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SEAFDEC Aquaculture Department 1992-1993 Report

R & D for Sustainable Aquaculture

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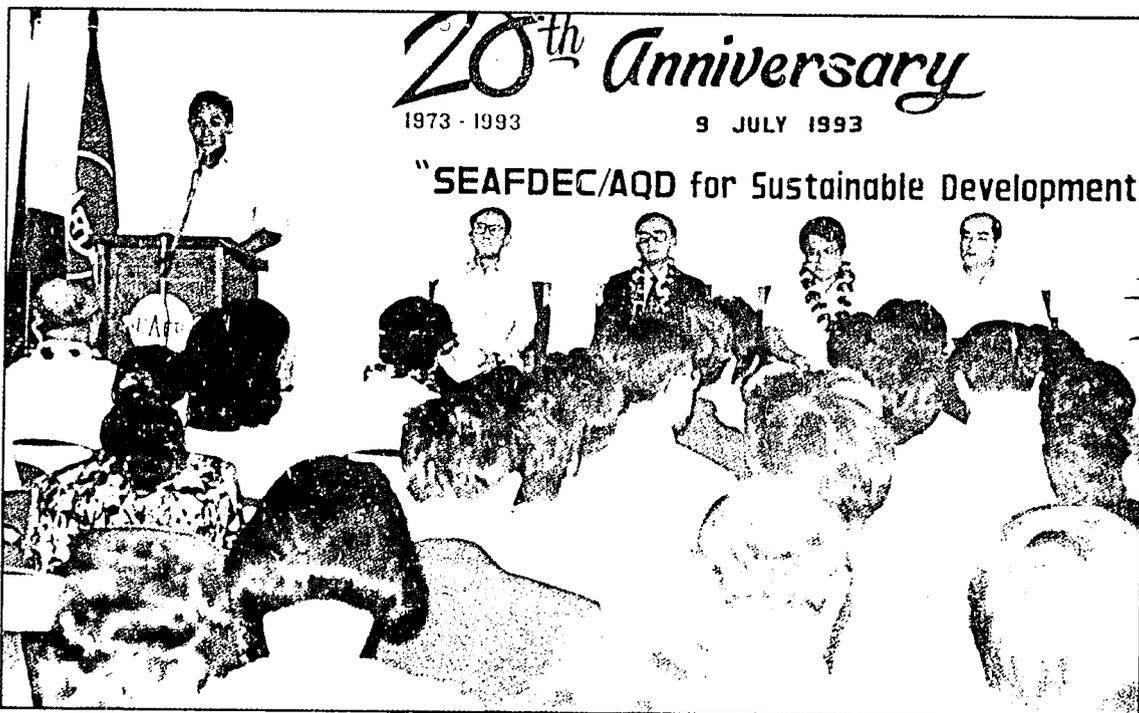
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Contents

SUSTAINABLE AQUACULTURE	2
RESEARCH ACTIVITIES	4
Studies	5
Seminars	37
Publications	43
Awards	53
Cooperation	54
Service laboratories	61
TRAINING AND INFORMATION	62
Training	63
Extension	67
Publications	69
Library and documentation	72
MANAGEMENT	73
Personnel	74
Infrastructure	78
Special notes	81
Financial report	84
THE PEOPLE BEHIND AQD	85



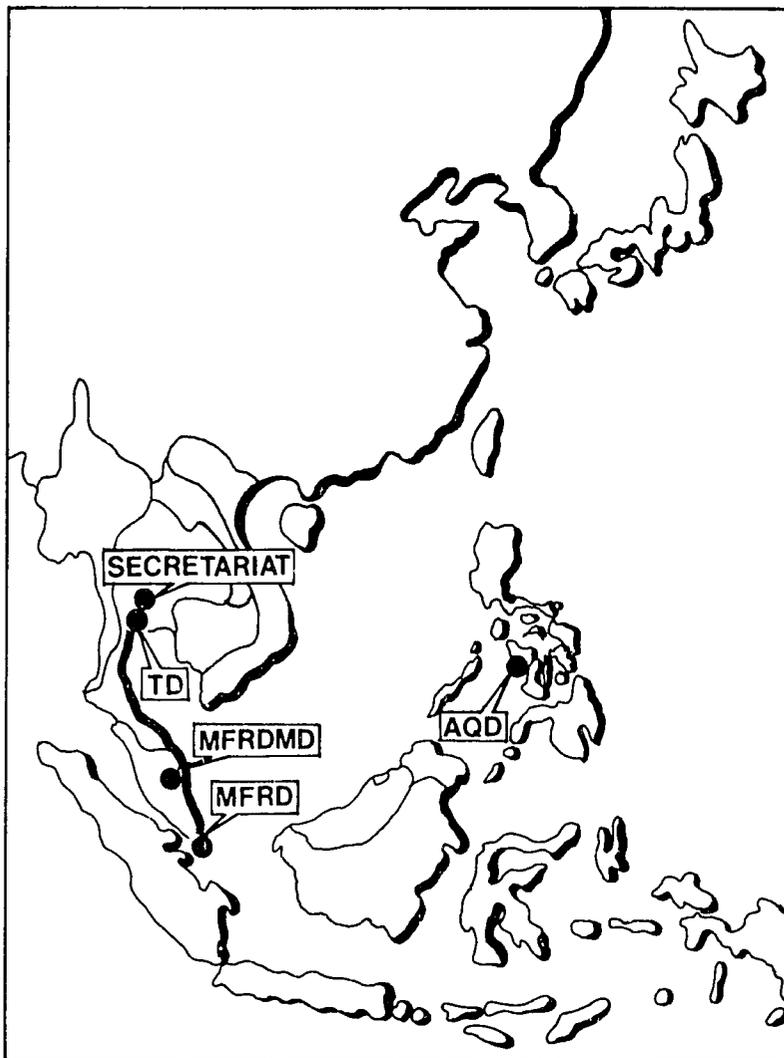
The SEAFDEC Program Committee at its Sixteenth Meeting.



SEAFDEC/AQD marks second decade of aquaculture R & D.

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in 1967. Its Member-Countries are Japan, Malaysia, the Philippines, Singapore, and Thailand.

Created to develop fishery potentials in the region in response to the global food crisis, SEAFDEC undertakes research on appropriate technologies, trains fisheries and aquaculture technicians, and collects, analyzes, and disseminates fisheries and aquaculture information. To pursue these objectives, the Center established four key departments -- the Marine Fisheries Training Department (Thailand), the Marine Fisheries Research Department (Singapore), the Aquaculture Department (Philippines), and the Marine Fishery Resources Development and Management (Malaysia).



Sustainable aquaculture

Aquaculture is necessary to produce more fish in the face of decreasing supply from marine fisheries and increasing demand from the burgeoning population. The challenge is how to make the best possible use of coastal and inland waters for aquaculture at low levels of costly inputs and without adverse environmental and socioeconomic changes.

The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD) was established in 1973 to:

- **Promote and undertake aquaculture research relevant and appropriate for Southeast Asia;**
- **Develop human resources for aquaculture development in the region; and**

- **Disseminate and exchange aquaculture information**

SEAFDEC/AQD has since contributed significantly to the development of aquaculture in the region, and will continue to respond to the challenges of the industry.

This *Report* chronicles the accomplishments of SEAFDEC/AQD in 1992 and 1993. We can promise in the future aquaculture technologies that enhance, not degrade, coastal resources, and improve, not take away, the livelihood of small-scale fisherfolk and fish farmers. These technologies will contribute to sustainable development in southeast Asia.



Efrén Ed. C. Flores
Chief

Research accomplishments

SEAFDEC/AQD conducted research on the priority species identified during the *Second Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA II)* in August 1991. Completed studies are presented in in-house seminars and published in scientific journals, especially those covered by *Current Contents*. SEAFDEC/AQD collaborates with other research organizations.

Studies are conducted at three research stations: freshwater aquaculture and lake ecology at Binangonan (Rizal), marine fish broodstock development at Igang (Guimaras), and breeding, nursery, health management, and feed development at Tigbauan (Iloilo). Pond studies are conducted in collaboration with the private sector, the University of the Philippines in the

Visayas, and the local Department of Agriculture. A special project on coastal resources management is underway at Malalison Island (Antique).

SEAFDEC/AQD operates service laboratories to raise plankton as larval feed; to produce feeds in bulk; to analyze feeds, soil and water; to diagnose fish diseases; and to process tissues for histological examination. The Data Bank and Statistical Services and the Laboratory Equipment Maintenance Unit also support research and data analysis.

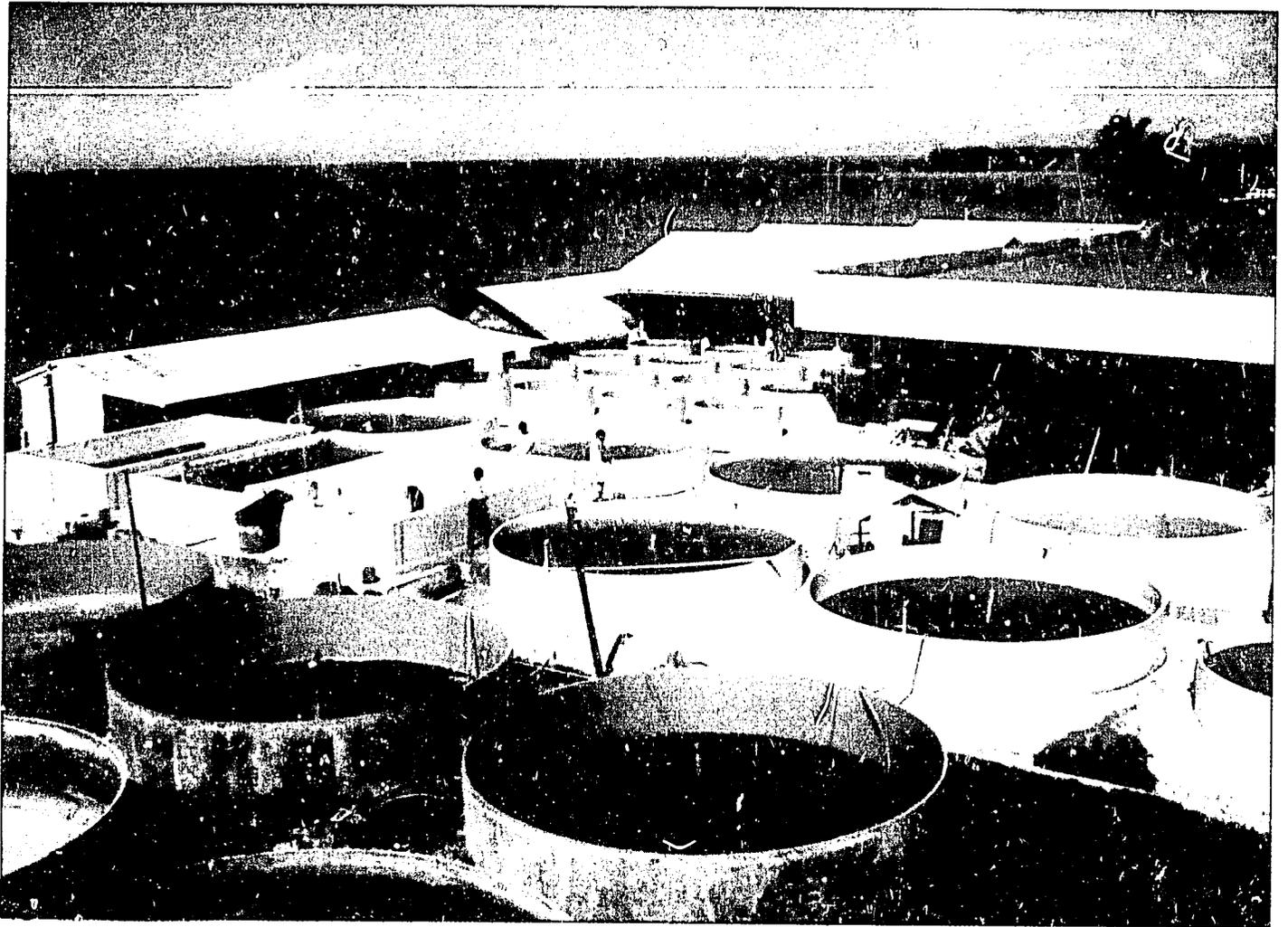
The Research Division comprises roughly 50% of the Department's 349 employees. As of December 1993, AQD had ten Ph.D. and 60 M.Sc. holders.

Research priorities in 1992-94 include breeding, nursery, and farming of economically important fishes, molluscs, and crustaceans in Southeast Asia: grouper, milkfish, snapper, sea bass, rabbitfish, mullet, tilapia, catfish, bighead carp, ornamental fishes, mud crab, tiger shrimp, white shrimps, oysters, mussels, abalone, scallops, and seaweeds. In support of the culture of these species are studies on feed development and health management.

AQD's research priorities are assessed every three years and realigned in response to the needs of the aquaculture industry and the environment.

**Research Division Head
Dr. Relicardo Coloso at the
laboratory.**





SEAFDEC/AQD operates the Tigbauan Main Station with its large fish hatchery, broodstock holding tanks, laboratories, and training and other facilities.

Developing grouper broodstock

Broodstocks of the groupers *Epinephelus suillus* and *E. salmoides* are being developed by Gerald Quintio in floating net cages in Igang Marine Station. Among the *E. suillus*, a 9-kg male spermiated in February, and in April to September 1992. Some females started to mature in March, and all females were mature in June to November, except one that had atretic oocytes in November. An 8-kg female that had mature oocytes in July spermiated in August, indicating sex inversion. On the other hand, *E. salmoides* stocked at a low density of 12-13 fish in one cage had 1-2 mature females in June to October, whereas those stocked at 29 fish in a cage had no mature females.

In an effort to induce sex inversion through manipulation of the social structure, Quintio in October 1992 stocked two mature *E. suillus* females of different sizes in each of three net cages (2 x 2 x 3 meter deep). Small fish in all cages had oocytes in May and June 1993, and those in two cages, as early as November 1992. The bigger fish in one cage had atretic oocytes in November and spermiated in February-August, although no milt was obtained in May and June. The bigger fish in the second cage had milt in May-August except in June; that from the third cage had milt only in August. In August, some females died due to bacterial infection and the experiment was terminated.



Dr. Gerald Quintio inspects the spawned eggs of grouper.

Quintio also fed three groups of *E. suillus* broodstock (1 male and 3 females in 50-ton concrete tanks) different diets and assessed the number and quality of the eggs they spawned. Groupers fed frozen fish (control) spawned the most eggs per month (3.3-10.2 million). (The frozen fish used as feed consisted of *Selaroides*, *Decapterus*, *Nemipterus*, or *Rastrelliger* and had 66-75% crude protein.) Groupers fed frozen fish enriched with cod liver oil spawned 1.1-6.3 million eggs in January to early June and in late September. Groupers fed frozen fish enriched with commercial HUFA (highly unsaturated fatty acids) spawned 4.1-8.2 million eggs in late June to early September and in late October. Control fish showed the highest average monthly egg production (180-450 thousand eggs per kilogram fish in six spawnings a month), fertilization rates (71%), egg viability (53%) and hatching (34%). The two diets with lipid supplements were similar in terms of the same variables. The

three diet treatments did not differ in the 'quality' of the resulting eggs and larvae; neither in egg diameter, oil globule diameter, percent normal larvae, survival of unfed newly hatched larvae, and crude protein and fat contents of floating and sinking eggs.

In a study of hormonal induction of sex inversion in *E. suillus*, Clarissa Marte assessed the gonad condition of three-year old broodstock (2-7 kg body weight) in May to December 1992. In May, 39 of 53 groupers were maturing or mature females; in July to September, all were mature females, except for a 7.5 kg one that spontaneously turned into a male in September. In December, 44 of 56 females were mature and a second sex-inversed male (5.4 kg) was obtained. From December 1992 to June 1993, female *E. suillus* were given hormones: biweekly injection of 17 α -methyltestosterone (MT), or bimonthly implants of either MT (4 mg/kg) alone, LHRHa (20 μ g/kg)

alone, or MT+LHRHa at the same concentrations. Bimonthly implants of MT or MT+LHRHa were as effective as biweekly injections of MT: the treated females no longer had oocytes upon biopsy in January to June, and had either gonads in transition stage, fully developed testes, or scanty milt by August. Females given only LHRHa implants still had oocytes upon biopsy in June to December, just like the controls (both untreated, or implanted with pellets not containing any hormone).

Japanese researcher Junji Imayoshi studied reproduction in humpback grouper *Cromileptes altivelis*. The monthly mean gonadosomatic index (%) of fish caught in Palawan in 1992 were: 0.7 in April, 3.0 in May, 3.8 in June, 19.2 in July, 28.9 in August, 25.6 in September, 29.2 in October, 12.7 in November, 1.5 in December. The natural spawning season is from July until November. Mature females had mean body weights of 600 grams and total length of 40 cm; males, 1.2 kg and 56 cm.

STUDIES

Rearing of grouper larvae

Larval rearing techniques are being developed by Marietta Duray for the grouper *Epinephelus suillus*. Grouper larvae started feeding on rotifers when they were two days old and 2.6 mm TL. The amount of rotifers ingested increased as the larvae grew. When *Artemia* nauplii were introduced on day 21, the

larvae preferred *Artemia* over rotifers. Feeding started at 4-5 AM and larvae were satiated at 9-10 AM. Feeding decreased in the evening and ceased at 9-10 PM.

Then Duray reared grouper larvae for 14 days at a density of 30 per liter in 200-liter tanks. One group of larvae was fed screened rotifers of size less than 90 μ m and another was fed unscreened rotifers. The larvae given screened rotifers ate more of them (about 180 rotifers per larva on average) than the larvae given unscreened rotifers (40 rotifers per larva). They were also significantly larger (5.4 mm) and survived better (38%). Then at day 21, groups of grouper larvae (6.6 mm) were fed either 1, 2, or 3 *Artemia* nauplii per milliliter per day for two weeks. Those fed the most nauplii were significantly longer (12 mm) and survived better (30%) than the others. At the end of the experiment, the larvae given the intermediate amount of nauplii had about 220 nauplii in each gut, and those given the lowest amount only had 146 nauplii in each gut.

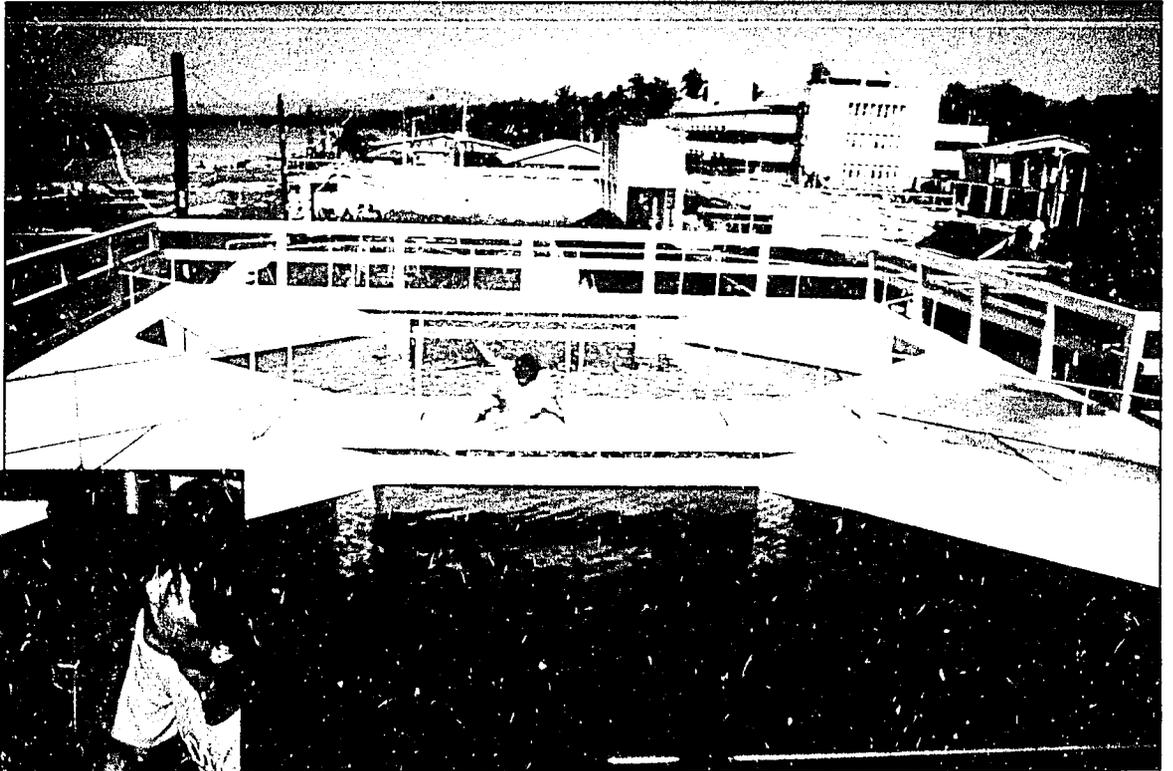
In a further experiment by Duray, grouper larvae 6.2 mm long were fed *Artemia* nauplii, alone or supplemented with either a commercial larval fish feed (Lansy A-2) or the SEAFDEC larval shrimp diet (CMBD). After two weeks, the larvae fed *Artemia* alone showed the highest survival (32%), but those fed Lansy A-2 grew largest (19.5 mm, 36.8 mg).

The effect of salinity on the survival of *E. suillus* larvae was studied by Fe Parado-Estepa. Tolerance tests were done on 5, 10, and 15 day old grouper larvae transferred from 32 ppt to different salinities between 4 and 40 ppt. The median lethal time, LT₅₀, was used to compare survival at differ-

ent salinities; a high LT₅₀ means better survival. Day 5 larvae had a higher LT₅₀ (38-63 hours) at 8-36 ppt than at lower or higher salinities. Similarly, Day 10 larvae survived best (52-63 hours) at 8-20 ppt; day 15 larvae, for 16-24 hours at 8-28 ppt. Grouper larvae should be reared at the salinity that allows the best survival at a given age.

Thyroid hormones affect fish development, especially the metamorphosis or transformation of larvae. Whole-body concentrations of the thyroid hormones were measured by Evelyn Grace de Jesus in grouper larvae at various stages of metamorphosis. The levels of both thyroxine (T₄) and triiodothyronine (T₃) were relatively low during the early stages of metamorphosis when fin rays were still growing, increased significantly on day 35, and remained high until day 50 when metamorphosis was completed. The increase in hormone levels corresponded with the resorption of the elongated fin spines. These data suggest the involvement of thyroid hormones in the regulation of metamorphosis in grouper larvae.

The effect of thyroid hormones on early development and metamorphosis of grouper was also determined by de Jesus. Three-week old grouper larvae were immersed in either 0.01 ppm T₄, 0.01 ppm T₃, or 30 ppm thiourea, an inhibitor of thyroid hormone synthesis. Many larvae died two days after transfer from the rearing tank to the immersion tanks. After 5 days, only 10% of the T₃-treated group survived but their long dorsal spines were completely resorbed. With hormone treatment, the long spines are normally resorbed 40-50 days from hatching. The experiment will be repeated to have more meaningful comparisons.



The Tigbauan Main Station has a centralized water settling tank that holds about 150 tons of seawater. A flow-through system that bypasses the settling tank is also an option.

STUDIES

Pond culture of grouper

Grouper juveniles from the wild were cultured in ponds for five months by Isidra Bombeo-Tuburan. The groupers were fed either frozen fish, a formulated feed, or live juvenile tilapia from broodstock (one male for every female) raised in the pond or added to the ponds weekly. Groupers fed frozen fish showed the highest survival (88%)

and average weight at harvest (393 grams), whereas those fed the formulated diet were intermediate (85% survival, 273 grams). The poorest result (77%, 258 grams) was among the groupers fed tilapia, which evidently were not sufficient to support growth and prevent cannibalism among the groupers.

A survey of grouper juveniles was conducted by Noel Solis in Sapien Bay and Tinagong Dagat in Capiz in 1992. Fishermen collectors were contacted to report on the occurrence, abundance, and size of the groupers caught for commercial grow-out ponds. Two species of groupers were collected by artificial shelters or 'bonbon,' bundles of

coconut palms tied to stakes in the bays. The fish were harvested from the shelters twice a month; samples of these were taken monthly. The 2-4 cm juveniles of *Epinephelus suillus* appeared in August and September and were not abundant. Juvenile *E. sexfaciatus* appeared in July (big school) and were abundant in August-September 1992. Other gears used were hook and line and bamboo tubes or 'pasok.' In 1993, the monthly size-frequency distribution of juvenile *E. suillus* at the two sites was determined. The 136 juveniles obtained in Sapien Bay ranged 3-30 cm and 0.8-1000 grams, and increased in average size between January (3.8 cm) and November (20 cm). The 563 juveniles obtained in Tinagong Dagat ranged 4-31 cm and also increased in average size between January (7.5 cm) and October (20 cm).

STUDIES

Developing milkfish broodstock

The effect of age and source of broodstock on the reproductive performance of milkfish (*Chanos chanos*) was studied by Arnil Emata. Broodstock (24 males and females) raised from the 1980 hatchery-reared fry — that is, 13 years old in 1993 — spawned 14 times and produced a total 10.1 million eggs. Broodstock (31 fish) raised from wild fry caught in 1980 spawned four times and produced 3.2 million eggs. Ten-year old broodstock (25 fish) from wild fry caught in 1983 also had 14 spawnings, but total egg production was only 4.85 million. Other younger broodstocks, 24 breeders from hatchery-reared fry in 1983, 25 breeders

from hatchery-reared fry in 1985, and 31 breeders from wild fry in 1985, all had very low egg production (total 0.1-1.2 million) in only 1-2 spawnings. Fertilization and hatching rates, percent viable eggs and normal larvae, and the morphology of eggs, larvae, and fry did not vary with the age or source of the broodstock.

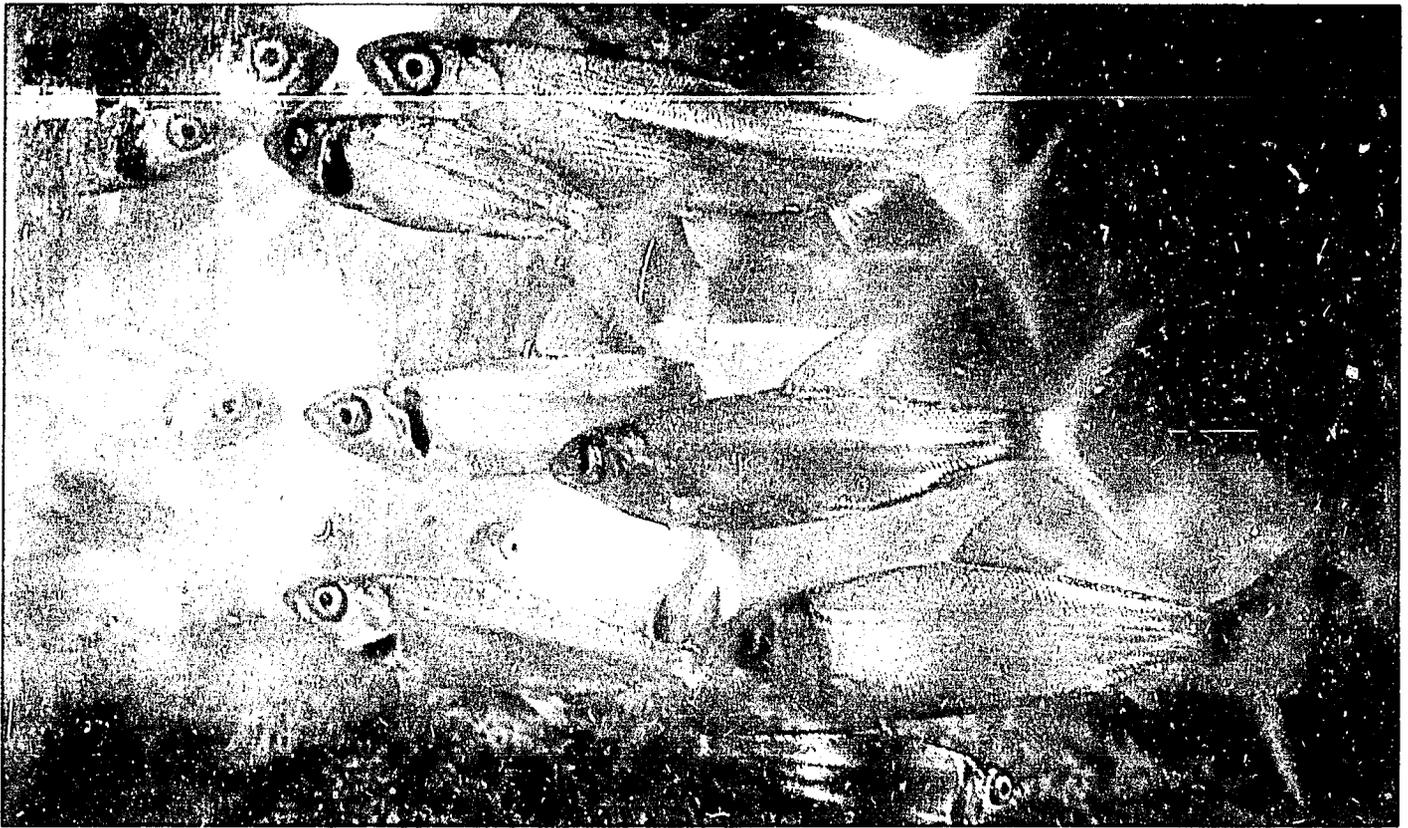
Photoperiod also affects gonadal development in milkfish in another Emata study. In 1992, broodstocks were held in concrete tanks for a year under either a constant long photoperiod (16 hours light), or a varied photoperiod (8 hours light in January-July, 12 hours light in August-September, and 16 hours light from October onwards). Milkfish kept under constant long photoperiod spawned 28 times until the last week of September and were still mature on 25 October. Those under the varied photoperiod spawned spontaneously 25 times on 22 April-2 September, but no fish were mature in October. These results suggested that long photoperiod may be conducive to spawning and maturation in milkfish. In 1993, the same broodstocks were kept in either the same constant long photoperiod, or a varied photoperiod (8 hours in January-May, 12 hours in June-July, and 16 hours from August onwards). Spawning of both groups were almost similar in frequency and duration: 33 times on 10 June-21 October under the constant long photoperiod, and 28 times on 16 June-11 November under the varied photoperiod. Whether photoperiod manipulation can induce out-of-season spawning in milkfish remains to be determined.

Hormones were used by Clarissa Marte to induce off-season maturation in milkfish. Groups of 6-8 females or 11-13 males were kept in separate concrete tanks. Females were given bimonthly silastic implants of estradiol-17B (E_2) and the

males, of 17 α -hydroxyprogesterone (17HP), at either high dose (1000 μ g per fish) or low (250 μ g per fish). The low and high E_2 doses and the low 17HP dose effectively initiated maturation of milkfish early in the spawning season (March), enhanced rematuration throughout the spawning season (April-October), but was not able to maintain gonadal maturity beyond the spawning season (November-January).

Experiments by Marte showed that broodstock performance can be improved through dietary manipulation. Milkfish broodstock (14 females and 23-25 males per cage) were fed formulated diets with 36% protein and either 10 or 6% lipid from cod liver oil at a ration of 2 or 4% of body weight per day. Fish fed the diet with 6% lipid at 4% ration spawned the most eggs, a total of 8.1 million in nine spawnings; those fed at 2% ration spawned 3.8 million eggs in nine spawnings. The high-lipid diet at 2% ration produced 2.5 million eggs in seven spawnings; at 4% ration, only 0.3 million in three spawnings. No differences were observed in the egg size and weight, number of viable eggs, fertilization rates, larval size at hatching, nor in the number of normal larvae. Survival at 21 days was highest (average 14% in five runs) among larvae from broodstock fed the low-lipid diet at 2% ration, but not significantly different from the other treatments.

Marte then varied the dietary protein level and ration size. Milkfish broodstocks were fed diets with either 36 or 42% protein at 2 or 4% of body weight daily. Fish fed the diet with 36% protein at 4% ration spawned 14 times in 1993. Total egg collection was 7.09 million and varied from 0.06 to 1.38 million per spawning. The same diet at 2% ration produced seven spawnings and 3.12 million eggs. Broodstock given the diet with 42% protein at 4% ration spawned only twice, and those fed at



One apparent disadvantage of hatchery-bred milkfish is that abnormalities occur in about 2-17% of those stocked in ponds and concrete tanks. Abnormal gill covers may be due to a Vitamin C deficiency in the diet as has been noted for trout and channel catfish.

2% ration spawned only once. Sizes of eggs and larvae, fertilization rates, hatching rates, and survival rates of larvae were similar among all broodstocks. Thus, the best diet for milkfish broodstock in floating cages is one that contains 36% protein and 6% lipid, given at 4% of body weight daily.

STUDIES

Verifying milkfish hatchery technology

Verification of the AQD larval rearing technique for milkfish was continued by Marietta Duray using commercial larval feeds. In one experiment, the use of Nosan R-1

as 50% replacement for rotifers during the first 15 days of rearing resulted in a mean survival of 36% at day 21 and an annual fry production of 3.47 million. Then, a carageenan-microbound diet (CMBD) was tested as total replacement for brine shrimp starting day 15. Larvae fed brine shrimp measured 13 mm and those fed CMBD were 10 mm at day 21. Both groups attained similar weights around 2.3 mg and survival rates of 25-27%. Larvae fed CMBD had to be reared an additional week to attain the size of the group fed brine shrimp.

