

1988 Annual Report

Aquaculture Department
Southeast Asian Fisheries Development Center



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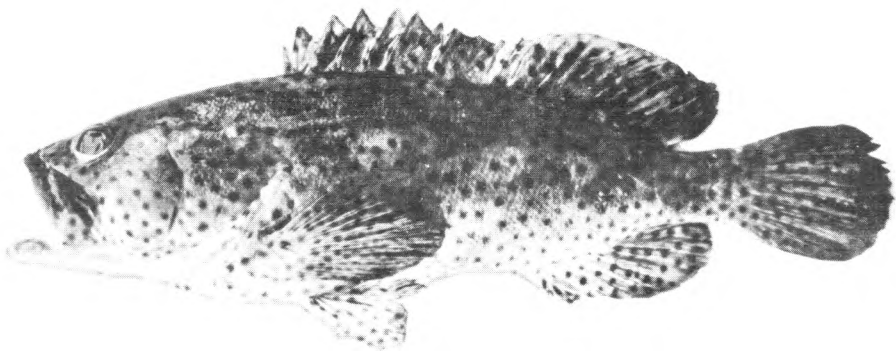
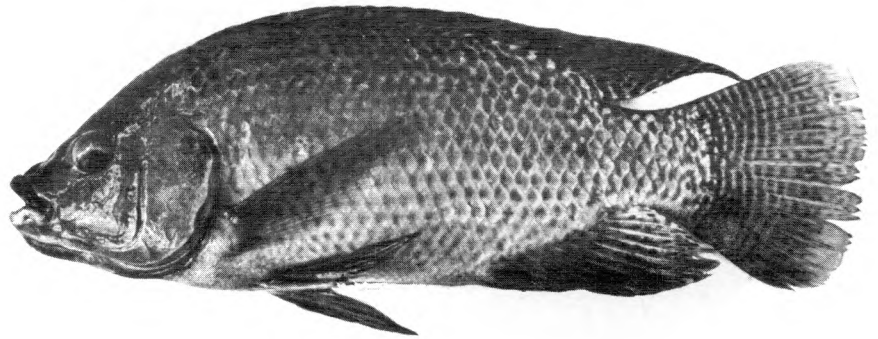
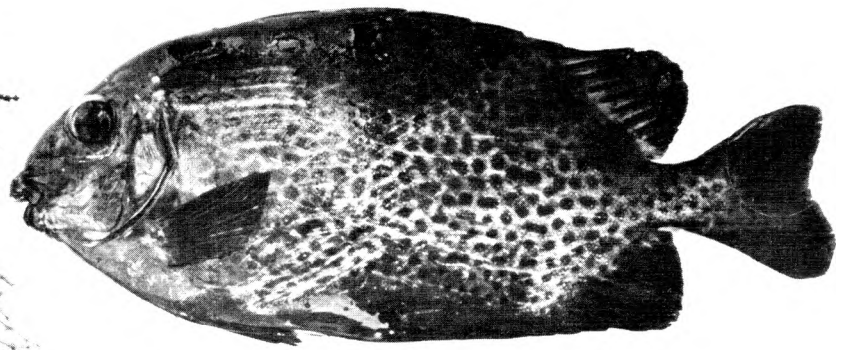
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ACRONYMS

ADSEA	- Aquaculture Development in Southeast Asia
AFSSRN	- Asian Fisheries Social Science Research Network
AQD	- Aquaculture Department
ARC	- <i>Artemia</i> Reference Center
ATOP	- Aquaculture Technology Outreach Program
BAA	- Brackishwater Aquaculture Abstracts
BFAR	- Bureau of Fisheries and Aquatic Resources
BFS	- Binangonan Freshwater Station
BRAIS	- Brackishwater Aquaculture Information System
CAL	- Centralized Analytical Laboratory
DA	- Department of Agriculture
DTI	- Department of Trade and Industry
FAO	- Food and Agriculture Organization
GnRH	- Gonadotropin-Releasing Hormone
ICLARM	- International Center for Living Aquatic Resources Management
IDRC	- International Development Research Centre of Canada
IFS	- International Foundation for Science
INFOFISH	- Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in Asia and the Pacific Region
JICA	- Japan International Cooperation Agency
LBS	- Leganes Brackishwater Station
LHRH	- Luteinizing Hormone-Releasing Hormone
NACA	- Network of Aquaculture Centres in Asia
NBBP	- National Bangus Breeding Program
NGOs	- Non-Governmental Organizations
PCARRD	- Philippine Council for Agriculture and Resources Research and Development
PCAMRD	- Philippine Council for Aquatic and Marine Research and Development
PUFA	- Polyunsaturated Fatty Acid
PHRDC	- Philippine Human Resources Development Center
RAFC	- Regional Agricultural and Fishery Council
SEAFIS	- Southeast Asian Fishery Information System
TLRC	- Technology and Livelihood Resource Center
TRS	- Tigbauan Research Station
UPV	- University of the Philippines in the Visayas

OVERVIEW

Since its establishment in 1973, AQD has shown sustained achievements in aquaculture, thus contributing greatly to the progress of the aquaculture industry in the region.

Continuing research on prawn culture at AQD has generated techniques in the areas of maturation, hatchery, nursery, and grow-out. Milkfish breeding technology developed at AQD is currently being verified at various sites in the Philippines. It is hoped that these technologies would significantly satisfy the demands of the industry in the region.

The economic viability of hatchery techniques developed for rabbitfish and refined for sea bass is being undertaken. Results of studies on other finfishes are being verified.

Significant research results are documented in numerous scientific papers published in local and foreign journals. Verified results are packaged into extension materials and disseminated to the aquaculturists and fish farmers.

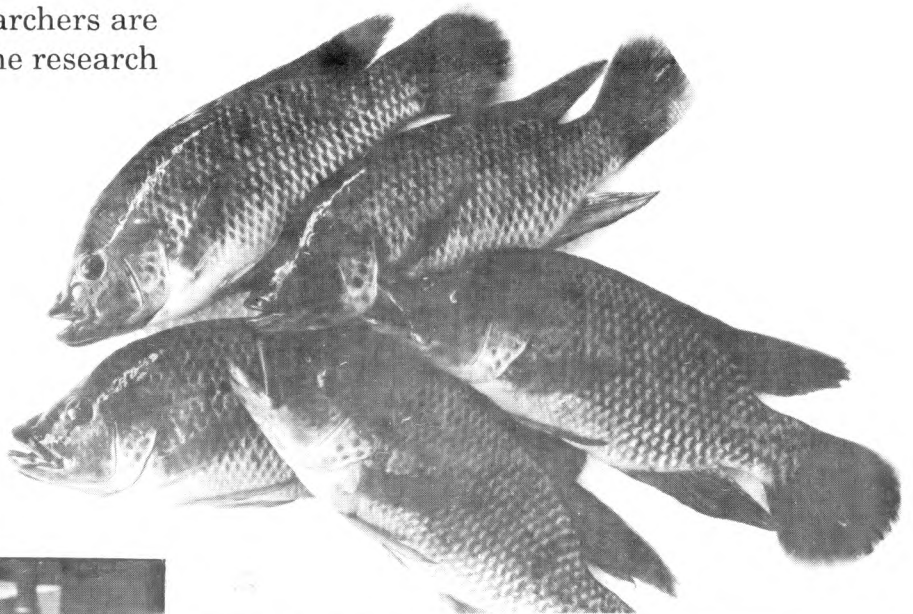
Research outputs of AQD researchers are being increasingly recognized by the research

and scientific communities. During the past two years, various awards for scientific papers were earned by AQD.

Specific for 1988 is the redirection of AQD's research thrust to reflect the regional research priorities identified during the *Seminar on Aquaculture Development in Southeast Asia* held in the Philippines in September 1987. Likewise, training programs were prioritized based on training requirements in aquaculture in Southeast Asia as assessed during a seminar held in Thailand in May 1988.

Extension activities were revived and intensified in order to help the small fish farmers raise their standard of living and contribute to the farmer's profitability campaign of the present government.

AQD likewise continues to foster closer relationship with various governments and organizations.



The Aquaculture Department has generated techniques in the areas of maturation, hatchery, nursery, and grow-out...It is hoped that these technologies would significantly satisfy the demands of the industry in the region... and help the small fish farmers raise their standards of living.

RESEARCH

AQD intensified its research activities on fin-fishes and crustaceans, and resumed activities on seaweeds. The research activities were grouped into four main categories - breeding, farming systems, feed development, fish health - and reflected the recommended research priorities identified during the *Seminar on Aquaculture Development in Southeast Asia* (ADSEA '87) held in Iloilo City, September 8-12, 1987. AQD also conducted research on economics of aquaculture systems.

Research Studies

Sea Bass (*Lates calcarifer*)

- Advancement of gonadal maturation and spawning in sea bass by LHRHa and 17- α methyltestosterone pellet implantation.

Implantation of pelleted luteinizing hormone-releasing hormone analogue (LHRHa) and LHRHa plus methyltestosterone (MT) (200 μ g/kg) in early March significantly increased the number of sexually mature females in April, whereas three monthly implantations of a lower dose (100 μ g/kg) of these pelleted hormones proved effective in May. Sexual maturation among male sea bass was significantly advanced in April and May following two and three monthly implants of pelleted MT (100 μ g/kg). Sea bass which were induced to mature early by these hormonal therapies were successfully induced to spawn in early May by a single injection of LHRHa.

- Ammonia and nitrogen excretion rates in juvenile sea bass: Effect of temperature, salinity, and pH.

There was no significant difference in the growth and survival of sea bass juveniles reared for 30 days in salinities 0, 8, 16, 24 and 32 ppt. Freshwater-adapted fish showed significantly higher ammonia excretion rate than seawater-adapted fish. A high negative correlation was established between body weight and ammonia excretion rate for freshwater- and seawater-adapted groups; it is best described by the allometric equation $Y=24.258X^{-0.494}$ for the former and $Y=20.824X^{-0.667}$ for the latter, where Y is the excretion rate in μ gNH₃-N/mg/hr and X is the body weight.

- Manipulation of stocking density and feeding regimes for mass production of sea bass juveniles.

Growth of sea bass larvae (day 14) stocked at 5 individuals/l was highest compared to those stocked at 10/l and



Sea bass juveniles feeding on pellets.

15/l. During the 30-day period, half of the stock was reduced every 10 days in all treatments. Average standard length (SL) and dry weight of the larvae after 30 days were 17.12 mm, 0.299 g (5/l); 12.23 mm, 0.117 g (10/l); and 13.06 mm, 0.138 g (15/l). Survival rates did not differ significantly among treatments. A feeding level of 5-6 *Artemia*/ml given four times daily resulted in highest growth (SL 14.4 mm; 0.176 g dry wt) and survival (59%).

- Integrated culture of sea bass and tilapia: The use of live tilapia as food for sea bass, *Lates calcarifer* (Bloch).

Two methods of rearing tilapia as forage fish for sea bass juveniles were evaluated. Tilapia stocked at 5000/ha at 1:3 male-to-female were reared two months prior to stocking sea bass juveniles. After 75 days, sea bass juveniles (initial body weight, 10-95 g) were bigger (49 g; 15.3 cm) in ponds where they mingled with tilapia compared to those in ponds (41 g; 13.7 cm) where they were separated from tilapia by a 1-cm mesh net enclosure.

- Alternate sources of protein for fishmeal in *Lates calcarifer* diets.

Different plant and animal proteins were evaluated as partial substitutes for fishmeal in diets of *Lates calcarifer* fry and juveniles. Weight gain of fry increased with the level of dietary protein (38, 43, 47%) and lipid (8, 12, 15%). Replacement of 20% fishmeal protein with shrimp head protein in 45% protein diet gave 0.22 g weight gain of fry in four weeks, better than did similar percentage protein substitutions with meat and bone meal (0.19 g), soybean meal (0.18 g), yeast (0.13 g), and all-fish meal (0.20 g). For juveniles, up to 10% fishmeal protein could be substituted with soybean meal protein without affecting growth. Animal protein diets (shrimp head meal, fishmeal, meat and bone meal) gave better growth than did diets with yeast protein or yeast-animal protein combination.

In progress:

- Effect of temperature and ration size on growth and energy utilization of sea bass: Food consumption, feeding rate, salinity and temperature tolerance of sea bass fry and fingerlings.

