late evidence for possible court action against local officials who are lax in controlling the sprouting of illegal fishpens in municipal rivers.

Over-stocking and river pol-

the bangus industry, especially in Binmaley town, once known as the province's fish center.

He is hoping that Binmaley Mayor Rolando Domaiaanta will follow the example of Anda Mayor Alice Pulido who demolished

ential people, might force the commission to resort to court action.

The mayor, he said, can be charged with dereliction of duty and usurpation of power for issuing permits without an en-

Domaiaanta to the town's rivers gal fishpens. Meanwhile, Anda r Alice J. Pulido demolition crew rwooped down on 300 illegal fishpens.

TODAY FRIDAY, MAY 24, 1996

## Chemicals blamed for fish kill

B-20 MANILA BULLETIN, Thurs., Apr. 10, 1997

*11 barangays affected*

## P40 M lost in worst Pangasinan 'fish kill'

By MELANDREW T. VELASCO

seabass markets ... from page 26

Spain (3,200 tons), Italy (1,800 tons), Tunisia (750 tons), and France (340 tons). Other producers are Egypt, Turkey, Cyprus, Portugal, and Malta. Italy used to be a leading producer of seabass but has now been overtaken by Greece even as it maintains its position as the leading EU market for seabass. *Infofish* projected that seabass production would increase in the coming years with the improvement of the Italian economy. But it is unlikely that the prices would increase greatly.

## Miscellany

The best fish leather is the seabass skin. More durable than normal leather, it is making a definite impact. *Infofish* reported in 1992 that the finished product is found to be pleasing to the eye and versatile in its use.

Although seabass is found almost everywhere in Asia, it is only in Australia that it grows beyond 800 g per piece, appropriate for leather processing. The main feature of this leather is the scale pattern which forms pockets once the scales are removed chemically. Reportedly, chemical removal of scales is the best method as it leaves the delicate skin with the scale pocket intact.

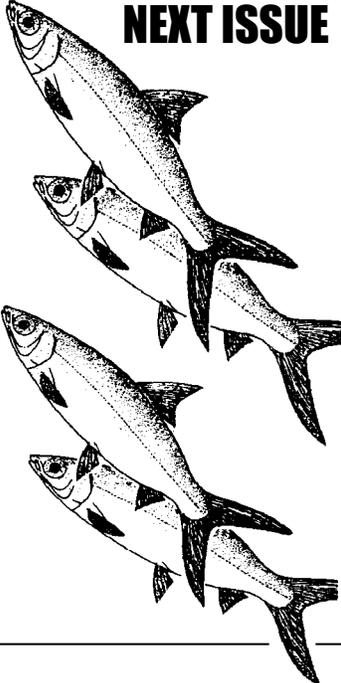
Fish skin leather can be made into shoes, fashion designer dresses, belts, and attractive accessories. But most people still don't know how attractive seabass skin is or how attractive it is when tanned, although reports say that once one sees it, its potential cannot be denied.

*Infofish* further says that processors of fish leather strictly guard their formulas and methods of processing. A reasonably sized tannery needs an initial capital of AU\$ 5 million and enough raw materials. Thus, fish skin tanneries diversify and process other fish skins from eel, shark, stingray, crocodile, etc.

Reports say that fish skin leather has a bright future because it does not harm the environment. Fish skin is normally discarded by the fishing industry.

## SOURCES

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**NEXT ISSUE** we will be featuring a series on the milkfish industry in the Philippines, starting with (1) **Ecological limits of high-density milkfish farming**, then (2) **Economic value of the milkfish industry**, (3) **Milkfish fry supply from the wild**, and (4) **Milkfish ponds from mangroves**.

WATCH FOR IT!

## Photographic competition on women in Asian fisheries

*The Asian Fisheries Society with PADEK (Partnership for Development in Kampuchea) welcome entries for their photographic competition on "Women in Asian Fisheries" which will coincide with the 5th Asian Fisheries Forum in Chiang Mai, Thailand on 11-14 November 1998. The objective of the competition is to highlight the crucial role of women in the socioeconomic fabric of Asian fisheries.*

*Entries should be of 8R size (8 x 10 inches) with a 1-inch border all around. The accompanying caption must not be more than 15 words. Entries should reach the organizers by 30 September 1998. Entries will be judged based on relevance to the central theme, photographic quality, and aesthetic content.*

*Entries and further inquiries should be addressed to: The Secretariat, Asian Fisheries Society, MC PO Box 2631, Makati City 0718, Philippines*



nature matters ... from page 10

111-ha mangrove reserve in Pagbilao Bay, southern Luzon, where research and experimental plantings are carried out by schools and by local and international private foundations. The Pagbilao secondary-growth forest contains a high diversity of mangroves and associated plants, including the 'nilad' *Scyphiphora hydrophyllacea*, which used to grow luxuriantly in Manila and gave the place its name ('May nilad' or where there is 'nilad'). Mangroves are now a rare sight around Manila Bay and other urban coastal areas. Many mangrove reforestation projects have been carried out all over the country, but only a few were successful, for example, those in Danacon Island in Bohol and in Busuang, Aklan. Mangrove plantations have become more common as community-based projects.