In another set of larval rearing runs by Duray, milkfish larvae on days 14-21 were fed either: *Artemia* alone; *Artemia* with Lansy A-2, a commercial larval diet; rotifers with Lansy A-2; or rotifers with CMBD. Survival was highest, 48%, among larvae fed *Artemia* with Lansy A-2, and lowest among those fed rotifers with CMBD (6%). Larvae

fed rotifers with CMBD were larger (average 18.7 mm, 8.8 mg) than those fed rotifers with Lansy A-2 or the control fed *Artemia* only. The smallest larvae were those fed *Artemia* with Lansy A-2 (13.1 mm, 2.5 mg).

The milkfish hatchery technology was verified by Duray in two private hatcheries. During the first two weeks of larval rearing, rotifers were supplemented with the commercial diet Nosan R-1. One hatchery produced 2.8 million fry out of 13 million eggs, a mean survival of 29% in 28 rearing runs. The other hatchery produced 0.66 million fry out of six million eggs, a mean survival of 31% in ten runs.

A team of researchers led by Luis Ma. Garcia evaluated the SEAFDEC/AQD milkfish hatchery technology transferred to private hatcheries. In 1992, about 37.4 million eggs and 3.4 million newly hatched larvae from AQD were reared by four commercial shrimp hatcheries in Panay. Hatching rates averaged 35-78% and survival rates 12-36% among the four hatcheries.

About 5.9 million fry were produced. Hatchery-produced fry sold at prevailing market prices (P350-P420 per thousand fry) earned gross revenues of P0.14-P1.7 million. A cost-and-return analysis showed a return-on-working capital of 108-719% and a return-on-investment of 14-90%. The hatcheries showed payback periods of 1 to 4.6 years. Milkfish hatchery operation in existing shrimp hatcheries is a profitable business venture when the cost of milkfish eggs or larvae does not exceed P6 000 per million.

Luis Ma. Garcia also assessed the production of milkfish fry in private hatcheries that availed of the Adopt-a-Milkfish broodstock scheme in 1993. Three cooperators adopted (financed and maintained) cages of milkfish broodstock and reared the eggs that were spawned. One cooperator terminated operations in September due mainly to low egg production of the adopted breeders. About 3.4 million fry were produced and sold by the two other cooperators. The production costs varied from P0.23 to P0.62 million for six larval rearing runs from May

to November and resulted in net incomes of P0.10-P0.64 million. Low profit margins were indicated by the study.

The morphological abnormalities in hatchery-produced milkfish were characterized by Grace Garcia. Among fry stocked in earthen nursery ponds at 42/m², 10% turned out to be abnormal; among those stocked at 200/m², only 2% did. Fry stocked at 500/m² in a concrete nursery pond produced 16% abnormal fish; those stocked at 1000/m² in a net cage in a tank had 17% abnormal. Common abnormalities seen among milkfish larger than 0.5 grams in body weight include deformed branchiostegal rays, cleft

Milkfish broodstock are held in 50-ton outdoor tanks that are drained during sampling

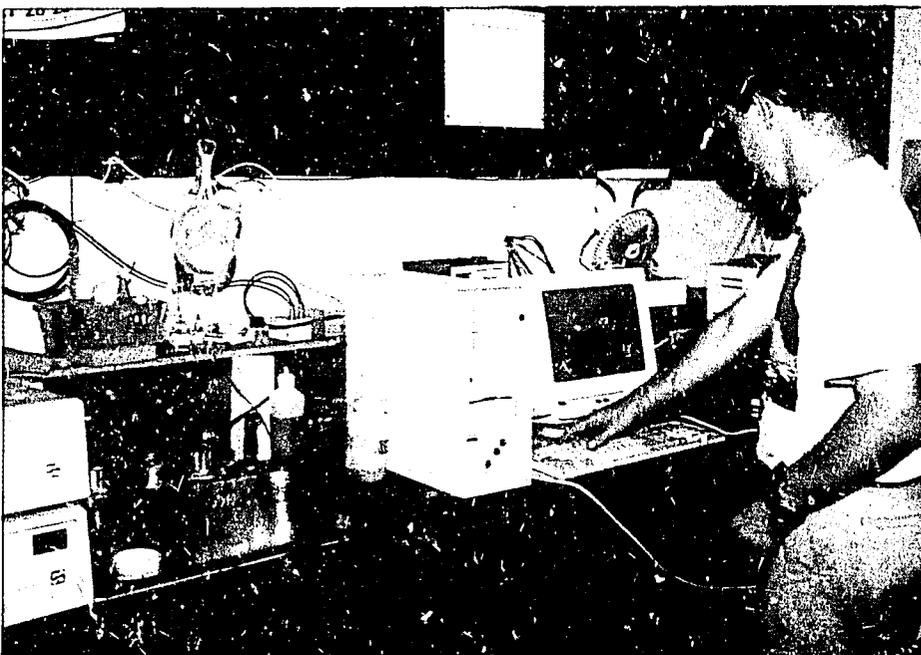


branchiostegal membrane, and deformed opercular bones exposing the gills. Some 71% of abnormal milkfish 0.5-5.6 grams in weight weighed less than 1 gram.

Induction experiments were then done by Grace Garcia to understand how abnormalities came about. One form of handling that was examined for adverse effects was the packing and transport of embryos. When oxygen was added to the transport water before the embryos and the embryos were not subjected to bubbling, 91% of the embryos hatched, 92% of the larvae survived 10-14 hours after hatching, and only 7% of the larvae were abnormal, that is, had bent bodies. When the trans-

port water with milkfish embryos was bubbled with oxygen for 2-3 seconds, only 81% hatched, 86% of the larvae survived 10-14 hours, and 16% of them were abnormal. Dissolved oxygen increased to 13.5-15 ppm when oxygen was added to the water and the air space in the transport bag and stayed at those levels after 5 hours of transport. The use of oxygen tablets (30 mg oxygen per tablet; one tablet per 5 liters of water) during transport of milkfish embryos had worse results: 65% hatched, 74% of the larvae survived 10-14 hours, and 35% of them were abnormal. Dissolved oxygen in the transport water decreased from 5 ppm to 3.0-3.5 ppm after 5 hours of storage and transport when oxygen tablets were used. In a separate experiment, storage of embryos for 3 or 9 hours unshaken in transport bags produced 32-37% abnormal larvae; embryos subjected to simulated transport on an orbit shaker produced only 10-12% abnormal larvae. Embryos immediately incubated in tanks without having been stored in transport bags nor subjected to simulated transport produced only 6% abnormal larvae.

Visiting Researcher Karsten Schroeder studies the bioenergetics of milkfish juveniles



The viral and microbial diseases affecting hatchery-reared milkfish are being investigated by Roselyn Duremdez-Fernandez. The bacterial loads were qualitatively and quantitatively enumerated in seawater agar medium, Zobell's 2216e medium, and bromthymol blue Teepol agar. Eleven batches of milkfish eggs from Igang and Tigbauan were examined. Each egg had 0-5 bacterial cells, but pooled samples of 5 eggs contained 5-450 bacterial cells. Larvae were monitored for normal bacterial loads through 20 days of rearing in the hatchery. Larvae on days 1-13 had loads of 10 to 1 000 bacterial cells each. On day 20, the bacterial load increased to 100 000 cells per larva and included a significant number of *Vibrio* species. The same trend was observed in the bacterial load of the rearing water. The isolated bacteria will be identified.

Another means to improve survival of fish larvae in hatcheries was tried by Rolando Gapasin. Live food organisms were enriched with essential fatty acids and vitamin C through bioencapsulation techniques. Milkfish larvae were reared the standard AQD way, except that the rotifers and *Artemia* were first enriched with vitamin C and highly unsaturated fatty acids. The initial results were not satisfactory and the experiment will be repeated.

An alternative rearing scheme for milkfish larvae was tried by Clarissa Marte. Concrete tanks of 90-ton capacity were fertilized with chicken manure to induce plankton growth. Milkfish larvae were stocked at a density of one per liter. Larvae harvested on day 18 were larger and were at a more advanced stage of development than larvae of the same age reared under the usual hatchery procedures. Survival rates were only 2-6% compared to 30% with usual procedures.

STUDIES

Feeds and feeding of milkfish

Species differences in energy reserves and utilization as they relate to growth and development are the focus of Ph.D. thesis research by Riza Ordonio-Aguilar. The lipid contents (triglyceride, free fatty acid, phospholipid) of whole larvae were measured. At hatching, the total lipid content of milkfish larvae was lower than in seabass larvae (57 versus 109 $\mu\text{g}/\text{mg}$ dry weight). Milkfish larvae consumed 68%, and seabass larvae 42% of its lipids during the first 48 hours from hatching. Rabbitfish larvae consumed 73%, and grouper 79% of their lipids during the same period. Milkfish larvae only have yolk, but the three other species have both yolk and oil globule during the first 3-5 days from hatching. Free fatty acids were consumed more rapidly than triglycerides and phospholipids, but the actual sequence of lipid consumption could not be deduced.

Practical diets for milkfish larvae, first feeding and older, are being developed by Ilda Borlongan. Experiments were made to determine the feed characteristics important to larvae: feed particle size, buoyancy, water stability, and acceptability. Milkfish larvae were then reared on various feeding regimes with formulated diets and evaluated in terms of growth and survival. One formulated diet was found effective as a supplement to rotifers for milkfish younger than 15 days, and another as a partial substitute for *Artemia* nauplii for larvae 15-21 days old. These promising results would reduce dependence on live foods and also the tank facilities for rotifer production in milkfish hatcheries.

Studies on milkfish bioenergetics were conducted by Karsten Schroeder, Ph.D. student from the University of Hohenheim. The maintenance ration, critical oxygen tension and oxygen consumption of different sizes of juvenile milkfish were determined at different temperatures. At 23-24°C, juveniles of body weights 40-100, 100-200, and 200-370 grams required maintenance rations of 3.9, 6.4, and 4.6 grams feed per kilogram metabolic body mass per day. The critical oxygen tension for juveniles of body weights 83-158 grams at 33°C and 32 ppt salinity was 55-90 torr, equivalent to an oxygen saturation of 35-60% under the conditions of the experiment. The standard (resting) oxygen consumption rates at 27°C were 69, 91 and 97 mg oxygen per kilogram metabolic body mass per hour among juveniles of body weights 45-100 g (group 1), 100-200 g (group 2), and 200-300 g (group 3). During routine activity, oxygen consumption was highest in group 3 and lowest in group 1 (142 compared to 120 mg oxygen per kilogram metabolic body mass per hour). Group 1 had the highest scope for spontaneous activity.

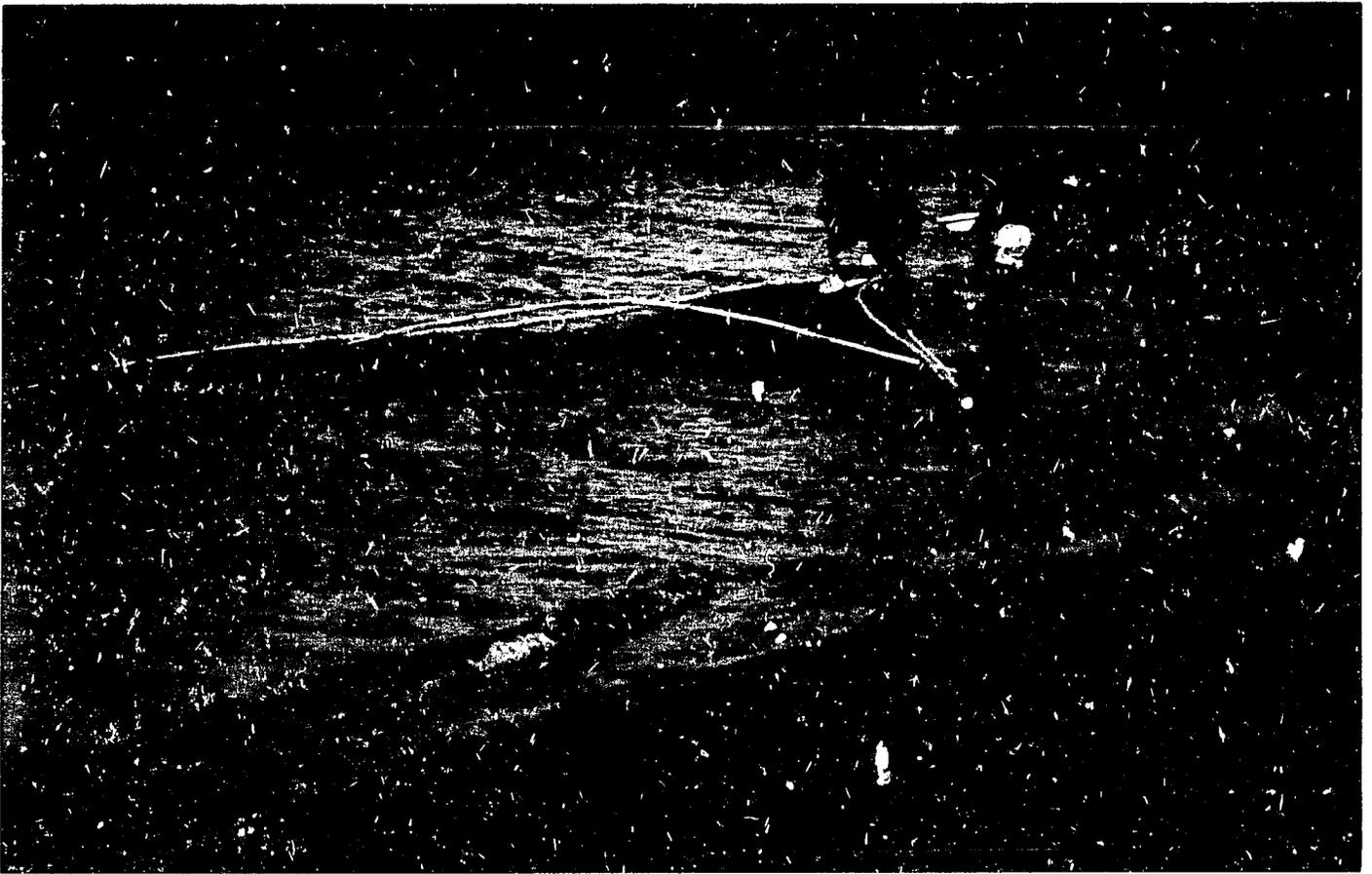
Plant protein sources were screened by Ilda Borlongan as part of the effort to develop practical feeds for milkfish in grow-out culture ponds. The control diet contained fish meal and soybean meal as protein sources. The test diets contained fish meal, soybean meal, and leaf meals replacing 15% of the fish meal protein: either kangkong *Ipomoea reptans*, kamote *I. batatas*, ipil-ipil *Leucaena leucocephala*, cassava *Manihot esculenta*, or a combination of kangkong, kamote, and cassava. Growth, feed conversion ratio, protein efficiency ratio, and survival of fish fed the test diets were not significantly different from the control diet. Therefore, leaf meals can be used to partially replace fish meal in a feed for milkfish juveniles.

The mineral requirements of juvenile milkfish are being studied by Grace Minoso. At first the mineral composition of milkfish tissues, culture water, and some commonly used feed ingredients were analyzed. The bones of juvenile milkfish (3-20 gram) have calcium at 92 milligrams per gram dry tissue and phosphorus at 56 mg/g. The liver and muscle have much lower levels of these two minerals. All three tissues have trace amounts of magnesium, manganese, copper, zinc, and iron. Filtered seawater has low concentrations ($\mu\text{g}/\text{ml}$) of all seven minerals. Feed ingredients for practical diets (shrimp meal, soybean meal, Chilean fish meal, Peruvian fish meal) have high levels of calcium (4-40 mg/g), phosphorus (5-29 mg/g), and magnesium (2-4 mg/g). Breadflour has $\mu\text{g}/\text{g}$ levels of these elements. Among the purified diet ingredients, casein has phosphorus in the mg/g range and calcium and magnesium in the $\mu\text{g}/\text{g}$ range; gelatin and casein have these minerals in the $\mu\text{g}/\text{g}$ level. Except soybean meal which has iron at 1.0-1.5 mg/g, all ingredients have manganese, copper, zinc, and iron in trace amounts.

STUDIES

Pond culture of milkfish

In response to questions from the private sector, Eduard Rodriguez compared hatchery-bred with wild milkfish in terms of growth and survival in nursery and grow-out ponds. Hatchery-bred fry showed consistently better growth than wild fry after 15 and 30 days in the nursery. However, survival at harvest (day 45) was higher among wild fry. Hatchery-bred fingerlings also grew faster in grow-out ponds up



A steady supply of wild milkfish larvae can no longer be assured in the future. Milkfish hatcheries will provide the larvae needed by the industry -- and ease the fishing mortality of other species of larval fishes and crustaceans.

to 30 days of culture, but wild fingerlings grew better from day 45 to harvest on day 90. Survival was higher among the wild than the hatchery-bred fish. About 13% of the hatchery-bred fish had irregularities in the jaws and gill covers and were stunted.

Growth and food consumption of juvenile milkfish in ponds during the dry and wet season were measured by Neila Sumagaysay. Food consumption increased as the fish grew. The caloric and protein intakes of all fish were higher during the wet season (average salinity 22 ppt) than during the dry season (average salinity 36 ppt). Based on the estimated contribution of natural food, a supplemental feed with 25-35% protein may be given to milkfish in ponds at 2-4% of body weight daily during the wet season and at 1-2% during the dry season. Supplemental

feeding during the dry season seemed to have little effect on growth. For effective feeding management, salinity should be maintained below 36 ppt.

In another experiment, Sumagaysay determined the effects of dietary protein and feeding levels on the growth and production of milkfish in brackishwater ponds. At both 23% and 31% dietary protein, fish fed at 4% of body weight per day grew better and had higher production of 1.16 tons per hectare than those fed at 2% (production was 0.84 tons per hectare). The similarity of the results for the two protein levels is probably due to the balanced amino acid profiles of the two diets. Thus, a formulated diet with 24% protein and a balanced amino acid profile, given at 4% of body weight per day, is economical and effective in producing milkfish in ponds.

STUDIES

Developing red snapper broodstock

A broodstock of the mangrove red snapper *Lutjanus argentimaculatus* is being developed by Arnil Emata for purposes of seed production. Snappers caught from the wild were kept in a floating net cage (5 x 5 x 3 meter deep) or a concrete tank (4 meter diameter x 1.5 meter deep). They were sexually mature in May-October 1992. In August, mature females with oocytes 0.40-0.45 mm in diameter and spermiating males were injected with 1 500 IU human chorionic gonadotropin (hCG) or 50 µg LHRHa

per kilogram fish body weight. About 1.2 million eggs were spawned 27-36 hours after injection with hCG but not with LHRHa. About 95% of the eggs were fertilized and 23% of these hatched after 16 hours at 27-28°C and 30-32 ppt salinity. Fish that spawned rematured 4-5 weeks later.

Emata continued the study in 1993. The snapper broodstock in the floating cage were sexually mature in March-November, but the tank-reared ones only in May-October. Among broodstock in the 5 x 5 x 3 meter deep cage, males of 1 kilogram and females of 2.5 kilograms were already mature. Females with oocytes 0.35-0.50 mm in diameter and males with flowing milt were placed in 2-meter deep 'hapa' nets 2 or 4 meter wide on each side for induction of spawning in

The mangrove red snapper is a new research priority for SEAFDEC/AQD. In two years, researchers were able to spawn the red snapper in captivity.



August, September and October. Single injections of 1 500 IU hCG per kilogram body weight resulted in spawnings 32-40 hours later. About 0.5-2.2 million eggs were collected from each female. Between 21 and 97% of these eggs were viable and 42-63% of these hatched.

STUDIES

Rearing of red snapper larvae

Larval rearing techniques for the mangrove red snapper are being developed by Marietta Duray. Snapper larvae only 2.3 mm long started feeding on rotifers on day 2, when about 40% of the larvae ate about one rotifer each. All larvae 3 mm long were feeding by day 7, each taking about three rotifers. Rotifer intake rates increased as the larvae grew. On day 22, snapper larvae 6.3 mm long started feeding on *Artemia* nauplii, each larva taking about two nauplii. In one experiment, snapper larvae were reared for the first two weeks on either rotifers alone or rotifers supplemented with two microparticulate diets. Larvae fed rotifers with FRIPPAK were larger (5.3 mm, 4.5 mg) than those fed rotifers alone or rotifers with Nosan R-1 (4.1-4.8 mm, 3.2-3.5 mg). Survival was not significantly different among the treatments.

Another experiment by Duray determined the optimum density of *Artemia* nauplii for rearing three-week old snapper larvae to day 35. Larvae provided 3 nauplii per ml grew larger (14 mm, 15 mg) than those provided 1-2 nauplii per ml (12.5 mm, 7.6 mg). Survival was as high as 81% but not different among

treatments. Another set of three-week old snapper larvae were fed 2 nauplii per ml either once, twice, or four times daily. Survival on day 35 was much better among larvae fed four times a day (63%) than among those fed once or twice daily (17-25%). But the larvae fed once daily grew larger (15 mm, 17 mg) than those fed twice or four times daily (12 mm, 9 mg).

STUDIES

Developing Asian sea bass broodstock

Studies on induced spawning of the sea bass *Lates calcarifer* were continued by Luis Garcia, this time using oral or rectal intubation with LHRHa. Pairs of sea bass in 'hapa' nets were given dissolved LHRHa at 500 µg per kilogram body weight through a fine tube forcibly inserted either in the mouth (to esophagus or stomach) or the rectum. Only rectal intubation stimulated spawning 29-33 hours later. Successive spawnings occurred at intervals of 19-26 hours over three days, but only the eggs spawned by one of three fish on the first day were fertilized and hatched. Egg production (200-260 thousand per kilogram fish) was highest on the first spawning day and declined afterwards. Control fish intubated with saline did not spawn.

Synchronization of the release of eggs and sperm by seabass treated with hormones was studied by Grace Garcia. Release of sperm in fish depends on milt dilution, which can be seen as a decrease in sperm count. An experiment showed that

the dose and frequency of LHRHa injection affected milt dilution. Injection of saline did not lower the sperm count. Two injections of 20 µg LHRHa per kilogram body weight, given 24 hours apart, lowered the sperm count by 15% at 12 hours, 11% at 24 hours, and 8% at 36 hours. A single injection of 40 µg LHRHa per kilogram lowered the sperm count by 28% at 12 hours, 4% at 24 hours, and 19% at 36 hours. In both cases, no milt was collected at 48 hours. Only one of three pairs of males and females (with oocytes 0.5 mm in diameter) injected with 40 µg LHRHa per kilogram successfully spawned and fertilized the eggs. Males injected with this same dose of LHRHa 24 hours after the females were so injected did not fertilize the eggs.

Through photoperiod manipulation, sea bass broodstock were induced to spawn off-season by Arnulfo Emata. Five females and 5 males were exposed to each of three photoperiods: 8, 12, or 16 hours light. All the fish spawned spontaneously in May to October 1992. Sea bass maintained under 8 or 12 hours light were all sexually mature in December, whereas only 40% of those under 16 hours light were mature. Almost all the sea bass kept under natural conditions (no photoperiod treatment) were immature in December. These data confirm earlier results that female sea bass kept under 8 or 12 hours light continue to have mature oocytes beyond the normal spawning season. A mature female and two mature males under 8 hours light were induced to spawn in January and in March 1993, both off-season months. About 400-500 thousand fertilized eggs were collected from both spawnings, but the eggs did not hatch. Mature females but not mature males were found in January-March among fish kept under 16 hours light every day.

STUDIES

Rearing of sea bass larvae and juveniles

The cladoceran *Diaphanosoma celebensis* was cultured by Milagros de la Pena as potential food for sea bass larvae. The reproductive rate, as intrinsic growth rate r was determined at three stocking densities (2, 5, 10 cladocerans per milliliter) and at three feeding rates (10, 50, and 100 thousand cells of *Tetraselmis tetrahele* per day). Significantly high r (0.72-0.75) was attained at the two higher feeding densities. Stocking density did not affect r although population count was higher at high initial density. In another experiment, the cladoceran was given four kinds of low-cost non-phytoplankton food. Rice bran at 0.3-0.6 grams per liter resulted in a promising $r = 0.38-0.39$. Lower reproductive rates were obtained with rice straw extract, bagasse extract, and Baker's yeast. The cladoceran did not reproduce at high concentrations of rice straw and bagasse extract (20-30 grams per liter) and Baker's yeast (0.6-1.2 grams per liter).

Live and dried adult *Artemia* biomass were used by Demetrio Estenor as feed for sea bass larvae (0.13 grams) in nursery tanks. After three weeks, the larvae fed live *Artemia* grew better (0.28 grams) and had a higher survival (89%) than those fed dried *Artemia* (0.15 grams, 54%).

Experiments in the rearing of sea bass in cages lighted at night were continued by Armando Fermin. The seabass in all cages were not fed except for whatever plankton was

available in the cages. In one experiment, five combinations of stocking size and density were tested: 3.5 mm larvae at 2500 per cubic meter, 6.5 mm at 2000/m³, 8.4 mm at 1500/m³, 8.8 mm at 1000/m³, and 10 mm at 500/m³. Specific growth rates after 40 days were 4-10% per day in the five treatments. Larvae of initial size 8.8 mm stocked at 1000/m³ grew the biggest (29 mm, 305 mg). Survival ranged from 4% among the 3.5 mm group to 21% among the 10 mm group. Diet composition was similar for all size groups and was dominated by copepods (67-90% of total zooplankton). Copepods were found in the guts of 84-93% of the larvae.

In a related experiment by Armando Fermin, the light intensity in the cages at night was varied. Zooplankton density was higher in cages lighted at 300 lux (653 per liter) than at 180 lux (162 per liter) or in those at 20 lux or not lighted at all (48-56 per liter). Survival and growth varied with the zooplankton density at night. Seabass in unlighted cages did not survive beyond 21 days in the cages. But 40% of those reared under 300 lux survived and grew to 3.5 cm and 642 mg in 35 days.

The oxygen consumption rates of different sizes of juvenile sea bass was studied by Jesus Manolo Almendras. For 35-225 gram seabass, the rates did not vary over the night-day cycle. Oxygen consumption per fish (y , mg O₂ per hour) increased with weight (x , gram): $y = 4.38 + 0.088x$. Weight-specific oxygen consumption (y , mg O₂ per hour per gram) decreased with body weight: $y = 183.83 - 0.386x$.

The oxygen consumption of juvenile sea bass at different salinities were determined by Fe Parado-Estepa. For 30-40 gram seabass, the standard rates (mg O₂ per hour per kilogram body weight)

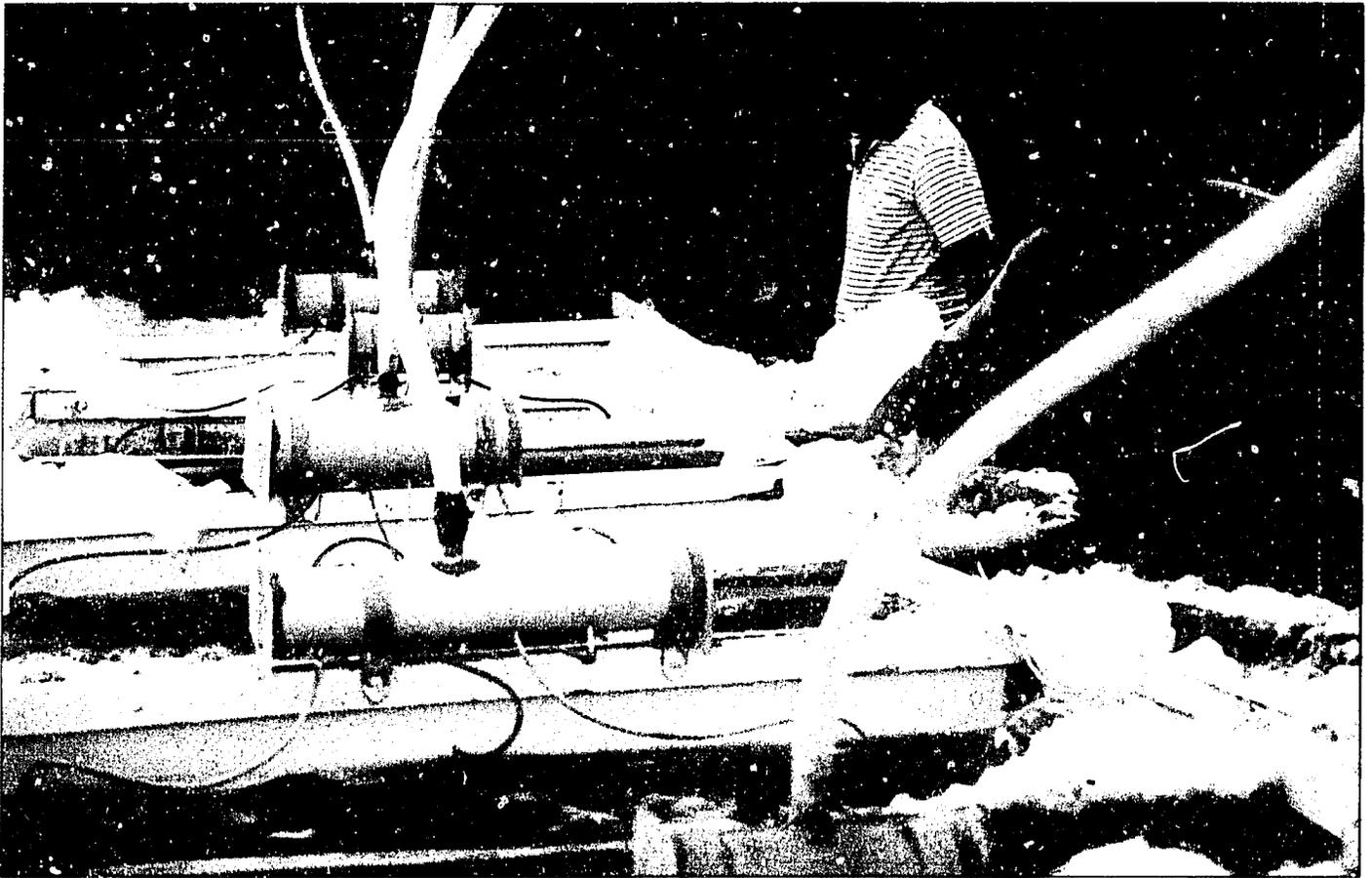
is 60-90 in freshwater, 87-120 at 16 ppt, and 110-143 at 32 ppt. These rates have to be confirmed in a second run.

STUDIES

Feeds and feeding of sea bass

Various levels of lipid and carbohydrate were tested by Mae Catacutan in practical diets for juvenile sea bass. Six diets were formulated with 42.5% protein and either 15 or 20% carbohydrate and 6, 12, or 18% lipid. They were fed to sea bass (0.9 gram) stocked at 10 individuals in 60-liter tanks. After 12 weeks, sea bass fed the diet with 20% carbohydrate and 12% lipid increased in weight 64x and showed feed conversion ratio (FCR) of 1.22; those fed the diet with 15% carbohydrate and 6% lipid gained 35x the initial weight and had an FCR of 1.65. Survival was 100% on all diets.

The amounts of essential amino acids required by juvenile sea bass were determined by Relicardo Coloso. L-lysine were given to juvenile seabass (5 gram) for 12 weeks at graded levels of 1.0 to 2.5 grams per 100 grams of semi-purified dry diets. Based on the breakpoint analysis of the growth response curve, the requirement of seabass for L-lysine is 4.5% of protein or 2.1% of the dry diet with 46% protein. Sea bass fed diets deficient in lysine had significantly lower survival. Similar experiments were done with graded levels of tryptophan, and then threonine. The tryptophan requirement of juvenile seabass is 0.5% of



The zooplankton *Artemia* is cultured in fiberglass tanks with recirculating water.

protein; for threonine, 4.4% of protein. The requirement for histidine will be determined in a succeeding experiment.

Practical diets with inexpensive indigenous ingredients were also developed by Coloso for juvenile sea bass. An eight-week feeding experiment was done with sea bass (15 gram) in 500-liter tanks to screen for a cost-effective diet for use in ponds and floating cages. Eleven formulations and one control feed were tested. Locally available protein sources were used: fish meal, shrimp head meal, scrap squid meal, blood meal, poultry feather meal, leaf meals, soybean meal, mung bean meal. The diets contained combinations of animal and vegetable protein sources and had essential amino acid

compositions similar to those in the tissues. Crude protein was 43% and fat was 10%. The control fish fed a combination of fish meal, shrimp head meal, and soybean meal showed a weight gain of 3.2x and FCR of 1.84. Seabass given a diet with fish meal, shrimp head meal, scrap squid meal, soybean meal, and kangkong leaf meal as protein sources showed the best weight gain (3.6x) and FCR (1.69). Worst growth rate and FCR were observed in fish given a combination of fish meal, cow's blood meal, scrap squid meal, soybean meal, and mulberry leaf meal. The two best diets will be tested in ponds and floating net cages. The intestines, livers, and pyloric caeca of treated and control fish are being examined for tissue changes.