Grouper (*Epinephelus* sp.)

In progress:

- Induced spawning and larval rearing of grouper, *Epinephelus* sp.

Rabbitfish (*Siganus guttatus*)

- Reproductive performance of hatchery-bred *Siganus guttatus* broodstock fed different levels of fats.

The criteria used to evaluate the effects of different levels of fats (12, 15, 18%) on the reproductive performance of *S. guttatus* on day 14 were: total number, size and weight of spawned eggs; fertilization and hatching rates; number of normal larvae; larval length, size of yolk sac and oil globule; rate of yolk resorption; and larval survival. Of these, only number of normal larvae and larval survival gave significant results. Broodstock fed diet with 18% fat had the highest number of normal larvae (368×10^3) with significantly higher survival (15%) compared to those fed diets with 12-15% fat.

- Effect of supplemental diet on signals cultured in ponds with filamentous green algae.

Two commercial feeds with protein content of 20.8 and 25.5% were given as supplemental diet (2% fish biomass) to siganid juveniles reared for one month in ponds grown with *lumut* (*Chaetomorpha* sp.) as forage. The fish stocked at 3000/ha and with average initial weight of 9.55 g were significantly bigger (ave. body wt., 81.6 g, $P < 0.05$) after 3 months of feeding supplemental diet containing 25.5% protein compared to those fed the commercial feed containing 20% protein (body wt., 55.5 g) and to those not fed the supplemental diet (body wt., 48.8 g).

- Weaning of siganid to artificial diets with varying protein-to-energy ratios.

Twenty-five-day old larvae were transferred in 250-l fiberglass tanks at a density of 3.3 ind/l and weaned gradually to isocaloric diets with 39, 41, 51, and 56% protein. Growth after 25 days was superior in larvae fed artificial diets as compared to larvae fed *Artemia* nauplii. Larvae in the artificial diet treatments did not differ significantly based on growth (body weight, percentage metamorphosis) and percentage survival.

Six semipurified diets with different levels of protein (25, 35, 45%) and energy (3,161; 3,832 kcal/kg) were fed for 8 weeks to *Siganus guttatus* fry in 250-l tanks at a stocking density of 80 fish/tank. Growth increased with increasing protein ($P < 0.01$) and energy ($P < 0.05$). Within isocaloric diets, a positive correlation ($r = 0.96$) was found between dietary pro-

tein-to-energy ratio (P/E) and fish growth. Protein productive value (PPV) and protein efficiency ratio (PER) were negatively correlated with P/E (PPV = $50.16 - 0.19X$, PER = $2.83 - 0.12X$; X is P/E). Based on growth rate and efficiency of protein utilization, a diet with 35% protein and 3,832 kcal/kg energy density is best for siganid fry. Carcass fat level increased in fish given 3,832 kcal/kg energy density. Carcass protein and ash remained essentially constant and independent of dietary treatment.

In progress:

- Application of thyroxine (T_4) to female *Siganus guttatus* broodstock and its effect on larval survival.

Milkfish (*Chanos chanos*)

- National Bangus Breeding Program (NBBP).

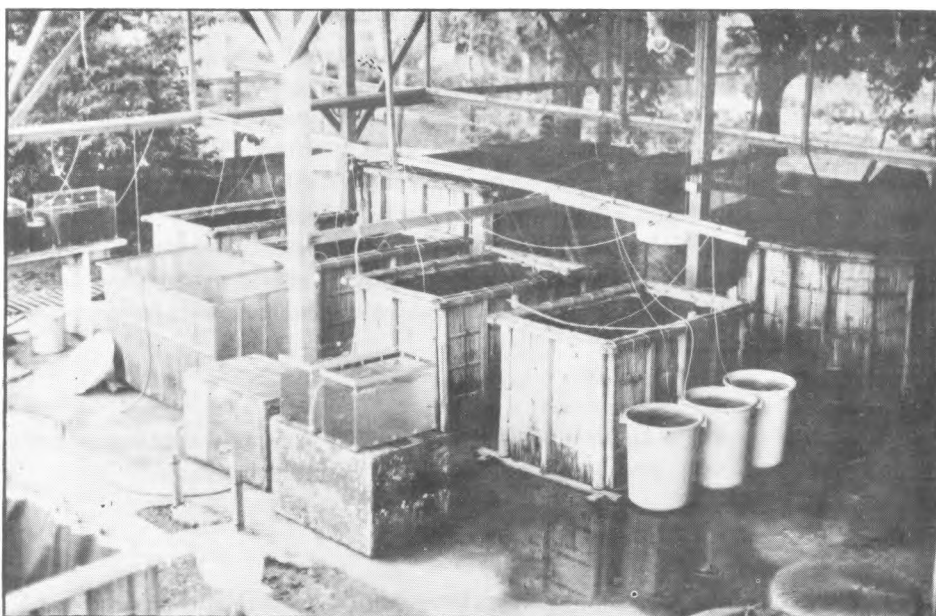
Milkfish matured and spawned in four NBBP sites (Pangasinan, Zambales, Bohol, Davao del Sur). Egg collection using egg sweeper net and *hapa* net cage was consistently low; thus, milkfish larvae have not been reared to day 21 at all sites.

- NBBP pilot hatchery.

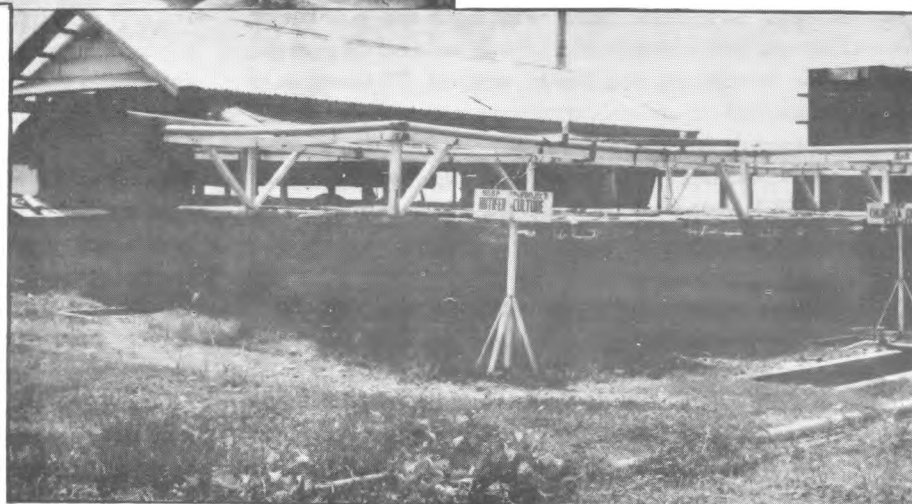
Thirty-four million eggs were collected from four broodstock cages from May to October. About 61% of 84 spawnings had fertilization rates above 80%. Hatching rate was 23-98%. Survival rates in 3-ton canvas and concrete tanks at a density of 30 larvae/l were $41 \pm 11\%$ and $32 \pm 16\%$, respectively, whereas at 50-60 larvae/l survival rate was $22 \pm 8\%$. About 448,500 fry were harvested from 13 runs. Factors which may have contributed to the highly variable results include diet, egg transport conditions, and sex ratio.



NBBP aims to supplement collection of milkfish fry in coastal areas.



National Bangus Breeding Program (NBBP): Rearing facilities at the Bureau of Fisheries and Aquatic Resources (BFAR) Pangasinan site (left) and SEAFDEC/AQD Tigbauan Research Station (bottom).



- Socio-economic analysis of the National Bangus Breeding Program (NBBP).

The productivity and economic viability of an integrated milkfish broodstock and hatchery system was analyzed based on annual stocking of 100 market-sized individuals (200-250 g each) in cages. Discounted cash flow revealed the cost for capital outlay (infrastructures and equipment), operations, and maintenance for both broodstock and hatchery operations. Egg production started in year 5, investment for hatchery facilities in year 4, and expansion to accommodate rearing to fry stage in subsequent years. Economic measures used were net present value and internal rate of return. Sensitivity analyses were also done to determine operation profitability approximating industrial level.

- Supplemental feeding of milkfish juveniles reared in modular ponds.

Milkfish fed practical SEAFDEC-formulated diet in the last month of rearing averaged 141.6 g at harvest, whereas

fish fed natural food (control) weighed 100 g. Survival was similar for both treatments (96 and 97%). Out of 58 respondents to a consumer test, 38 preferred SEAFDEC diet fed-fish, 13 preferred control fish, and 7 had no preference.

In progress:

- LHRHa-induced spawning in milkfish: Dose response studies.
- Isolation and characterization of a female-specific plasma protein (vitellogenin) in milkfish, *Chanos chanos* Forsskal.

Tilapia (*Oreochromis niloticus*)

- Development of salinity-tolerant strains/hybrids of *Oreochromis niloticus* for brackishwater culture. II. Growth performance of *O. niloticus*, *O. mossambicus* and their F₁ hybrids at various salinities.

Several families for each strain, *O. niloticus* (N=5), *O. mossambicus* (M=2) and their F₁ hybrids (MxN=8) in-

cluding reciprocals (NxM=4) were grown at 0, 10, 15, 20, 25, and 32 ppt salinities. Preliminary results showed that *O. niloticus* and F₁ hybrids had significantly higher growth than *O. mossambicus* in all test salinities, with the highest at 25-32 ppt. Salinity had no effect on their survival rates. *O. niloticus*, on the other hand, grew best at 10 ppt although not significantly different at 15-32 ppt. Survival rates, however, were significantly reduced at 25-32 ppt.

- Development of genetic evaluation and selection criteria for tilapia broodstock: I. Effect of crowding on survival and growth of strains of *Oreochromis niloticus* juveniles.

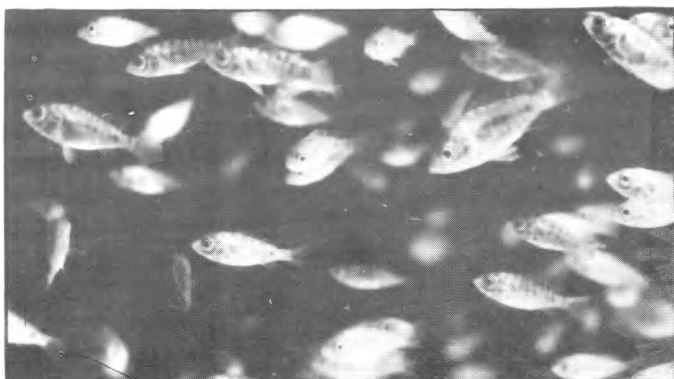
A comparison of the effect of crowding on growth of tilapia from 10 families derived from two strains, with a third (red) strain as internal reference population, was completed. Grow-out was for 16 weeks with the last 8 weeks in cages in Laguna Lake. Between-group error variance was greatly decreased by the internal control procedure and increased the statistical power of strain comparison. Some families in one test strain suffered mortality and survivor fish grew unusually well. An environmental effect usually increased variations among replicates.

- Development of genetic evaluation and selection criteria for tilapia broodstock: II. Effect of salinity stress on survival and growth of strains of *Oreochromis niloticus* juveniles.

Three strains were used, with a third (red) strain as internal reference population. Tilapia was held in freshwater for 2 weeks, acclimated for 4 days in 32 ppt, and reared in seawater for 2 weeks. At 32 ppt, survival was 80-90% for the red strain and 20-50% for the Nile tilapia strains. The red tilapia also grew better than did the Nile strains.

- Development of genetic evaluation and selection criteria for tilapia broodstock: III. Effect of dietary stress on growth of *Oreochromis niloticus* strains.

Four-week-old fry sorted by collimation and paired with red tilapia of the same size were stocked in 60-l aquaria. Treatment fish were fed commercial fish pellets, then rice bran, and finally, commercial fish pellets for six weeks, shifting diets biweekly. Control fish were fed commercial diet



throughout at 20% of fish biomass as for stress batches. Body length and weight measurements as well as scales were taken for analysis. Fish exposed to dietary stress showed irregular circuli on the scales. Control batches showed normal scale features. Uncorrected and corrected growth did not differ significantly between treatments. No significant difference was noted between strains in batches exposed to dietary stress.