The International Institute for Rural Reconstruction (IIRR) in Silang, Cavite espouses regenerative agriculture and maintains a campus that is a biodiversity exhibit in its own right. Various fruit trees, hardwoods, ornamentals, and farm crops including grasses for fodder make the landscape. IIRR has bio-intensive gardens where many kinds of vegetables are raised without chemical inputs. IIRR also produces a variety of information materials for teachers, trainers, students, policymakers, and sectoral leaders involved in environment education.

Home gardens also promote biodiversity awareness, in addition to providing income, ornamentation, fruits and vegetables, spices and medicine, fish and meat, firewood, and fodder. The government launched several home garden programs but these always lacked funds, well-trained garden teachers, textbooks and other instructional materials, garden tools, and improved seeds and planting materials. At present, the Department of Education, Culture, and Sports encourages school gardens to teach children about the variety and importance of vegetable, fruit, and medicinal plants.

Commercial plant nurseries propagating many varieties of orchids, bromeliads, anthuriums, heliconias, roses, ferns, palms and other ornamentals are veritable biodiversity exhibits. Nurseries for fruit and hardwood trees are also becoming more numerous. Plant nurseries and the cutflower business are growing strong in several places in the Philippines, including Los Baños, Bacolod, Iloilo, and Davao. Garden fairs are held frequently and are very well patronized.

### Zoos, aquariums, and wildlife breeding centers

Zoos and aquariums are effective vehicles for the environment education and entertainment of children and adults alike. The Philippines does not have a national zoo and aquarium. The old Manila Zoo is a perennial crowd-drawer and a low-priced alternative to shopping malls. But the animal enclosures, the visitor facilities, and the interpretive trails and signs need improvement. Happily, there are now plans to make the Manila Zoo world-class. Indeed, zoos, aquariums, and animal showplaces are major tourist attractions and income earners in Hongkong, Singapore, and other Asian countries.

Several conservation programs have been launched by the government to protect endemic wildlife and some endangered species. The Tamaraw Conservation Program was launched in 1969 to protect the habitats of the endemic 'tamaraw' *Bubalus (Anoa) mindorensis*, including the ancestral lands of the Mangyans, from the cattle ranchers. Mt. Iglit and Mt. Baco, both tamaraw haunts in Mindoro, were declared a game reserve and bird sanctuary in 1969 and a national park in 1970. In October 1990, the first 'tamaraw' born in captivity was recorded in the Canturoy Gene Pool.

The 3,760-ha Calait Game Preserve and Wildlife Sanctuary in northern Palawan was established in 1976 and now maintains several species of herbivorous African mammals and populations of the endemic Calamian deer, mouse deer, Philippine

crocodile, Palawan pheasant, Palawan bear cat, porcupine, as well as marine turtles, giant clams, and dugong. The government now spends about P4 million on Calait, whose management has been contracted to a non-government organization.

The conservation of the Philippine eagle *Pithecophaga jeffreyi* was given impetus by Charles Lindbergh himself in 1970. The Philippine Eagle Research and Nature Center, managed by the Philippine Eagle Foundation Inc., lies at the foothills of Mt. Apo in Davao City. PEFI has produced information materials on wildlife conservation and biodiversity, and the Center has a good collection of raptors, small mammals, trees, and ornamental plants. But only the Philippine eagles have large cages, and the other birds look so forlorn in their small cages. The Center's reception room is small and has little instructional function.

The Wildlife Rescue Center at the Ninoy Aquino Park in Quezon City houses animals confiscated from illegal traders and owners. It now has 26 species of birds, 6 reptiles, and 14 mammals and operates with a staff of 18 on a budget of P3.8 million (P26=US\$1). Problems include lack of funds for food and medical care of animals, lack of quarantine facilities, overcrowding due to lack of cages, and bureaucratic red tape in deciding matters concerning the welfare of the animals. The Center for Philippine Raptors on Mt. Makiling rehabilitates captured birds of prey and serves as a back-up facility for the Philippine eagle conservation program. It conducts captive breeding research, laboratory and field studies, and education and information campaigns, with a staff of 10 people and funds of less than P1 million from the government and private organizations. Clearly, these wildlife centers could not go very far with such limited budgets.