Several species of legumes were evaluated by Perla Eusebio as protein and energy sources for practical diets for sea bass. Samples of white cowpea, black cowpea, green mungbean, yellow mungbean, soybean, and rice bean were subjected to different processing methods (dehulling, roasting, boiling, and solvent extraction). To measure the digestibility of these protein sources, the protease activity in sea bass was first determined. The specific protease activity in the gut extract was 219 azocasein units per milligram protein. This activity was increased to 500 units through dialysis with polyethylene glycol. Digestibility studies are on-going.

STUDIES

Screening tilapia strains for culture

Several strain-testing procedures in small to medium-size experimental facilities were evaluated in their efficiency to detect economically important strain differences. The statistical evaluation was done by Zubaida Basiao for her Ph.D. thesis. Two strains of Nile tilapia were reared under various experimental comparison procedures. The strains were size-matched (graded) and grown separately, together, or grown separately but

Sunset In Laguna de Bay. Aquaculture competes with open-lake fishery, agriculture, and industry for use of the lake. Concern for the lake's future is mounting and now guides researchers, policy-makers and lake managers.



Toxicological studies are conducted to screen for tilapia strains that can tolerate heavy metal stress.

with an internal reference fish (red tilapia) in each replicate cage or tank. At the same time, mixed sizes and ages (ungraded) of the two strains were grown together, separately, or separately with the internal reference red tilapia. On-farm strain testing was also done in four rice-fish farms. The size dependence of growth rates in fish have important implications in strain testing and selection programs in aquaculture. Observed growth differences are not always due to genetic variance, which is what is sought in strain testing or selection. Initial size differences resulted in apparent growth depensation under experimental conditions and growth compensation in rice-fish farms. Size-grading, or having a common starting size among genotypes, allows for detection of true strain differences much better than mixed-size rearing.

Red tilapia reference lines are used to measure and reduce the effects of uncontrolled non-genetic (environmental) variables in experiments that evaluate Nile tilapia strains. Genetically stable reference populations of red tilapia are being developed by Ma. Rowena Romana-Eguia from two existing strains: FAC and BFS. In terms of reducing environmental variance, hybrids of FAC female x BFS male were not significantly different from the old reference line, but hybrids of BFS female x FAC male were. Variation in the the growth data of Nile tilapia test strains was lower when either one of the new hybrid reference lines was used as a covariate. The coefficients of variation in the old reference line were greater than in the new hybrid reference lines ($cv_{old} = 4.965$ compared with $cv_{B \times F} = 3.956$; $cv_{old} = 5.301$ versus $cv_{F \times B} = 3.305$).

The only difference between the two new hybrid reference lines was that, when the FAC female x BFS male line was used as a reference, a significant strain effect was detected (the commercial strain Nile tilapia grew better than the NIFI strain Nile tilapia). This significant strain difference was not observed when the old reference line and the BFS female x FAC male hybrid reference line were used in the strain comparison.

The reproductive performance of four red tilapia strains in different seed production systems were also studied by Romana-Eguia. Breeders of four strains (NIFI, FAC, BFS, and PF) were stocked in lake cages and laboratory tanks (12 females:4 males per enclosure). A total of 59,415 fry were produced in two months. NIFI breeders in tanks produced 18,129 fry and those in cages produced 2,540 fry. Seed production by all strains were generally lower in cages than in tanks.

The resistance of *Oreochromis niloticus* strains to heavy metal stress was evaluated by Ma. Lourdes Cuvin-Aralar. One-month old juveniles that were full siblings from nine families of the NIFI and the commercial strain were used. They were exposed to different concentrations of inorganic mercury in a static system. The 24-hr and 96-hr LC₅₀ values, calculated by probit analysis, were not different from each other, nor between the two strains. Thus, most of the fish that survived the first 24 hours of exposure were able to acclimate to the toxicant.

The effect of exposure to a sublethal heavy metal mixture (zinc Zn, cadmium Cd, and inorganic mercury Hg) on two generations of two Nile tilapia strains (NIFI and CLSU) were assessed by Ma. Lourdes Cuvin-Aralar. Survival and growth of the two strains after a two-

month exposure were not significantly different. Whole-body burden (per gram fish weight) reached the following levels in the two strains: NIFI — 78.5 µg Cd, 1447 µg Zn, and 13.9 µg Hg; CLSU — 82.4 µg Cd, 1591 µg Zn, and 14.2 µg Hg. After the metal exposure period, the fish were transferred and grown in lake cages. Both strains eliminated 88 to 99% of the three metals after two months. Two females and one male were then stocked in tanks and monitored for time to first spawning, spawning frequency, fry production, and fry survival and growth after 30 days. Neither the strain nor the metal exposure seemed to affect the selected variables. Thus, both NIFI and CLSU strains are resistant to long-term exposure to heavy metals and are able to eliminate them during the grow-out period such that effects on reproduction are minimal.

STUDIES

Feeds and feeding of Nile tilapia

Growth and reproductive performance of Nile tilapia under different feeding regimes were determined by Corazon Santiago. Tilapia fingerlings (initial weight 1.9 grams) were fed practical diets with 25 and 18% protein for 7 weeks. Control fish fed the 25% protein diet throughout had the highest weight gain. Fish fed the 25% protein diet for 2-3 days alternate with the 18% protein diet for one day also showed high weight gain. Weight gains were low when fish were fed the 18% protein diet throughout, or the 18% protein diet for 1-4 days alternate with the 25% protein diet for one day.

STUDIES

Diseases of Nile tilapia

Skin lesions in Nile tilapia have been reported from several places in the country. The incidence of these lesions was monitored in a pond in Mindoro Oriental, in Lake Danao in Cebu, and in Lake Sebu in South Cotabato. Tilapia sampled in August 1993 from Lakes Danao and Sebu had no skin lesions, but the local fisherfolk confirmed that during the cold months (January-March), the lesions do appear. The pond in Mindoro was monitored monthly from April to December 1993. Pond water chloride, alkalinity, and hardness were highest in July, when 51% of the pond reared tilapia had lesions. Infected fish also had bloated eyes, or one or both eyes missing. No ectoparasites were found. Bacteria were isolated from infected tilapia. Of the 58 strains, most were *Acinetobacter*, the others were *Vibrio*, *Enterobacter* and *Plesiomonas*. In tests, none of these bacteria were pathogenic to juvenile sea bass.

STUDIES

Lake ecology and fish kills

The effect of wastes from intensive tilapia farming on the ecology of Sampaloc Lake was studied in more detail by Alejandro Santiago. The biochemical oxygen demand in the lake was 10-20 ppm, indicating a high organic load mostly

due to feeds. The dissolved oxygen content of the water column progressively declined between April and November 1992. Only the top meter of water with oxygen levels above 3 ppm can support fish at present. At 5 meters deep, ammonia was about 3 ppm and hydrogen sulfide about 5 ppm. Species diversity was low, with green algae and flagellates dominating the plankton. These conditions differ drastically from the lake conditions before tilapia cage culture was introduced in 1976. Oxygen levels then were 12 ppm in the top 1 meter and near 3 ppm at 8 meters deep. Diatoms and blue-green algae dominated the phytoplankton. A reduction of the cage culture area from 33 to 5 hectares and a moratorium on intensive feeding were recommended to save Sampaloc Lake from imminent biological death.

From January to May 1993, the dissolved oxygen in Sampaloc Lake was constantly near zero at two meters deep and 3 ppm only near the surface (1 meter). On 29 January 1993, a massive fish kill worth P25 million occurred in the lake. A Presidential Task Force for the Seven Crater Lakes of San Pablo City was created in March with SEAFDEC/AQD as member. Upon the recommendation of the Task Force, water hyacinths and other debris were removed in July, and tilapia culture in the lake was temporarily banned. In September, the dissolved oxygen increased to 3 ppm at 7 meters deep. In July, phytoplankton populations reached counts of 300,000 cells per milliliter. Diatoms and cyanobacteria replaced the green algae, dominated until September, but disappeared from lake samples in October-December when the lake overturned. After the

overturn, surface waters had 1 ppm oxygen and 3 ppm ammonia. Thus, the overall conditions in the lake are still unsuitable for fish culture.

Mass fish kills in Laguna de Bay are being studied by Alejandro Santiago and colleagues at the Binangonan Freshwater Station from interviews with farmers, historical records, and earlier scientific investigations. Mass fish kills have occurred in the lake since the 1930s usually during July-August. These

early mass kills were primarily due to blooms of the cyanobacterium *Microcystis*, which releases toxins and clogs fish gills. When the blooms died, they consumed the oxygen in the lake water and left little for the animals in the lake. Other causes may have been the hydrogen sulfide associated with 'masamang tubig' (bad water). In recent years, the incidence and severity of fish kills in the lake have increased. The 1993 fish kill in Muntinglupa appeared to have been due to industrial pollution.



Monitoring Laguna de Bay

STUDIES

Spawning native catfish

The native catfish *Clarias macrocephalus* in the laboratory do not ovulate without hormone injection and do not spawn spontaneously. The females have to be stripped of the eggs and the males sacrificed to get the milt. Methods to make the native catfish spawn spontaneously were tested by Luis Ma. Garcia. Male and female catfish were given a single injection of 0.05 µg LHRHa + 1 µg pimozide per gram body weight. Sixteen hours later, they were dipped for two hours in a shallow basin containing 1 µM of either etiocholan-3a-ol-17-one glucuronide, 11β-hydroxyetiocholanolone glucuronide, or their combination. These chemicals may act as pheromones that attract ovulating females and ripe males to each other. The fish were then returned to a larger tank. No spontaneous release of ovulated eggs nor hydrated milt was observed in any of the pairs up to 30 hours after injection.

Different hormone treatments were used by Josefa Tan-Fermin to induce captive catfish to spawn at different times: before (April-May), at the peak (June-September), at the end (October-December) of the breeding season, and during the off-season (January-March). With a combined dose of 0.05 µg LHRHa and 1 µg pimozide per gram catfish, ovulation rate was 100% when fish were injected before and at the peak of the season, but decreased to 80% at the end, and to 60% during the off-season. In contrast, ovulation was never observed in fish given no hormones, LHRHa alone, or pimozide alone.

The optimum milt-to-egg ratio to use in artificial fertilization of the native catfish was determined by Victoria Tambasen-Cheong using the commercial hormone preparation Ovaprim (a combination of salmon gonadotropin-releasing hormone and domperidone) injected at 2 µl per gram fish. Fertilization and hatching rates were significantly affected by milt volume, but not by the amount of eggs inseminated. Fertilization and hatching rates were consistently high when 2.5-10 grams of stripped eggs were inseminated with 25-50 µl milt. Thus the optimum insemination ratio was 25-50 µl milt to 10 grams eggs, or about 4,000-8,000 sperm per egg. Survival of larvae was 60-70% at all milt volumes and egg quantities tested.

STUDIES

Rearing of catfish larvae

Improvement of the hatching efficiency of artificially spawned eggs of native catfish is being worked out by Tan-Fermin. First, the stocking density to use in further experiments was established. In static hatching containers, dissolved ammonia levels were higher when eggs were stocked at 200-800 eggs than at 100 eggs per liter, but pH, nitrite, total hardness, and total alkalinity were not different. All eggs died when incubated at 800 per liter. Then, several ways were tested to remove the adhesive coat of catfish eggs and improve hatching. Fertilized eggs were washed with either: tapwater, a salt solution (4 grams NaCl per liter), tannin (0.6 grams per liter), a salt-tannin combination, or a salt solution with 3 or 20 grams urea per liter followed by tannin. In two

trials, hatching rates were 22% in salt solution, 17% in tannin, 23% in salt and tannin, and 10-12% in tapwater and other treatments.

The hatchery and nursery techniques for native catfish are being refined by Armando Fermin. Catfish (1.6 cm, 30.6 mg) were fed formulated dry diets at 0, 10, 20, 30, or 40% of body weight. After 35 days of feeding, lengths (2.6-2.9 cm) and survival (45-71%) of juveniles were not different among treatments. Starved fry all died within 13 days. In another experiment, catfish fry were fed either once every two days, or once, 3x, or 5x a day. After 49 days, the catfish fed once or 3x daily were significantly larger (249-392 mg) than those fed 5x a day or once every two days (163-199 mg). But survival was best among fish fed 5x daily (46%) and lowest among fish fed 3x daily (25%).

STUDIES

Feeds and feeding of catfish

Practical diets for native catfish are being developed and evaluated by Corazon Santiago. A 21-week feeding trial with wild juveniles showed poor growth and high mortality on four practical diets. A separate feeding trial was then done on hatchery-reared juveniles (8 grams). Control catfish were fed a combination of frozen fish and commercial pellets; four other groups were fed four practical diets with different sources of protein. All four diets contained fish meal, soybean meal, and meat and bone meal at different levels; one diet also contained copra meal, and another diet had ipil-ipil



leaf meal. After 36 weeks, all catfish were relatively small (15-23 grams) but some had already matured. Fully 50% of those fed the diet with copra meal were mature but only 12% were of those fed the diet with ipil-ipil leaf meal.

The ecological impact of the introduced African catfish (*Clarias gariepinus*) is being studied by Alejandro Santiago. The African catfish can grow to 1.5 meters long and 13 kg in weight. First, the predatory habits of the catfish were observed in aquaria. Mixed sizes of tilapia, tiger perch (*ayungin*), and gobies (*bulig* and *dulong*) were provided. The African catfish consumed about five tilapia, or five gobies, but one *ayungin* a day. Fish less than 4 cm long were preferentially taken. Culture of the African catfish is now regulated by the Bureau of Fisheries and Aquatic Resources.

STUDIES

Developing bighead carp broodstock

The hatcheries of bighead carp (*Aristichthys nobilis*) around Laguna de Bay were surveyed by Angelito Gonzal in order to develop standard methods for managing and selecting broodstock. Purchase and exchange of broodstock and movement of fish between farms are common practices that could lead to genetic deterioration of bighead carp in the lake. While inbreeding may not be an immediate problem, negative selection (that is, when the runts that could not be sold grow up to be broodstock) already is. In 1993, the broodstock and breeding management commonly practiced by three commercial hatcheries was evaluated in terms of the growth of bighead carp juveniles. Fry were obtained from broodstock that had been either raised in cages, raised in ponds, or conditioned in cages set in ponds before induced spawning. These fry (1.8 cm, 0.05 grams) were stocked in

The vanishing native catfish *Clarias macrocephalus* calls for artificial breeding then restocking in natural waters.

either cages or laboratory tanks and reared for 90 days. Growth of juveniles was significantly affected by the source broodstock and the rearing environment. Cage-reared juveniles that originated from broodstock in cages grew best (11 cm, 13 grams). Laboratory-reared juveniles from broodstock in ponds grew poorly.

Feeds for bighead carp broodstock are being developed by Corazon Santiago. Non-conventional feed sources and vitamin supplements are used in the test diets. Breeders (about 1.7 kg each) were stocked at 12 fish per cage (4 x 4 x 4 meter) and fed diets with or without vitamin A, E, and C supplements. After eight months, the breeders grew to about 2.5 kg. Three spawning runs were conducted, but fertilization rates, hatching rates, and numbers of larvae produced varied widely even within treatments.

Rearing of bighead carp

The production of freshwater zooplankton for the hatchery rearing of bighead carp is being studied by Susana Baldia. The freshwater rotifer *Brachionus calyciflorus* (158-348 μm ; mean egg-bearing size: 325 μm) was isolated from Sampaloc Lake and Laguna de Bay. The rotifers were grown in different culture media: filtered lake water, yeast (0.1 gram per liter), chicken manure extract (500 grams dry manure boiled in 500 ml water), media with the green alga *Scenedesmus*, *Scenedesmus* + chicken manure extract, and green water (lake water enriched with commercial fertilizer and algae such as *Chlorella*, *Golinkinia*, *Merismopedia*, and *Coscinodiscus*). The rotifers grew in media with *Scenedesmus* alone at an intrinsic rate of $r = 0.72$, and in *Scenedesmus* + chicken manure extract at $r = 0.91$. Rotifer growth peaked on the eighth day of culture and population densities reached 18/ml and 54/ml in the two media.

Diseases of snakeheads

Studies on the parasitology, epidemiology and the predisposing environmental factors of the epizootic ulcerative syndrome (EUS) in Laguna de Bay and Naujan Lake were continued by Fermin Palisoc. EUS-infected snakehead (*Ophicephalus striatus*) were more common in Laguna de Bay (43%) than in Naujan Lake (8%). These two lakes differed significantly in depth, turbidity, water hardness, and chloride levels. The levels of most trace metals in sediments from both lakes were similar, except copper and lead which were higher in Laguna de Bay. Levels of organochlorines (heptachlor, endosulfan, and heptachlor epoxide) in the sediments of both lakes were also similar. Several species of parasites were found in snakeheads, catfish, goby, silver theraponids, tilapia, and gourami.

Studies on the histopathology of EUS in snakehead in Laguna de Bay were continued by Erlinda Cruz-Lacierda for her Ph.D. thesis. Snakeheads with moderate to severe EUS showed granulomas surrounding an aseptate fungus in their lesions and in the spleen, kidney, liver, and gonads. Snakeheads with early signs of EUS did not show such granulomas. Infected fish showed hematocrit (Ht, 29.3%), hemoglobin (Hb, 4.7%), and serum protein (Sp, 4.7%) levels significantly lower than in normal and apparently normal fish (Ht 46%, Hb 9.7 %, Sp 6-7%). Granulocyte counts per 100 000 red

blood cells were significantly higher in infected (210) than in normal (26) or apparently normal (60) snakeheads.

Transmission experiments were then conducted by Cruz-Lacierda. Healthy, well-fed snakehead could all be infected with EUS after 14-20 days of cohabitation with already infected fish, or after 44-55 days of exposure to water from an EUS-endemic environment. Starved snakeheads developed EUS lesions 10-14 days after being stocked with EUS-infected fish and 18-20 days after being stocked in EUS-contaminated water. The gross pathology, including tissue and blood changes, in experimentally infected snakehead were identical to those of wild EUS-infected snakehead.

Studies on the viral and bacterial etiology of EUS were continued by Gilda Lio-Po for her Ph.D. thesis. A virus (similar to a rhabdovirus) isolated from EUS-affected snakehead induced cytopathic effects in snakehead cells. Virus numbers increased at 15-30°C but were almost nil at 37°C. The virus did not tolerate low pH and chloroform, but tolerated freeze-thaw exposures. When filtrates from EUS-affected fish tissues were injected intramuscularly and intraperitoneally into healthy snakeheads, no significant EUS-like lesions were apparent even after four weeks.

In another study, Lio-Po tested five isolates of the bacterium *Aeromonas hydrophila* from snakehead for sensitivity to various antibacterial drugs. All isolates were sensitive to amikacin, chloramphenicol, sulfamethoxazine trimethoprim, and nalidixic acid.

STUDIES

Culture of mudcrab

Grow-out culture of mudcrab in pens and floating cages was attempted by Avelino Triño. Juvenile mudcrabs (20-86 grams) were stocked at densities of 5, 10 and 15 per square meter in pens and cages set up in Iloilo River and were fed trash fish or formulated diet for 120 days. Specific growth rates ranged from 1.17 to 1.37 grams per day and survival from 13 to 22% in the various treatments. The best results were obtained at a stocking density of 5/m².

The abundance of juvenile mudcrab *Scylla serrata* in mangrove and non-mangrove areas in Tinagong-Dagat and Sapián Bay was studied by Noel Solis. The mangrove areas had muddy bottom and secondary growth of bungalow *Avicennia* and were affected by river run-off. The non-mangrove areas had sandy bottom and were nearly always fully saline. The mudcrabs were caught by baited conical bamboo traps or 'taon' 55 cm long, 24 cm in diameter at the expanded middle, and 20 cm in diameter at the two openings. The traps were operated during the full moon and new moon periods, set during the low tides and harvested during the next low tides about five hours later. A total of 1402 juvenile mudcrabs were caught during the 12 monthly samplings at the four sites. The catch per unit effort was about 1 crab per trap every two sets. Abundance peaked in March-April and was lowest in July-August. Mudcrabs in the mangrove area ranged 2-10 cm in carapace width; 25% of those in Tinagong Dagat and 50% of those in Sapián Bay were of

the modal size 5 cm. Mudcrabs in the non-mangrove area ranged 3-14 cm; 20-22% were of the modal size 7-8 cm. Greater numbers of smaller crabs were caught from January to May; larger specimens were caught in November.

STUDIES

Developing shrimp broodstock

The effect of captivity on the sperm quality of wild and pond-reared adult tiger shrimp (*Penaeus monodon*) was investigated by Emilia Qunitio. Sperm counts declined over time in wild shrimps, but not in pond-reared shrimps. Percent live and normal sperm also decreased over time in wild shrimps, but increased in pond-reared shrimps. The most common abnormalities encountered in both groups were sperm with missing or bent spikes and sperm with deformed heads.

The reproductive performance of tiger shrimp fed various sources of carotenoids was also studied by Emilia Qunitio. Carotenoids, the pigments that impart the bright color to shrimp eggs, have been noted to improve reproductive performance. Shrimps are not able to make their own carotenoids and must get them from the diet. Three groups of pond-reared broodstock were fed pelleted diets (with carotenoids) from mussel, crab, or *Artemia*. After three months, 80% of shrimps fed mussel carotenoids matured and had yolky oocytes; only 60% of those given crab and 50% of those given *Artemia* did.

Of those that matured on mussel carotenoids, 70% spawned; of those that matured on *Artemia* carotenoids, only 33% spawned. These did not differ significantly from the 61% spawning rate on crab carotenoids. Among shrimps fed carotenoids from mussel and *Artemia*, first spawning occurred 20 days after removal of the eyestalk; shrimps fed crab first spawned 34 days after ablation. One female that had been fed mussels spawned a second time. The number of eggs spawned per gram body weight did not differ among treatments. Shrimps fed mussel carotenoids produced good-quality postlarvae.

Morphometric changes and gonadal development among pond-reared tiger shrimp broodstock (30-90 gram) was studied by Fe Parado-Estapa. Length of the petasma was not correlated with the number of sperm cells in each spermatophore. The sperm count increased linearly with body weight, but only 16% of the variation in counts can be attributed to variation in body weights.

The reproductive performance of *Penaeus indicus* spawners collected off Tigbauan and Guimbal, Iloilo was studied by Cesar Villegas as a function of spawner size. The number of eggs spawned per female was positively correlated with body weight, indicating that larger spawners produced more eggs and potentially more larvae. In 1993, samples of several species of shrimps were obtained from the wild for selective breeding studies using morphometric traits. Three specimens of *P. indicus* were obtained from Aklan and 91 from Tigbauan-Guimbal. More specimens of *P. merguensis* were collected: 64 from Tigbauan-Guimbal, 236 from Aklan, and 134 from Capiz. Some 35 specimens of *P. monodon* and 49 *P. japonicus* were collected from Capiz and none from the other sites.

STUDIES

Tiger shrimp hatchery

Water management techniques in the shrimp hatchery were compared by Fe Parado-Esteva in terms of the survival, growth and development of tiger shrimp stocked at 50 nauplii per liter. The rearing water (chlorinated and aged seawater) was replaced starting at either the protozoa, mysis or postlarval stage. Significantly better results were obtained when water replacement was started later in the rearing period, during the postlarval stage. In this group, survival to PL5 was 38%, including 80% that had undergone second molting, and survival from PL5 to PL18-20 was 39%. Among those disturbed at the protozoa and mysis stages, 16-26% survived to PL5, including 0-30% that had undergone second molting, and 19-25% of PL5 survived to PL18-20.

The economic condition of tiger shrimp hatcheries in Panay Island was assessed by Rene Agbayani through interviews with operators and technicians. Stocking densities range from 53 000 to 65 000 nauplii per ton. Survival at fry stage range from 10 to 19%. Each hatchery can have 5-7 rearing runs a year and usually discard 1-2 runs for various reasons. Small-scale hatcheries

Technicians at the shrimp hatchery at the Tigbauan Main Station.

produce a total of two million fry per year and earn an average annual net income of P17 000. Medium-scale hatcheries produce 7 million fry per year and earn an average annual net income of P118 000. Of the total variable costs, spawners represent 22-26%, incentives to technicians 14-17%, and *Artemia* 13-15%.

STUDIES

Feeds and feeding of tiger shrimp

The requirement of tiger shrimp for the essential amino acids arginine and valine were determined by Oseni Millamena. Postlarvae (PL20) were fed diets with 40% crude protein and arginine at 2.0, 3.3, 4.6, 5.8, 7.0 and 8.3% of dietary protein. After 56 days, survival was 62-86% and weights increased 2-7x. Best growth and survival were obtained with arginine at 4.6% of dietary

protein, or 18.3 grams arginine per kilogram diet. A similar experiment was conducted with test diets containing 40% crude protein and valine at 2.80, 3.55, 4.30, 5.05, 5.80, and 6.55% of dietary protein. After 56 days, shrimp survival was 75-88% and weights increased 4-6x. Highest weight gain and survival were obtained with valine at 5.8% of dietary protein.

A fish protein concentrate and a lactic yeast were evaluated by Millamena as protein sources for tiger shrimp feeds. Four diets were formulated: a basal SEAFDEC diet with fish meal and soybean meal as major protein sources, and three variations of the basal diet in which the fish meal was replaced by 5% or 10% fish protein concentrate, or the soybean meal by 10% lactic yeast. A commercial diet was used as the control. Highest survival (90%) and best FCR (2.0) were obtained with the basal SEAFDEC diet; lowest survival (65%), with the commercial diet. Growth and net production of shrimps in ponds were not significantly different among the diets. Thus, fish protein concentrate and lactic yeast may be used to partially



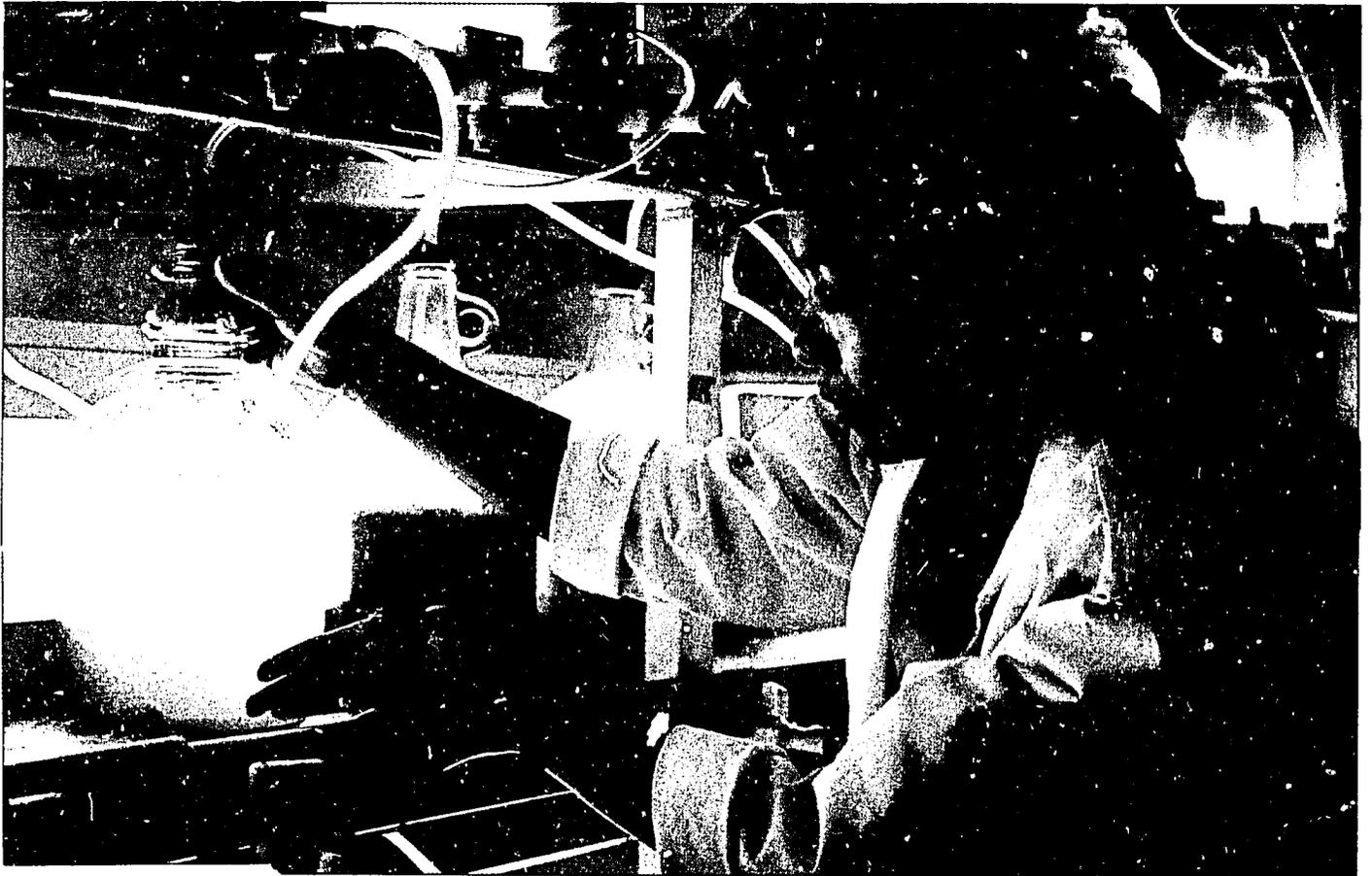
replace the usual protein sources in tiger shrimp diets.

Four fish meals were also evaluated by Millamena as protein sources in grow-out diets for tiger shrimp. Four diets were formulated to contain either: fish meal processed at low temperature, press cake processed at low temperature, special fish meal, and Chilean fish meal. A commercial diet was used as control. After 60 days of feeding, survival ranged 74-91% and not different among the five diets. Shrimps fed the control diet gained 30x the initial weight. The two diets with low-temperature fish meals allowed weight gains of 26-28x, not significantly different from the control. The other two fish meals resulted in lower weight gains of 22x. FCR varied from 1.2 to 1.5 on the four experimental diets and was 1.8 on the control diet.

A low-cost feed for semi-intensive and intensive culture of tiger shrimp in ponds was field-tested by Millamena. The grow-out diet contained 15% local fish meal, 15% Chilean fish meal, and 20% cowpea meal as major protein sources but no vitamin and mineral supplements. It was given to shrimps stocked in brackishwater ponds at densities of 5, 10, and 20 postlarvae/m² typical of modified extensive, semi-intensive, and intensive culture systems. After 120 days, the shrimps weighed 26, 21, and 20 grams at the three stocking densities.

Phosphated ascorbic acid (magnesium L-ascorbyl-2-phosphate, or MAP), a stable form of vitamin C, was used by Mae Catacutan in practical diets for tiger shrimp (130-250 mg). In Experiment I, shrimps were given MAP at 0 to 1,500 mg/kg

A service laboratory supplies starter stocks of phyto- and zooplankton for AQD research and for the private sector.



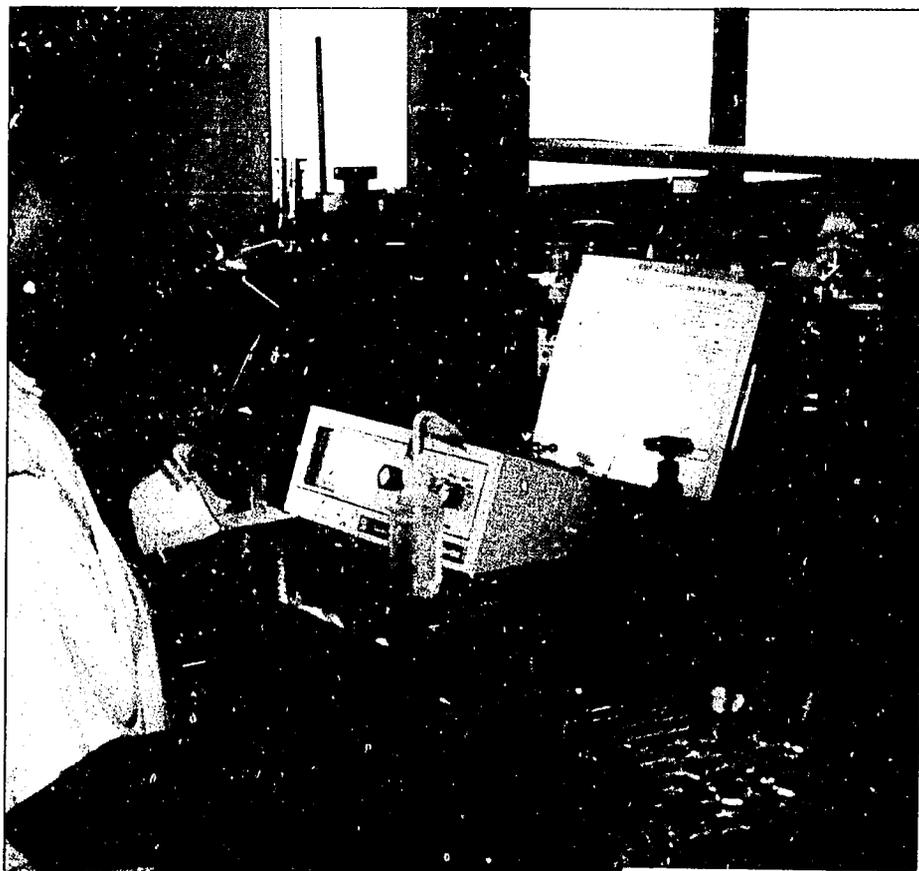
diet for 92 days. Shrimps fed a diet without MAP had the lowest growth, survival, and feed conversion efficiency, but not significantly different from those given diets with various levels of MAP. Shrimps infected with monodon baculovirus were also fed diets with MAP; those given MAP at 100 mg/kg or higher showed improvements in the hepatopancreas. In Experiment II, shrimps were fed diets without seaweed but containing MAP at 0 to 8,000 mg/kg diet. Again, shrimps fed a diet without MAP showed low survival and feed conversion efficiency. After 81 days on the various diets, shrimps were wounded and further maintained on the respective diets to observe the effects of MAP in wound healing. Complete healing of wounds was observed among shrimps given MAP at 100 and 200 mg/kg. For tiger shrimp postlarvae, the adequate levels of MAP are 100-200 mg/kg, equivalent to ascorbic acid at 50-100 mg/kg. In both experiments, shrimps without dietary MAP were weak and showed symptoms of vitamin C deficiency. However, high levels of MAP from 1,000 to 8,000 mg/kg did not result in very high mortalities, contrary to other shrimp species.