In progress:

- Development of genetic evaluation and selection criteria for tilapia broodstock. IV. Effect of restrictive and non-restrictive feeding on growth of strains of *Oreochromis niloticus*.

Catfish (*Clarias macrocephalus*)

In progress:

- Broodstock development and induced spawning of *Clarias macrocephalus* Gunther.

Bighead Carp (*Aristichthys nobilis*)

- Monitoring of gonadal maturation and rematuration of bighead carp (*Aristichthys nobilis*) broodstock reared in floating cages in Laguna Lake.

Females matured in March-April and August-September. Maturation rates were low in January (69%) and May (62%). For males, maturation was 0-40%. Four of five females were induced to spawn with a single injection of LHRHa (75 ug/kg) together with domperidone (15 mg/kg), a dopamine antagonist.

- Effect of dietary protein levels on gonadal development of bighead carp (*Aristichthys nobilis*) reared in floating cages.

Nine months of feeding resulted in maturation of 62% of carp given 20% protein pellets and 75% of those given 40% protein pellets. Only 54% of the fish fed natural food (control) attained sexual maturity.

- Effects of dietary protein levels on gonadal development of bighead carp (*Aristichthys nobilis*) reared in floating cages: Reproductive performance of broodstock.

Based on a total of 18 females induced to spawn, the highest number of eggs, fertilization rate and hatching rate were obtained from fish fed the 40% protein diet. The number of eggs was higher for fish fed the 20% protein diet than for fish fed natural food (control) but mean fertilization and hatching rates were higher for the latter.

- Dietary protein requirement of bighead carp (*Aristichthys nobilis*) fry.

Growth rate increased as the dietary protein level increased from 20 to 30%. Growth rate, however, was lower at protein levels higher than 30%.

- The effects of dietary carbohydrates, lipid and energy on growth, feed efficiency, protein utilization, and tissue

composition of bighead carp (*Aristichthys nobilis*) fry.

At low protein level (34%), weight gain, feed efficiency and protein efficiency ratio increased as lipid level increased from 7 to 10.5% and decreased at 14% lipid. At 42% protein, all three response parameters decreased as lipid level increased. Dietary carbohydrate levels (24 to 40%) did not show a clear effect on growth, feed efficiency and protein efficiency ratio.

Giant Tiger Prawn (*Penaeus monodon*)

- Effect of light quality on maturation and survival of *Penaeus monodon*.

Results from three experimental runs using wild broodstock showed that (a) unablated females matured and spawned under various low-intensity light (green, cool white, blacklight blue, natural daylight) with best results under green light, and (b) ablated females produced higher egg numbers and hatch rates under natural daylight (13.0×10^6 eggs, 75% HR) compared to green (510 nm) light (10.5×10^6 eggs, 71% HR). Reproductive performance of either unablated or ablated females was not satisfactory under cool white (575nm) and blacklight blue (360-370 nm). Under green light, ablated females produced 15 to 17 times more eggs and nauplii than did unablated ones.

- Comparison of different water treatment schemes used in larval rearing of *Penaeus monodon*.

Penaeus monodon reared from nauplius to postlarva 1 using different water treatment schemes had significantly greater survival ($P < 0.01$) when stocked at 25 ind/l (68%) compared to those stocked at 100 ind/l (42%). Results from two runs showed that more larvae survived in water treated with hypochlorite with daily water change (53% survival) than with Sterilizer (active ingredient said to be humic acid) administered once throughout the rearing period without water change (18%) or in untreated water (22%). However, application of Sterilizer twice (once at nauplius, then at mysis stage) during the culture period resulted in survival rate (35%) higher than that obtained with a single application (12%) but was still lower than that obtained in hypochlorite-treated water (40%).

- Temperature-salinity tolerance of *Penaeus monodon* larvae.

P. monodon nauplii and zoea acclimated at 28°C and 32 ppt were abruptly exposed to various temperatures (22, 24, 26, 30, 32°C) at the same salinity. Controls were held at acclimation conditions. Although survival rates were similar at all temperature levels for each stage, metamorphosis was delayed at lower temperature.

- Effect of temperature and salinity on survival, growth, and energy utilization of *Penaeus monodon* postlarvae.

Low-temperature tolerance of *P. monodon* postlarvae (PL₂₂) acclimated at 30°C and 32 ppt salinity was examined. PL₂₂ exposed to 10°C had 100% mortality after 12 h. At 15°C, 25-40%



Free-flowing tidal water in prawn pond, Igang, Guimaras Isl.

mortality occurred after 72 h and 90-100% mortality after 96 h. At 20°C, 5-10% mortality occurred after 96 h.

- Effect of stocking density and diet on *Penaeus monodon* broodstock production in ponds.

Prawns with initial body weight of 46-59 g were fed commercial diet for 2.5 months and SEAFDEC-formulated broodstock diet for another 1.5 months. Those stocked at 0.25/m² attained an average body weight of 82.6 g, whereas those stocked at 0.50/m² weighed 92.2 g. Two females developed Stage II gonads after 4 months of rearing.

- Prawn culture techniques for ponds with free-flowing tidal water.

The feasibility of adopting a Japanese culture system for tiger prawn using free-flowing tidal water in .01-ha brackishwater pond near the mouth of Leganes, Gui-gui Creek was evaluated. Water depth was 0.9-1.0 m at low tide. A wooden secondary gate was installed on another side of the pond for flow-through drainage and harvesting. Juveniles (3.3 g body weight, 71.1 mm body length) were stocked at .9/m². Commercial feed was given 3-5 times daily at 4-8% of total biomass. After 116 days of culture final mean weight was 32g, daily growth increment 0.27 g/day, and survival rate 66%.

- The effect of dietary astaxanthin and vitamin A supplementation on reproductive performance of *Penaeus monodon* broodstock.

Pond-reared *Penaeus monodon* broodstock were fed formulated diet with or without supplementation of astaxanthin, vitamin A, or both. Maturation was highest at 60% but was not improved by astaxanthin-vitamin A supplementation. Spawning was highest at 33% with astaxanthin or vitamin A supplementation. Fecundity was maximum at 118,260 eggs/spawner. However, eggs were not fertilized.

- Chemical control of luminous bacterium (*Vibrio harveyi*) in prawn larvae.

Twenty chemicals were tested for their *in-vitro* effects on seven isolates of the luminous bacterium *V. harveyi*

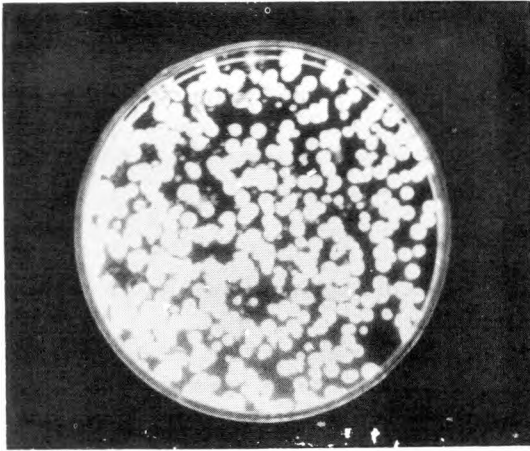


Plate culture of *Vibrio harveyi*, causal bacterium of luminous vibriosis in prawn hatcheries. Photo taken in total darkness to accentuate emission of light by bacterial colonies.

from hatcheries in Iloilo, Aklan, and Capiz. Only chloramphenicol, Furacin (9.3% nitrofurazone) and 10% sodium nifurstyrenate showed relatively lower bactericidal concentrations of 3-30 $\mu\text{g/ml}$. *P. monodon* larvae exposed to drug levels for *in-vivo* use (5-50 $\mu\text{g/ml}$) showed high survival rates but developed morphological deformities like bent setae and deformed carapace.

- Pathogenicity of luminous bacterium (*Vibrio harveyi*) on larvae and postlarvae of *Penaeus monodon*.

Significant mortalities occurred among zoea challenged with initial bacterial density of 10^2 cells/ml after 24 h exposure. A higher initial dose (10^4 cells/ml) of bacteria was needed to effect significant mortality in postlarvae. Scanning electron microscopy showed significant build-up of bacteria on larval surfaces after exposure.

- Effects of rotenone and saponin on the shell quality and survival of juvenile *Penaeus monodon*.

Only the higher levels of the pesticides (10-50 ppm for rotenone and 100 ppm for saponin) resulted in soft-shelling but did not cause any significant mortality in 10-15 g prawns. These levels are much higher than those commonly used in grow-out ponds to remove unwanted fish species.

- Bacteria associated with tail rot in *Penaeus monodon*: Identification and electron microscopy.

An early form of tail rot was detected in pond-reared *P. monodon* samples collected from Negros. Microbial isolation and screening resulted in the identification of 56 *Vibrio* and 2 *Aeromonas* isolates.

- Pathological syndrome of aflatoxicosis in *Penaeus monodon*.

High incidence of reddening was observed in prawns fed the diet containing 150 and 200 μg of aflatoxin B_1 per gram of feed. A highly significant decrease in the hepatosomatic index of prawns fed diet containing 200 μg of aflatoxin B_1 per gram occurred 2 weeks after feeding as did severe

necrosis, fibrosis, and haemocytic infiltration in the hepatopancreas.

In progress:

- Effects of *B*-ecdysone on ovarian maturation and rematuration of *Penaeus monodon* Fabricius.
- Verification studies on SEAFDEC-developed technology on *Penaeus monodon* hatchery and broodstock operations using formulated diet.
- Evaluation of supplementary diets on growth, survival, and production of *Penaeus monodon* in ponds.
- Vibriosis of *Penaeus monodon* in hatchery: Epidemiology and control.
- Development of microbiological processing techniques for agricultural products and wastes as partial replacements for ingredients in compounded feeds for prawn.

White Shrimps (*Penaeus indicus*/*Penaeus merguensis*)

- Determination of optimum larval rearing conditions for white shrimps (*Penaeus indicus* and *P. merguensis*) with reference to salinity levels, feeds, and feeding.

Studies to determine the effects of salinity levels on spawning, hatching, larval survival, and 24-h salinity tolerance of postlarval stages had the following results: 1) *P. indicus* and *P. merguensis* spawned at 10-32 ppt and 15-45 ppt, respectively; 2) hatching occurred at 20-32 ppt for both species with relatively high hatching rates at 25 ppt; and 3) larval survival in *P. indicus* was highest at 30 ppt (49 \pm 17%) and in *P. merguensis* at 35 ppt (57 \pm 7%) although not significantly different at 25-35 ppt.

- Growth and survival of *Penaeus indicus* at different stocking densities using SEAFDEC-formulated feed.

P. indicus stocked at 50,000; 100,000; and 150,000/ha and fed SEAFDEC-formulated diets had similar mean weight gains (11.12, 10.82, 10.38 g, respectively) ($P > 0.05$), indicating that stocking density did not affect growth as long as enough feed was provided to the animals. Significantly lower mean weight gain (7.13 g) ($P < 0.05$) was obtained when only natural food was available to shrimps stocked at 50,000/ha.

- The effect of dietary lipid sources on reproductive performance and tissue composition of *Penaeus indicus* broodstock.

Broodstock diet (50% protein) with various lipid supplementation was fed for 53 days to 80 7-g unblasted *Penaeus indicus* broodstock stocked at 1:1 male-female in concrete tanks. Maximum maturation (85%) and fecundity (26,564 eggs/spawner) were obtained with 1:1 (v/v) cod-liver oil-soya oil, spawning (43%) with cod-liver oil, and hatching (91%) with soya oil. Fresh squid diet (control) performed poorest with only 1% maturation. Results indicate the significance of dietary lipid source in broodstock reproductive performance.

- Evaluation of plant proteins as partial replacement for animal protein in diets of *Penaeus indicus* juveniles.

Penaeus indicus juveniles were fed for 45 days with diets with 10-20% substitutions of fishmeal protein with plant proteins from *Candida utilis*, soybean meal, and leaf meal of *Ipomea aquatica*, *Carica papaya* and *Cassia tora*. Significantly high weight gain was obtained with soybean meal (103%) and *C. tora* (107%). Survival was higher with *C. utilis* and *C. papaya* (70%) than with other plant protein substitutions (35-60%).

In progress:

- Development and evaluation of larval diets for *Penaeus indicus*.