The Crocodile Farming Institute was established in Irawan, Puerto Princesa in 1987 to focus on the propagation, protection, and conservation of *Crocodylus mindorensis* and *C. porosus*, with support from the Japan International Cooperation



Agency. Under the Marine Turtle Conservation Program, turtle sanctuaries have been declared in the Turtle Islands, in El Nido and Calauit in Palawan, and in Caluya Island. The Dugong Conservation Program is being conducted in Palawan with the cooperation of the Toba Aquarium of Japan. The Philippine Tarsier Conservation Program is being implemented in Bohol, Samar, Leyte, and Mindanao through the Debt-for-Nature Swap. The DENR's Protected Areas and Wildlife Bureau (PAWB) oversees all wildlife conservation and breeding programs in the country. PAWB also organizes bird banders to conduct mid-winter bird counts for the Asian Waterfowl Census.

Universities are also involved in wildlife breeding and conservation. Silliman University in Dumaguete City established in 1993 the Alfredo Y. Reyes Botanical and Zoological Garden, where wildlife are shown in a dipterocarp forest setting and some endangered species (bats, crocodile, deer) are bred in captivity. The West Visayas State University also established the Mariit Wildlife Conservation Park in Iloilo in 1993 in collaboration with the Mulhouse Zoo of France and England. Plans include ecotourism and captive breeding of Philippine spotted deer, warty pig, muskrat, hornbill, and other wildlife indigenous to Panay Island. The Marine Science Institute of the UP-Diliman has an ongoing breeding and conservation project for the endangered giant clams. Several species of *Tridacna* and *Hippopus* are spawned and grown at the UP Bolinao Marine Station and then transferred to selected reef areas that enjoy some form of protection and management by the local fisherfolk. But even in these 'protected' areas, the giant clams are not always safe from exploitation.

#### Note

Full citations are given in the original paper entitled *Nature parks, museums, gardens, and zoos for biodiversity conservation and environment education in the Philippines* that has been accepted for publication in *Ambio*.

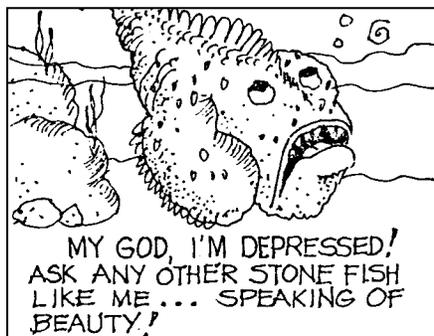
#### aqd journal publications ... from page 8

incisor-shaped or a mixture of somewhat incisor-shaped and canine-like; (b) the setal types replacing other types previously borne on the same site; and (c) the degree of occurrence of the denticulated setae on the 45 mm TL juvenile and adult stages. The implications of these mouthpart transformations on the feeding ability of the early juveniles, late juveniles, and adults are discussed, with mention of the potential ability of the redclaw for suspension feeding. Types of food appropriate for each stage were inferred.



**Golez NV, Kyuma K.** 1997. Influence of pyrite oxidation and soil acidification on some essential nutrient elements. *Aquacultural Engineering* 16 (1-2): 107-124 --

Influence of soil acidification on some essential nutrient elements was observed experimentally during periodic leaching at 10-day intervals of pyritic soil materials. Pyritic soil in glass columns saturated with distilled water was treated under waterlogged or submerged and drained conditions. Waterlogged was inundated and had overlying water of 2-cm depth above soil surface. Extremely acidic soil conditions, caused mainly by oxidation of pyrite (FeS<sub>2</sub>), led to other serious problems. Results showed that strong acidification of soils influenced the solubility and availability of some nutrients. The loss of calcium (Ca), magnesium (Mg), zinc (Zn), and copper (Cu) was enhanced by acidification. Intense acid conditions also dissolved manganese (Mn), high amounts of which would lead to toxicity problems in plants and animals. As oxidation progressed, soil acidification increased and depressed availability of phosphorous (P), thereby leading to the deficiency of this nutrient. Sodium (Na) and Chlorine (Cl)



were leached out rapidly in both treatments regardless of soil acidification. The common problems associated with acid soil formation from oxidation of pyrite are fish mortalities and very poor response of the soil to phosphorous fertilization. For idle land or areas abundant in pyritic materials, soil acidification can be avoided by inundation with water to a depth of 2-3 cm, rather than draining and exposure, which lead to the formation of acid sulfate soil. Periodic leaching was found effective in reducing soil acidity although some essential nutrients were also removed. Therefore, fertilization during amendments is found to be of necessity.