In related experiments by Catacutan, tiger shrimps (88 mg) were fed for 14 weeks practical diets containing: no added vitamin C, 50 mg/kg of ascorbic acid (ASA), L-ascorbic acid α -glycoside (AAG), or magnesium L-ascorbyl-2-phosphate (MAP). One set of test diets was prepared in the feed mill and the other set in the laboratory. Survival rates were similar among all diets. Feed conversion ratios (FCR) were similar among shrimps fed all three forms of vitamin C. However, shrimps fed diets with ASA started to weaken on the 12th week. Among shrimps given the feed mill-prepared diets, those without any vitamin C had the poorest weight gain and FCR. Among shrimps fed the laboratory-prepared diets, weight gain and FCR were highest among those given AAG. The vitamin C levels used in the study were probably marginal because shrimps with blackened carapace occurred in all treatments, more in those without vitamin C or

with ASA, and less in those with AAG or MAP. Shrimps were analyzed for vitamin C content. Those fed diets with AAG and MAP incorporated more vitamin C in their bodies than those fed diets with either ASA or no added vitamin C.

To partially replace fish meal in diets of juvenile tiger shrimp, various leaf meals were tested by Veronica Peñaflorida. The leaves of kamote *Ipomoea batatas* and kangkong *I. aquatica* had higher tannin than malunggay *Moringa oleifera* and papaya *Carica papaya* leaves. Before they were used in the diets, these leaves were soaked in either water or sodium hydroxide for 6 or 18 hours and blanched for 2 or 4 minutes. For all leaves, soaking for 18 hours in water or alkali followed by blanching for 4 minutes resulted in 82-89% removal of tannin. In one feeding experiment, juvenile shrimps (50 mg) were stocked, 10 in each 60-liter tank, and fed five diets: one with

Analyses of water, soil, feed and carcass are done by the Centralized Analytical Laboratory.



fish meal (control), and four with fish meal partially replaced with 16% kamote or papaya leaf meal, either soaked or unsoaked. After 56 days, survival rates were similar in all treatments. Shrimps on the control diet increased in weight 24x and had a specific growth rate of 5.7% per day, significantly higher than those of shrimps fed unsoaked kamote leaf meal (14x, 4.8% per day). Weight gains and specific growth rates of shrimps fed diets with soaked or unsoaked papaya leaf meal and soaked kamote leaf meal were intermediate but not significantly different from the other two.

The red seaweeds *Kappaphycus alvarezii* and *Gracilaria heteroclada* were evaluated by Peñaflores as binders for shrimp diets. Tiger shrimp juveniles (22 mg) were stocked in 60-liter flow-through tanks, 10 shrimps per tank, and reared for 56 days on 17 diets with five different binders. Sixteen

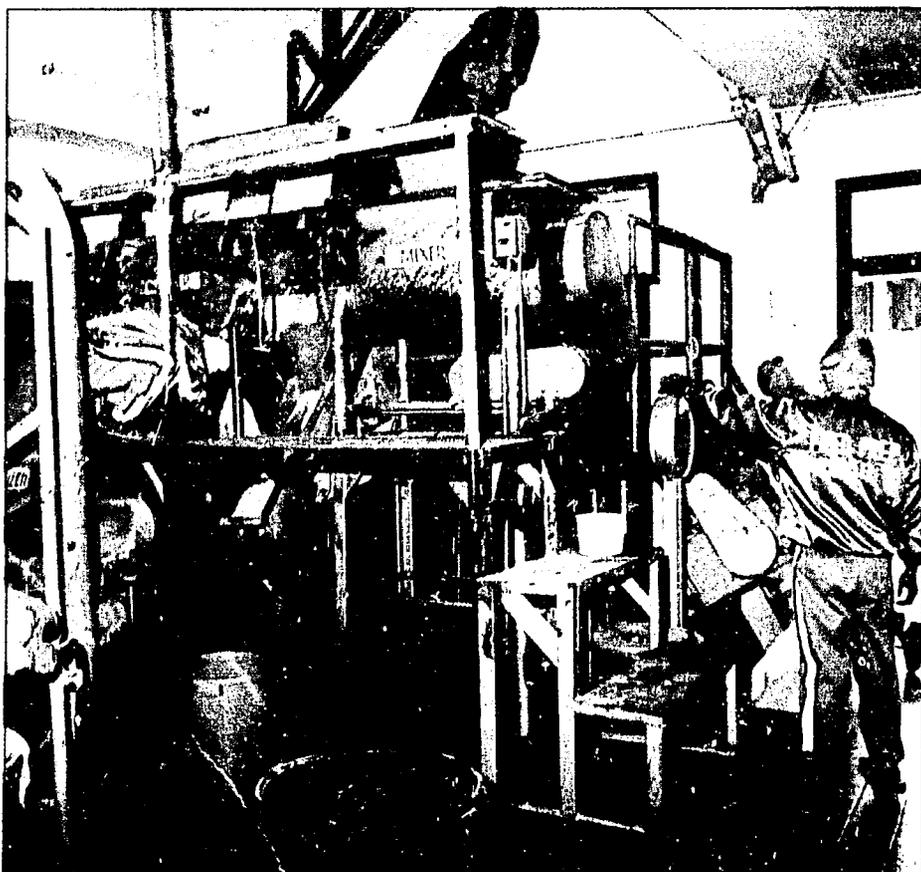
diets contained either *Kappaphycus*, its carrageenan extract, *Gracilaria heteroclada*, or its agar extract, each at 3, 5, 7, or 10% of the diets. Corn starch served as the control binder. Survival was highest (95%) among shrimps fed diets with 3% *Kappaphycus*. Shrimps on diets with 3% carrageenan increased in weight 18x and had a specific growth rate of 5.2% per day. Results for these two binders were not statistically different from the others.

The *in vitro* digestibility of 21 locally available feedstuffs was studied by Perla Eusebio. First, the proteolytic activities of gut extracts of white shrimps (5-18 grams) were determined. The specific protease activities (in azocasein units per milligram protein) were: 2 242 in males and 4 482 in females. Then, with enzyme activity set at a known level, the digestibility of feed ingredients was determined. Papaya leaf meal, shrimp head meal, and Peru-

vian fish meal were equally digestible by white shrimp. Mungbean was the most digestible among the legumes; black cowpea and rice bean were not. Defatted soybean was significantly more digestible than unprocessed soybean.

The quality of shrimp feeds and feed ingredients was assessed by Myrna Bautista. First, the aflatoxin B₁ levels in commercial shrimp feeds were measured. Then, the tolerance of tiger shrimp to aflatoxin was determined. Juveniles (5.65 grams) were fed diets with aflatoxin at 0 (control), 25, 50, 75, or 100 parts per billion (ppb) for 60 days. Shrimps fed diets with 75-100 ppb aflatoxin grew significantly slower than those fed lower levels. Survival of shrimps fed aflatoxin was significantly lower than the control. Aflatoxin was not detected in shrimp tissues after 60 days. The hepatopancreas of shrimps fed aflatoxin showed various degrees of damage. The antennal glands of shrimps fed 75-100 ppb aflatoxin were destroyed.

The level of fat oxidation tolerated by tiger shrimp was determined by Bautista. Tetraethoxypropane (TEP), a malonaldehyde, was added to five practical diets at levels of 1, 10, 20, 50, and 100 grams



The pilot feed mill at AQD can produce 50 tons of feed a day for experiments and maintenance of fish stocks.

per kilogram dry diet; a control diet had no TEP. Thiobarbituric acid (TBA) levels in the diets were measured at the start of the experiment and every two weeks thereafter. After six weeks of storage at room temperature, the diet with the most TEP showed signs of physical deterioration and had the highest TBA level (1262 mg/kg diet). The unsaturated fatty acid content of the feed decreased in diets with high TEP. After six weeks of storage, the six diets were fed to juvenile tiger shrimp. Survival rates of 70-90% did not differ among diets, but weight gains were lowest on the diets with the two highest TEP levels. No damage was seen in the hepatopancreas. Fat oxidation levels up to 828 mg TBA/kg diet did not adversely affect shrimp growth.

The effect of the antioxidant butylated hydroxytoluene (BHT) on the quality of shrimp diets stored at different temperatures was studied by Precilla Subosa. In one experiment, diets with and without BHT were stored at 10, 20, 30, and 40°C, and malonaldehyde levels were measured with the thiobarbituric acid test. Malonaldehyde is an end product of fat oxidation and high thiobarbituric acid values indicate rancidity. After two weeks at all temperatures tested, diets without BHT became rancid, and those with BHT did not. After four weeks, all diets without BHT became more rancid, and except those stored at 10°C, diets with BHT became rancid too. In another experiment, the diets with or without BHT stored at various temperatures were fed to shrimps. Weight gain of shrimps fed diets with BHT gained 5.7-6.4x their initial weight, significantly better than those fed diets without BHT (4-6x). No changes were observed in the tissues of shrimps fed diets with and without BHT.

The bio-availability of various phosphorus sources for juvenile tiger shrimp is being studied by Subosa. Two practical diets A and B were prepared with ingredients containing different levels of phosphorus plus dicalcium phosphate as inorganic source (these two diets are existing formulations for shrimp). Two other diets C and D had similar compositions as A and B but had no dicalcium phosphate. Shrimp juveniles (5.4 grams) were fed these four diets for 60 days. The weight gains of shrimp were 35% on A, 50% on B, 36% on C, and 32% on D.

The growth of tiger shrimp fed formulated diets with and without vitamin and mineral supplements was evaluated by Avelino Triño. Postlarvae (6 mg) were stocked at 75 000 per hectare in fertilized earthen ponds and reared for 120 days on either a complete diet, a diet without vitamin and mineral supplements, and a commercial diet. Growth, survival, and net production were not significantly affected by the lack of vitamin and mineral supplements. Average body weights ranged from 20 to 26 grams; survival, 90-93%; food conversion ratio, 1.45- 1.8; and net production, 1.47-1.77 tons per hectare.

found within 24 hours in sterilized seawater and lasted beyond eight days. Counts were lower in untreated seawater and mixed diatom cultures. The population decreased from 10,000 to less than 10 cells per ml after 96 hours in untreated seawater; this suggests that it is good to age seawater before use. The presence of the diatoms *Chaetoceros calcitrans* and *Skeletonema costatum* also effectively controlled the bacterium in hatchery tanks. Luminescent vibriosis in shrimp hatcheries can therefore be prevented by modifying water management practices.

The incidence and etiology of the swollen hindgut syndrome in hatchery-reared tiger shrimp postlarvae was also studied by Lavilla-Pitogo. Affected postlarvae have swollen rectal ridges that no longer show rhythmic movements; thus they fail to defecate. Histopathological sections show hemocytic infiltration in the hindgut tissues. Affected postlarvae showed signs of recovery upon transfer to UV-sterilized seawater, but size and morphological development were significantly different from the healthy ones. Although the mortality of affected postlarvae was not high, their smaller size makes them unsuitable for stocking in grow-out ponds.

STUDIES

Diseases of tiger shrimp

The transfer mechanisms of the luminescent bacterium *Vibrio harveyi* in tiger shrimp hatcheries were investigated by Celia Lavilla-Pitogo. Elimination of the natural microflora from seawater enhanced the survival of the bacteria. High counts (100,000 cells per ml) were

The role of *Vibrio* spp. in the etiology of red disease syndrome in tiger shrimps was examined by Eleonor Tendencia for her M.Sc. thesis. The dominant bacteria recovered from pond-raised shrimps with symptoms of red disease were *V. parahaemolyticus*, *V. fluvialis*, *V. harveyi*, and *Vibrio* sp. In one experiment, shrimps were injected with live bacterial cells of the two most dominant species, or their extracellular products. Then the bacteria were reisolated from the injected shrimps. In the pathogenicity tests, *V. parahaemolyticus* was found to be



Mangroves are home to different kinds of larval shrimps and fishes. Their conservation is of utmost importance.

the most virulent; injection (dose: a million bacterial cells per ml) into shrimps produced the characteristic red discoloration. Shrimps injected with crude extracellular products of *V. parahaemolyticus* also showed symptoms of red disease. Lesions in the hepatopancreas of experimental shrimps were similar to, though less severe than those observed in pond-reared shrimps affected with red disease.

STUDIES

Mangroves as nurseries for shrimps

The role of mangroves as nurseries for juvenile shrimps is being studied by Jurgenne

Primavera. A riverine and island mangrove in Guimaras were selected as study sites based on mangrove area, extent of disturbance, accessibility, and other criteria. Among four gears, the pocket seine was chosen for its efficiency in collecting juveniles. Juveniles were most effectively caught in the pocket seine at night during the outgoing high tides of full and new moon periods (spring tides). The shrimp populations at the two sites include *Penaeus monodon*, *P. latisulcatus*, *P. merguensis*, and *P. semisulcatus* and at least four *Metapenaeus* species. The activity patterns of four shrimp species showed strong diel periodicity, usually burrowing during the day and emerging to feed at night. Only *P. monodon* used artificial shelters consistently. Stable isotope ratios determined on single samples indicate that mangrove leaves ($\delta C = -27.3\text{‰}$ and $\delta N = 4.3\text{‰}$) are not the primary food source for juvenile *P. merguensis* ($\delta C = -17.6\text{‰}$ and $\delta N = 8.0\text{‰}$).

STUDIES

Oyster and mussel farming

Technical and socioeconomic assessment of oyster (*Crassostrea iredalei*) and green mussel (*Perna viridis*) culture in Binaobawan, Pilar, Capiz and Lakaran, Dumangas, Iloilo was conducted by Wenresti Gallardo. Rapid rural appraisal was used to understand the physical layout of the two villages and the livelihood and socioeconomic situation of the villagers, particularly the oyster and mussel farmers. Fishing is the major source of livelihood in both villages. In Binaobawan, 77% of the villagers are engaged in oyster and mussel farming. Oysters are cultured by the bottom method and mussels by the platform method. Production of oysters in Binaobawan could be increased by adapting the method used in Lakaran. In Lakaran, all residents are engaged in oyster farming by the rack hanging line method. Culture of the green mussel and the brown mussel *Modiolus metcalfei* is being developed in Lakaran with the active participation of the oyster farmers.

Setting up a mussel filter in a shrimp pond.

STUDIES

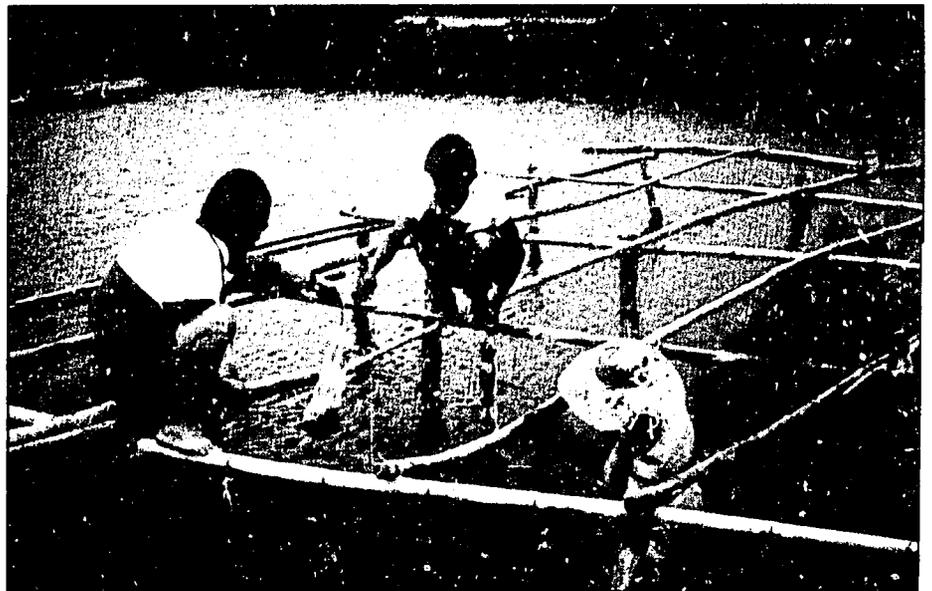
Green mussels as biofilter in shrimp ponds

The green mussel was tested by Kaylin Corre as a biological filter in shrimp ponds stocked with 50,000 tiger shrimp larvae per hectare. The mussels prevented excessive growth of phytoplankton and an increase in suspended solids. Water transparency was higher in shrimp ponds with green mussels than those without. However, the mussel filter seemed to affect only the final weight of the shrimps. After a 98-day culture period, shrimps in ponds with mussels had higher body weight (33 grams) than those without mussels (31 grams), but survival (87-89%) and production (1.33-1.45 tons per hectare) were not significantly different. Mussels attained final weights of 31 grams, shell length of 82 mm, and survival of 51%. Plenty of mussels died when it rained during water exchange; also, the mussels probably spawned and died soon after.

STUDIES

Kapis fishery

A survey of the window-pane oyster (*Placuna placenta*) or 'kapis' fishery in the Philippines was conducted by Wenresti Gallardo. There are 27 remaining kapis beds, six of which are now the major sources. Kapis stocks are declining and many beds are already depleted due to excessive gathering, siltation, trawling, and pollution. Kapis shells are the object of an open-access fishery; anybody can gather shells by handpicking in shallow areas, compressor diving in deeper areas, and dredging. To prevent further depletion of this resource, several measures are recommended: establishment of sanctuaries, ban on trawling and other destructive fishing, enforcement of existing regulations, community-based fishery management, and further research on seed production, restocking, and transplantation.

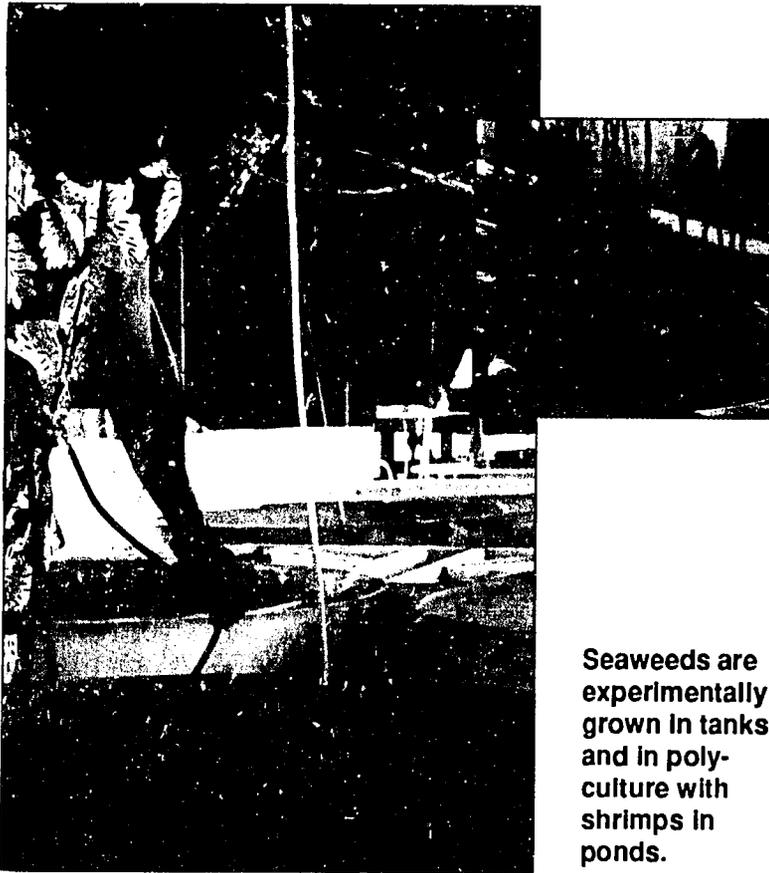


STUDIES

Spawning of kapis

Spawning of the window-pane oyster was induced by Jocelyn Ladja through injection of 1 ml of 2 mM serotonin into 31 female and 17 male oysters. At 24-26°C and 34 ppt salinity, spawning occurred 15-60 minutes after injection. Sixteen females (75-110 gram in shell-on weight, 10-14 centimeter in shell height) released about 5,000-100,000 eggs each; the reddish to brown eggs had average diameter of 68 micrometers. One male released sperm in a steady stream, but no fertilization occurred. Control oysters (18 females, 17 males) injected filtered seawater did not spawn. In another trial at 30°C, oysters (2 females to 3 males) injected with 0.5 ml of 2 mM serotonin all spawned. Fecundity was greater than 5 million eggs per female (50-75 gram, 10-12 cm); the average egg diameter was 56 µm. Cell division occurred 15 minutes after fertilization. Straight-hinge veligers appeared at 15 hours, umbo veligers at 48 hours, and crawling pediveligers (150 x 140 µm) at 168 hours after fertilization.

Kapis larvae feed on phytoplankton such as the chrysophyte *Isochrysis galbana*. The optimal growth conditions of phytoplankton in outdoor continuous culture in hatcheries was studied by Milagros de la Pena. For *Isochrysis*, the culture period in the chemostat is the same as in batch culture. In both batch and continuous culture systems, high algal density can be sustained for 5 days only. A nutrient flow rate of 25 and 50 ml per minute can supply 15 and 24 billion *Isochrysis* cells per day.



Seaweeds are experimentally grown in tanks and in polyculture with shrimps in ponds.

STUDIES

Developing abalone broodstock

The reproductive biology of the abalone *Haliotis asinina* is being studied by Emmanuel Capinpin. Monthly field sampling was conducted in Panagatan Cays (between Antique and Palawan) in November 1993-February 1994. Ninety-five specimens with shell lengths of 4-10 cm have been collected. A modified gonad bulk index was calculated, then gonads were preserved and processed for histological observations. Many of the abalones brought to the hatchery have spawned.

STUDIES

Seaweed biology and culture

Visiting Japanese researcher Hiroshi Yabbu determined the chromosome count of *Kappaphycus alvarezii* from Panay and Guimaras Islands. New branchlets bearing tetrasporangia were fixed with acetic acid - alcohol (3:1) to observe the dividing nuclei. Aceto-iron-hematoxylin-chloral hydrate was used for staining. The chromosome number counted at late diakinesis was $n=34$. All the chromosomes at this stage were bar-shaped and small, about 3 µm long.

The influence of some environmental factors on growth rate and agar quality of *Gracilaria* species in Iloilo was studied by Ph.D. student Helen Pontevida. Monthly variations of biomass and agar quality were monitored for one year at four sites: for *Gracilaria changii* in Guimbal, *Gracilaria rubra* in Concepcion, and *Gracilaria heteroclada* in Zarraga and Estancia. The *G. heteroclada* from Zarraga had the highest biomass (7 g/m² in July; 119 g/m² in August) and gel strength (194 g/cm² in April; 780 g/cm² in January). The interaction of light, salinity, and nutrients significantly influenced growth rate and agar sulfate content of *G. heteroclada* grown in tanks, and the interaction of light and salinity affected the gel strength.

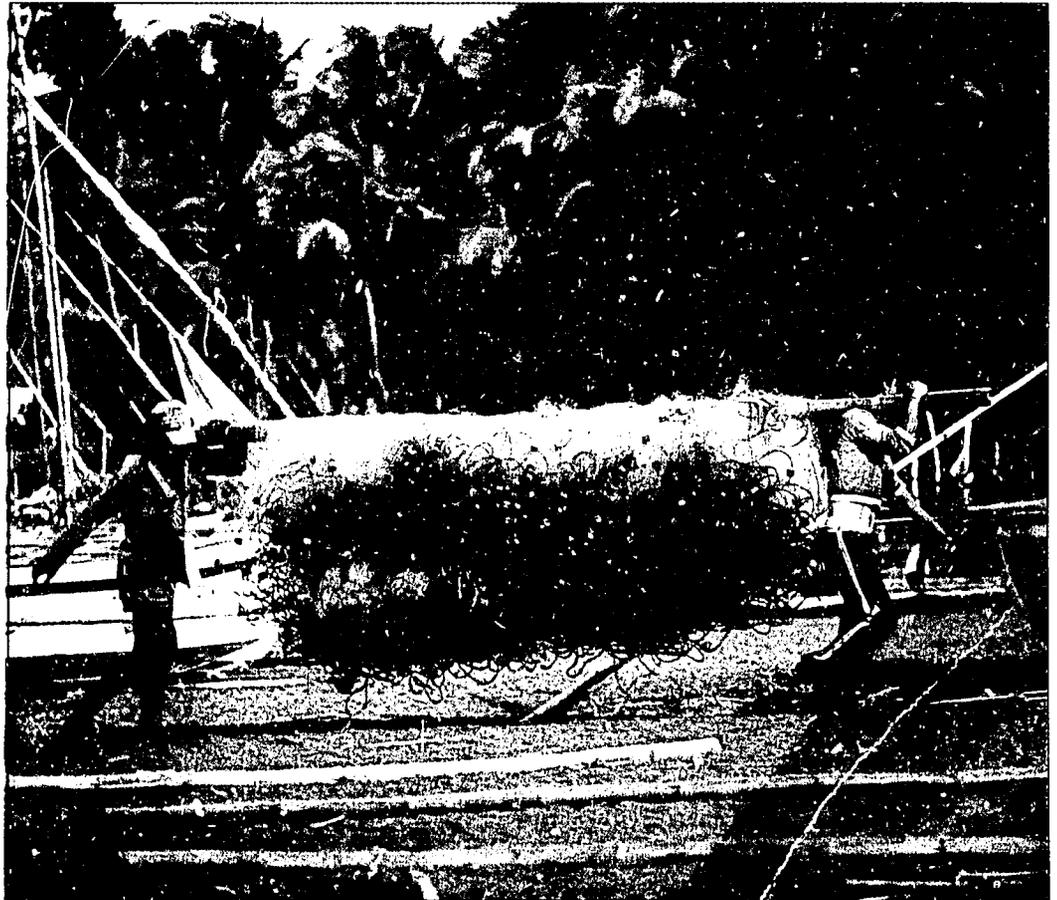
The effect of photoperiod on the spore release and sporeling growth of *Gracilaria heteroclada* was studied by Ma. Rovilla Luhan. Fertile plants bearing reproductive cysts were collected from fishponds. They were incubated at 28-30°C under the same light intensity but different photoperiods: 11, 12, or 13 hours light. Spores were released under all photoperiods, but only spores under 13 hours light developed to the 8-12 cell stage; the others died.

Growth, yield, and agar quality of *Gracilaria heteroclada* cultured in tanks were determined by Anicia Hurtado-Ponce. In one experiment, the seaweed was stocked at densities of 0.5, 1, or 2 kilograms per tank (with 300 liters or 1 m² surface area) with or

without inorganic fertilizers (10 parts ammonium chloride to one part dipotassium phosphate by weight). Growth was measured weekly. The seaweed grew faster under enriched conditions (1.6-3.5% per day) and at the lowest stocking density (3.5% per day). Significant differences in gel strength (332-651 grams per cm²), dynamic gelling temperature (31°-36°C) and melting temperature (90°-100°C) were detected between fertilized and unfertilized stocks.

Gracilaria heteroclada and the tiger shrimp *Penaeus monodon* were cultured together in brackishwater ponds by Hurtado-Ponce. Eight stocking density combinations were tested. Seaweed was planted at either 2 500, 5 000 or 7 500 kilograms and the shrimps stocked at either 2 500 or 5 000 per hectare. Seaweeds were also grown

on long lines at 5 000 kilograms with either 2 500 or 5 000 shrimps per hectare. A control pond had seaweed only. After five months, the best results were obtained in the combination of 2 500 kg seaweed and 2 500 shrimps. The specific growth rate of seaweed was 4.8% per day and production was 9 tons per hectare. Growth of the seaweed was positive in September-November when temperatures were 28-31°C, salinities were 23-31 ppt, and water depths were 70-81 cm. Negative growth was recorded in June-August at 27-34°C, 33-35 ppt, 50-60 cm water depth, and when filamentous green algae were abundant. Survival of tiger shrimp was 21% in the combination of 7 500 kg seaweed and 2 500 shrimp; body weights were 14-35 grams. No shrimps survived in the other stocking combinations.



STUDIES

Managing the coastal resources

Community-based management of fishery resources in Malalison Island was studied by Giselle Samonte. Low fish catch and poverty were identified by the Malalison residents as the priority issues that need to be addressed. Management techniques suggested by Malalison fishers include prohibitions on illegal fishing (muro-ami and dynamite), setting seasonal exploitation limits, public education on resource conservation, and alternative livelihood.

The traditional marine boundaries and territorial use rights in fisheries in Malalison Island were

investigated by sociologist Susana Siar. Aside from Malalison fishers, traditional users of fishing grounds around Malalison come from 12 of 16 coastal barangays of Culasi, including the nearby island of Batbatan. These fishing grounds possess the characteristics of open access, communal, and state property. There is no claim or ownership of specific fishing spots. Certain arrangements are observed for setting up gears. The accepted practice of "first come" determines allocation of fishing space for hook and line. Fishing nets are usually set about 50 meters apart.

Case studies on women in fishing and oyster farming were also made by Siar, focusing on women in Malalison Island and in Binaobawan, Capiz. Based on whole-village interviews and time allocation charts, women work longer hours than men each day. In Malalison, women work 4 hours at home and 6 hours in income-generating activities. Men spend 2 hours in house

Malalison, Antique: SEAFDEC/AQD helps an Island community manage its coastal resources. Baseline studies on available resources and their uses have been conducted and a fishermen's association organized.



work and 7 hours in fishing and other livelihood. In Binaobawan, women work 4 hours at home and 5 hours in buy-and-sell; men spend one hour in house work and 5 hours in fishing and other livelihood.

The economic utilization of resources in Malalison Island was determined by Rene Agbayani. A village transect enumerating and depicting the location of water- and land-based resources was completed along with a survey of the income and expenses of 35 fishermen using different gears. The coastal resources are the main sources of income for 90% of the households. Land-based activities including fish selling, net mending, and boat making are also fishery-related. There are also households that raise pigs and chicken for market. Fishermen who use nets have the highest average annual income of ₱17 600. Those who use spears earn ₱12 900 a year whereas those who use hook and line earn ₱5 040. The peak fishing season is April-May; incomes fall during the rest of the year.

Resource assessment in the waters around Malalison Island was conducted by Ronald Cheong in 1991. A total of 210 species of fish belonging to 29 families were identified. Labrids and pomacentrids were dominant in terms of species richness and abundance. Five species of seagrasses were identified. Numerically dominant species were *Cymodocea rotundata*, *Halodule uninervis* (wide-leaf) and *Thalassia hemprichii*. Greatest cover was exhibited by *H. uninervis* (wide- and narrow-leaf) and *T. hemprichii*. Sixty-four species of macrobenthic algae were identified: 21 greens, 15 browns, and 28 reds. Dominant species were the brown algae *Padina*, *Turbinaria*, *Sargassum* and *Dictyota*. At the south side of the island, encrusting corals were dominant and live coral cover was 17%. At the north side of the island, non-

Acropora branching corals were dominant, and live coral cover was 35%.

Stock assessment of fish populations in Malalison Island was continued by Edgar Amar. Some 494 fishing operations were recorded from February 1991 to January 1992. Mean catch per unit effort (CPUE, kilograms per man-hour) by gear type were: spear, 1.1; spear with compressor, 1.4; set gill net, 0.4; drive-in gill net, 2.4; drift gill net, 1.2; and hook and line, 0.7. The common species caught by the various gears were: surgeonfish and octopus by spear; fusiliers and surgeonfish by gill nets; and emperors, snappers and groupers by hook and line. The total catch by all gears was highest in July and October and lowest in November and December.

The work on resource assessment in Malalison was continued by Clarissa Marte in 1993. The coral species were identified. A manta tow survey around Malalison showed that live coral cover on the fringing reefs varied from 19 to 69% with a mean of 35%. Reefs on the northeast side of the island were in better condition than those on the southwest side. The number of fish species and the abundance of fish populations varied with the coral cover. The comparatively low estimate of fish yield in Malalison reefs based on data from fish landing indicates an overfished condition.