Seaweeds (*Gracilaria*)

- Inventory and assessment of biomass production of *Gracilaria* spp. in Panay Island.

Seventeen species of macrophytes based on 224 specimens from Panay Island belong to three orders of Chlorophyta (6 species), two of Phaeophyta (3 species), and four of Rhodophyta (8 species). Peak *Gracilaria* production at Leganes (Iloilo), Ivisan (Capiz), and Batan (Aklan) occurred in August to October with a slight peak in May at Ivisan. Wet weight harvest from these sites ranged from 459 to 1282 g/m².

- Preliminary studies on field cultivation of *Gracilaria* utilizing hatchery-produced sporelings and vegetative fragments.

Evaluation of the productivity of vegetative fragments seeded on horizontal and vertical lines at intervals of 10, 15, and 20 cm showed that for the horizontal method of seeding, productivity decreased at wider seeding intervals, whereas for the vertical method, productivity increased with wider seeding intervals. Hatchery production of sporelings was hampered by bacterial infection of carposporophytes. Diatoms also grew profusely in the absence of germanium dioxide (GeO₂), a diatom growth suppressor.



The red alga *Gracilaria eucheumoides*, a source of agar.

In progress:

- Production of *Gracilaria* spp. using different culture systems.
- Characterization of agar extracted from different species of *Gracilaria*.

Others

- Feeding of different nutritional quality *Artemia* to finfish and prawn larvae.

Usual mortality at day 21 in the larviculture of sea bass was reduced from 95 to 0% when sea bass larvae were previously fed HUFA-enriched *Artemia*. Enrichment also improved significantly the performance of fish/prawn larvae during stress tests.

- Optimal growth conditions of the marine diatom *Skeletonema costatum* in large outdoor continuous culture.

At low media flow rates and high nutrient concentrations the system behaved like a batch culture.

- Effects of different liming techniques on brackishwater fishponds.

Lime was applied on pond bottom and dikes by broadcasting (I), on dikes by broadcasting and to 15-cm depth on pond bottom by tilling (II), and on pond bottom only (III). No lime was applied in control ponds (IV). Soil pH and organic matter increased while soil phosphorus and iron decreased after applying lime regardless of method. Growth of prawn juveniles stocked at 10,000 fry/ha in these ponds is being monitored.

- Selectivity coefficient estimate of cultured fish species in Laguna de Bay.

Tilapia had high preference for diatoms particularly *Coscinodiscus* sp. A filamentous blue-green alga, *Lyngbya* sp., was the dominant species ingested in 20% of the tilapia examined. Tilapia and bighead carp had no specific preference for zooplankton. Percentage occurrence and abundance of rotifers, copepods, and cladocerans in the stomach were similar.

- Pollution in Laguna Lake: Toxic heavy metals in sediment, water, and selected finfishes.

Mercury levels in sediments ranged from 26.7 to 117 ppm, with samples from Pasig and Sucat generally having the highest concentration. Water samples had very low mercury levels (below detectable to 0.567 ppm). Water conductivity and dissolved oxygen, but not turbidity were negatively correlated with mercury level. Mercury burden in fish was below the maximum permissible level of 0.5 ppm set by WHO and USFDA.

- Costs and returns analysis of newly developed aquaculture production systems in the Philippines.

(a) An economic analysis of the modular pond system

in milkfish production in the Philippines.

Pilot-scale production was done in Iloilo at Leganes Brackishwater Station and three private commercial farms. Two to seven runs were recorded in a year with per hectare output ranging from 278 to 341 kg per run. Input costs were based on actual figures and ex-farm milkfish price was P21.00 (4-6 pieces/kg). Average return-on-investment was 68.8%, and payback period for all sites was 1.25 years. The modular pond system can help close the gap between potential and actual yield through efficient use of pond capacity by increasing the number of cropping to seven per year.

(b) Technical and economic evaluation of monoculture of mudcrab (*Scylla serrata* Forsskal).

Ninety-day monoculture was done at stocking densities of 5,000; 10,000; 15,000; and 20,000 crabs/ha. Highest mean weight, percentage survival, growth increment, best feed conversion value (1.72) and net production (908 kg/ha/crop) were obtained at 5,000/ha stocking. Return-on-investment, return-on-equity, payback period, net present value, benefit-cost ratio, and internal rate of return were maximum also at the same stocking level. Partial budgeting at higher stocking densities gave no incremental benefit.

(c) Comparative economic analysis of different scales of prawn (*Penaeus monodon*) hatchery production systems.

All hatchery systems (backyard, small scale, medium scale, large scale) in Western Visayas (Region VI) were highly profitable business operations. Small hatcheries gave higher profit than did big ones due mainly to high investment requirements for infrastructures, equipment, and facilities for the latter. Small hatcheries generally required lower capital investment. The backyard type, for example, used tanks and related facilities which are cheap and available locally.

(d) An economic analysis of the polyculture of prawn with tilapia in brackishwater fishponds.

Polyculture at 6,000 prawn-6,000 tilapia and 6,000 prawn-4,000 tilapia/ha was compared with monocultures of both species at 4,000-6,000/ha. Total production at 283 kg/ha and income at P6,532/run were maximum at 6,000 prawn-4,000 tilapia. Return-on-investment, return-on-equity, payback period, net present value, benefit-cost ratio, and internal rate of return were determined for all monoculture and polyculture systems.

- Tolerance of selected phytoplankton species to furazolidone, nitrofurazone and chloramphenicol: *Chaetoceros calcitrans*.

Exposure to 0.5 ppm furazolidone and 2 ppm nitrofurazone significantly lowered the growth rate and chlorophylla content and reduced cell size of *C. calcitrans*.

- Regional research on the relationship between ulcerative syndrome in fish and the environment.



Typical backyard prawn hatchery - a direct result of the success in spawning *P. monodon* in captivity and mass culture of natural food.

Highest incidence of the ulcerative disease syndrome (UDS) was observed during the period November-December when the water in the lake was coolest (22-26°C vs 26-34°C for the rest of the year), had the highest level (550 cm vs 215 cm during summer months), and was highly turbid (Secchi disc readings of 15-20 cm vs 30-70 cm during June-October). Heavy metal levels in the water and fish tissues were generally below detectable levels, and similar in both ulcerated and non-ulcerated fish. The ulcerative syndrome was also observed during the period January-March but with lower incidence and severity than during the November-December period. Alkalinity, chloride and hardness of the water were lowest during the November-March period when UDS occurred. Ulcerated fish samples collected were the snakehead (*Ophiocephalus striatus*), Thai catfish (*Clarias batrachus*), and goby (*Glossogobius giurus*).

In progress:

- Use of rice straw in the eradication of snails in brackish water ponds.
- Optimal growth conditions of the marine diatom *Skeletonema costatum* in large continuous culture for developing a continuous feeding apparatus for use in hatcheries.
- Natural food succession in ponds using different organic fertilizers.
- Use of rice straw in the eradication of "bagongon" and "suso" in ponds.
- Nutrient dynamics in Laguna Lake. I. The compartmentalization of nitrogen and phosphorus in the ecosystem.
- Studies on the ulcerative fish disease in Laguna Lake: Associated parasites.

Abstracts of Research Publications

Scientific Journals

- Alava, V.R. and Lim, C. 1988. Artificial diets for milkfish, *Chanos chanos* (Forsskal), fry reared in seawater. *Aquaculture*, 71:339-346.

Milkfish fry obtained from the wild (0.009 g body weight, 10 mm total length) were stocked at 200 individuals in each of 18 fiberglass tanks containing 30 l of filtered aerated seawater. Mean salinity and temperature were 33 ppt and 28.3°C, respectively. The fry were fed with six artificial dry diets containing a mean crude protein of 40.8%. The diets were fed at the rate of 20% of the biomass/day for the first 14 days and 15% of the biomass/day for the last 14 days.

Results indicated that there were no significant differences among the treatment means ($P > 0.05$). Milkfish fry had mean body weights of 0.173-0.202 g, mean total lengths of 29-31 mm, mean feed efficiency values of 0.94-1.16, and mean survival rates of 92-98%. The remarkably similar response of milkfish fry to the six diets demonstrated that the diets contain the essential nutrients necessary for a fast-growing fish. Soybean meal can replace corn gluten meal and meat and bone meal can substitute shrimp head meal for up to 8% of the crude protein.

Final mean weight, total length, specific growth rate, feed efficiency, and survival rate of milkfish fed different diets for 28 days¹ (After Alava and Lim, *Aquaculture* 71:343.1988)

Diet	Weight ±SD (g)	Total length ±SD (mm)	Specific growth rate ² (%/day)	Feed efficiency ³	Survival rate (%)
I	0.202±0.123	31±7	11.11	1.16	97
II	0.198±0.122	30±7	11.03	1.09	92
III	0.184±0.138	29±8	10.77	1.03	96
IV	0.181±0.112	29±7	10.72	0.96	97
V	0.178±0.105	29±6	10.66	0.94	98
VI	0.173±0.127	29±8	10.56	0.97	97

¹Treatment means are not significantly different at $P > 0.05$: mean ± standard deviation of 150 fish (50 fish/replicate)

²Specific growth rate = $\frac{\ln(\text{final weight}) - \ln(\text{initial weight})}{28} \times 100$

³Feed efficiency = g weight gain/g feed.

- Almendras, J.M., Duenas, C., Nacario, J., Sherwood, N.M. and Crim, L.W. 1988. Sustained hormone release. III. Use of gonadotropin-releasing hormone analogues to induce multiple spawnings in sea bass, *Lates calcarifer*. *Aquaculture* 74:97-111.

Two gonadotropin-releasing hormone analogues (GnRHa), [D-Ala⁶, Pro⁹-ethylamide] mammalian GnRH and [D-Arg⁶, Pro⁹-ethylamide] salmon GnRH, were shown to induce spawning in sea bass. A single injection of GnRHa

induced one spawning, but multiple (two to four) injections spaced 24 h apart produced one to four spawnings in individual females. More striking were the sea bass that spawned up to five times after an osmotic pump, which releases GnRHa for 14 days, was implanted. A less expensive, but equally effective method was implantation of GnRHa in pellets with a cholesterol-cellulose matrix. Multiple spawnings in a single female were produced by only two pellets implanted at one time; individual fish released up to 7 million eggs with good fertility and hatching rates. Individual sea bass were shown to remature in the same season and produce multiple spawnings in both June and September if stimulated with GnRHa in pellets. Stimulation of multiple spawnings was not clearly different if the mammalian or salmon GnRH analogues were used or if the stimulation occurred at the new or first quarter moon. Finally, an individual male was shown to be capable of fertilizing the eggs of one female for at least four sequential spawnings, although the fertility and hatching rates were higher if two males were placed with a female. In conclusion, pellets, pumps and repeated injections produced multiple spawnings in sea bass, but the pellets were more reliable, cheaper, and less stressful to the fish.

- Bautista, A.Ma., Carlos, M.H. and San Antonio, A.I. 1988. Hatchery production of *Oreochromis niloticus* L. at different sex ratios and stocking densities. *Aquaculture* 73:85-95.

The influence of various sex ratios and stocking densities on hatchery production of Nile tilapia, *Oreochromis niloticus* L., was studied in land-based (concrete tanks) and lake-based (*hapa* nets) systems. In both hatchery systems, egg and fry production was maximum at a sex ratio of 4:1 females to males and a density of 4 females per m².

Seed production varied significantly among treatments at different periods of the year. In concrete tanks, significantly high seed production of 12.98 and 11.77 eggs and fry per spawner per day was obtained in March and August, respectively. In *hapa* nets, irrespective of sex ratios, 10.18 seeds per spawner were collected daily in March.

In relation to the broodstock density in concrete tanks, significantly bigger daily harvests of 13.41 and 13.00 eggs and fry per spawner were produced in late February and March, respectively. In *hapa* nets, daily harvests of 8.95 and 7.74 eggs and fry per spawner were the highest seed production levels which occurred in April and March, respectively.

Seed production was significantly higher in concrete tanks than in *hapa* nets while insignificant differences ($P > 0.05$) were found among sex ratio and broodstock density treatments.

- Bautista, M.N. and De la Cruz, M.C. 1988. Linoleic ($\omega 6$) and linolenic ($\omega 3$) acids in the diet of fingerling milkfish (*Chanos chanos* Forsskal). *Aquaculture* 71:347-358.