**Tan-Fermin JD, Pagador RR, Chavez RC.** 1997. LHRHa and pimozone-induced spawning of Asian catfish *Clarias macrocephalus* (Gunther) at different times during an annual reproductive cycle. *Aquaculture* 148 (4): 323-331 --

Captive *Clarias macrocephalus* were induced to spawn during the off-season (February), before (May), during (August) and end (November) of the natural breeding period to test their seasonal responsiveness to hormone treatment, and assess the resulting egg and larval quality. Intramuscular injections were given to five fish in each treatment consisting of 0.05 mu g LHRHa + 1 mu g PIM g(-1) body weight (BW). 0.05 mu g LHRHa. 1 mu g PIM, or LHRHa vehicle (0.9% NaCl) and PIM vehicle (1 dimethylsulfoxide: 9 propylene glycol, v/v). At any phase of the annual cycle, only fish injected with a combination of LHRHa and PIM spawned, although initial egg size was similar among fish within a season. However, initial egg size was largest in fish induced to spawn in May (1.59 mm), followed by fish induced in August and November (1.54 mm), and smallest in fish induced in February (1.49 mm). All fish ovulated when induced to spawn in May and August, but ovulation rates decreased to 80% and 60% when fish were injected in November and February, respectively. Catfish induced to spawn in May, August and November had higher egg production, fertilization and larval survival rates than the fish induced in February. Hatching rates were higher in fish induced in May and August than in February, while hatching rate of fish induced in November was similar to those spawned at other times of the year. These results provide useful information regarding the broodstock management and hatchery production of *C. macrocephalus*.



stamps ... from page 12

other natural objects—which requires that people go outdoors—makes people conservation oriented. However, stamps can be used in information dissemination—when little messages and striking images on them pass among people through letters and postcards.

Though Babes and Doris think that collecting fish and marine life stamps does not directly lead one to take active interest in resources conservation and the field of aquaculture science, it is still worth one's while to take up the craft as it is a joy to leaf through the pages of a stamp album and see the rewards of effort.

If by the benefit of an odd chance, one has grown up to be a prominent taxonomist from leafing through an heirloom album as a kid, then stamps would have served its purpose doubly well.

a feed for seabass ... from page 24

than did the other age groups. There was a low feeding incidence on *Moina* by 15-day old seabass. The number of ingested *Moina* by the same age group was not influenced by the length of time after feed introduction.

*Moina* is a freshwater cladoceran (flea) which thrives in ponds and reservoirs but primarily inhabits temporary ponds or ditches.

In another experiment, AQD researcher Milagros dela Peña showed that seabass larvae fed *Diaphanosoma* either alone or combined with *Artemia* gave a comparable growth and survival with those fed *Artemia* alone.

Seabass attained total length of 20.3 mm in 13 days from the initial length of 8.8 mm. Specific growth rate was 16% per day while survival rate was 98%. *Diaphanosoma celebensis* is a transparent/whitish marine cladoceran that inhabit nearshore estuarine waters.

1 9 9 8

AQD TRAINING COURSES

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Mr. Joemari Gerochi  
Undersecretary and SEAFDEC Council Director  
Department of Agriculture  
Elliptical Road, Diliman, Quezon City 1104  
FAX: 0(2)927 8405

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

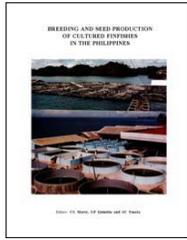
Seabass larvae needs sufficient amounts of unsaturated fatty acids as an essential component of the diet for proper growth and development. Fermin reported that the young seabass larvae hardly ingest the large freshwater cladoceran if given unsieved to fish compared with *Artemia*.

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SEAFDEC / AQD Report 1992-94, 1994-95

# New publications, training courses NOTICES



## PROCEEDINGS OF THE SEMINAR-WORKSHOP ON BREEDING AND SEED PRODUCTION OF CULTURED FINFISHES IN THE PHILIPPINES

Edited by CL Marte, GF Quintitio, AC Emata. 1997. 182 pages.

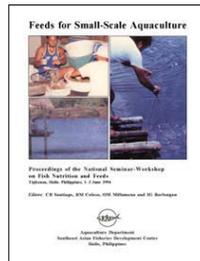
Price: US\$25 for foreign orders, P150 in the Philippines (price includes postage)

**DOCUMENTS** the proceedings of the seminar-workshop AQD hosted in 4-5 May 1993 in Tigbauan, Iloilo.

**INCLUDES** four review papers on:

- control of gonad growth, maturation, and spawning in teleosts (by AD Munro and TJ Lam)
- the AQD fish breeding research (by LMaB Garcia)
- mass larval rearing technology of marine fishes in Japan (by K Fukusho)
- the AQD fish seed production research (by GF Quintitio)

**ALSO CONTAINS** 5 full papers on breeding and 6 full papers on seed production.



## FEEDS FOR SMALL-SCALE AQUACULTURE

Edited by CB Santiago, RM Coloso, OM Millamena, IG Borlongan. 1996. 144 pages.