The cage farming of siganids (*Siganus* spp.) was studied by Edgar Amar as an alternative livelihood for the Malalison Island fisherfolk. Weekly sampling by dragged seine showed that juveniles less than 2 cm long appeared in seagrass flats in Malalison between the new moon and first quarter; numbers were highest in June but very few in July. New schools of small juveniles appeared in September and October but not in November. The dominant

species were *S. spinus* and *S. canaliculatus*. Juvenile *S. guttatus* were not present in the seine samples, but a few 6 cm long were caught by gill nets. So, *S. guttatus* (about 7 grams) were obtained from an estuary in nearby Pandan town and transported to Malalison for cage farming. Stocked at 30 per cubic meter, the juveniles grew to 33 grams after 75 days. These were transferred to Igang for grow-out in cages. They grew to 202 grams after 120 days on a SEAFDEC formulated diet with 40% protein; feed conversion ratio was 1.3. A cost-return analysis showed a 10% return on investment. Feed was the major expense, about 60% of production cost. Labor accounted for 8% and seed for 5% of the costs. If a low-cost feed can be developed for juvenile *S. guttatus* (siganids are herbivorous in nature) and if two crops can be raised each year in a sheltered location, then cage farming of siganids may be profitable. But siganid cage farming is not a suitable alternative livelihood for Malalison fisherfolk.

Cultivation of the seaweed *Kappaphycus alvarezii* with the grouper *Epinephelus* sp. was initiated by Hurtado-Ponce in Malalison Island. In one experiment, the seaweed was grown on horizontal lines, vertical lines, or clusters. The % weight increase per day varied significantly by culture technique: 5.3% in horizontal culture, 3.8% in vertical culture, and 3.7% in clusters. Production was not different among culture techniques and ranged 0.8-2.0 kilograms per meter of line every 45 days. In another run, the seaweed was grown for six months on a bamboo raft (4 x 4 meter) with or without an enclosing net cage (5 x 5 x 3 meter deep) with juvenile groupers. Highest growth and production of seaweed were recorded in March-April and a total of 406-454 kg was harvested. About 24 kg of grouper (97%) survived, each 170 gram on average.

RESEARCH SEMINARS

Every week on Thursday, the researchers gather for the seminar presentation of just concluded (or even ongoing) studies. They criticize research results prior to publication or presentation in scientific meetings.

The seminar series also features the visiting scientists and guests of SEAFDEC/AQD.

SEMINARS

DATE	SPEAKER	TITLE OF SEMINAR
1992 16 Jan	Bagarinao T	Sulfide tolerance and adaptation in the California killifish <i>Fundulus parvipinnis</i> , a salt marsh resident
20 Feb	Sollows J *	User participation in research and development: some experiences and thoughts
2 Mar	Newkirk G *	User involvement in coastal aquaculture: experiences in the Mollusc Culture Network
5 Mar	Garcia G	Milt production response of the sea bass to LHRHa and methyltestosterone
27 Mar	Pomeroy R *	Managing the commons: an institutional perspective on resource management
2 Apr	Lacanilao F	Research output of AQD, 1976-1991
2 Apr	Preide L *	Salmon farming and protection of the environment
23 Apr	Primavera J	The Lake Lanao-Agus River system and the Mindanao power crisis
29 Apr	Brand A *	Population dynamics, fishery, and cultivation of scallops in the North Irish sea
7 May	Catacutan M	Optimum protein-to-energy ratio in practical diets for sea bass, <i>Lates calcarifer</i>
22 Jun	Sumagaysay N	Utilization of feed and rice straw compost for milkfish, <i>Chanos chanos</i> , in brackishwater ponds

DATE	SPEAKER	TITLE OF SEMINAR
9 Jul	Primavera J	Prawn/shrimp biology and culture in the Philippines: charting future research directions (First Dean D.K. Villaluz Memorial Lecture)
6 Aug	Fermin A	LHRH-a and domperidone induced oocyte maturation and ovulation in bighead carp, <i>Aristichthys nobilis</i> (Richardson)
	Samonte G	Economic analysis of bottom line and raft monoline culture in <i>Kappaphycus alvarezii</i> var <i>tambalang</i> in Western Visayas, Philippines
13 Aug	Ortega R	Some social consequences of brackishwater shrimp farming: an experience in Indonesia
11 Aug	Goosen M *	Polymers for the controlled release of bioactive agents
17 Sep	Leaño E	Toxicity of four botanical insecticides to fingerlings of Nile Tilapia and common carp
	Quinitio G	Occurrence of aberrant spermatids in freshwater sculpin, <i>Cottus nozawae</i>
18 Sep	Hurtado-Ponce A	Agar production from <i>Gracilariopsis heteroclada</i> at different salinity levels
	Siar S	Learning from fishers: indigenous knowledge and SEAFDEC pilot seafarming/searanching project
30 Sep	Baldia S	Studies on the growth physiology and the chemical composition of a cyanophyte, <i>Spirulina platensis</i>
	Santiago A	Ecological impact of tilapia cage culture in Sampaloc Lake, Philippines: an update
1 Oct	Garcia L	Sea bass breeding in captivity: a research update
6 Oct	Samonte G	Socio-economics of oyster and mussel farming in Western Visayas, Philippines
	Gallardo W	Farmers' methods of oyster and mussel culture in Western Visayas
8 Oct	Quinitio E	Changes of the external genitalia in relation to ovarian development in captive <i>Penaeus monodon</i>
	Fermin A	Effects of different feeding regimes using <i>Moina macrocopa</i> on growth and survival of sea bass fry

13

DATE	SPEAKER	TITLE OF SEMINAR
13 Oct	Tan-Fermin J	LHRHa and pirozide induced breeding of the Asian catfish <i>Clarias macrocephalus</i>
	Ladja J	Preliminary results of spawning induction of <i>Placuna placenta</i>
15 Oct	Montano M *	Chemistry of Philippine seaweed polysaccharides
19 Oct	Schroeder K	Studies on energy metabolism of milkfish
	Millamena O	Evaluation of fish protein concentrate and lactic yeast as potential protein sources for shrimp feeds
	Bautista M	Response of <i>Penaeus monodon</i> juveniles to aflatoxin B ₁ dietary contamination
	Siar S	Conflict in small-scale fisheries: a case study of Malalison Island, Philippines
22 Oct	Cruz-Lacierda E	The effect of epizootic ulcerative syndrome on selected hematological parameters of snakehead (<i>Ophicephalus striatus</i>)
	Lavilla-Pitogo C	Survival of luminescent <i>Vibrio harveyi</i> exposed to different physico-chemical conditions and simulated hatchery situations
19 Nov	Andersen M *	A suggestion for possible solution to the pollution problems in connection with shrimp farming
27 Nov	Gironella A *	Some multivariate methods for analyzing fishery data
9 Dec	Pascual F *	Aquaculture feed industry in the Philippines
10 Dec	Lubzens E *	Low temperature preservation of rotifers
1993		
15 Jan	Borlongan I	Leaf meals as protein sources in diets of milkfish
9 Feb	Chavez D	Larval rearing of the giant freshwater prawn, <i>Macrobrachium rosenbergii</i> de Man, using an upwelling tank recirculation system
17 Feb	Woodland D *	Detection of cryptic species in the rabbitfishes (Siganidae)
24 Feb	Cheong MV	Milt-to-egg ratio in artificial fertilization of <i>Clarias</i>

DATE	SPEAKER	TITLE OF SEMINAR
		<i>macrocephalus</i> (Gunther) using salmon gonadotropin-releasing hormone analogue and domperidone
4 Mar	Balena R *	El Niño and warm water displacements during 1982-83
11 Mar	Luhan MR	Biomass, reproductive states and agar quality of <i>Gracilaria heteroclada</i> from Jaro, Iloilo
17 Mar	Seraspe E	Regulation of final oocyte maturation in two model systems: fish and mammals
25 Mar	Fermin A	Nursery rearing of sea bass, <i>Lateo calcarifer</i> (Bloch), fry in illuminated floating net cages: preliminary experiments on growth and survival
31 Mar	Gapasin R	Bioencapsulation of chemotherapeutics and vaccine in brine shrimp (<i>Artemia</i>) nauplii: a tool in larviculture
23 Apr	Rodriguez E	Nursery rearing of <i>Penaeus monodon</i> (Fabricius) using suspended (hapa) net enclosures installed in a pond
5 May	Triño A	The effect of heat from burning known amounts of rice straw on pond snails and soil in brackishwater pond
13 May	Yabu H *	Cultivation of seaweeds in Japan
21 May	Kapraun F *	Nuclear genome organization of commercial agarophytes: <i>Gracilaria</i> and <i>Gelidium</i>
21 May	Bird K *	Cultivation and assessment of commercial seaweeds
24 May	Villegas C	The influence of spawner size on the biological components of the reproduction process in <i>Penaeus indicus</i> H. Milne Edwards
	Parado-Esteva F	Effect of different salinity levels on the survival and rate of metamorphosis of <i>Penaeus monodon</i> larvae
6 Jun	Bombeo-Tuburan I	Golden apple snail, cassava, and maize as supplementary foods for <i>Penaeus monodon</i> (Fabricius) in extensive ponds
10 Jun	Agbayani R	Problems encountered in the implementation of a community fishery resource management project
	Almendras J	Role of growth hormone in the seawater adaptation of salmonids

13

DATE	SPEAKER	TITLE OF SEMINAR
17 Jun	Subosa P	Chicken manure, rice hulls and sugar mill wastes as potential organic fertilizers in ponds for the shrimp <i>Penaeus monodon</i> (Fabricius)
	Santiago C	Effects of dietary lipid source on reproductive performance and tissue lipid levels of Nile tilapia (<i>Oreochromis niloticus</i>) broodstock
23 Jun	Bagarinao T	Writing for fishery journals: the AQD experience
1 Jul	Sumagaysay N	Growth and food consumption of fish in ponds
9 Jul	Marte C	Milkfish industry: beyond breeding and fry production research (Second Dean D.K. Villaluz Memorial Lecture)
15 Jul	Primavera J	The role of mangroves as nurseries for penaeid juveniles: a proposal
22 Jul	Miñoso G	Enrichment and determination of chromium traces in environmental samples
5 Aug	de Jesus E	Thyroid hormone monodeiodinase activity during metamorphosis in the Japanese flounder
12 Aug	Solis N	The length-weight relationship and food habits of <i>Epinephelus</i> spp. in Carles, Iloilo
19 Aug	Pontevida H	Influence of some environmental factors on growth rate, agar yield and quality of <i>Gracilaria heteroclada</i> cultured in tanks
26 Aug	Amar E	Small-scale fisheries and yield from coral reefs in Malalison Island, west central Philippines
30 Aug	Sato O *	Fisheries in Japan
8 Sep	Nakai T *	Viral nervous necrosis disease of larval and juvenile marine fish
9 Sep	Geduspan J *	The developing limb as a model for studying morphogenesis
	Duray M	The effect of tank color and prey density on rotifer ingestion, growth and survival of milkfish (<i>Chanos chanos</i>) larvae
21 Sep	de Wolf T*	Super intensive culture and improvement of the nutritional value of <i>Brachionus plicatilis</i> (O.F. Muller) as a prey for marine fish larvae

DATE	SPEAKER	TITLE OF SEMINAR
23 Sep	Fernandez R	Fish cell lines: establishment and characterization of new cell lines and comparative sensitivity to fish viruses
30 Sep	Coloso R	Requirements of juvenile sea bass, <i>Lates calcarifer</i> Bloch, for tryptophan
1 Oct	Lavens P	Recent improvements in larviculture production of marine species
7 Oct	Peñaflorida V	Partial replacement of fish meal with papaya and camote leaf meals in diets for juvenile tiger shrimp <i>Penaeus monodon</i>
14 Oct	Palisoc F Jr	Parasitology and histopathology of the epizootic ulcerative syndrome (EUS) in Lake Naujan
20 Oct	Cruz-Lacierda E	Experimental transmission of epizootic ulcerative syndrome (EUS) in snakehead (<i>Ophicephalus striatus</i>)
	Leaño E	Siderophore detection among bacteria associated with epizootic ulcerative syndrome (EUS)
25 Nov	Gallardo W	Exploitation of the window-pane shell (<i>Placuna placenta</i>) in the Philippines
	Bagarinao T	Systematics, distribution, genetics and life history of milkfish (a review)
2 Dec	de la Peña M	Growth comparison of <i>Isochrysis galbana</i> in batch and continuous culture
	Lavilla-Pitogo C	Bacterial diseases of penaeid shrimps: an Asian view
8 Dec	Ueda H *	Olfactory imprinting and homing mechanisms in salmonids
	Hara A *	Comparative studies on immunoglobulin M (IgM) in fish

* SEAFDEC AQD guests

RESEARCH PAPERS

SEAFDEC/AQD research is published in scientific journals covered by *Current Contents*, other journals, and in conference proceedings.

SEAFDEC/AQD

aims to have a publication ratio of one paper per researcher per year. In 1992 and 1993, the senior researchers (Ph.D. and M.Sc.) numbered 70.

PUBLICATIONS

Published papers

- Agbayani RF, Lopez NA, Tumaliuan RT, Benjamin D. 1991. Economic analysis of an integrated milkfish broodstock and hatchery operation as a public enterprise. *Aquaculture* 99: 235-248.
- Almendras JME, Prunet P, Boeuf G. 1993. Responses of a non-migratory stock of brown trout, *Salmo trutta*, to ovine growth hormone treatment and seawater exposure. *Aquaculture* 114: 169-179.
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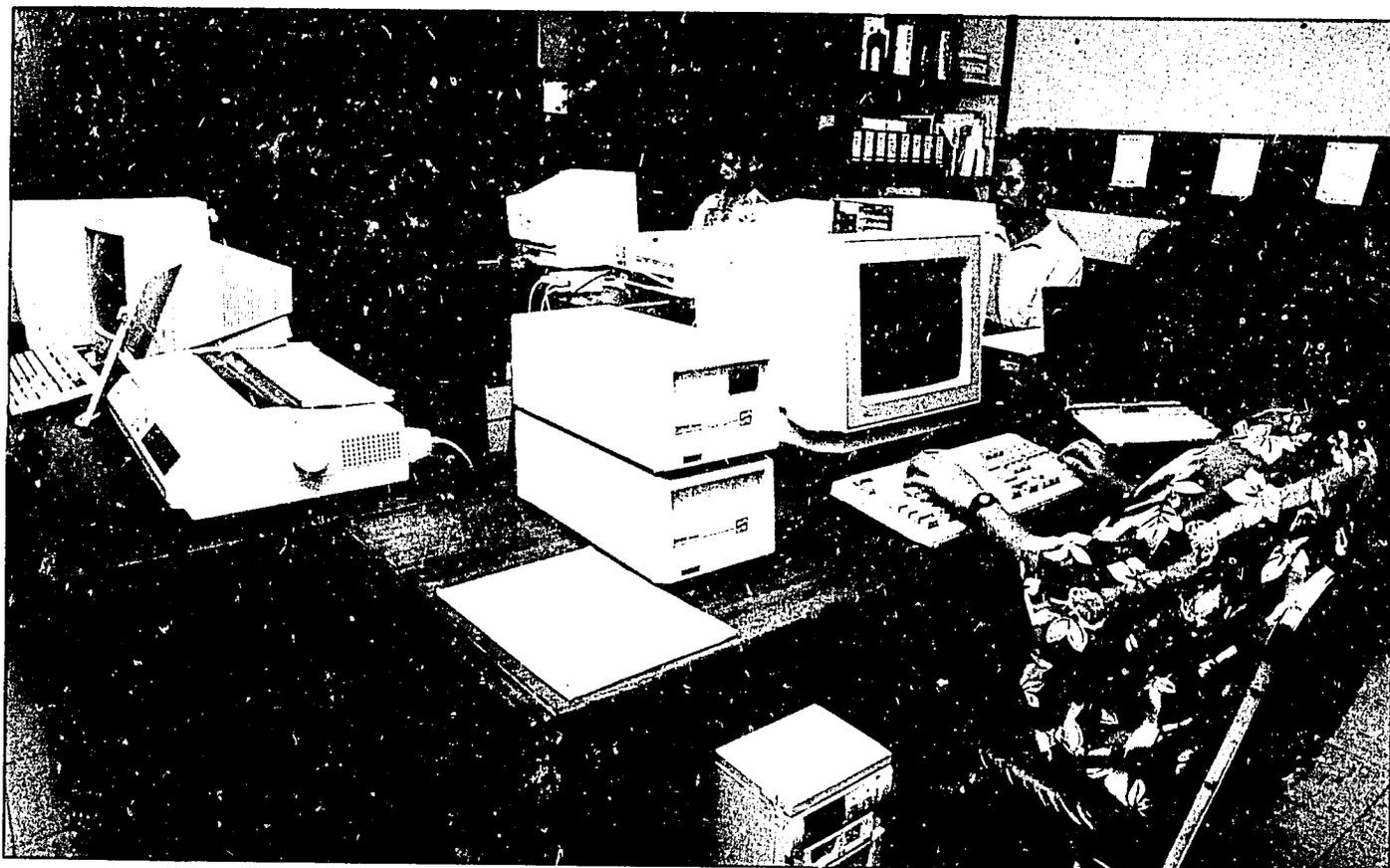
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- Hurtado-Ponce AQ. Agar production from *Gracilariopsis heteroclada* at different salinity levels.
- Lacierda EC, Shariff M. The hematological changes in snakehead (*Ophicephalus striatus*) affected with epizootic ulcerative syndrome.
- Lavilla-Pitogo CR, Albright LJ, Paner MG. Survival of luminescent *Vibrio harveyi* exposed to different physico-chemical conditions and simulated hatchery situations.
- Leaño EM, Cagawan AG. Toxicity of four botanical toxins to fry of Nile tilapia and common carp.
- Luhan RJ. Biomass production of *Kappaphycus alvarezii* cultured in tanks.
- Marte CL, Nocillado J, Borlongan IG, Duray MN. Improved survival and growth of milkfish (*Chanos chanos*) larvae reared on high HUFA-containing larval feeds as supplement to live food.
- Marte CL, Borlongan IG, Emata AC. Changes in lipids and fatty acids during larval development of milkfish (*Chanos chanos*): influence of broodstock diet.
- Millamena OM, Triño AV. Evaluation of fish protein concentrate and lactic yeast as potential protein sources for shrimp feeds.
- Parado-Esteva FD, Llobrera JA. Effect of prey density on the ingestion of *Artemia nauplii* by sea bass larvae.
- Quinitio ET, Caballero RMV, Gustilo L. Changes of the external genitalia in relation to ovarian development in captive *Penaeus monodon*.
- Quinitio GF, Takahashi H. Occurrence of aberrant spermatids in the freshwater sculpin, *Cottus nozawae* Snyder.
- Samonte GPB, Siar SV, Ortega RS, Espada LAT. Socio-economics of oyster and mussel farming in Western Visayas, Philippines.
- Santiago AE. Ecological impact of tilapia cage culture in Sampaloc Lake, Philippines.
- Schroeder K, Coloso RM, Marte CL, Focken U, Becker K. Studies on energy metabolism of milkfish, *Chanos chanos*.
- Siar SV. Conflict in small-scale fisheries: a case study of Malalison Island, Philippines.
- Tan-Fermin JD. LHRH and pimozide-induced breeding in the catfish *Clarias macrocephalus* (Gunther).
- Second National Symposium in Marine Science, Mindanao State University, Tawi-Tawi, Sulu, 5-6 Nov 1992:**
- Fermin AC, Bolivar MEC. Preliminary studies on the nursery rearing of sea bass, *Lates calcarifer* in illuminated floating net cages.
- Hurtado-Ponce AQ. Cage culture of *Kappaphycus alvarezii* and *Epinephelus* sp.
- Samonte GPB, Gallardo WG. Oyster and mussel farming in Western Visayas, Philippines (video presentation).
- National Seminar-Workshop on Breeding and Seed Production of Cultured Finfishes in the Philippines, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, 4-5 May 1993:**
- Duray MN. Larviculture of milkfish (*Chanos chanos*) in outdoor tanks.
- Garcia LMaB. A review of SEAFDEC/AQD finfish breeding research.
- Quinitio GF, Duray MN. Review of SEAFDEC/AQD finfish seed production research.

RESEARCH AWARDS

Scientific institutions in the Philippines have recognized the quality of research conducted by SEAFDEC/AQD. A total of 15 scientific papers by AQD researchers have been recognized between 1987 and 1993.

In 1992 and 1993, the awardees are among AQD's newest and youngest recruits. Ms. Neila Sumagaysay joined AQD in 1989, working on milkfish culture with supplemental feeds. Ms. Perla Eusebio joined AQD in 1991, developing feeds for shrimps. Mr. Armando Fermin had been with AQD since 1984, working on carp breeding and sea bass culture. Ms. Giselle Samonte came to AQD in 1988 and worked on socioeconomics of farming systems; she has left for graduate studies.

AWARDS

1992 Elvira O. Tan Memorial Award

To principal author Neila Sumagaysay (AQD Research Associate) and Faith Marquez and Yvonne Chiu (University of the Philippines-Visayas) for the paper:

Evaluation of different supplementary feeds for milkfish (*Chanos chanos*) reared in brackishwater ponds (Aquaculture 93: 177-189, 1991)

The Elvira O. Tan Memorial Award is given by the Philippine Council for Marine and Aquatic Research and Development.

1993 Elvira O. Tan Memorial Award

To Perla Eusebio for the paper:

Effect of dehulling on the nutritive value of some leguminous seeds as protein sources for tiger prawn, *Penaeus monodon*, juveniles (Aquaculture 99: 297-308, 1991)

1992 Philippine Science Talent Search

Neila Sumagaysay won the fourth place in the 1992 Philippine Science Talent Search for the paper:

Utilization of feed and rice straw compost for milkfish (*Chanos chanos*) production in brackishwater ponds (Journal of Applied Ichthyology 7: 230-237, 1991)

The award was given by the National Academy of Science and Technology.

1992 DA-BAR National Research Symposium

Armando Fermin won the first place for the Fisheries and Aquatic Resources Category for his paper:

LHRH-a and domperidone-induced oocyte maturation and ovulation in bighead carp, *Aristichthys nobilis* (Richardson) (Aquaculture 93: 87-94, 1991)

Giselle Samonte and co-authors Anicia Hurtado-Ponce and Romeo Caturao won the second place in the Socioeconomics Category for their paper:

Economic analysis of bottom line and raft monoline culture of *Kappaphycus alvarezii* var. *tambalang* in Western Visayas, Philippines (Aquaculture 110: 1-11, 1993)

COOPERATION IN RESEARCH AND TRAINING

SEAFDEC/ACD's collaboration with different organizations is based on specific research studies. Collaboration allows ACD staff to attend scientific meetings and trainings, and to pursue degree programs abroad.

COOPERATION

Cooperation with international organizations and agencies

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC) OF CANADA

Research

Genetics Project (3 years: 1989-1992)

Seafarming Project (3 years: 1989-1992)

Mollusc Project (2 years: 1992-1993)

Fish Microbiology (3 years: 1989-1992)

Staff development

- Fellowship grant to Zubaida Basiao for a Ph.D. in Fish Genetics, Dalhousie University, Halifax, Canada
- Fellowship grant to Gilda Lio-Po for a Ph.D. in Biological Sciences, Simon Fraser University, British Columbia, Canada
- Fellowship grant to Erlinda Cruz-Lacierda for a Ph.D. in Tropical Fish Health, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia
- Fellowship grant to Gregoria Erazo for an M.Sc. in Tropical Fish Health, Universiti Pertanian Malaysia
- Attendance of Giselle Samonte in the Training Program on Integrated Coastal Resources

Management: Special Area Management Planning, Prince of Songkla University, Hat Yai, Thailand, 23 Mar-3 Apr 1992

- Attendance of Celia Lavilla-Pitogo in the Workshop on Diseases of Cultured Penaeid Shrimps in Asia and the United States, Honolulu, Hawaii, 27-30 Apr, and observation of shrimp disease diagnostic procedures in the laboratory of Dr. James Brock, Aquaculture Disease Specialist, State of Hawaii, 1-5 May 1992

- Attendance of Zubaida Basiao in the World Fisheries Congress, Athens, Greece, 2-9 May 1992

- Attendance of Wenresti Gallardo in AQUA '92 and in the International Bivalve Workshop, Orlando, Florida, USA, 21 May - 2 Jun 1992

- Attendance of Alex Babol in the International Symposium on Indigenous Knowledge and Sustainable Development, Silang, Cavite, 22-26 Sep 1992

- Attendance of Anicia Hurtado-Ponce and Giselle Samonte at the Second National Symposium on Marine Science, Tawi-Tawi, Sulu, 5-7 Nov 1992

- Attendance of Erlinda Cruz-Lacierda, Wenresti Gallardo, Celia Lavilla-Pitogo, Anicia Hurtado-Ponce, Susan Siar, and Rovilla Luhan at the Third Asian Fisheries Forum, World Trade Center, Singapore, 26-30 Oct 1992

- Attendance of Fermin Palisoc Jr. in the Training Course on Electron Microscopy and Applied Microbiology, National Institute of Biotechnology and Applied Microbiology, UP at Los Banos, 9-13 Nov 1992

- Attendance of Rene Agbayani in the National Workshop on Methods of Analysis for Fisheries Socio-

economics Research, ICLARM,
Makati, 7-9 Dec 1992

- Attendance of Ilda Borlongan and Corazon Santiago in the Fifth Fish Nutrition Network Workshop, Udornthani, Thailand, 24-31 Jan 1993

- Attendance of Ilda Borlongan in the Fish Nutrition Training Course, Fish Nutrition Network and Asian Institute of Technology, Bangkok, Thailand, 31 Jan - 8 Feb 1993

- Attendance of Susana Siar in the Seminar on Coastal Marine Resource Management, Dumaguete City, 7-12 Feb 1993

- Attendance of Ma. Rowena Romana-Eguia in the Seminar on Basic Population Genetics at the University of the Philippines, Diliman, Quezon City, 18-22 Oct 1993

- Attendance of Edgar Amar, Emmanuel Capinpin, Luis Ma. Garcia, Clarissa Marte, and Yasmin Primavera in the Training on Coral and Reef Fish Survey conducted by the University of the Philippines - Marine Science Institute, in Malalison, Antique, 18-24 Oct 1993

- Attendance of Erlinda Lacierda, Eduardo Leño, and Celia Lavilla-Pitogo in the Second Symposium on Diseases in Asian Aquaculture in Phuket, Thailand, 25-29 Oct 1993

- Training of Jocelyn Ladja in mollusc hatchery at the Center for Marine and Coastal Studies, Universiti Sains Malaysia, Penang, for five weeks starting 4 Nov 1993

- Attendance of Zubaida Basiao in the IDRC-sponsored Aquaculture Biodiversity Meeting, Bangkok, Thailand, 22-27 Nov 1993

- Attendance of Wenresti Gallardo in the International Conference on Fisheries and Environment: Beyond 2000, University of Pertanian Malaysia, Serdang, 6-9 Dec 1993

- Attendance of Ma. Rowena Romana-Eguia and Zubaida Basiao in the Workshop on Basic Techniques in Genetics Engineering, University of the Philippines - Diliman, Quezon City, 6-17 Dec 1993

- Attendance of Clarissa Marte and Luis Garcia in the Geographic Information System Workshop, San Fernando, La Union, 13-15 Dec 1993

INTERNATIONAL FOUNDATION FOR SCIENCE (IFS)

Research

- Photoperiodic effects on gonadal development of milkfish

- Nutrition and feed development for sea bass: quantitative essential amino acid and fatty acid requirements of juvenile sea bass, *Lates calcarifer* Bloch. II. Requirements for lysine, arginine, and histidine

- Quality assessment of shrimp feeds and feed ingredients: thiobarbituric acid value, urease activity, aflatoxin level and the biological effects on tiger shrimp

- Nursery of sea bass, *Lates calcarifer* (Bloch) in illuminated cages. II. Different body sizes at transfer and stocking densities

Staff Development

- Attendance of Relicardo Coloso in the 8th Chemistry Congress, Bacolod City, 28-30 May 1992

- Attendance of Myrna Bautista, Arnil Emata and Relicardo Coloso in the Third Asian Fisheries Forum, World Trade Center, Singapore, 26-30 Oct 1992

- Attendance of Relicardo Coloso in the Annual Meeting of the National Research Council of the Philippines, Manila, 12-13 Mar 1993

- Attendance of Relicardo Coloso, Arnil Emata, and Isidra Bombeo-Tuburan in the Seminar-Workshop on IFS-Funded Projects, Makati, Metro Manila, 26-29 Apr 1993

- Attendance of Isidra Tuburan in the Training on the Use of Stable Isotopes in Aquatic Ecosystems, Marine Biological Laboratory, Massachusetts, USA, 14-30 Sep 1993

- Attendance of Myrna Bautista and Relicardo Coloso in the 6th International Symposium on Fish Nutrition and Feeding, Tasmania, Australia, 4-7 Oct 1993

JAPAN MINISTRY OF EDUCATION (MONBUSHO)

- Fellowship grant to Veronica Alava for a Ph.D. in Fisheries (Nutritional Chemistry) at the Kagoshima University

- Fellowship grant to Felix Ayson for a Ph.D. in Fish Physiology at the Tokyo University of Fisheries

- Fellowship grant to Nicholas Guanzon Jr. for a Ph.D. in Tropical Agriculture (Fisheries Resources) at the Kyoto University

- Fellowship grant to Ma. Rovilla Luhan for a Ph.D. in Fisheries (Aquatic Botany), Tokyo University of Fisheries

- Attendance of Erlinda Lacierda and Eduard Rodriguez in the Short-term Research Program for Former Foreign Students, through the Association of International Education

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Research

- Reproductive biology of the grouper *Cromileptes altivelis*
- Effect of Ektecin on bacteria affecting sea bass larvae
- Occurrence of diseases in cultured fishes in the Philippines

Staff development

- Attendance of Joel Garcia in the 1992 three-month Training on Fish Physiology and Prevention for Epizootics, Fukuoka, Japan and of Emiliano Aralar in 1993
- Observation tour by Efren Ed. C. Flores of various academic and research institutions in Japan, 11-28 July 1993

Facilities development

- Donation of two vehicles in 1993

Technical experts

- Services of Soichiro Shirahata, Deputy Department Chief
- Services of Dr. Hiroshi Yabu, JICA Expert in Seaweeds
- Services of Norio Yasunaga, JICA Expert in Fish Diseases
- Services of Junji Imayoshi, JICA Expert in Fish Breeding

JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE (JSPS)

- Fellowship grant to Emilia Qunitio under the RONPAKU Program for a Ph.D. in Crustacean Breeding Physiology at Hokkaido University

- Fellowship grant to Josefa Tan-Fermin under the RONPAKU Program for a Ph.D. in Fish Breeding Physiology at the Hokkaido University

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT (ICLARM)

Research

- Economic assessment of the shrimp (*Penaeus monodon*) hatchery industry in Panay Island

Staff development

- Attendance of Giselle Samonte and Rene Agbayani in the Seminar on Economic Valuation, Bali, Indonesia, 20-25 Apr 1992
- Attendance of Giselle Samonte and Rene Agbayani in the Third Asian Fisheries Forum, World Trade Center, Singapore, 26-30 Oct 1992

- Attendance of Giselle Samonte and Susana Siar at the National Workshop on Methods of Analysis for Fisheries Socioeconomic Research, ICLARM, Makati, 7-9 Dec 1992

UNIVERSITY OF GHENT - LABORATORY OF AQUACULTURE AND ARTEMIA REFERENCE CENTER (LAARC), BELGIUM

Research

- Enrichment of live food organisms with EFA and vitamin C: effects on growth rate, survival, stress resistance and deformities in marine fish larvae

Staff development

- Observation study tour for Demetrio Estenor in laboratories in Ghent, Belgium to learn the latest techniques in *Artemia* culture, 10-25 Jun 1993

- Attendance of Corazon Espegadera and Rosemarie Caballero-Chavez in the Seventh International *Artemia* Larviculture Training Course, at LAARC, 1 Aug - 15 Sep 1993

- Short-term assignment at SEAFDEC AQD of two Belgian junior scientists, Daan Delbare on 29 Jul - 7 Sep and Tanya De Wolf on 18 Aug - 22 Sep 1993

UNIVERSITY OF HOHENHEIM, GERMANY

Research

- Determination of the maintenance ration of milkfish (*Chanos chanos* F.) of varying body size at different rearing temperatures
- Measurement of critical oxygen tension of milkfish (*Chanos chanos* F.) at different rearing

temperatures and for different body mass groups

- Studies of the oxygen consumption of milkfish (*Chanos chanos* F.) with different body mass at different rearing temperatures

Staff development

- Observation tour by Relicardo Coloso and Clarissa Marte of facilities and laboratories at the University of Hohenheim and other institutes, Federal Republic of Germany, 20 Sep - 2 Oct 1992

- Fellowship grant to Neila Sumagaysay for a Ph.D. program at the University of Hohenheim, beginning September 1992; N. Sumagaysay withdrew from the program in December for health reasons

- Attendance of Karsten Schroeder in the Third Asian Fisheries Forum, World Trade Center, Singapore, 26-30 Oct 1992

INTERNATIONAL INSTITUTE FOR RURAL RECONSTRUCTION (IIRR)

- Attendance of Efren Flores in the Workshop on Indigenous Knowledge and Sustainable Development in the Philippines, Silang, Cavite, 23-26 Jun 1992

- Attendance of Efren Flores and Susan Siar in the International Symposium on Indigenous Knowledge and Sustainable Development, Silang, Cavite, 22-26 Sep 1992

- Attendance of Teodora Bagarinao in the MacArthur Workshop to Prepare Environmental Education Materials: Ideas for

Action, Silang, Cavite, 23-28 Nov 1992

- Attendance of Rene Agbayani and Susan Siar in the Fourth Annual Meeting of the International Association for the Study of Common Property, Metro Manila, 15-19 Jun 1993

- Attendance of Rene Agbayani and Susan Siar in the Workshop on Community Management and Common Property of Coastal Fisheries and Upland Resources in Asia and the Pacific: Concepts, Methods and Experiences, Silang, Cavite, 21-23 Jun 1993

CAMOSUN COLLEGE, VICTORIA, CANADA

Also in collaboration with the Association of Canadian Community Colleges and the Canadian International Development Agency (CIDA)

- Attendance of Bernardita Eullaran in the Training on Marine Fish Larval Rearing Techniques, Canada, 1-30 Apr 1993

- Attendance of Roseño Pagador in the eight-month Course on Environmental Technology starting Sep 1993

- Attendance of Eva Aldon in the eight-month Course on Applied Communication starting Sep 1993

NETWORK OF AQUACULTURE CENTRES IN ASIA-PACIFIC (NACA)

Third Country Training — Training of 16 Iranians in Pond Engineering at UPV-BAC, 16 Aug - 25 Sep 1993, and one Pakistani for

six months beginning 17 Aug 1993; AQD researchers served as resource persons.