Feeding trials were conducted to determine the

Mean seed production per tilapia spawner per day at different sex ratios and broodstock stocking densities in two hatchery systems (February to January) (After Bautista et al., *Aquaculture* 73:87.1988)

Treatments	Concrete tank hatchery	Hapa hatchery
Sex ratios (female:male)		
4:1	8.41	4.96
7:1	6.96	4.24
10:1	5.18	5.04
Mean*	6.85 ^a	4.75 ^b
Stocking density (per m ²)		
4	8.76	5.77
7	8.04	2.52
10	4.11	2.17
Mean*	5.64 ^a	3.49 ^b

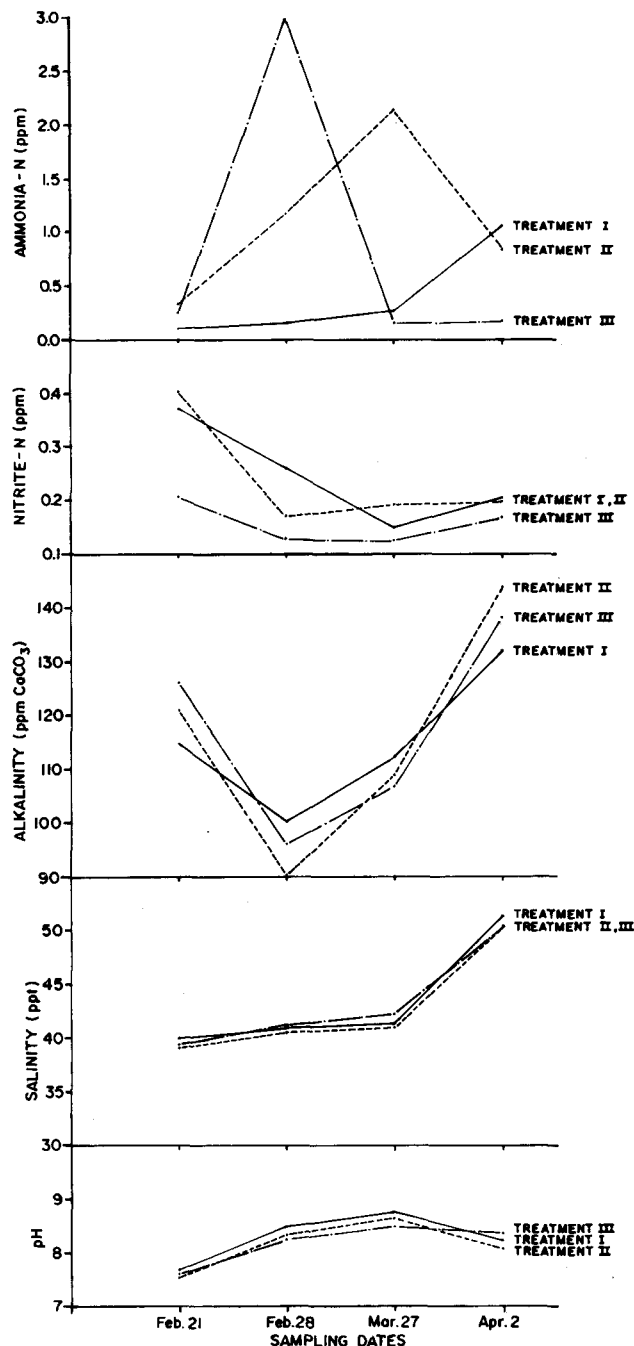
*Row means with different superscripts are significantly different (P<0.05).

effects of linoleic and linolenic acids on growth, survival, fatty acid composition and liver histology of milkfish. Five isocaloric semi-purified diets were formulated, either lipid-free or containing the following lipids: 7% lauric acid (LA), 6% LA+1% linoleic acid, 6% LA+1% linolenic acid, and 6% LA+0.5% linoleic + 0.5% linolenic acids, and fed to milkfish with average weight of 1.55±0.25 g. There were no significant differences in growth or survival between fish fed the lipid-free and the LA diets in the five treatments tested. However, growth of fish fed with linoleic and linolenic acids was significantly higher (P<0.05) than that obtained in fish fed lipid-free and LA diets. The best growth response (233%) was attained with fish fed linolenic acid alone. Fatty acid analyses of the total lipid showed that lipid-free and LA diets increased the levels of monoenoic acids in the fish. The addition of linoleic and linolenic acids, alone or in combination, suppressed the levels of these monoenes and increased the levels of polyunsaturated fatty acids (PUFA). Histological analyses using light microscopy revealed slight abnormalities in the hepatocytes of fish fed lipid-free and LA diets. Both linoleic and linolenic acids are effective for good growth and survival of fingerling milkfish; however, the effect of linolenic acid on the growth of this species is better than that of linoleic acid.

- Bombeo-Tuburan, I. 1988. The effect of stunting on growth, survival, and net production of milkfish *Chanos chanos* (Forsskal). *Aquaculture* 75:97-103.

The seasonal abundance of milkfish fry in the Philippines has led to the practice of buying a sufficient supply during the peak season to compensate for the shortage during slack periods. Fry that are not immediately grown out are crowded and stunted in transition ponds until they are transferred to rearing ponds. Milkfish farmers believe that stunted fingerlings grow faster than newly grown ones and therefore yield extra croppings. To assess the efficiency of production schemes, stunted and non-stunted milkfish fingerlings were cultured in twelve 144-m² ponds for a 3-month period. The treatments employed were: Treatment I, 2-month-old fingerlings; Treatment II, 3-month-old fingerlings; and Treatment

III, 6-month-old fingerlings, with the initial weights of 3.3 g, 7.8 g, and 43.1 g, respectively. Survival, net production, cumulative and monthly weight gains did not differ significantly (P>0.05) among the three treatments. The results indicate that stunting did not illicit a significant increase, nor did it adversely affect the growth, survival, and net production of milkfish in a straight culture system. Stunting can therefore be practiced by farmers to provide an adequate supply of fingerlings for year-round operation.



Water quality parameters in milkfish ponds (After Bombeo-Tuburan, *Aquaculture* 75:101. 1988).

● Carlos, M.H. 1988. Growth and survival of bighead carp (*Aristichthys nobilis*) fry fed at different intake levels and feeding frequencies. *Aquaculture* 68:267-276.

This study was conducted to assess the effect of different levels of dietary intake and feeding frequencies on growth and survival of bighead carp, *Aristichthys nobilis*, fry. The feeding rates consisted of 10%, 20%, and 30% of body weight while feeding frequencies were one, three, and five times daily. Results showed that final weight, final length, and specific growth rate (SGR) differed in relation to feeding rate but not to feeding frequency. Highest values were obtained for fish on the 30% ration and fed once a day. A significant effect of higher feeding rate using lower feeding frequency on growth was manifested in final mean weight and SGR; increasing feeding rate resulted in increased growth.

Feeding frequency significantly influenced fry survival with highest values observed when fry were fed once or three times per day. Highest survivals were achieved by fry on the 30% ration fed once daily. At higher feeding rates using lesser feeding frequencies, better survival was noted. Survival rate had an inverse relationship to feeding frequency, but no overall relationship existed between feeding rate and survival rate.

Both ration and feeding frequency significantly influenced normalized biomass index (NBI). Highest values were again obtained on the 30% ration and feeding once daily. Higher NBI values were observed with higher feeding rates at lower feeding frequencies. Increasing ration resulted in a corresponding increase in NBI.

● Coloso, R.M., Benitez, L.V. and Tiro, L.B. 1988. The effect of dietary protein-energy levels on growth and metabolism of milkfish (*Chanos chanos* Forsskal). *Comp. Biochem. Physiol.* 89A:11-17.

Groups of milkfish juveniles (mean weight, 2.8 g) were fed diets containing white fishmeal and gelatin with varying protein-energy to total metabolizable energy (PE:TME) ratios.

Amino acids were incorporated in the diets to stimulate the pattern of milkfish protein. The control diet contained fishmeal as sole protein source and was not supplemented with amino acids.

Among the amino acid supplemented diets, best growth was observed at PE:TME ratio of 44.4%. However, the control diet gave better growth rate than any of the amino acid supplemented diets.

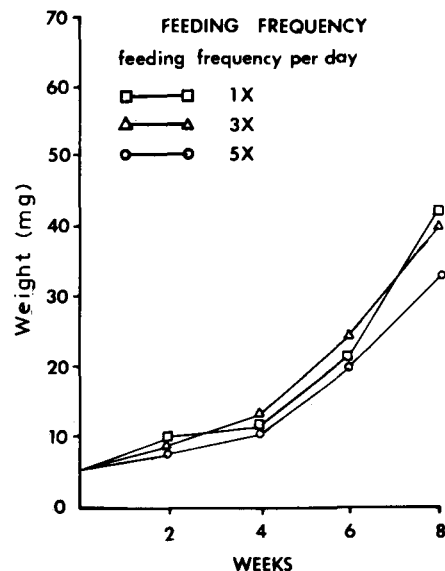
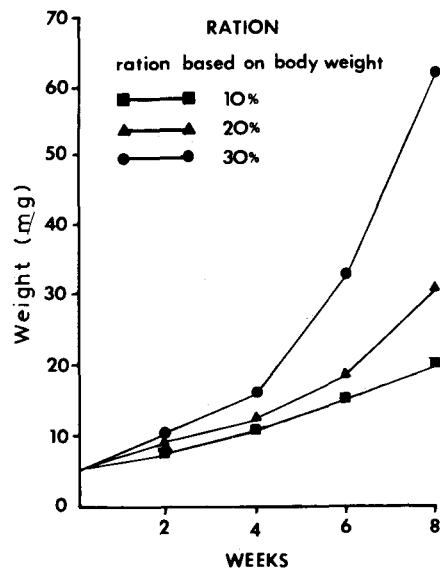
Specific activities of pyruvate kinase (PK) and glutamate dehydrogenase ((GDH) increased significantly with increase in dietary protein-energy level.

● Duray, M.N. and Kohno, H. 1988. Effects of continuous lighting on growth and survival of first-feeding larval rabbitfish, *Siganus guttatus*. *Aquaculture* 72:73-79.

The effects of 24-h lighting on feeding, growth and survival of first-feeding larvae of *Siganus guttatus* were tested. Continuous light gave a higher mean survival (31.69%) with a maximum of 40.50% compared to natural daylight (17.10%). Larval size on day 7 also showed that continuous lighting gave improved results. Although feeding incidence increased with age of the larvae, a higher incident rate was observed for larvae held in continuous light from day 3.

● Fermin, A.C. and Recometa, R.D. 1988. Larval rearing of bighead carp, *Aristichthys nobilis* Richardson, using different types of feed and their combinations. *Aquacult. Fish. Manage.* 19:283-290.

The effects of different types of feed, given singly or in combination, on the growth and survival of bighead carp, *Aristichthys nobilis* Richardson, larvae reared for a period of



Growth of bighead carp fry fed at different ration levels and maintained on different feeding frequencies (After Carlos, *Aquaculture* 68:271. 1988).

12 weeks were determined. Growth was highest for fish fed with the combination of *Moina* and artificial feed followed by fish fed with artificial feed alone. Significantly lower ($P < 0.05$) growth was found in fish fed with green water + *Moina* + artificial feed; green water + artificial feed; green water + *Moina* and *Moina* alone, in a descending order. Carp larvae reared in green water alone did not survive after the fifth day of feeding. Specific growth rates ranging from 0.59% day⁻¹ to 2.75% day⁻¹ were exhibited by fish in all the remaining six treatments.

Although green water alone did not support the growth of the larvae, enhanced survival rates were observed when green water was given in combination with other feeds. Survival rate was highest in fish fed with the combination of green water, *Moina* and artificial feed, but was not significantly different ($P > 0.01$) from those given *Moina* + artificial feed. Consequently, normalized biomass index was significantly high ($P < 0.05$) in fish fed with the combination of green water, *Moina* and artificial feed.

- Ferraris, R.P., Almendras, J.M. and Jazul, A.P. 1988. Changes in plasma osmolality and chloride concentrations during abrupt transfer of milkfish (*Chanos chanos*) from seawater to different test salinities. *Aquaculture* 70:145-157.