Price: US\$25 for foreign orders, P150 in the Philippines (price includes postage)

**DOCUMENTS** the proceedings of the *First National Seminar-Workshop on Fish Nutrition and Feeds* AQD hosted in 1-2 June 1994 in Tigbauan, Iloilo.

**INCLUDES** four review papers on:

- future considerations in fish nutrition research (by C Lim)
- nutritional requirements of commercially important shrimps in the tropics (by M Boonyaratpalin)
- feed formulation and evaluation for semi-intensive culture of fishes and shrimps in the tropics (by A Tacon)
- preparation, management, problems, and recommendations for farm-made feeds (by F Piedad-Pascual)

**ALSO CONTAINS** 7 full papers and 19 abstracts.



## AQUACULTURE FOR PEOPLE, THE ENVIRONMENT, AND DEVELOPMENT: 1994-1995 SEAFDEC/AQD REPORT

Prepared by VT Sulit, MT Castañon, EG de Jesus, A Gonzal, EM Huervana, N Ebron, TA Natividad. 1996. 106 pages.

**THIS VOLUME** tracks the two-year progress of AQD since the last biennial report issued in 1993. **INCLUDES** summaries of research studies, research and popular publications, collaborative programs, training and extension activities, and management matters.

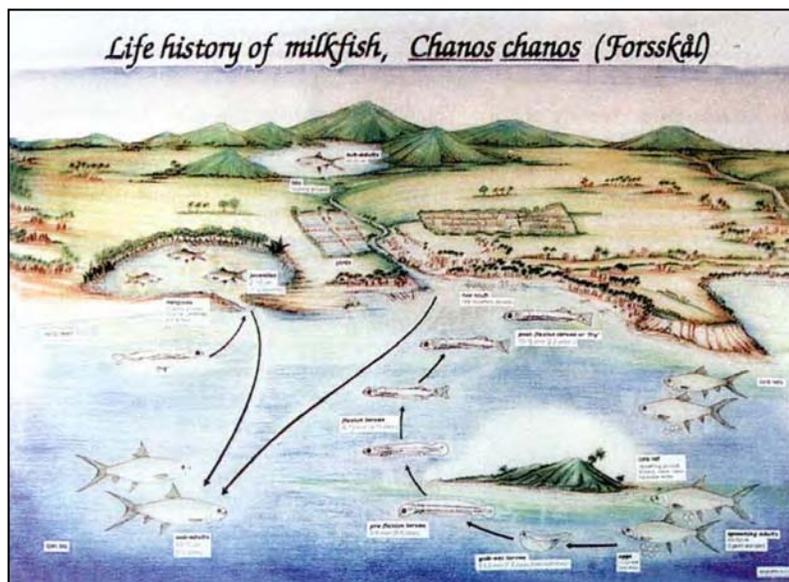
**OF PARTICULAR INTEREST** is the progress of AQD's pilot project on coastal fishery resources management at Malalison Island in Culasi, Antique. The project is development-oriented, integrating a multidisciplinary research approach. The major thrusts include the implementation of territorial use rights in fisheries, community organizing, economic utilization of resources, and co-management of fishery resources.

AQD's website at: <http://www2.mozcom.com/~seafdec>

## LIFE HISTORY OF THE MILKFISH

COLORED POSTER 83 x 61 cm  
By the AQD Museum and Biodiversity Garden  
Price: P50 or US \$20 (includes postage)

**TRACES** the life history of milkfish based on Dr. Teodora Bagarinao's monograph published by AQD in 1991, and on her paper entitled *Systematics, distribution, genetics, and life history of milkfish* published in the *Environmental Biology of Fishes*, Vol 39 (1994): 23-41.



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

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### Contributions

We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs, line drawings must be camera-ready, glossy B&W prints or colored slides.

Cut-off date for contributions considered for the issue indicated is every 1st of January, March, May, July, September, or November.

### Gifts and exchanges

Publication exchanges with *SEAFDEC Asian Aquaculture* are also encouraged. AQD has publications exchange agreements with 800 institutions worldwide.

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## On changes and natural sex inversion in seabass

By E Ledesma



Better life through aquaculture