SOUTHEAST ASIAN CENTER FOR TROPICAL BIOLOGY (SEAMEO-BIOTROP)

Attendance of Rolando Ortega in the Training Course and Symposium on Coastal Zone Management with Emphasis on Brackishwater Aquaculture, Bogor, Indonesia, 12 Feb - 16 Mar 1992

ASIAN PRODUCTIVITY ORGANIZATION (APO)

Attendance of Clarissa Marte in the Asian Productivity Seminar on Aquaculture, Tokyo, Japan, 24 Aug - 6 Sep 1992

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

Attendance of Ma. Lourdes Cuvin-Aralar in the UNEP Workshop on Biological Effects of Pollutants at Phuket Marine Biological Center, Phuket, Thailand, 16-25 Nov 1993

AQUATIC ANIMAL HEALTH RESEARCH INSTITUTE

Attendance of Eduardo Leaño in the Collaborative Research and Workshop on Antibiotic Resistance, Bangkok, Thailand, 3-8 Nov 1993

ASIAN FISHERIES SOCIAL SCIENCE RESEARCH NETWORK

Visit of Susana Siar to the Research Institute for Marine Fisheries, Jakarta, Indonesia, 12-20 Oct 1993, to gain cross-cultural understanding of the role of women in fisheries and small-scale aquaculture

MARYLAND BIOTECHNOLOGY INSTITUTE, U.S.A.

Attendance of Celia Lavilla-Pitogo in the International Workshop on Environmental and Aquatic Microbiology and Biotechnology, Maryland, U.S.A., 4-11 Sep, and visit of fish health laboratories, 12-14 Sep 1993

ADVICE COUNCIL FOR DEVELOPMENT COOPERATION (VUBARCS)

Fellowship grant to Romeo Caturao for an M.Sc. in Fundamental and Applied Marine Ecology at the Vrije Universiteit, Brussels, Belgium, starting 15 Sep 1993

GESELLSCHAFT FÜR BIOTECHNOLOGISCHE FORSCHUNG MB-H - SOUTHEAST ASIA

Attendance of Nelson Golez in the Workshop on Biotechnology of Animal Feeds, Bangkok, Thailand, 14-27 Mar 1993

COOPERATION

Cooperation with institutes and agencies in the Philippines

DEPARTMENT OF AGRICULTURE - BUREAU OF AGRICULTURAL RESEARCH

Research under the Fisheries Sector Program

- Induced sex inversion in grouper *Epinephelus suillus* using various methods of chronic administration of 17 α -methyl-testosterone
 - Effect of different fat sources on the egg quality of *Epinephelus suillus*
 - Broodstock development of grouper for seed production: reproductive biology of *Epinephelus suillus* in captivity
 - Development of larval rearing techniques for the grouper, *Epinephelus suillus*: food, feeding, and water management
 - Study on the biology and ecology of *Epinephelus* spp. in Capiz, Panay Island
 - Effects of various stocking densities and food types on growth, survival and net yield of grouper *Epinephelus suillus* cultured in floating cages
- Age and reproductive performance of milkfish
 - Effect of dietary protein levels and ration size on reproductive performance of milkfish broodstock
 - Alternative rearing scheme for milkfish larvae: extensive method of rearing in large tanks and ponds
 - Verification and economic analysis of improved hatchery techniques for milkfish
 - Development of practical diets for first feeding and older larvae of milkfish
 - Feed development for sea bass juveniles based on inexpensive and indigenous ingredients
 - Nutritional evaluation of some leguminous seeds as protein and energy sources for sea bass
 - Spontaneous spawning of the native catfish, *Clarias macrocephalus*
 - Improvement of hatching efficiency in the Asian catfish *Clarias macrocephalus* eggs
 - Refinements of hatchery and nursery techniques for freshwater catfish, *Clarias macrocephalus* I. Different feeding rates and feeding frequencies
 - Development and evaluation of practical diets for catfish *Clarias macrocephalus* broodstock
 - Evaluation of low-cost feed for *Penaeus monodon* reared under semi-intensive and intensive conditions in brackishwater ponds
 - The role of mangroves as nurseries for penaeid juveniles

- Evaluation of *Kappaphycus* sp. and *Gracilaria heteroclada* as binders for shrimp diet

- Seasonal variation in agar quantity and quality of *Gracilaria heteroclada* culture in ponds

- Cultivation of *Gracilaria heteroclada* and *Penaeus monodon* at different stocking densities in brackishwater ponds

- Abundance of mudcrab *Scylla serrata* in the intertidal and mangrove areas: a comparative study

- Economic feasibility of the polyculture of *Gracilaria heteroclada* with tiger shrimp *Penaeus monodon* in brackishwater ponds

Staff development

- Attendance of Armando Fermin in the Aquaculture Symposium-Technology and Investment Opportunities, Riyadh, Saudi Arabia, 11-14 Apr 1993

- Attendance of Jurgenne Primavera in the Basic Training in Population Genetics, UP Marine Science Institute, Quezon City, 25-29 October.

BUREAU OF FISHERIES AND AQUATIC RESOURCES

- Morphometric changes and gonadal development among pond-reared *Penaeus monodon* broodstock

- Ecological impact of introducing African catfish *Clarias gariepinus*: Predation on selected freshwater species

DEPARTMENT OF AGRICULTURE - REGION VI

Use of ponds for experiments

- Development of supplemental diet for milkfish. II. Growth and food consumption during dry and wet season

- Evaluation of CPSP and PROTIBEL as potential protein sources for shrimp feeds (Also in collaboration with Cooperative de Traitement des Produits de la Peche of France)

- Growth and survival of hatchery-bred and wild milkfish in nursery and grow-out ponds

- Pond culture of hatchery bred and wild groupers

PHILIPPINE COUNCIL FOR AQUATIC AND MARINE RESEARCH AND DEVELOPMENT

- Fellowship grant to Jurgenne Primavera for Ph.D. in Marine Biology, Marine Science Institute, University of the Philippines, Diliman

UNIVERSITY OF THE PHILIPPINES, DILIMAN

- Thesis research of Helen Pontevida: Influence of some environmental factors on the growth rate and agar quality of selected *Gracilaria* species in Iloilo

- Thesis research of Jurgenne Primavera: The role of mangroves as nurseries for penaeid juveniles

UNIVERSITY OF THE PHILIPPINES IN THE VISAYAS

- Third-Country Training in collaboration with the Network of Aquaculture Centers in Asia-Pacific

- Use of experimental ponds at the Brackishwater Aquaculture Center in Leganes, Iloilo

- Roundtable discussion with UPV faculty and research staff on important issues in fisheries and aquaculture.

UPV and SEAFDEC/AQD voiced out concern regarding the use and abuse of chemicals in aquaculture. A position paper was submitted to the Philippine Government in 1992.

PROCESS, a non-government organization

- SEAFDEC AQD and PROCESS (Participatory Research Organization of Communities and Education Towards Struggle for Self-Reliance) organized the Fishermen's Association of Malalison Isand and are jointly training the members of the association in alternative livelihood and self-governance.

COOPERATION

Cooperation with non-member governments

AUSTRALIA

Fellowship grant to Gilda Javellana for Ph.D. in Biological Sciences at the University of Queensland

BELGIUM

Fellowship grants to Denny Chaves and Rolando Gapasin for M.Sc. in Fundamental and Applied Marine Ecology at Vrije Universiteit, Brussels

Fellowship grant to Grace Minofo for M.Sc. in Environmental Sanitation at the State University of Ghent

CANADA

Fellowship grant to Monina Parazo for Ph.D. in Nutrition, Canadian Institute of Fisheries Technology, Technical University of Nova Scotia, Halifax

Attendance of Angelito Gonzal in the Training Course on Bioengineering and Controlled Release Technology, Department of Chemical Engineering, Queen's University, Ontario, Canada, 26 Oct-24 Nov 1992

FRANCE

Fellowship grant to Jesus Manolo Almendras for Ph.D. in Physiology at Rennes University, Rennes

ISRAEL

Attendance of Cesar Villegas in the International Workshop on Aquaculture Extension, Ruppin Institute of Agriculture, Emek Hefer, Israel, 29 Jun - 26 Jul 1993

KINGDOM OF SAUDI ARABIA

Attendance of Armando Fermin in the Aquaculture Symposium - Technology and Investment Opportunities, Riyadh, Saudi Arabia, 11-14 Apr 1993

UNITED KINGDOM

Attendance of Myrna Bautista in the 1993 International Mycotoxin Training Course, Natural Resources Institute, Chatham, Kent, England, 27 Mar - 27 Jun 1993, through a British Council Technical Cooperation Training Award

COOPERATION

Cooperation with private corporations

ASSOCIATION OF FISH MEAL AND FISH OIL MANUFACTURERS IN DENMARK

- Evaluation of various fish meals as protein sources for shrimp feeds

TAKEDA CHEMICALS

- The use of L-ascorbic acid α -glucoside in shrimp diets

CTTP-BEL INDUSTRIES, INC.

- Evaluation of CPSP and PROTIBEL as potential protein sources for shrimp feeds

NICHIMEN CORPORATION/SHOWA DENKO

- L-ascorbyl-2-phosphate Mg as Vitamin C source for juvenile *Penaeus monodon*

SERVICE LABORATORIES

SEAFDEC/AQD's service labs provide starter culture of algae and zooplankton to private hatcheries, diagnose diseases of shrimps and fishes, and analyze feed, water and soil samples from grow-out farms.

AQD also allows the faculty and students of local universities to use the laboratories for their research and practicum training.

SERVICE LABS

Larval Food Laboratory

A total of 41.4 tons of phytoplankton, 5.5 tons of the rotifer *Brachionus plicatilis* and 24 sets of enriched media stock solutions were given to various research studies and training courses conducted at AQD. Starter cultures of phytoplankton (1.4 tons) and rotifer (31 liters) and 16 sets of enriched media stock solutions were prepared for the private sector at minimal costs. Collaborative projects were also provided starter cultures — two tons of phytoplankton and 200 liters of rotifer.

Artemia nauplii (776 million) and pre-adult and adult biomass (1,360 kg) were given to research studies and training courses at AQD. Commercial brands of *Artemia* cysts were analyzed for hatching efficiency, hatching percentage and naupliar size.

The laboratory trained 33 students on the the off-campus internship and summer youth programs.

Centralized Analytical Laboratory

The samples analyzed during the period consisted of feeds (940), soil (62), and water (3,716). Of these, 66 samples of feeds, 27 of

soil, and 1,454 of water came from the private sector. The rest were from the ongoing studies at AQD. Analyses done on feeds were for: moisture content, crude protein, crude fat, crude fiber, ash, calcium, and phosphorus. Water quality analyses included pH, nitrite-nitrogen, ammonia-nitrogen, phosphate, total alkalinity, dissolved oxygen, total hardness, and turbidity. Soil analyses included pH, organic matter content, available phosphorus, potential acidity, lime requirement, available sulfate and available iron.

Fish Health Laboratory

A total of 469 diagnostic cases — consisting of shrimp, fish, and water samples — were processed for bacteriological analysis. Of these cases, 90% were submitted by the private sector and the rest came from research studies at AQD and the University of the Philippines-Visayas.

Microtechnique Service Laboratory

A total of 4,884 samples were processed: whole larvae, or liver, gills, kidney, skin, muscles, stomach, intestine, heart tissues of different species of fishes; hepatopancreas, gonads and larvae of shrimp; gonads of abalone and windowpane oyster; and seaweed thalli. A total of 10,226 slides were made in support of the research studies at AQD.

Training and information

SEAFDEC/AQD instituted a training and information dissemination program to complement research. AQD itself packages the information it generates from research in the form of training courses, seminar-workshops, newsletters, extension manuals, and videos. A library and documentation center exchanges information with 730 other agriculture or fisheries institutions around the world. The Visitors Services office toured about 10,000 visitors in 1992 and 1993, including students (85%), government workers, fishfarmers and business men (14%), dignitaries and foreign scientists (1%). Among them was SEAFDEC Secretary-General Maitree Duangsawasdi who guested in AQD's 20th Anniversary celebration together with the crew and trainees of the training vessel M/V SEAFDEC.

The priority areas for manpower training in Southeast Asia were laid out in the *Seminar on Training Requirements in Fisheries and Aquaculture* in Thailand in 1988, hosted by SEAFDEC and FAO-NACA. The specific training courses offered by AQD in 1992-1994 were prioritized during ADSEA II in 1991.

A survey of actual training needs in the Philippines is on-going. It will evaluate the extent of utilization of AQD-developed technologies. In addition, AQD publications and video productions are also being evaluated by consultants.

AQD has about 30 information specialists and technicians manning its training and information program.

SEAFDEC/AQD offers four training courses every year and two others every other year. The training courses are about a month and a half long. They consist of 80-90% practical or field work and 10-20% lectures. The training facilities include audiovisual and lecture rooms, laboratories, fish and shrimp hatcheries, nurseries, and a feed mill. The resource persons or lecturers include AQD's professional research staff, faculty from the University of the Philippines in the Visayas, and experts from other institutions and the private sector.

The TID Building houses conference and lecture rooms, a printshop and audio-visual facilities.



TRAINING COURSES

Regular training courses

CULTURE OF NATURAL FOOD ORGANISMS

This training course is offered every other year. The session conducted from 3 March to 1 April 1993 had eight participants from Malaysia (1), Thailand (3), and the Philippines (4). Six participants received SEAFDEC fellowship grants.

The four-week course imparts skills in the production of natural food essential to aquaculture. Among the topics covered are the importance of natural food organisms, suitability, and nutritive value; plankton culture and use of *Artemia* in hatcheries.

Practical activities include collection of plankton samples; isolation and purification of specific phytoplankton species; monitoring of growth; laboratory and outdoor cultures of *Chlorella*, *Skeletonema*, and *Moina*; and decapsulation, disinfection, hatching, enrichment, and biomass culture of *Artemia*.

The training in fish health management.

SHRIMP HATCHERY AND NURSERY

The training course is also offered every other year. It was conducted from 18 March - 8 May 1992 with 12 participants from Malaysia (2), Thailand (3), Philippines (6), and Kenya (1). SEAFDEC/AQD provided fellowships to 8 of the 12 participants from Member Countries.

The seven-week course develops skills in operating a small-scale shrimp hatchery, including broodstock and nursery management. Emphasis is on *Penaeus monodon*. The course covers site and species selection, design and construction of hatchery and nursery tanks, larval rearing, culture of natural food, harvest, packing and transport of fry, and marketing systems.

Practical activities include eyestalk ablation, broodstock sampling and monitoring, natural food production, larval rearing, feeding and water management, harvesting and packing.

FISH HEALTH MANAGEMENT

This training course is offered every year. In 1992, 14 participants from Malaysia (2), Thailand (3), Singapore (2), and the Philippines (7) attended the course held from 22 April to 27 May. Ten of the 14 participants had SEAFDEC/AQD fellowships.

In 1993, 14 participants from five countries attended the course from 21 April to 31 May: Malaysia (2), Philippines (7), Singapore (1),



Thailand (3), and Nigeria (1). Ten participants received SEAFDEC fellowships.

The five-week course provides practical and theoretical training in fish health management to government and fisheries extension workers and aquaculture technicians.

The course covers the occurrence and spread of diseases in aquaculture, microbial diseases, non-infectious diseases, and disease prevention and control.

Among the practical activities are anatomical examination of fish specimens, preparation of culture media and solutions for microbial analysis, bacterial isolation and identification, bacterial count, fungal isolation and identification, histological preparation and analysis, bioassay, and health monitoring of shrimp larvae.

MARINE FISH HATCHERY AND NURSERY

This course is offered yearly. Two sessions were conducted in 1992. The first - conducted from 3 June to 24 July - had 16 participants from Malaysia (4), Thailand (2), and Philippines (10). Nine participants received SEAFDEC fellowships. The second - conducted from 12 August to 2 October - had 14 participants from local government agencies and the private sector.

In 1993, only one session was conducted from 1 June until 21 July with 13 participants from Malaysia (1), Thailand (2), Philippines (8), Egypt (1), and Nigeria (1). Six

participants received SEAFDEC fellowships.

The seven-week course equips the participants with basic technical skills in operating fish hatcheries. The course covers seed production techniques for marine fishes such as milkfish, sea bass and grouper.

Practical activities include hormone injection or implantation, spawning, egg collection, transport of fish eggs and larvae, larval rearing, and culture of natural food.

AQUACULTURE MANAGEMENT

The course is offered yearly. It was conducted from 30 September to 29 October 1992 with 19 participants from Malaysia (2), Thailand (2), Philippines (12), India (1), Saudi Arabia (1), and Nigeria (1). Eight participants from SEAFDEC Member Countries were provided fellowships.

In 1993, the course was conducted from 21 September to 20 October with 18 participants: Malaysia (4), Thailand (2), Philippines (8), China (3), and Hongkong (1). Eight of the participants received SEAFDEC fellowships.

The four-week course develops the skills of project managers in aquaculture planning and implementation, monitoring and evaluation. The course covers technical topics: seed production of fishes and shrimps, grow-out culture, nutrition and diseases. The course's management module covers production, economics, marketing, financing, and government policies.

FISH NUTRITION

The course is offered yearly. It was conducted from 22 October to 2 December 1992 with 13 participants from Malaysia (3), Thailand (2), Philippines (6), Indonesia (1), and Hongkong (1). Seven participants from SEAFDEC Member Countries received fellowships.

In 1993, the course was conducted from 21 October to 1 December with 12 participants from Malaysia (2), Philippines (7), Thailand (2), and Nigeria (1). Eight participants received SEAFDEC fellowships.

The six-week course addresses the needs of aquaculture technicians and fish nutritionists for basic theoretical information and technical skills. The topics covered are basic nutrition and feeding theories, nutrient requirements of cultured species, formulation and preparation of artificial feeds based on feeding habits and digestive physiology, evaluation of feeds in terms of conversion rates and digestibility, feed preparation and storage, and feeding procedures.

CULTURE OF SEAWEED

This is a new three-week course designed by SEAFDEC/AQD for small-scale fish farmers. It covers identification of local seaweed species, biology and culture of *Kappaphycus*, post-harvest handling, and economics. The course was scheduled in 1993 but was cancelled due to lack of participants.



Training and Information Division Head Dr. Cesar Villegas welcomes trainees.

Since 1974, more than 10,000 technicians, students, teachers, researchers, and businessmen have undergone training at AQD. They now constitute the aquaculture work force in Southeast Asia.

TRAINING PROGRAMS

Upon request, less formal training courses were arranged for individuals and small groups in laboratories and disciplines of their choice.

PRACTICUM TRAINING

Practicum training is a requirement for undergraduate Fisheries degrees in the Philippines.

Thirty-four graduating students from eight universities, colleges and fishery schools in the Philippines availed of the practicum training in

1992. Another 12 students finished their practicum at AQD in 1993.

INTERNSHIP TRAINING

Ten college graduates from the Philippines underwent internship training in the fields of phycolgy, chemical analysis, pathology, microtechnique and aquaculture economics in 1992. Another 21 underwent training in phycolgy, pathology, fish hatchery, fish larval rearing, fish nutrition, and chemical analysis in 1993. A student from Deakin University in Victoria, Australia interned in aquaculture research on 15 April-14 May 1993.

SUMMER WORK APPRECIATION PROGRAM

SWAP was implemented in compliance with Executive Order No. 395 (the Philippine President's Summer Youth Program) and in collaboration with the Philippine Department of Labor and Employment - Region VI. In 1992, a total of 50 students and out-of-school youths from Iloilo participated in the program. In 1993, 75 completed the program.

SUMMER SCIENCE INTERNSHIP

Four sophomore students from the Philippine Science High School trained in various research laboratories at AQD on 19 April to 14 May 1993.

One student from the Special Science Class of the Iloilo National High School did the same on 10 to 29 May 1993.

COLLABORATIVE TRAINING

A special training course in Aquaculture Engineering was conducted for 16 participants from Iran on 16 August - 25 September 1993, and for one participant from Pakistan for six months beginning 17 August 1993. These courses were in collaboration with NACA and UPV-BAC.

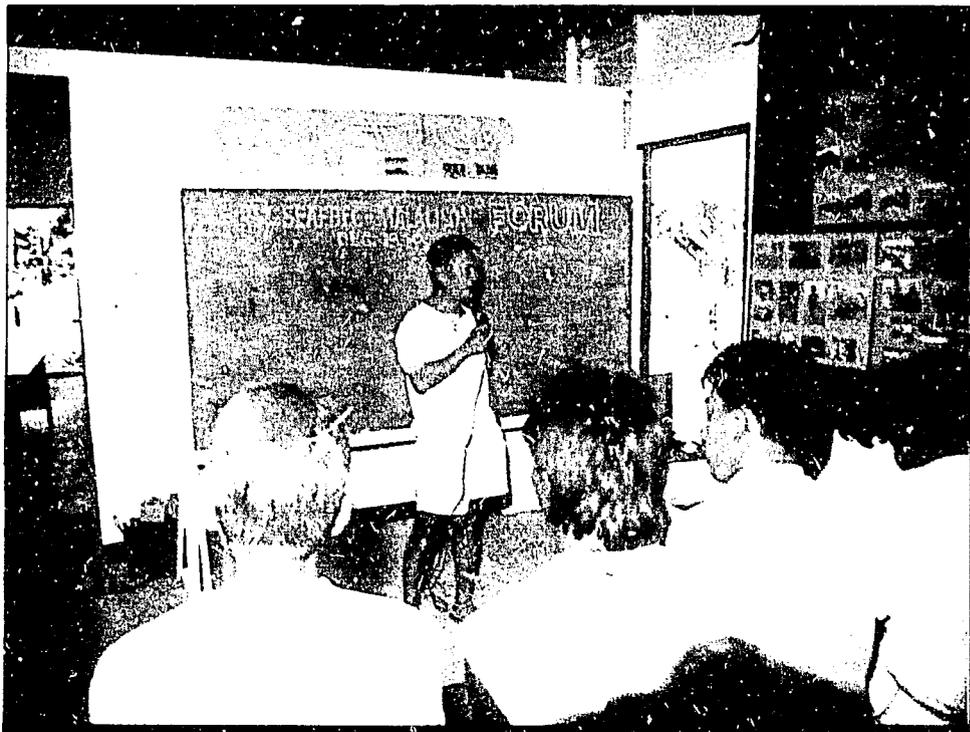
TRAINING NEEDS

Survey of aquaculture training needs

More than 90% of government aquaculturists in the Philippines responded to the survey -- questionnaire on aquaculture training needs. To confirm responses, field visits were made and consultation were arranged with the Department of Agriculture personnel and fish farmers' associations in Regions 1, 2, 3 and 5. A second phase will cover the rest of the country's 13 regions.

The survey will also cover Malaysia, Thailand, Singapore, Brunei Darussalam, and Indonesia.

One of the activities of the Community Fishery Resource Management Project in Malalison Island, Culasi, Antique, is to educate the fisherfolk about the importance of conserving the coastal resources.



AQD participates in various fairs and exhibits at the invitation of host institutions, and provides resource persons in seminars and consultative meetings.

Fishfarmers discuss their problems with AQD researchers at fairs and exhibits.

EXTENSION

AQD in fairs and exhibits

Third Science and Technology Fair sponsored by the Department of Science and Technology, Manila, 22-26 Jun 1992

Kabisig Tiangge sa D.A. sponsored by the Department of Agriculture, DA Parking Lot, Elliptical Road, Diliman, Quezon City, 16-21 Oct 1992

Techno Fair, a joint effort of the Department of Science and Technology, Philippine Information Agency, Negros-Agri-Aqua Development Institute, and Iloilo State College of Fisheries, Sagay, Negros Occidental, 21-22 Oct 1992

UPV Fisheries Week Exhibits, University of the Philippines in the Visayas - College of Fisheries, Miag-ao, Iloilo, 1-6 Feb 1993

Agrifood-Agrimach Fair '93, Department of Agriculture and Regional Agricultural and Fisheries Council-VI, PNB Multi-Purpose Hall, Iloilo City, 6-13 Mar 1993

Agri-Fair Exhibit, Department of Agriculture, Quezon City, 3-7 May 1993

Workshop-Convention, Chamber of Fisheries and Aquatic Resources of the Philippines, Metro Manila, 22 Oct 1993

First Philippine International Agri-Aqua Poultry and Livestock Exhibition and Symposium, Metro Manila, 4-7 Nov 1993

EXTENSION

Outreach

Seafarming research staff assessed Pinubulon in Guimaras as a probable site for an artificial reef and seaweed farm. This was requested by Save the Children, Philippines in summer 1992.

AQD participated in the radio program *Iloilo Agri-Kapihan* that is aired over DYLL-Radyo ng Bayan in Iloilo City. Dr. Anicia Hurtado-Ponce talked about the seaweed resources of Panay on 29 Jun 1992. Dr. Cesar Villegas updated the listeners on AQD's research and development programs and services on 31 Aug 1992. The radio program is part of an information campaign targetted at small-scale farmers by the Department of Agriculture and the Municipal Agricultural and Fishery Council.



AQD staff served as resource speakers. Celia Pitogo lectured on *Fish Health Management with Emphasis on Prawn Diseases* at Dumaguete City, 18 Jul 1992 for the Negros Oriental Prawn Growers Association. Milagros Castaños and Romeo Caturao gave lectures during the *Seminar on Writing Scientific Papers and Project Feasibility Studies* at the Tario Lim Memorial Antique School of Fisheries, Antique, 16-18 Sep 1992. Renato Agbayani, Marietta Duray, Fe Parado-Esteva, Avelino Triño, and Veronica Peñaflorida served as resource speakers during the *First Regional Aquaculture Congress*, Davao City, 29-30 Apr 1993.

EXTENSION

Adopt-A-Milkfish Broodstock Scheme

The scheme was implemented in 1993 to extend the milkfish broodstock and hatchery technology generated at AQD to the private sector. The cooperators shoulder all expenses in maintaining the adopted breeders and gets all the spawned eggs to rear in the hatchery. AQD provides the milkfish breeders, a cage, an egg collector, and technical assistance. AQD researchers also monitor the broodstock, hatchery, and grow-out performance of the adopted milkfish.

Three cooperators availed of the scheme. See result on p. 10.

EXTENSION

Seminar-Workshops

AQUACULTURE WORKSHOP FOR SEAFDEC/AQD TRAINING ALUMNI

The workshop was held 8-11 September 1992 at AQD's Tigbauan Main Station. A total of 82 participants and observers attended the workshop: Malaysia (5), Thailand (3), Iran (1), USA (1), and Philippines (72). The workshop provided a forum for former trainees of AQD to share post-training experiences, interact with fellow graduates, and based on their experiences, recommend ways to make the training program more responsive to the needs of the aquaculture industry. The workshop provided the participants updates on the recent R&D at AQD.

The participants presented country papers on the status, practices and problems in shrimp and fish seed production, grow-out culture, fish diseases, and fish nutrition. In turn, AQD researchers presented papers on the recent advances in shrimp and fish seed production, fish health management, and fish nutrition. Overview of AQD research, training, and information dissemination were also given.

The workshop was funded by the Government of Japan.

BREEDING AND SEED PRODUCTION OF CULTURED FISHES IN THE PHILIPPINES

The seminar-workshop was conducted at AQD's Tigbauan Main Station, 4-5 May 1993. About 130 scientists and technicians from Japan, Malaysia, Singapore, Canada, UK, USA, Australia, and the Philippines attended.

The workshop promoted the exchange of information and views regarding breeding and seed production of various fishes. The scientists became aware of each other's past and ongoing research projects. Priority research areas were recommended and so was the closer cooperation among various institutions and private individuals who share the common goal of sustainable aquaculture.

The workshop was sponsored by the Government of Japan.

SEAFDEC/AQD produces newsletters, extension manuals, monographs, leaflets, and videos — all to disseminate aquaculture science and technology. AQD has computers for desk-top publishing, a small printing press, and equipment for video production.

AQD also distributes *Aqua Dept News*, an internal newsheet, to its employees.

PUBLICATIONS

Newsletters



SEAFDEC ASIAN AQUACULTURE

This 12-page quarterly describes AQD research and related developments in aquaculture. Edited by M.B. Surtida, the following were distributed in 1992 and 1993:

- December 1991 issue (Vol. XIII No. 4)
- March, June, September, December 1992 issues (Vol. XIV No. 1, 2, 3, 4)
- March-June 1992, September 1992 issues (Vol. XV, Nos. 1-2, 3)



AQUA FARM NEWS

This 20-page bimonthly newsletter is a production guide for fishfarmers and extension workers. It discusses

technology for cultured species and other recent information excerpted from various sources. Edited by M.T. Castañón, the following were distributed in 1992 and 1993:

- December 1991 (Vol. IX No. 6)
- February 1992 issue on ornamental fish; April issue on mud crab; June issue on grouper; August issue on mollusc culture; October issue on aquaculture training; December issue on snappers (Vol. X, No. 1, 2, 3, 4, 5, 6)
- February 1993 issue on small-scale aquaculture; April issue on milkfish breeding; June issue on tilapia culture; August-October issue on policing fisheries (Vol. XI, No. 1, 2, 3, 4-5)

PUBLICATIONS

Books

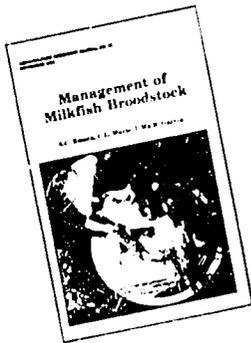


SEAWEEDS OF PANAY

By A.Q. Hurtado-Ponce, Ma. R. J. Luhan, and N.G. Guanzon, Jr. Lists the species of seaweeds found in Panay and Guimaras Islands in April 1988 to February 1989. Common names, descriptions, habitats, economic importance, and collection sites are given for 100

species of green, brown, and red algae, 41 of which are new records for Panay.

The monograph was launched 11 June 1992 at AQD's Tigbauan Main Station, Iloilo.

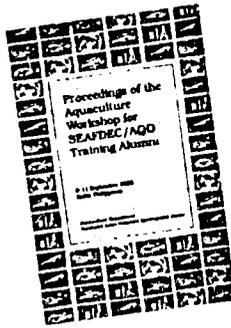


MANAGEMENT OF MILKFISH BROODSTOCK

By A.C. Emata, C.L. Marte, and L.Ma.B. Garcia

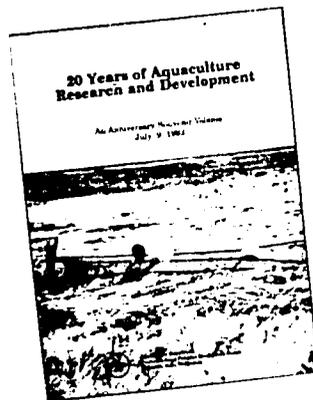
Updates the manual published in 1984. Describes improved egg collection techniques, the standard egg transport procedure, the spontaneous maturation and spawning of milkfish in concrete tanks, and the improved hatchery technology. (AQUACULTURE EXTENSION MANUAL NO. 20, 22 PAGES.)

The manual was launched on 4 March 1993 during the Agrifood-Agrimach Fair '93 in Iloilo City. Mass reprinting was funded by the DA - Fisheries Sector Program in line with the government's move to privatize the National Bangus Breeding Project (NBBP) of the Department of Agriculture.



PROCEEDINGS OF THE AQUACULTURE WORKSHOP FOR SEAFDEC/AQD TRAINING ALUMNI

Edited by C.T. Villegas, M.T. Castaños, and R.B. Lacierda
Contains country papers and the experiences of former AQD trainees, now aquaculture practitioners. Includes review of AQD research, training, and information dissemination from 1988 to 1992, and an assessment of the manpower needs in aquaculture.