Milkfish juveniles (40, 120 or 260 g) were acclimated to 32 ppt seawater, then abruptly transferred to water with salinities of 0, 16, 32 (control) or 48 ppt. Blood samples were taken 0, 1, 2, 3, 5, 7 or 14 days after transfer. Survival rate was 95% or greater in all salinities. Plasma osmolality in fish exposed to salinities other than 16 or 32 ppt deviated from control values immediately after transfer but were subsequently regulated to near normal levels after several days. Although these deviations were significant, they were relatively small ($\leq 20\%$ of initial) as plasma osmolality changed by less than 0.07 mOsm/kg per unit change environmental salinity. Plasma chloride values generally followed the same pattern of changes as plasma osmolality. When these deviations were integrated across time, summed deviations (mOsm.day kg⁻¹ or mEq.day l⁻¹) were proportional to the osmotic or ionic gradient but were inversely proportional to size. For 40-g fish, summed deviations were larger in 48 than in 0 ppt; for 120 or 260 g fish, these deviations were larger in 0 than in 48 ppt. These results indicate that small milkfish tend to adapt better to fresh than to hypersaline water while larger milkfish are more likely to find hypersaline water less stressful than freshwater. Like other systems previously studied in milkfish, these size-dependent adaptations in osmoregulatory mechanisms reflect natural habitat shifts during development.

- Garcia, L.Ma.B. and Gapasin, R.S.J. 1988. An inexpensive tag for short-term studies in milkfish (*Chanos chanos* Forsskal) and in sea bass (*Lates calcarifer* Bloch). *J. Appl. Ichthyol.* 4:101-104.

An opercular tag for marking adult milkfish (*Chanos*

chanos Forsskal) and sea bass (*Lates calcarifer* Bloch) is described. High tag retention and relatively low mortality rates were observed in adult fish handled two to ten times during 14- to 60-day tests. The features and advantages of the tag for marking large-sized fish in short-term studies are discussed.

- Garcia, L.Ma.B., Marte, C.L. and Travina, V.S. 1988. A collecting gear for naturally-spawned milkfish (*Chanos chanos* Forsskal) eggs in circular floating net cages. *Aquaculture* 68:83-86.

A collecting gear for naturally-spawned milkfish (*Chanos chanos* Forsskal) eggs in circular floating net cages is described. The gear has been shown to be effective in collecting large numbers of eggs. The collecting gear can be adopted for other broodstock fish species held in circular floating net cages.

- Garcia, L.Ma.B. and Toledo, J.D. 1988. Critical factors influencing survival and hatching of milkfish (*Chanos chanos* Forsskal) eggs during simulated transport. *Aquaculture* 72:85-93.

The effects of loading density, length of transit time, temperature and salinity on milkfish (*Chanoschanos* Forsskal) eggs during simulated transport were examined. Rocking motion approximating conditions of transport of eggs collected from milkfish broodstock floating net cages to a hatchery was simulated using a laboratory orbit shaker. Loading densities of more than 7000 eggs/l in shipping bags resulted in decreased rates of survival and correspondingly lower hatching rates. Prolonged shaking simulating extended periods of egg transport also resulted in low egg survival and hatching rates compared to fertilized eggs not subjected to simulated transport. Egg survival after simulated transport at 20°C was lower than at 28°C, except at 20 ppt salinity, where survival was equal. Egg survival at 20°C progressively increased with declining salinity levels whereas high egg survival rates were observed after 2 h of simulated egg transport at 28°C and at the three salinities tested. Hatching rates of fertilized eggs after simulated transport were higher at 28°C than at 20°C regardless of salinity. Neither salinity nor its interaction with temperature affected hatching rates of eggs after simulated transport. These results indicate that survival and hatching of fertilized milkfish eggs after simulated transport is influenced by loading density, transport time, temperature and, to some degree, the salinity of the water. Based on these results, guidelines for handling and transporting milkfish eggs are given.

- Gerochi, D.D., Lijauco, M.M. and Baliao, D.D. 1988. Comparison of the silo and broadcast methods of applying organic fertilizer in milkfish, *Chanoschanos* (Forsskal), ponds. *Aquaculture* 71:313-318.

The efficacy of the silo and broadcast methods of applying organic fertilizers in ponds for the production of pond-floor, microbenthic biological complex, a natural food source

Growth, survival and net production of milkfish reared in ponds fertilized by silo and broadcast methods (After Gerochi et al., *Aquaculture* 71:315.1988)

Treatment	Mean initial wt. (g)	Mean final wt. (g)	Relative growth increment (g/day/fish)	Survival (%)	Net production (kg)
Silo method					
1	20.70	298.66	3.08	95.13	790.3
2	5.45	226.80	2.45	97.40	646.6
3	9.06	188.21	1.00	98.10	526.7
Mean	11.74	237.89	2.51	96.88	654.5
Broadcast method					
1	20.70	257.79	2.63	96.67	682.2
2	5.45	211.70	2.29	98.70	610.3
3	9.06	169.09	1.77	97.20	465.6
Mean	11.74	212.83	2.23	97.52	586.0

Treatments were not significantly different from each other ($P>0.05$).

known as *lablab*, was tested in 1-ha ponds, replicated thrice in time. Although there were no statistically significant differences ($P>0.05$) in milkfish growth, survival and production after 90 days tended to be higher in ponds prepared with the silo method. Advantages of the silo method are that it is less laborious, cheaper, and less time consuming than the broadcast method and results in consistent *lablab* growth until the end of the culture period.

●Kohno, H., Hara, S. and Duray, M. 1988. Transition from endogenous to exogenous nutrition sources in larval rabbitfish *Siganus guttatus*. *Nippon Suisan Gakkaishi* 54:1083-1091.

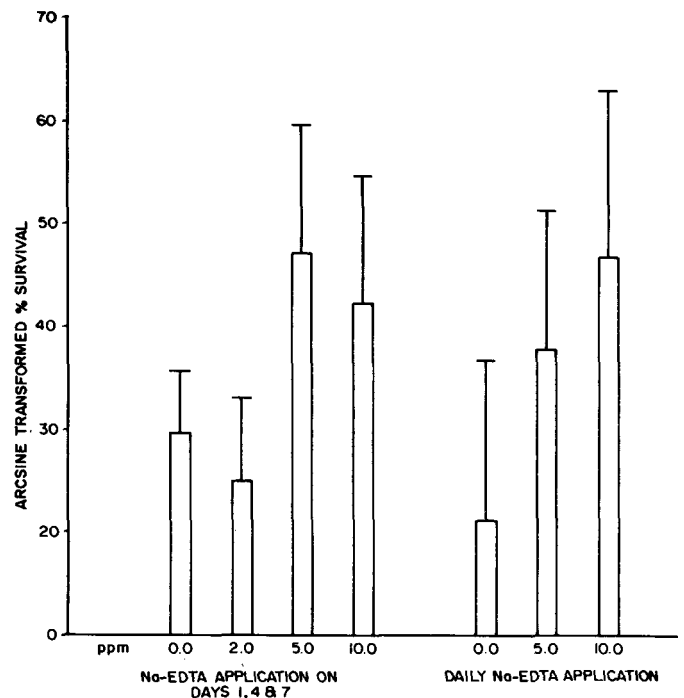
The early larval development of *Siganus guttatus* was studied with emphasis on the transition from endogenous to exogenous feeding. Three rearing trials were conducted as follows: 1) rearing in a 5-ton concrete tank at 27.9-29°C (T-85 trial); 2) rearing in a 0.5-ton fiberglass tank at 22.2-26°C (T-86A trial); 3) rearing in the same manner as in T-86A but without food (T-86B trial). On the basis of the developmental events and energy flow in T-86A trial, the early life history of the species could be divided into the following seven phases: 1) rapid larval growth due to rapid yolk resorption [from hatching to about 15 h after hatching (time after hatching:TAH)]; 2) slow growth and organogenesis based mainly on yolk energy (to about 50 h TAH); 3) slow growth based on energy of yolk, oil globule and exogenous food (to about 70 h TAH); 4) slow growth based on two sources of energy, oil globule and exogenous food (to about 90 h TAH); 5) the same mode of development and energy flow as in the preceding phase, but with a certain level of feeding amount (to about 120 h TAH); 6) accelerated larval growth and effective feeding and swimming based only on exogenous food (to about 150 h TAH); and 7) the same mode as in the preceding phase with accelerated increase of feeding amount (beyond 150 h TAH). Differences in developmental mode were observed in T-85 and T-86A trials, but it could not be ascertained in this particular study which of the environ-

mental factors played the greatest influence. The results of T-86A and B showed that the larvae, in order to survive, have to get over two obstacles on feeding, that is, to start feeding and to change from endogenous to exogenous feeding suitably.

●Licop, M.S.R. 1988. Sodium-EDTA effects on survival and metamorphosis of *Penaeus monodon* larvae. *Aquaculture* 74:239-247.

The effects of Na-EDTA on growth and survival of *Penaeus monodon* larvae were determined for applications given daily or every 3 days. Application of 2.0, 5.0, and 10.0 ppm were given on day 1, day 4 and day 7 in Experiment 1, and 5.0 and 10.0 ppm were given daily for 8 days in Experiment 2. Larvae stocked at 100/liter were given a natural food diet of *Chaetoceros calcitrans* and *Artemia salina* nauplii. Chloramphenicol (2.0 ppm) and Treflan R (0.05-0.10 ppm) treatments were applied on the same days as Na-EDTA. Water change was 30% on day 4 and 50% daily thereafter.

Results showed that the applications of Na-EDTA at 5.0 and 10.0 ppm on days 1, 4 and 7 greatly improved the survival of *P.monodon* larvae. With daily application, the larvae treated with 10.0 ppm showed the best survival rate during the 8-day culture period. Na-EDTA treatments at dosages above 2.0 ppm seem to prevent significant mortality. It is believed that Na-EDTA improved survival rates by chelating toxic elements in the culture medium. Growth (rate of metamorphosis) was not greatly improved except for nauplii



Survival of *Penaeus monodon* larvae at stages M_{11} and M_{111} for different Na-EDTA treatment levels and applications. Vertical lines indicate the 95% confidence intervals (After Licop, *Aquaculture* 74:244. 1988).

to zoea where the highest percent molts were observed with the 10.0 ppm treatment in both experiments.

- Marte, C.L. 1988. An improved method for collecting naturally spawned milkfish eggs from floating cages. *Aquaculture* 71:387-392.

Natural spawnings of captive milkfish (*Chanos chanos* Forsskal) held in floating cages were observed in 1980, 1981, 1983, and 1985. Frequency of spawnings increased from two in 1980 to 41 in 1985. Various collectors and collection methods were tried with only slight improvements in number of eggs collected. Although the number of eggs collected per spawning increased from 900 in 1980 to a maximum of 769,000 in 1985, the numbers were not sufficient for mass-scale fry production. The most urgent problem was egg predators inside the floating cages during the spawning season. This paper presents an improved method of egg collection using fine-mesh net cages (*hapa* nets, 1 mm mesh) which effectively prevented entry of egg predators. Before *hapa* nets were installed the number of eggs collected ranged from 3,300 to 668,000. From 330,000 to 2,942,000 eggs were collected by using *hapa* net cages. With the new method mass-scale production of milkfish fry can be achieved.

Number of eggs collected in two milkfish broodstock cages with and without "hapa" cage (After Marte, *Aquaculture* 71:389.1988)

Cage	Without "hapa"			With "hapa"		
	No. of spawns	Range of eggs collected	Total eggs collected	No. of spawns	Range of eggs collected	Total eggs collected
42	17	3,340-668,000	2,141,000	14	330,000-2,040,000	10,902,000
43	9	6,400-200,000	329,500	14	292,000-2,942,000	15,355,000
Total	26		2,470,500	28		26,237,000

- Marte, C.L., Crim, L.W. and Sherwood, N.M. 1988. Induced gonadal maturation and rematuration in milkfish: limited success with chronic administration of testosterone and gonadotropin-releasing hormone analogues (GnRHa). *Aquaculture* 74:131-145.

Nine experiments were conducted to investigate the influence of chronic administration of testosterone (T) and gonadotropin-releasing hormone (GnRH) analogues on first maturation of 4- to 6-year-old fish and rematuration of 6- to over 9-year-old spent/regressed fish.

Implantation of T or T in combination with luteinizing hormone-releasing hormone analogue (LHRHa) had no marked effect on maturation rate of 4-year-old milkfish. The percentage of maturing fish was low and similar to controls in Experiment 1 (T, 31-35%; control, 35%) and Experiment 3 (T, 13%; T plus LHRHa, 28%; control, 22.2%). Most of the 4-year-old maturing fish were males; maturing females were obtained only from the T-implanted groups in Experiment 1. In Experi-

ment 3, T-implanted maturing females were able to retain yolk eggs whereas maturing control females did not, indicating that testosterone may have enhanced vitellogenesis and maintained the integrity of vitellogenic oocytes. Tank-reared, maturing 4-year-old females, about half the size of older first-maturing females, were induced to spawn. This is the first case of maturation and spawning of 4-year-old milkfish reared in tanks.

As in Experiments 1 and 3, the percentage maturation of spent fish in Experiments 7 and 8 was similar for T-implanted and controls. On the other hand, the 4-year-old immature fish in Experiments 2 and 4, the 5- and 6-year-old immature fish in Experiments 5 and 6, and the spent 6-year-old fish in Experiment 9 were immature or regressed throughout. The factors which may have influenced the results of these experiments include age and reproductive history of the fish, timing of hormone implantation, experimental and holding conditions, and stress.

Spermiation index of testosterone-implanted and control males implanted once with LHRH-A silastic pellet (After Marte et al., *Aquaculture* 74:138.1988)

Fish	18 Apr	30 Apr	28 May	26 June	17 Jul	31 Jul
Testosterone-implanted + LHRH-A						
P2	+	++	++	-	-	-
P3	+	+++	-	NS	+	-
P6	+	-	+++	++	-	+
P12	++	++				
Blank pellet-implanted + LHRH-A						
D1	+	+	+++	-	-	-
D7	+	+++	NS	+	-	-
D10	+	NS	+	-	-	-
Testosterone-implanted						
P7	+	-	-	-	-	-
S4	+++	+	NS	-	+	-
C3	+	NS	+++	+	-	-
Blank pellet-implanted						
D3	+	-	NS	-	-	-
D6	+	+	NS	+	-	-

NS = Not sampled.

- Marte, C.L., Sherwood, N., Crim, L. and Tan, J. 1988. Induced spawning of maturing milkfish (*Chanos chanos*) using human chorionic gonadotropin and mammalian and salmon gonadotropin-releasing hormone analogues. *Aquaculture* 73:333-340.

The response of maturing female milkfish to D-Ala⁶-des Gly¹⁰ mammalian GnRH ethylamide (mGnRHa), D-Arg⁶-des Gly¹⁰ salmon GnRH ethylamide (sGnRHa) and human chorionic gonadotropin (hCG) was investigated. The GnRH analogues and hCG were equally effective when administered by intramuscular injection at doses of 10 µg/kg and 100 µg GnRHa/fish or 1000 IU hCG/fish. All of the females injected with hCG and 87.5% (7/8) of females injected with GnRHa spawned. Pellet implantation of the GnRH analogues,

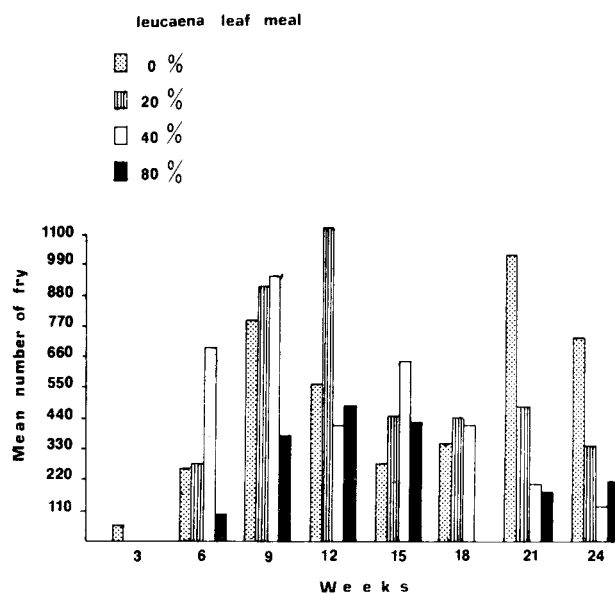
however, was less effective based on 100 μ g of pellet per fish, which provided from 20 to 36 μ g of analogue per kg fish. Fish implanted with mGnRHa or sGnRHa showed responses which varied from oocyte hydration to spawning. Only 3/7 implanted with mGnRHa and 1/7 implanted with sGnRHa spawned; in the latter group, the average egg diameter was 11-17% smaller at the time of treatment compared with the other treated groups. Except for one, all fish with egg diameters above 0.65 mm had hydrated/ovulated oocytes or spawned. Females which spawned had egg diameters above 0.71 mm.

- Millamena, O.M., Bombeo, R.F., Jumalon, N.A. and Simpson, K.L. 1988. Effects of various diets on the nutritional value of *Artemia* sp. as food for the prawn *Penaeus monodon* Fabricius. *Mar. Biol.* 98:217-222.

The nutritional value of *Artemia* sp. as food for marine fish and crustacean larvae has been linked to the level of its polyunsaturated fatty acid (PUFA) content. Experiments in August 1984 were conducted to determine the effects of various artificial diets and algae on fatty acid composition of PUFA-deficient *Artemia* sp. (Utah GSL strain) and their resulting value as food for postlarvae of the prawn *Penaeus monodon* (Fabricius). Nauplii of the brine shrimp were grown on extracts of corn, copra, soybean and rice bran containing precursors (C_{18}) to long-chain PUFA and also on algal species containing different levels of long-chain PUFA (C_{20}). The nauplii were then used as food for *P. monodon* postlarvae. The results revealed that absence of C_{20} polyunsaturates from the feeds and their presence in the algae were reflected in the polyunsaturated fatty acid content of the tissues of *Artemia* sp. When fed with brine shrimp fed on algae, *P. monodon* displayed better postlarval survival and significantly higher growth related to the content of polyunsaturated fatty acids in *Artemia* sp. A practical feeding approach in prawn hatcheries would be to grow *Artemia* sp. on a cheap diet such as rice bran, and then to enhance its nutritional value with a diet high in PUFA prior to harvesting, in order to improve hatchery production.

- Santiago, C.B., Aldaba, M.B., Laron, M.A. and Reyes, O.S. 1988. Reproductive performance and growth of Nile tilapia (*Oreochromis niloticus*) broodstock fed diets containing *Leucaena leucocephala* leaf meal. *Aquaculture* 70:53-61.

The effects of dietary *Leucaena* leaf meal on reproductive performance and growth of Nile tilapia were determined. In the preliminary trial, sexually mature Nile tilapia were fed with a control diet or a test diet which had *Leucaena* leaf meal as the only protein source for 24 weeks. Fish fed with the *Leucaena* diet lost some weight and had significantly low ($P < 0.05$) gonadosomatic index and fry production compared to those fed with the control diet. Subsequently, four iso-nitrogenous diets (20% crude protein) containing varying amounts of *Leucaena* leaf meal (0, 20, 40 and 80%) were fed to Nile tilapia



Fry production of Nile tilapia fed with diets containing various levels of *Leucaena* leaf meal (After Santiago et al., *Aquaculture* 70:57, 1988).

broodstock. Mean weight gain of the female fish decreased as the level of *Leucaena* leaf meal in the diets increased. Females fed with the 80% *Leucaena* diet invariably lost weight. Mean weight gain of males fed with the control diet and the 20 and 40% *Leucaena* diets did not differ significantly ($P > 0.05$). However, growth of males fed with the 80% *Leucaena* diet was remarkably low. Fry production was highest for those fed with the control diet and the 20% *Leucaena* diet. Fry production decreased slightly in fish fed with the 40% *Leucaena* diet and was significantly low ($P < 0.05$) for those fed with the 80% *Leucaena* diet. The low fry production was preceded by a decrease in body weight of the female fish. However, the gonadosomatic indices of the females and the males were not markedly affected by the diets. On the basis of both fry production and growth, *Leucaena* leaf meal should not exceed 40% of the diet of Nile tilapia broodstock.

- Santiago, C.B. and Lovell, R.T. 1988. Amino acid requirements for growth of Nile tilapia. *J. Nutr.* 118:1540-1546.

A series of feeding experiments was conducted in aquaria to determine the quantitative requirements of the 10 essential amino acids for growth of young Nile tilapia (*Oreochromis niloticus*). The test diets containing casein and gelatin supplemented by crystalline *L*-amino acids to provide an amino acid profile similar to 28% whole egg protein except for the test amino acid. Each set of test diets consisted of seven isonitrogenous diets containing varying levels of the amino acid to be tested. Weight gains analyzed by the broken line-regression method indicated the following requirements as a percentage of the dietary protein: lysine, 5.12; arginine, 4.20; histidine, 1.72; valine, 2.80; leucine, 3.39; isoleucine,

3.11; threonine, 3.75; tryptophan, 1.00; methionine with cysteine (0.54% of the protein), 3.21; and phenylalanine with tyrosine (1.79% of the protein), 5.54.

- Villaluz, A.C. and MacCrimmon, H.R. 1988. Meristic variations in milkfish *Chanos chanos* from Philippine waters. *Mar. Biol.* 97:145-150.

Variations in meristic characters occur within and between samples of milkfish *Chanos chanos* (Forsskal) collected in June 1977 from five localities in Philippine waters. The unbranched anal and ventral fin rays are the most plastic, and vertebral number is the most stable of nine meristic characters examined. The number of ventral fin rays is the only meristic feature which differed consistently enough to suggest distinct population groups: South China Sea, comprising samples from Ilocos and Panay Island; Pacific Ocean from Bicol; and Celebes Sea, from Zamboanga and Davao. A discriminant analysis which incorporated generalized distance (Mahalanobis D_2) and percent overlap of a reduced set of characters indicated several morphometric subgroups of milkfish in Philippines waters, although geographic subgroups were not clearly demonstrated.

Edited Proceedings

- Camacho, A.S. and Macalincag-Lagua, N. 1988. The Philippine aquaculture industry. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988: 91-116.

The aquaculture sector of the Philippine fishing industry registered the highest growth rate of 12.5% in 1977-1986. The contribution of aquaculture to the total fish production was equivalent to 24% in 1986 compared to only 85 in early 1970's. In terms of quantity, the mariculture subsector registered the highest growth rate of 10.2% in 1982-1986, whereas in terms of value the brackishwater fishpond subsector showed the highest growth rate of 33%. Meanwhile, freshwater aquaculture production exhibited a negative growth rate due to reduction of activities in Laguna de Bay and the slow expansion in hectareage of the commercial freshwater fishponds.

Research by several agencies concentrated heavily on the culture of milkfish (*Chanos chanos*), tilapia (*Oreochromis niloticus*), Chinese carps (*Aristichthys nobilis* and *Hypophthalmichthys molitrix*), tiger prawn (*Penaeus monodon*), and sea bass (*Lates calcarifer*). Innovations in seaweed, oyster, and mussel farming are also discussed.

Research directions are presented to assure an ecologically sustainable growth in aquaculture with emphasis on countryside development.

- Carlos, M.H. and Santiago, C.B. 1988. Nursery and grow-out operations for tilapia and carp. Juario JV, Benitez LV,



Enrichment culture of brine shrimp (*Artemia*), a widely used live food for larvae of prawns and finfishes. (Inset: instar II nauplius.)

eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988: 281-292.

Most researches conducted at the Binangonan Freshwater Station of the SEAFDEC Aquaculture Department were directed toward enhancing growth and survival of the young tilapia and carp in the nursery as well as increasing yields in grow-out cages, pens, and ponds. Studies included the culture and evaluation of phytoplankton and zooplankton as feeds of the tilapia and carp fry to fingerlings; determination of protein and amino acid requirements of young Nile Tilapia; development of practical dry diets; evaluation of feeding regimes, feeding rates, and feeding frequencies; and the use of fertilizers in nursery ponds.