20 YEARS OF RESEARCH AND DEVELOPMENT: AN ANNIVERSARY SOUVENIR VOLUME

Written by a committee chaired by V. T. Sulit. This 94-page volume commemorates AQD's 20th year on 9 July 1993. The volume includes

messages from SEAFDEC officials and collaborating institutions and the visions of past and present AQD Chiefs. A historical account of AQD's accomplishments in technology generation and techno-transfer is presented in brief.

The volume also describes AQD's organization, stations and project sites, manpower support, technical collaborations, and financial matters. Former trainees and AQD employees who have rendered 20 years of service provide personal insights. AQD's future direction is also charted.

1991 ANNUAL REPORT

Details the research and development at SEAFDEC/AQD in 1991

REPRINTS

Four extension manuals were reprinted:

- *Diseases of Penaeid Shrimps in the Philippines*
- *Milkfish Hatchery*
- *Recommended Practices for Disease Prevention in Prawn and Shrimp Hatcheries*
- *Nutrition and Feeding of Penaeus monodon*

PUBLICATIONS

Videos

LET US MAKE AQUACULTURE SUSTAINABLE

A 30-seconder that won the second prize of P20,000 in a 1993 contest sponsored by the Philippine Department of Environment and Natural Resources (The script was written by the Environment Action Group of SEAFDEC/AQD)

MUSSEL AND OYSTER FARMING IN WESTERN VISAYAS

Documents the 1993 survey done by SEAFDEC/AQD in collaboration with the ICLARM Asian Fisheries and Social Sciences Research Network (The script was written by G.PB. Samonte and W. Gallardo)

CARING FOR MILKFISH LARVAE

A 14-min program that demonstrates the milkfish hatchery technology developed by AQD and successfully adopted by private and government cooperators. With instructions on hatching of milkfish eggs, stocking of newly hatched larvae, larval rearing, and harvest (The script was written by M.T. Castaños and A.C. Emata, 1992)

PUBLICATIONS

Services

AQD distributes *Aqua Dep't News*, a monthly internal newsheet, to the employees.

About 38 press releases were written and distributed to *SEAFDEC Newsletter* and the local and national media.



Catalogues of SEAFDEC/AQD services and products were made.

- *Aquaculture Training Programs*
- *Aquaculture Publications and Video Tapes*
- *Library Acquisitions Lists*

The SEAFDEC/AQD 1992 and 1993 desk calendars were designed and printed (500 copies each).

Program and Abstract volumes and other materials were printed for the conferences and meetings sponsored by SEAFDEC/AQD.

The AV-Print staff provided AQD researchers and other units services in photography, blow-up recopies, graphics, video coverage, and sound track recording.

PUBLICATIONS

Sales and circulation

SEAFDEC/AQD reduced the prices of its publications and videos by 30-50% to cover only the authors' royalties and the mailing cost. AQD shoulders the production cost to make aquaculture information more affordable to fishfarmers. Subscriptions to the newsletters were also discounted.

Sales of books and video tapes, and newsletter subscriptions amounted to about P150,000 in 1992 and P170,000 in 1993.

About 2,500 copies of each issue of the newsletters were circulated: 730 as library gifts and exchanges, 500 to offices of the Department of Agriculture and non-government organizations, 180 to paying subscribers, 250 to AQD staff, and the rest, at fairs and exhibits.

The SEAFDEC/AQD Library maintains an exchange agreement with 730 foreign and local institutions for relevant publications. AQD contributes to the SEAFIS Regional Bibliography for Fisheries and Aquaculture of the SEAFDEC Secretariat in Thailand.

The Library documents its holdings in a computer database and services queries and requests for references.

LIBRARY

Library holdings

The library collection stands at 11,575 monographic volumes, 6,083 pamphlets, 2,620 SEAFDEC publications and 3,941 journal volumes.

The library acquired a brand new compact disc-read only memory (CD-ROM) drive and received a free disc from the USAID Center for Development Information and Evaluation in 1992. The Library subscribes to the Aquatic Sciences and Fisheries Abstracts (ASFA) on compact disc covering issues from 1988. Two trial discs were received from ASFA, the WATERLIT and WASTEINFO databases covering 1975-1992 and 1973-1992.

Researchers, managers, planners, students, teachers, librarians, and technicians comprise most of the readership in the AQD library.

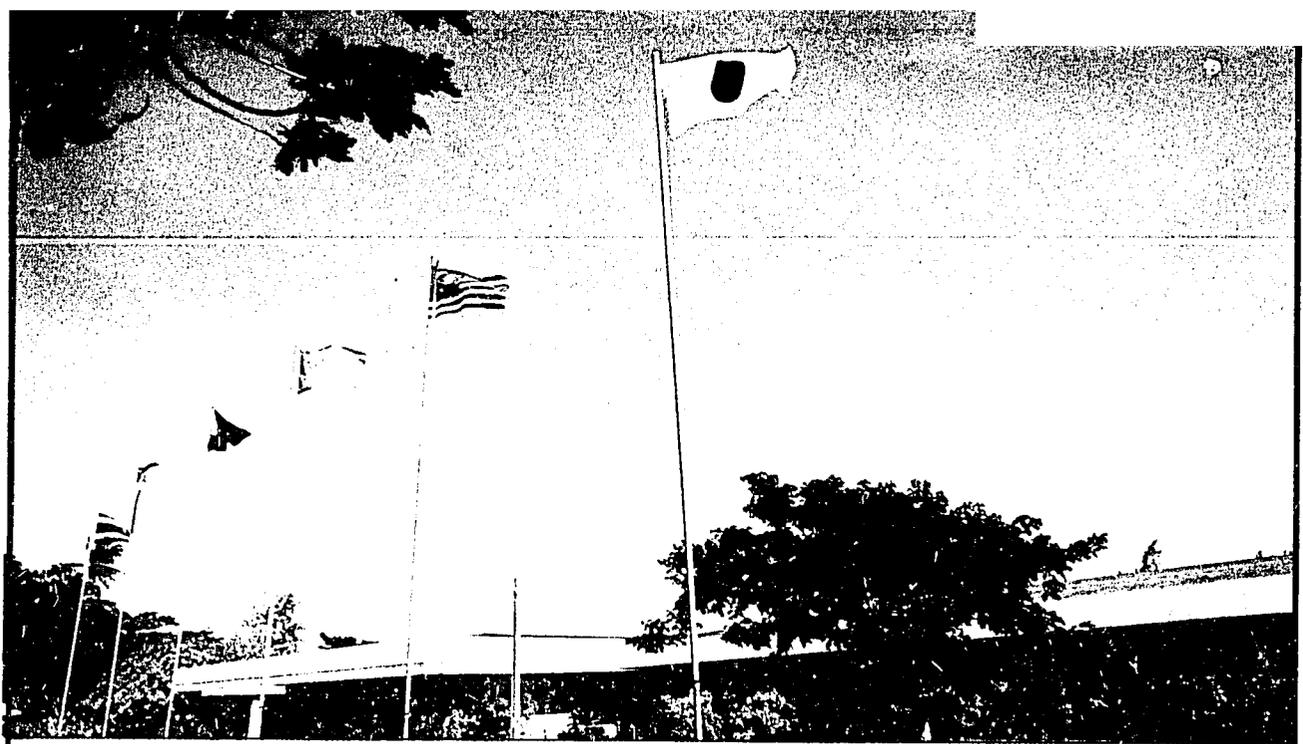
The library circulates a brochure on its document delivery service and 22 issues of the *Library Acquisitions List*. The library advertises new materials and maintains a bulletin board on government and industry policies and practices.

Documentation

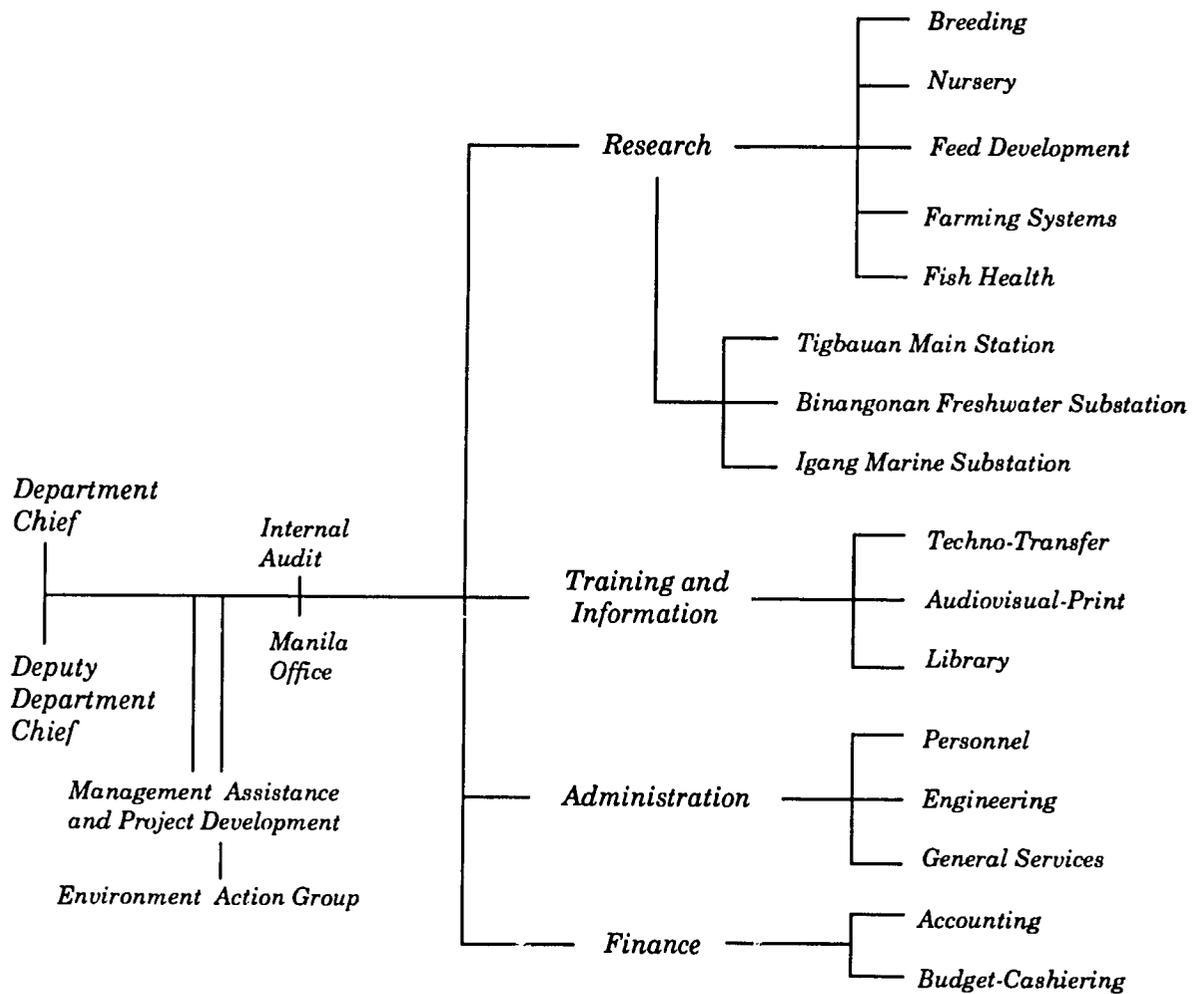
A monograph on AQD's book holdings, covering 2,000 titles, was generated from the library database. Almost complete, this volume will be test-used as the computerized version of the Library Catalog.

SEAFDEC/AQD contributes to the SEAFIS project of the SEAFDEC Secretariat. About 439 papers on Philippine fisheries and aquaculture, including AQD research publications, dated 1990-1992 were sent to Bangkok. These materials are part of the *SEAFIS Regional Bibliography for Fisheries and Aquaculture*.





Management



As of 31 December 1993, the permanent staff of SEAFDEC/AQD totalled 349, with 160 in Research, 30 in Training and Information, 117 in Administration, 22 in Finance, and 21 in the Office of the Chief.

AQD management, researchers, and non-technical staff are listed in the Annex.



Dr. Efren Eduardo C. Flores



Mr. Soichiro Shirahata

New AQD Chief

Dr. Efren Ed. C. Flores was inducted AQD Chief on 21 April 1992 for a two-year term. The appointment was renewed for another two-year term, April 1994 to April 1996. He succeeded Dr. Flor Lacanilao.

Prior to his appointment as AQD Chief, Dr. Flores was Dean of the College of Fisheries, University of the Philippines in the Visayas. He finished his doctorate in fisheries at Hokkaido University in 1979, M.S. Fisheries at Nagasaki University in 1972, and B.S. Fisheries at the University of the Philippines in 1964. Dr. Flores had been a Colombo Plan Fellow on coastal fisheries in Japan in 1968, an ACTIM Fellow on fishing industry organization and management in France in 1980, and a DAAD Fellow on research organization and management in the Federal Republic of Germany in 1983.

Dr. Flores was Director of the Philippine Fisheries Research Society (1981, 1982), and is a founding member of the Asian Fisheries Society (1985) and a member of the

Japanese Society of Scientific Fisheries. He has published papers in scientific journals and in conference proceedings, mainly on squid biology and fisheries.

Management Group

The Government of Japan extended the appointment of Soichiro Shirahata as Deputy AQD Chief beginning 7 July 1993.

AQD Chief Dr. Efren Ed. Flores appointed Dr. Relicardo Coloso as Head of the Research Division. He extended the terms of Dr. Cesar Villegas as Training and Information Division Head, Mr. Rufil Cuevas as Administrative Division Head, and Mr. Rene Alger as Finance Division Head. Other appointments and special designations were also made.

PERSONNEL

Expatriates

Dr. Hiroshi Yabu, Japanese expert on seaweeds culture, completed his short-term assignment at AQD on 26 June 1993. Prior to his departure, Dr. Yabu donated an incubator, a microscope, and a photography apparatus for microscopes.

Junji Imayoshi, JICA Expert on Grouper Culture, completed his short-term assignment at AQD on April 1992.

The services of Norio Yasunaga, JICA Expert on Fish Disease, has been extended by the Government of Japan for another year beginning 9 September 1993.

Carolina da Costa Reis, University of Hohenheim, Germany, conducted her thesis research on milkfish digestive physiology from October 1990 to July 1991.

Karsten Schroeder, visiting Researcher from the University of Hohenheim, conducted research on milkfish bioenergetics from October 1989 to October 1992.

Daan Delbare, visiting Junior Belgian Scientist, conducted research on *Artemia*, from 29 July to 7 September 1993, under the collaborative project between AQD and LAARC.

Tanya De Wolf, visiting Junior Belgian Scientist, conducted research on *Artemia* from 18 August to 22 September 1993, under the collaborative project between AQD and LAARC.

PERSONNEL

Hiring and separation

Seven contractual employees were given permanent appointments in 1992. Another 38 contractual employees were hired in 1992-93, 19 of them under the Fisheries Sector Program, a collaborative project with the Department of Agriculture-Bureau of Agricultural Research. The terms of 48 contractual employees hired in 1991 were extended.

In 1992-93, 32 employees were separated from AQD: 12 retired, one passed away, 17 resigned, and 2 terminated for failure to return after an extended leave of absence.

STAFF DEVELOPMENT

Graduate studies*

Roselyn Fernandez obtained her Ph.D. in Fisheries Science, from Hokkaido University, Japan in March 1993.

Didi Baticados is pursuing a Master's degree in Business Administration, University of San Agustin, Iloilo City, starting June 1993.

Sarah Loma Ortiguero is pursuing a Master's degree in Business Administration, University of San Agustin, Iloilo City, starting July 1993.

STAFF DEVELOPMENT

Non-degree training*

Gilda Lio-Po, Culture Collection and Animal Cell Technology and the Use of Computers in Microbiology, Beijing, China, 6-21 Oct 1992

Luis Ma. Garcia, collaborative work with Prof. Tetsuya Hirano, University of Tokyo, Japan, 9-23 Oct 1992

Teresita Natividad, Short Course on Micro CDS/ISIS, Quezon City, 25-29 May 1992

Romeo Caturao, Basic Trainer's Training, Manila, 21-30 Apr 1992

Ma. Antonia Tresvalles and Domingo Jutajero, Records Management Training, Manila, 5 Aug 1992

Efren Huervana, Technical Writing, Manila, 19-21 Oct 1992

Nancy Acdol, Alfredo Gustilo, Salve Gotera, Ramon Soriano, Lucy Torres, Delicia Tupas and Paciencia Garibay, Records Management Training, Manila, 24-26 Nov 1992

Didi Baticados, Training-Seminar on Voluntary Arbitration Advocacy, Iloilo City, 25-27 Mar 1993

Teresita Natividad, Data Base Design and Implementation, Quezon City, 3 May-8 Jun 1993

Eva Aldon and Milagros Castaños, Workshop on Newsletters: New Methods for a New Mission, Manila, 20-22 Jan 1993 and 24-26 Mar 1993

Isidro Tendencia, Workshop on Documentary Film Making, Manila, 26-28 Jan 1993

Ma. Clara Dato, In-House Computer Training Services, Manila, 8-19 Mar 1993

Esther Camacho, In-House Computer Training Services, Manila, 15-28 Apr 1993

*See also Cooperation, p. 54

Renato Agbayani, Training Course on Social Indicators for Evaluating Development Projects, Asian Institute of Journalism, Manila, 14-16 Sep 1993

Lydia Plondaya, Software Training in FilemakerPRO for Macintosh Computer, Manila, 25-29 Oct 1993

Antonina Duremdez, Nelda Ebron, and Anna Ma. Josefa Ortiz, Seminar on Effective Writing, Asian Institute of Journalism, Manila, 26-29 Oct 1993

Lina Gustilo, Seminar on Technical Writing, Manila, 4-8 Nov 1993

Nerissa Buelo, In-House Computer Training sponsored by the Department of Agriculture, Quezon City, 10-20 Nov 1993

Lucena Mallo, Seminar on Financial Control and Analysis, Manila, 18-21 Dec 1993

Nineteen employees attended the In-house Seminar on Values Clarification and Commitment to Service, Guimbal, Iloilo, 13-14 Dec 1993

STAFF DEVELOPMENT

Attendance in conferences**

Efren Ed. Flores represented AQD in about 20 consultative meetings and conferences in fisheries and aquaculture including hearings at the Philippine Senate. In conferences discussing AQD operation, Dr. Flores was accompanied by the Deputy Chief, RD Head, TID Head, and Special Assistant VT Sulit.

Twenty-three researchers, Third Asian Fisheries Forum, Singapore, 26-30 Oct 1992

Ninfa Calvez, Techniques and Methods of Transfer, Removal and Termination of Property Accountability in Government, Manila, 8 Feb 1992

Leonardo Pineda, Forum on Operation of a Procurement System for Common Used Supplies, Materials and Equipment for Government and Private Offices, Manila, 15 Feb 1992

Rene Alger and Jocelyn Coniza, Seminar on Taxation, Iloilo City, 21 Mar 1992; SGV Foundation Seminar, Iloilo City, 23 Sep 1992; Special Tax Seminar, Bacolod City, 29 Jul 1993

Lorna Rodriguez, Occupational and Environmental Health, UP-Manila, 6-11 Apr 1992

Relicardo Coloso, Mae Catacutan, Myrna Bautista, Ilda Borlongan, and Ma. Teresa de Castro, Updates for Biochemistry Teachers, Iloilo City, 21-23 May 1992

Susana Siar, Workshop on Developing Appropriate Rapid Rural Appraisal Techniques for Coastal Zone, Dumaguete City, 20-24 Jul 1992

**See also Papers Presented at Meetings, pp. 49-52, and Cooperation, p. 54

The Binangonan staff on their way to the station by pumpboat.



- Renan Saliente, Seminar on Control and Auditing in a Computerized Environment, Bacolod City, 24-27 Aug 1992
- Teresita Hilado and Gregorio Genzola, Seminar on Asset Disposal Systems and Procedures in Government, Manila, 5 Sep 1992
- Didi Baticados and Bienvenida Benedicto, Personnel Management Association of the Philippines National Convention, Iloilo City, 23-24 Sep 1992
- Ener Tacuyan, Technical Seminar for Electrical Engineers and Master Electricians, Iloilo City, 26 Sep 1992; Mid-year Membership of the Institute of Integrated Electrical Engineers of the Philippines, Inc., Bacolod City, 24-26 Jun 1993; 18th Annual Convention of the Institute of Integrated Electrical Engineers of the Philippines, Manila, 3-7 Nov 1993
- All Training and Information Division staff, Group Dynamics, Tigbauan, Iloilo, 8-9 Oct 1992
- Amelia Arisola, National Convention on Developing Special Collections: Filipiniana and General Assembly of the Philippine Librarians Association, Inc., Quezon City, 24-26 Nov 1992; First Professional Librarian Board Oath-taking, Manila, 18 May 1993; Seminar-Workshop on the Librarian's Changing Role in the Year 2000, Tagaytay City, 16-18 Sep 1993
- Augusto Surtida, Seminar on Current Trends of Graphics Design, Manila, 25-28 Nov 1992
- Antonina Duremdes, Accounting Update, Manila, 7-11 Dec 1992
- Marubeth Ortega and Luisa Pacino, Seminar Workshop on Professional Development for Librarians and Information Specialists, Iloilo City, 9-11 Dec 1992
- Evangeline Tubungan, 32nd Anniversary and Annual Convention and WONCA Regional Conference for Asia, Metro Manila, 5-10 Feb 1993
- Anicia Hurtado-Ponce, National Research Council of the Philippines Annual Meeting, Manila, 12-13 Mar 1993
- Rene Alger, Jocelyn Coniza, Erlinda Natividad, and Nora Tillo, Seminar on Withholding Income Tax and Simplified Net Income Tax Systems, Iloilo City, 13 Mar 1993
- Salvador Rex Tillo, Sr., Seminar on Health and Safety, Fire Protection and Control, Iloilo City, 19 Mar 1993
- Rolando Mamauag and Nemesio Ganon, Seminar on Warehouse Operations and Management, Makati, 22-31 Mar 1993
- Gilda Lio-Po, 22nd Annual Convention of the Philippine Society for Microbiology, Inc., Iloilo City, 12-16 Apr 1993
- Salvador Rex Tillo, Samson Jaspe, and Zaldy Suriaga, 13th Philippine Society of Mechanical Engineers Regional Conference, Iloilo City, 16-17 Jul 1993
- Sarah Loma Ortiguero, Seminar on Effective Business Writing, Manila, 4-5 May 1993
- Sixty-four researchers, National Seminar-Workshop on Breeding and Seed Production of Cultured Finfishes in the Philippines, Tigbauan, Iloilo, 4-5 May 1993
- Ma. Teresa de Castro, Workshop on Processing of Cephalopods and Seaweeds, Iloilo City, 5 Jul 1993; Annual Regional Convention of the Pollution Control Association



The Manila Office staff with the AQD Chief Dr. Flores (extreme left)

- of the Philippines, Inc., Iloilo City, 3-4 Dec 1993
- Ma. Luisa Pacino, ABAP Seminar on AACR 2.5 with emphasis on Second and Third Level Cataloguing, Quezon City, 15-16 Jul 1993
- Erlinda Natividad, Accounting Update Seminar, Manila, 23-27 Aug 1993
- Fe Parado-Estepa, Meeting of the Presidential Coordinating Committee on the Prawn Industry, Manila, 23-24 Aug 1993
- Relicardo Coloso, Arnil Emata, Josefa Tan-Fermin, Clarissa Marte, Oseni Millamena, Anicia Hurtado-Ponce, Gerald Quintio, and Susana Siar, Second Annual Research Review for the National Fisheries Research Program, Manila, 1-3 Sep 1993
- Rex Alobba, National Conference of the Personnel Management Association, Bacolod City, 15-17 Sep 1993
- Marubeth Ortega, Philippine Bookfair '93, Manila, 15-17 Sep 1993; Megatrends Management: Librarianship in the 21st Century Seminar, Manila, 7 Oct 1993; Seminar-Workshop on Health Documentation, Cebu City, 16 Nov 1993
- Bienvenida Benedicto and Perla Triño surveyed the training programs in Metro Manila in preparation for the formulation of the AQD Staff Development Program, 20-25 Sep 1993
- Sylvia Corro, SGV Group Conference on Profitable Materials Management, Bacolod City, 22-24 Sep 1993
- Alejandro Santiago, Consultative Meeting on African Catfish, Munoz, Nueva Ecija, 14 Oct 1993
- Nelda Ebron, Juan Garin, Jr., Jocelyn Coniza, Lucena Mallo and Amelita Subosa, Seminar on Techniques of Financial Statement Analysis and Management, Iloilo City, 23 Oct 1993

INFRASTRUCTURE

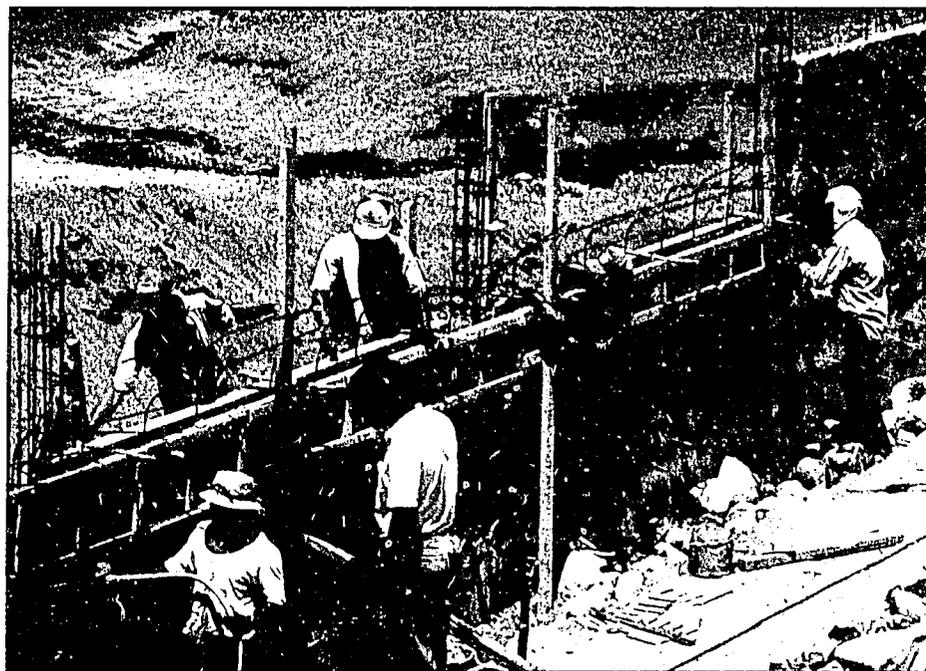
To continually upgrade research facilities, hatchery-laboratories for fishes, seaweeds, and molluscs were constructed. Several other structures were built, upgraded or replaced.

Future plans include a new telephone system, installation of a back-up generator that can power all of the Tigbauan Main Station, and upgrading of aeration, freshwater supply, and electrical systems.

INFRASTRUCTURE

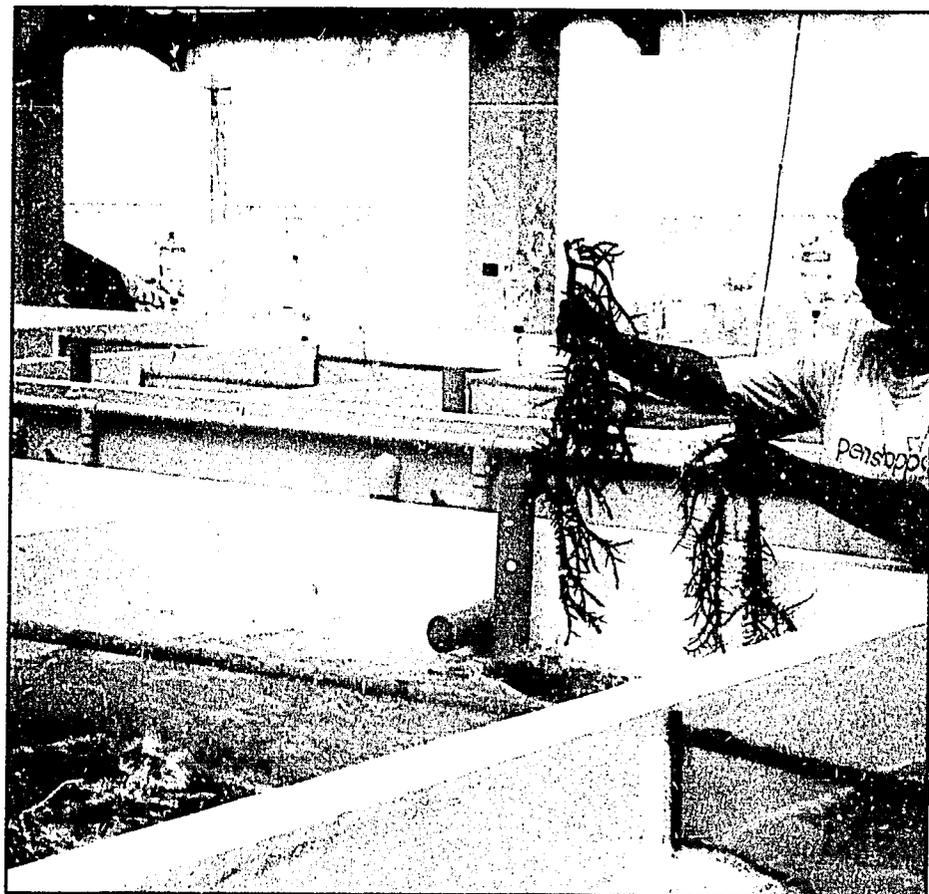
New infrastructure

- Marine Fish Hatchery (Phase I and II). Phase II was funded by the Government of Japan
- Seaweed-Mollusc Hatchery and Wet Laboratory
- Cooling tower for the 450 and the 85-KVA standby generators
- Pontoon bridge from floating cages to researchers quarters at Igang Marine Substation
- Shoreline protection and fences at TMS (Phase I and II)
- Concrete columns of covered walk between Research and Nutrition Buildings
- Footwalk and fence to the housing area
- Plant Nursery and botanical garden
- Car shed between Research and Administration Buildings



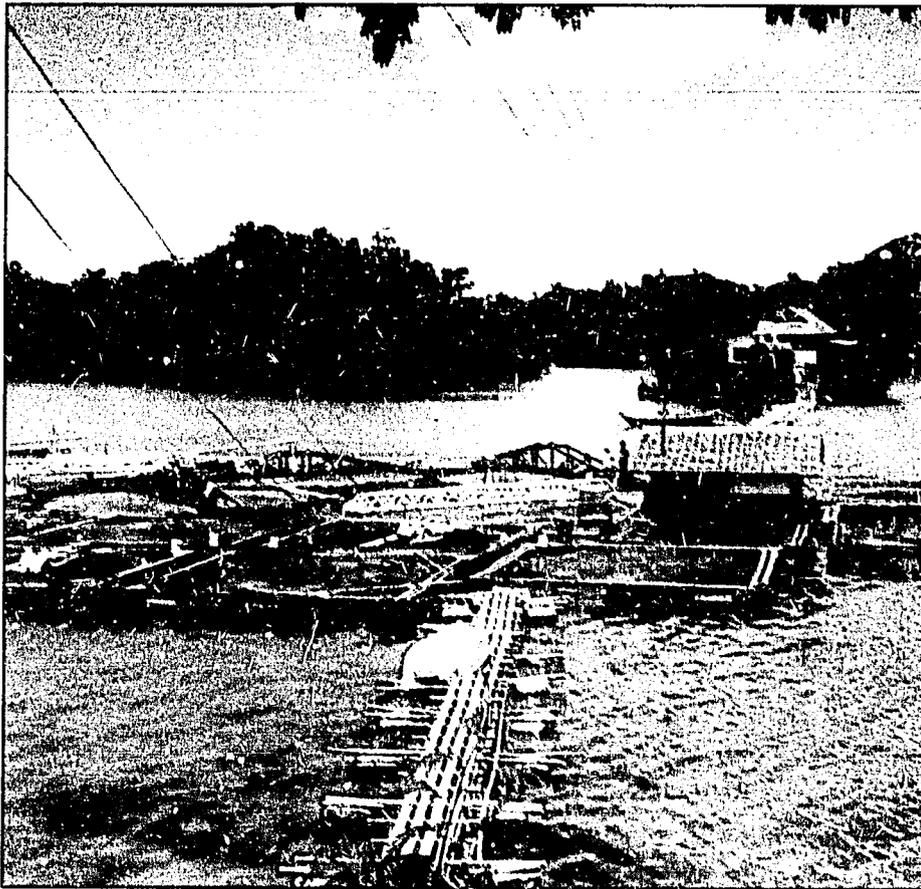
A perimeter fence was started on the seaward side.

**The newly constructed
Seaweed-Mollusc
Hatchery and Wet
Laboratory**

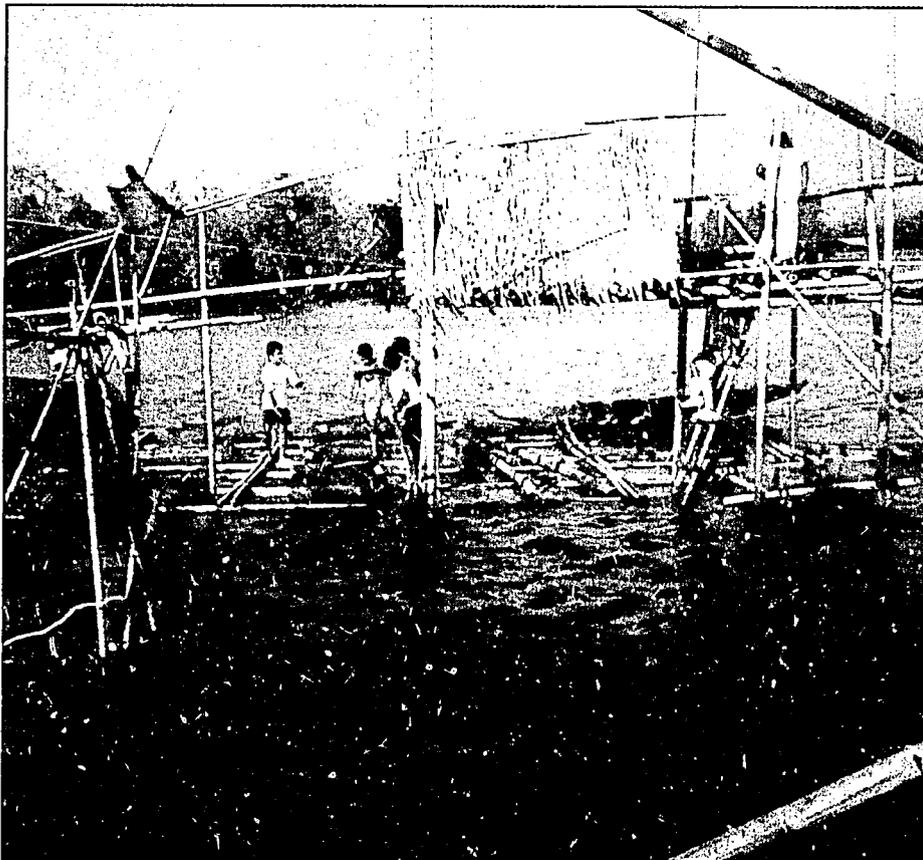


**Tigbauan Main Station
is well maintained and
is rapidly becoming a
woodland park.**





The Igang Marine Station has a new bridge, egg collectors and floating cages.



AQD built floating cages in the Iloilo River for collaborative studies with the Department of Agriculture.

SPECIAL NOTES

SEAFDEC/AQD inaugurated the Museum and Biodiversity Place in 1993. AQD also organized an ad hoc committee for environmental protection.

AQD commissioned an organizational review to determine how AQD can increase its efficiency and how it can wisely use its resources. The first of the three phases has been completed.

The Philippines convened in August 1993 the PTAC that oversees SEAFDEC/AQD's progress. Recommendations for AQD programs were made; these were incorporated in the 1994 program proposed during the 16th Meeting of the SEAFDEC Program Committee and approved during the 26th Meeting of the SEAFDEC Council.

AQD celebrated its 20th year of research and development on 9 July 1993. The occasion was highlighted by the visit of the training vessel M/V SEAFDEC from Thailand with Secretary-General Maitree Duangsawasdi.

SPECIAL NOTES

20th AQD Anniversary Celebration

AQD celebrated on 9 July 1993 its 20th Anniversary with a program attended by the SEAFDEC Council Director for the Philippines, the SEAFDEC Secretary-General, and former AQD Chiefs. Certificates of Recognition were awarded to four former AQD Chiefs and to seven employees who also celebrated their 20th year of service. Certificates of Appointment were awarded to 16 Scientists. The Second Dean D.K. Villaluz Memorial Lecture, "Milkfish industry: beyond breeding and fry production research," was given by AQD Scientist Dr. Clarissa Marte.

The 20th Anniversary was highlighted by the visit to Iloilo City of M/V SEAFDEC, the new training vessel of the SEAFDEC Training Department. M/V SEAFDEC has highly sophisticated fishing and navigation equipment.

An Anniversary Souvenir Volume was published that highlighted AQD research and development the past 20 years.

SPECIAL NOTES

AQD Museum and Biodiversity Place

The SEAFDEC AQD Museum and Biodiversity Place, inaugurated 9 July 1993, is an ongoing exhibit

open to the public. It is located in the west wing of the Research Building.

The AQD Museum had its beginnings in 1975-1980 when Hiroshi Motoh and Shigeru Kumagai collected crustaceans and fishes in the course of ecological studies on tiger shrimp and milkfish. Motoh and his assistants identified the crustacean collection and Teodora Bagarinao identified the fish collection. The collections were brought together in a 'museum' in 1985 but it was not until 1992 that AQD formally established the Museum.

The AQD Museum now contains the 1975-1980 collections of crustaceans and fishes and the more recent fish collections of Bagarinao and Hiroshi Kohno. It is also home to the 'Seaweeds of Panay' collection of Anicia Hurtado-Ponce, Ma. Rovilla-Luhan and Nicolas Guanzon. Molluscs were added to the museum starting with the personal shell collections of Bagarinao, Wenresti Gallardo, and Ma. Rovilla Luhan. Corals are being acquired, starting with beached specimens, and now new specimens from the resource assessment study of Clarissa Marte in Malalison. In the future, seagrasses, mangroves, and more invertebrates will be collected.

Rather than being merely a depository of marine plants and animals, the AQD Museum aims to be an interesting and educational exhibit for SEAFDEC employees and visitors, particularly for school children and older students. Posters on biodiversity and the environment are displayed in the hallways. Additional exhibits will be set up to highlight different aquatic species — their beauty, biology, and importance in fisheries and aquaculture. Just outside is a garden of a wide variety of ornamental plants. The

AQD Museum is thus also a Biodiversity Place, part of AQD's effort to increase public awareness of nature's beauty and immense variety.

The AQD Museum and Biodiversity Place also aims to be a laboratory for undergraduate and graduate students interested in natural history studies. AQD will provide specimens, workspace, and scientific advice to interested students. For more information, contact the Museum Curator, Teodora Bagarinao.

SPECIAL NOTES

Environment Action Group: Think Globally, Act Locally

The Environment Action Group was organized in August 1992 by Teodora Bagarinao and 20 other researchers and information specialists at SEAFDEC/AQD. The Office of the Chief officially recognizes the EAG as the AQD Working Committee for the Protection of the Environment and provides funds for EAG activities. The aims of EAG are:

- To identify local environmental problems (at AQD, in Tigbauan, in Iloilo, in Region VI) and study how they might be solved;
- To formulate and implement guidelines for the protection of the environment at AQD, particularly in terms of waste management and resources conservation;

- To promote nature-environment education, especially among young people.

EAG examined the environmental situation at AQD and held consultations to implement workplans, or guidelines and regulations, for a better environment. Most of the following are already in effect and the others are continuing efforts.

- Prohibit garbage dumping on the beach.
- Prohibit smoking in laboratories and common offices; set up smoking and non-smoking areas.
- Ban the purchase of chlorofluorocarbon aerosols.
- Ban the use of synthetic pesticides. Keep offices and laboratories clean all the time.
- Discourage the use of styrofoam and plastic food packaging.
- Separate recyclables (paper, cardboard, glass, metal, plastics) from wastes before disposal.
- Quantify and characterize AQD effluents, including chemicals from laboratories.
- Conserve electricity (minimize aircon hours; turn off all electricals when not in use).
- Conserve water (report and repair leaky faucets and toilets immediately).
- Grow trees and other plants all over AQD all year round: make AQD green.
- Encourage walking and bicycling at AQD for health, fitness, and nature awareness.

EAG built a kiosk for outdoor meetings. The kiosk reduces dependence on airconditioning, brings people 'back to nature' in a garden, and showcases the reuse and recycling of plastic containers and other 'wastes' as plant containers. EAG made waste bins (cum plant box and environment

poster) for the lobbies of major buildings at AQD.

EAG established a botanical garden in July 1993 and spearheaded a massive tree-planting at AQD. A variety of trees were planted on a barren hillside that will later be landscaped into an educational botanical park. Various ornamentals and other small plants are grown in the EAG Garden behind the AQD Museum. These gardens showcase plant diversity and aim to inform people of the value of forests and plant resources.

EAG held a workshop on 11-13 January 1993 to prepare environment education materials. The 10 leaflets from that workshop were expanded to about 60 others, all of which will be published as the environment education kit "Towards a Viable Environment: What Individuals Can Do" by Teodora Bagarinao, Milagros Castanos and Sid Tendencia.

EAG has an on-going environment consciousness program for the elementary schools near AQD. Environment Consciousness Day was held at two schools in 1992 — with a rally-parade, nature exhibits, films, art and writing competitions, and nature books and T-shirts as prizes. Three elementary schools attended Children's Day at the Museum (plus nature films and a visit to the fish hatchery) during AQD's 21st Anniversary. A Community Library will be set up by EAG in the Buyuan Elementary School.

SPECIAL NOTES

Organizational review

Phase I of the AQD organizational review, conducted by the Sycip, Gorres and Velayo, Inc. (SGV), concentrated on the organization and human resources management. The review assessed the capability of the organization and how its human resources support the organization's new thrusts, plans, and strategies. It covered organizational structure, personnel recruitment and staffing, job evaluation and compensation, performance appraisal, and training and development.

The top and middle management of AQD served as members of the Steering and Technical Study Teams. Selected AQD employees were interviewed.

SGV submitted its initial findings in August 1993 and recommended the following:

- Total overhaul of management policies and practices. The present rules governing AQD functions are to be reviewed, strengthened if appropriate, or changed to better address the needs of AQD itself, its target clientele, and its employees.

Personnel management will be reviewed as to the qualifications for line management positions, workplace behavior and disciplinary action, performance measures and rewards, incentives for research work, employee empowerment, communication and interaction.

- A detailed organizational study to design an organizational structure that can best achieve AQD's

mandate. Job design and structural alignment, work planning and staffing will be assessed.

SGV also noted that the short-term tenure (two years with possible extension) of the Chief resulted in the interruption of promulgated administrative policies to the detriment of AQD.

SPECIAL NOTES

7th Meeting of the Philippine Technical and Administrative Committee (PTAC) for SEAFDEC

PTAC is tasked to review AQD's progress and its proposed program of activities before these are presented to the SEAFDEC Program Committee for deliberation. The Seventh Meeting of PTAC was held at DA in Quezon City on 9 August 1993 and was attended by the DA Undersecretary, the BFAR Director, the Dean of UPV College of Fisheries, and the AQD Chief. The DA Undersecretary (also the SEAFDEC Council Director

for the Philippines) chaired the meeting in the absence of the DA Secretary.

Highlights of the discussion:

- AQD fellows returning from training or degree programs abroad are requested to serve BFAR or other government institutions in the Philippines. However, the AQD Chief noted that this might not be possible as researchers have to conduct studies at AQD immediately upon their return or in many cases continue previous studies. But returning fellows may provide short-term technical assistance to BFAR upon request. BFAR was asked to propose a mechanism concerning this program.
- AQD was commended for its Adopt-a-Milkfish Broodstock Scheme. To give it more coverage, the DA Undersecretary agreed to formally launch the program at the Igang Marine Substation.
- PTAC asked AQD to compare the sales and distribution of its publications before and after the prices were reduced by half.

PTAC endorsed AQD's 1994 program of activities for the 16th Meeting of the SEAFDEC Program Committee.

On its third decade, SEAFDEC/AQD aims to develop aquaculture technologies that are sustainable and environment-friendly and that give more equitable benefits to fisherfolk.

FINANCE

Funds for the operation of SEAFDEC/AQD is contributed by the Philippine Government, and augmented by AQD's auxiliary income — sale of research by-products and in-house publications, training fees, housing rentals, vehicle use charges, interest income, and sale of unserviceable items.

The Government of Japan contributes funds for equipment, fellowships for trainees and researchers, and a portion of operation. Grants were also received from collaborating institutions.

FINANCE

Financial report

The contributions, grants, and other receipts received in 1992 and 1993 were as follows:

	<i>1992</i>	<i>1993</i>
• CONTRIBUTIONS		
Philippine Government	US \$ 3,369,063	3,472,400
Government of Japan		
Cash	451,643	480,541
In Kind	293,830	201,328
• GRANTS		
DA-BAR Fisheries Sector Program	144,354	79,692
IDRC	110,768	46,608
NACA	-	38,800
ICLARM-AFSSRN	5,287	8,416
IFS	9,500	9,882
CTPP-BEL Industries, Inc.	-	6,250
Association of Fish Meal and Fish Oil Manufacturers in Denmark	-	7,400
Nichimen Corporation/Showa Denko	2,981	-
Takeda Chemicals	9,380	397
LAARC	-	5,666
• OTHER RECEIPTS	131,879	369,211
TOTAL	US \$ 4,528,685	4,726,591

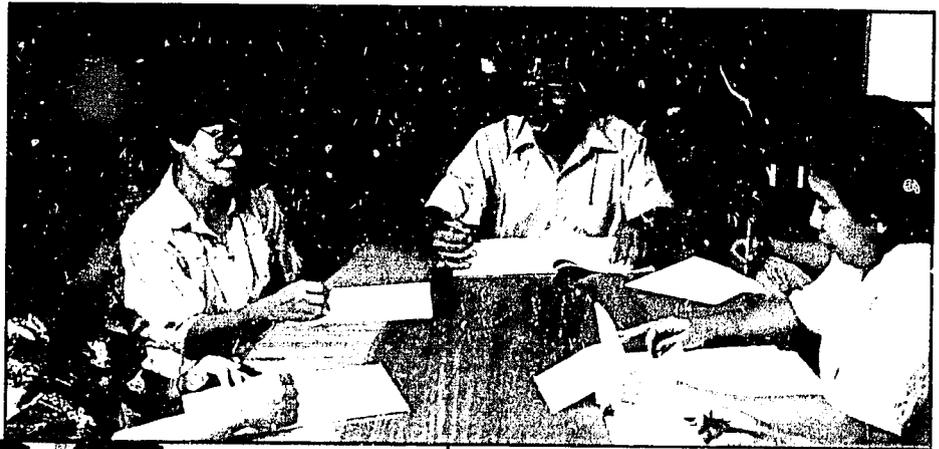
Expenses by function and by classification for 1992 and 1993 were as follows:

	<i>1992</i>	<i>1993</i>
BY FUNCTION:		
• Research Division	US \$ 2,108,004	2,427,490
• Training and Information Division	457,084	436,150
• Administration Division	1,056,789	1,282,915
• Finance Division	197,767	240,163
• Office of the Chief	<u>198,662</u>	<u>214,871</u>
TOTAL	4,018,306	4,601,589
BY CLASSIFICATION:		
• Personnel services	2,274,482	2,800,785
• Maintenance and other operating expenses	1,353,169	1,260,945
• Capital outlay	<u>390,655</u>	<u>539,859</u>
TOTAL	US \$ 4,018,306	4,601,589

Note: Fund balances at year-end represent unspent grants and contributions for subsequent period project requirement.

Annex

The People Behind SEAFDEC/AQD



Finance Division Head
Rene Alger discusses budget
plans with his staff.



Audlovisual Technician Isidro
Tendencia at the video
editing console.

Water pump operators
Rufino Bocol and
Teofilo Tusalem.



Administration Division Head
Rufil Cuevas at a meeting with
his staff.



MANAGEMENT

Efren Ed. C. Flores, *PhD, Department Chief*
Soichiro Shirahata, *BS, Deputy Chief*
Relicardo Coloso, *PhD, Research Division Head*
Cesar Villegas, *PhD, Training & Information Head*
Rufil Cuevas, *BS, Administration Division Head*
Rene Alger, *CPA/BS, Finance Division Head*

FOREIGN EXPERTS

Norio Yasunaga, *PhD, JICA Expert*
Hiroshi Yabu, *PhD, JICA Expert*
Junji Imayoshi, *MS, JICA Expert*
Karsten Shroeder, *MS, Visiting Scientist*

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Josefa Fermin, *MS, Scientist*
Arnold Emata, *PhD, Asso. Scientist*
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Grace Garcia, *MS, Res. Associate*
¹Nieves Toledo, *MS, Res. Associate*
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Rosenio Pagador, *BS, Tech. Assistant*
²Miguel delos Santos, *BS, Tech. Assistant*
²Josephine Nocillaño, *BS, Tech. Assistant*
²Dennis Candia, *BS, Tech. Assistant*

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²Evelyn Grace de Jesus, *PhD, Scientist*
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Armando Fermin, *MS, Asso. Scientist*
Jesus Almendras, *MS, Asso. Scientist*
Fe Dolores Estapa, *MS, Asso. Scientist*
³Felix Ayson, *MS, Res. Associate*
³Gilda Javellana, *MS, Res. Associate*
Demetrio Estenor, *MS, Res. Associate*

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Rolando Gapasin, *MS, Res. Associate*
Milagros de la Peña, *MS, Res. Associate*
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Daniel Lojera, *BS, Tech. Assistant*
²Sonny Boy Balad-on, *BS, Tech. Assistant*
²Nora Caberoy, *BS, Tech. Assistant*
²Mary Chona Estudillo, *BS, Tech. Assistant*
²Glendell Seronay, *BS, Tech. Assistant*

Farming Systems Section

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Isidra Tuburan, *MS, Asso. Scientist*
Renato Agbayani, *MBA, Asso. Scientist*
Neila Sumagaysay, *MS, Asso. Scientist*
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Wenresti Gallardo, *MS, Res. Associate*
³Ma. Rovilla Luhan, *MS, Res. Associate*
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Edgar Amar, *MS, Res. Associate*
Kaylin Corre, *MS, Res. Associate*
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²Esperanza Chavoso, *BS, Tech. Assistant*
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²Helen Marcial, *BS, Tech. Assistant*
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²Bothany Gumban, *BS, Tech. Assistant*
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Lydia Plondaya, *BS, Information Assistant*
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Luisa Pacino, *BS, Information Assistant*
Carolina Unggui, *BS, Clerk*
Alfredo Gustilo, *BS, Clerk*

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Salve Gotera, BS, *Clerk*

Office of the Deputy Chief

Lina Gristilo, BS, *Secretary*

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Corazon Cendaña, BS, *Administrative Assistant*
Larni Angellie Espada, BS, *Tech. Assistant*
Nancy Accol, BS, *Secretary*
Rufino Macalalag, *Tech. Assistant/ Supervisor,*
Lab. Equipment Maintenance

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Rolando Mamauag, BS candidate, *Adm. Assistant*

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Ma. Clara Dato, BS, *Adm. Assistant*
Estrella Camacho, BS, *Financial Assistant*
Leticia Mariano, BS candidate, *Auditing Assistant*
Nerissa Buelo, BS, *Information Assistant*
Elma Africa, BS, *Property Custodian*
Florencio Dalusong, BS, *Property Custodian*
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Binangonan Freshwater Substation

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Igang Marine Substation

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Engineering

Salvador Rex Tillo, BS, *Section Head*
Samson Jaspe, BS, *Mechanical & Electrical Engineering Supervisor*
Zaldy Suriaga, BS, *Actg. Water & Aeration Services Supervisor*
Mario Jopson, BS, *Actg. Carpentry Supervisor*
Jose Edgar Gaton, BS, *Craftsman/Janitorial-in-Charge*
Reynaldo Tenedero, BS, *Engineer*
²Ener Tacuyan, BS, *Engineering Assistant*
Susana Sanchez, BS, *Clerk*
Ramon Soriano, BS, *Clerk*

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Gregorio Genzola, BS candidate, *Actg. Property & Supply Supervisor*
Reynaldo Tuburan, BS, *Property Custodian*
Dante Guinalon, 2nd yr. *College/Warehouse-in-Charge*
Leonardo Pineda, AB, *Adm. Assistant*
Juan Bautista, BS, *Clerk*
Augusto Canto, AB, *Clerk*

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Perla Triño, BS, *Personnel Assistant*
Cynthia Animas, BS, *Personnel Assistant*
Ma. Antonia Tresvalles, AB, *Personnel Assistant*
² Ma. Rizza Tenerife, AB, *Clerk II*

Medical Services

²Evangeline Tubungan, MD, *Physician*
²Therese Hilomen, DDM, *Dentist*
Lorna Rodriguez, BS, *Nurse*
²Bernie Golmayo, BS, *Medical Technologist*

FINANCE DIVISION

Accounting

Jocelyn Coniza, *CPA/BS, Section Head*
Erlinda Natividad, *BS, Accountant*
Nora Tillo, *BS, Financial Assistant*
Evelyn Torres, *BS, Financial Assistant*
Amelita Subosa, *CPA/BS, Financial Assistant*
Jesus Mansoy, *BS, Financial Assistant*
Romulo Taleon, *BS, Financial Assistant*
Joaquin Vera Cruz, *BS, Financial Assistant*

Budget-Cashiering

Nelda Ebron, *BS, Section Head*
Juan Garin, Jr., *BS, Actg. Head, Cashiering*
Lucena Mallo, *BS, Actg. Budget-in-Charge*
Arden Tillo, *BS, Financial Assistant*
Ester Cang, *BS, Financial Assistant*
Rosario Torred, *BS, Financial Assistant*
Levy Jean Hilado, *BS, Financial Assistant*
David Grió, Jr., *BS, Financial Assistant*
Yolanda Gepulla, *BS, Financial Assistant*



Engineering Section Head Salvador Rex Tillo discusses structural design with staff.



Laboratory equipment maintenance staff at work.

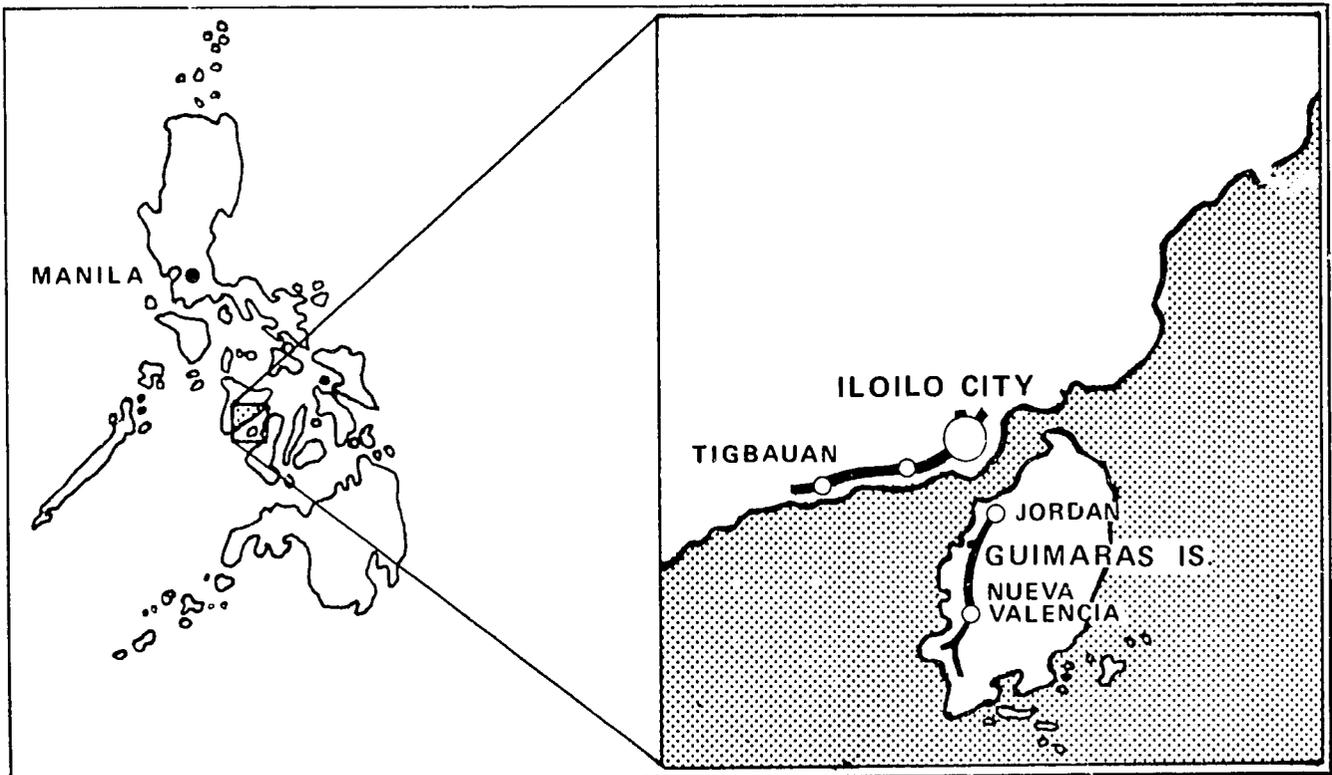
-
- 1 *On leave*
 - 2 *Contractual*
 - 3 *On study leave*

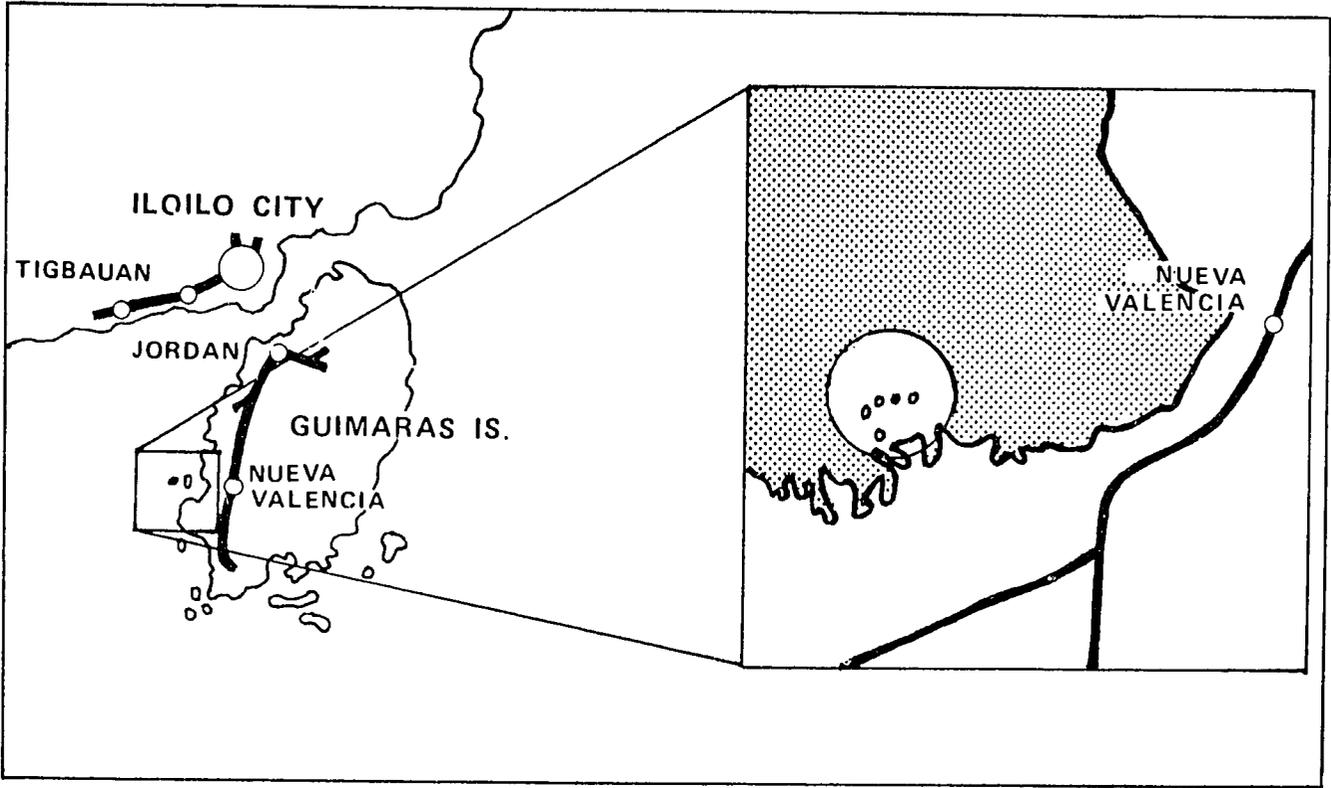
Dr. Evangeline Tubungan conducting annual staff medical check-up.



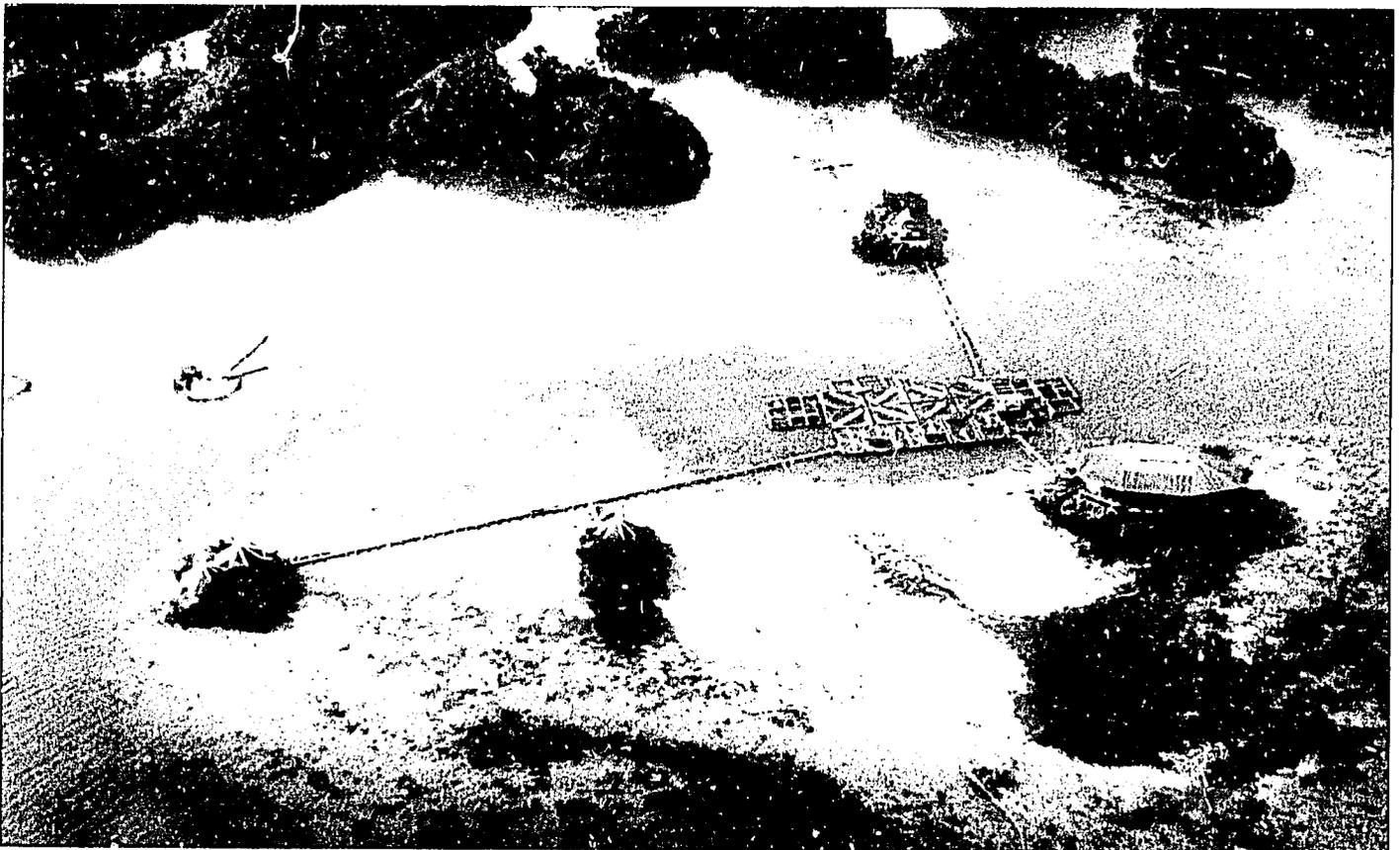


Aerial photo of Tigbauan Main Station, Iloilo





Aerial photo of Igang Marine Station, Guimaras province.



AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
TRAINING AND INFORMATION DIVISION

TENTATIVE TRAINING PROGRAM FOR 1995

	Dates
Coastal Aquaculture*	16 January - 15 March
Culture of Natural Food	07 March - 06 April
Fish Health Management	18 April - 29 May
Marine Finfish Hatchery	06 June - 25 July
Larviculture	02 August - 19 September
Freshwater Aquaculture	04 September - 13 October
Aquaculture Management	21 August - 20 September
Fish Nutrition	24 October - 08 December

* *By invitation only.*

INTERNSHIP/PRACTICUM TRAINING

Upon request, internship training may be arranged for individuals and small groups in areas of nutrition and feed formulation, chemical/proximate analyses, plankton culture, instrumentation and other laboratory work. The Department also accepts a number of undergraduate fisheries students for practical work (maximum of 400 hours) as a requirement for graduation.

For application forms and further information, please contact:

**TRAINING AND INFORMATION DIVISION
SEAFDEC AQUACULTURE DEPARTMENT
P.O. Box 256 5000 Iloilo City
Philippines
Tel. No.: 270-379, 7-05-05, 271-009
Cable: SEAFDEC Iloilo
Fax: 63-33-271-008**

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Cable: SEAFDEC Manila
Telex No.: 29750 SEAFDC PH
Fax: 63-2-924-55-11 loc. 23**