For the grow-out aspect, one of the earliest studies demonstrated the profitability of the monoculture of tilapia in cages which triggered the initial proliferation of tilapia cage culture by the private sector in areas near the Station. Subsequently, supplemental feeds were developed and evaluated; non-conventional feedstuffs were tested as feeds or feed components; and the growth rates of Nile tilapia fingerlings in cages at varying stocking densities were evaluated at three distinct rearing periods covering one year.

Prior to the successful mass production of bighead carp fingerlings at the Station, studies on polyculture of tilapia, milkfish, and different species of carp were conducted in cages and pens with remarkable results. This led to the technology-verification projects on polyculture at various areas in Laguna Lake. With the availability of freshwater fishponds for research purposes, studies on polyculture in ponds were also conducted.

- Corre, K.G. 1988. Nursery and grow-out operation and management of *Penaeus monodon* (Fabricius). Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia: 1987 September 8-12; Iloilo City, Philippines.* Iloilo: SEAFDEC AQD, 1988:245-267.

The results of research on nursery and grow-out rearing of prawn conducted by the SEAFDEC Aquaculture Department for over a decade are reviewed. Different rearing facilities designed to accommodate hatchery-produced prawn fry are presented with corresponding data on growth, survival and production. Studies on stocking density, fertilization/natural food production, water management, feeds and feeding schemes and harvest/post-harvest handling are evaluated and viable technology identified. Diseases, pests and predators and other factors considered as production constraints are also mentioned.

The success in hatchery operation for prawn coupled by the gradual emergence of nursery and grow-out rearing technology have triggered off a technology-dependent prawn industry. When SEAFDEC AQD was established in 1973, there were very few commercial prawn monoculture ventures in the country. Prawn pond production was mostly an incidental crop in milkfish culture. At present, various prawn grow-out techniques ranging from extensive, semi-intensive and intensive culture systems are in practice. SEAFDEC AQD focused its research on the extensive and semi-intensive culture systems which are within the reach of most farmers in contrast to the intensive system that is highly capital-intensive.

There have been much work done in nursery and grow-out operations, but much remains to be done in research, among which are the development of nutritionally-efficient and low-cost feed, control of diseases, etc.

- Duray, M. and Juario, J.V. 1988. Broodstock management and seed production of the rabbitfish *Siganus guttatus* (Bloch) and the sea bass *Lates calcarifer* (Bloch). Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Department in Southeast Asia: 1987 September 8-12; Iloilo City, Philippines.* Iloilo: SEAFDEC AQD, 1988: 195-210.

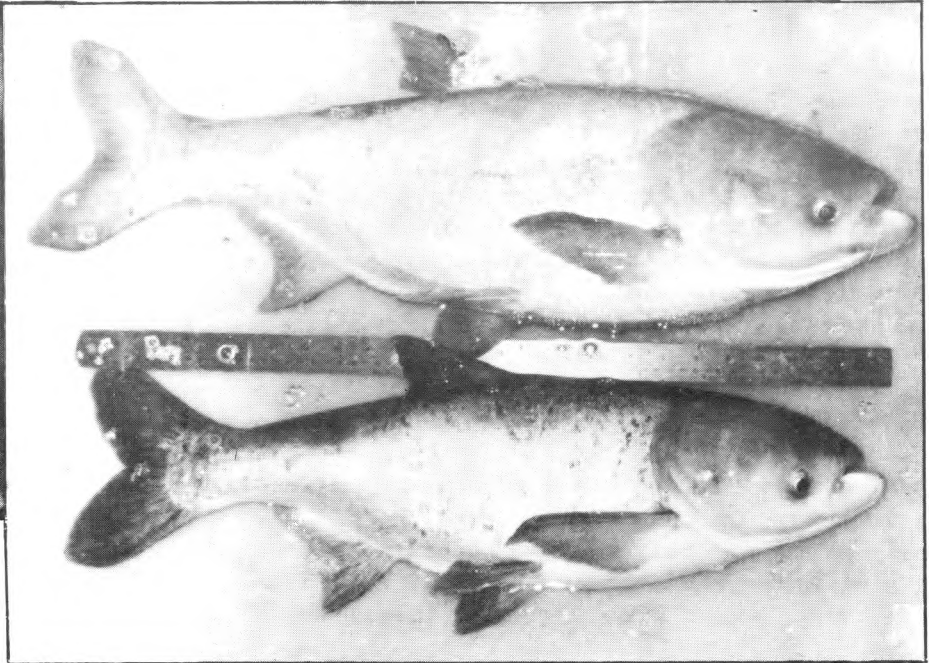
This paper reviews results of studies conducted on the rabbitfish, *Siganus guttatus* (Bloch), and the sea bass, *Lates calcarifer* (Bloch), at the Aquaculture Department of the

Southeast Asian Fisheries Development Center. Studies include broodstock development and management, induced breeding, effect of handling stress and diet on egg quality, early life history, food, feeding strategy, weaning to artificial diets, effect of stocking density and salinity on egg development, larval growth and survival, and advancement of metamorphosis in sea bass by using thyroxine.

A seed production technique had been developed for rabbitfish with survival rates ranging from 5-35% while the



Eyestalk ablation of prawn broodstock to induce spawning (top), and roadside peddling of fry in plastic bags (bottom).



Carp broodstock (right) are induced to mature sexually by injection of hormones (top) and reared to spawn in ponds, pens and cages at the Binangonan Freshwater Station on Laguna Lake.

seed production technique for sea bass developed in Thailand had been modified to suit local conditions. Based on results from recent morphological and physiological studies, the stocking density, water management, and feeding scheme for the production of rabbitfish and sea bass fry had been modified to reduce cannibalism and improve survival.

and inconsistent survival led to a shift in rearing methods toward pure phytoplankton culture grown in separate tanks as food for the larvae. Thereafter, refinement of rearing methods have been conducted to improve larval survival through effective water management, nutrition, and disease control. Efforts are continuously being geared toward making the technology affordable to Filipino farmers.

- Estepa, F. and Honculada-Primavera, J. 1988. Broodstock management and seed production of *Penaeus monodon* (Fabricius). Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988:149-168.

- Fermin, A.C. 1988. Broodstock management and seed production of tilapia and carp. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988:211-230.

Research on the maturation of *Penaeus monodon* at AQD has focused on three broad areas, namely, reproductive biology and ecology, induced maturation, and broodstock management. Studies on reproductive biology provides information on the life cycle, ovarian maturation stages, courtship and mating behavior, minimum size at sexual maturation (sperm, occurrence, first spawning), and morphological egg types. Induced maturation has mainly been done through the eye-stalk ablation method. Nutritional and environmental parameters were studied to enhance reproductive performance or as an alternative to ablation. Pond-reared and wild broodstock sources and marine pen and land-based tanks as maturation systems were also tested and compared. Size, shape, color, substrate material and other aspects of tank design and construction, sex ratio, stocking density, water management, and other parameters of the management system were also studied and refined.

Bighead (*Aristichthys nobilis*) and silver (*Hypophthalmichthys molitrix*) carps were reared in ponds, pens and floating cages in Laguna Lake until maturity. Spontaneous gonadal maturation and rematuration of carp broodstock occurred within 2-2.5 years with average weight of 3-4 kg. Under lake conditions, broodstock were not given supplemental feeds. Induced spawning gravid females was done by intraperitoneal injections using hCG combined with either common carp pituitary homogenates or LHRHa. Stripping and dry-fertilization of eggs were done 6-8 hr after the final injection. Eggs were incubated in water containing 300-500 ppm total hardness. Fertilization and hatching rates were 23-88% and 7-36%, respectively. Post-larval carps were reared in tanks and fine-meshed nylon net cages installed in manured ponds. Tank-reared postlarvae were fed with *Brachionus plicatilis* and subsequently with *Moina macrocopa* in combination with powdered formulated feeds containing 40% crude protein. Fry were harvested and stocked in nursery cages after 30-45 days of rearing in tanks.

Early techniques in larval and postlarval rearing of *P.monodon* at AQD were based on the community culture method of growing natural food in larval tanks. However, low

Four-month old 50-100 g tilapia (*Oreochromis niloticus*) stocked in *hapa* net cages, tanks or ponds were used for breeding. Egg and fry production was significantly high at 4 females/m² stocking density. Different sex ratios, however, did not affect fry production. Spawning frequency and total growth of broodstock was highest in fry fed formulated diets containing 50% crude protein. Harvesting of fry was done every 15 days during summer months and every 21 days during cold months. Fry were reared in tanks and *hapa* cages and fed diets containing 35% crude protein. Supplemental feeding in the lake was suspended when productivity reached 3 g C/m²/day.

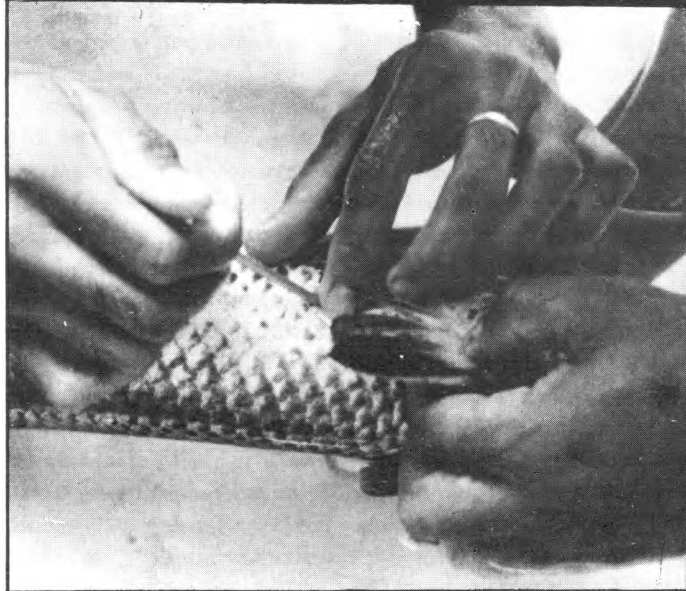
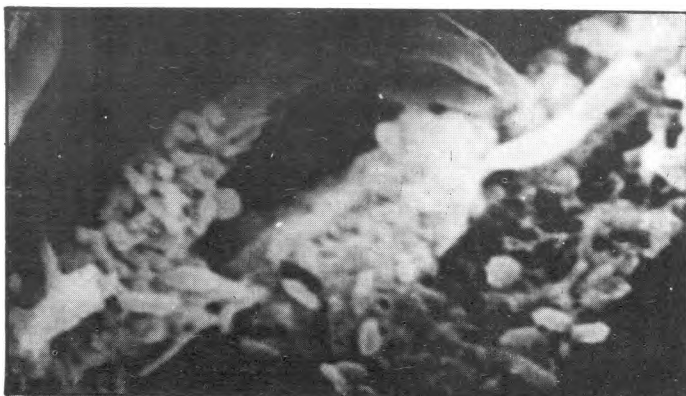
●Lacanilao, F. 1988. Constraints and prospects in aquaculture development. Ohnishi E, Nagahama Y, Ishizaki H, eds. *Proceedings of the First Congress of the Asia and Oceania Society for Comparative Endocrinology (AOSCE): 1987 November 4-7; Nagoya, Japan. Nagoya University, 1988:359-364.*

The development of aquaculture in developing countries of the Asia-Pacific region is constrained by inadequate seeds, diseases and other causes of mortality, lack of effective natural food and formulated feeds, problems associated with

technology of culture systems, and lack of knowledge of the breeding biology of culture species. Other problems include inadequate qualified technicians and skilled labor and high costs of fertilizers, pesticides, pumps, and blowers. All these are only those related with production part of aquaculture. Problems associated with post harvest are also numerous, not to mention financing, socioeconomic condition, and local peace and order situation. The problems are aggravated when fish farmers go into semi-intensive and intensive methods of culture.

Application of endocrinology will have their greatest impact in enhancing aquaculture development by improving the seed supply. These may be done through induced maturation and spawning, larval rearing, and nursery management. T.J. Lam reviewed the applications of endocrinology to fish culture in 1982. Hormonal intervention of seed production can result in (1) year-round supply of fry, (2) accelerated larval development and metamorphosis, which save on cost of hatchery operation, and 3) production of monosex individuals that are faster growing and which reduce rearing cost. The quantity and quality of seed supply will determine the extent of development, whether by expansion in area or by intensification of culture. The present source of seeds in many areas is still largely from the wild which is inadequate, uncertain, and threatened by coastal pollution. Milkfish farming, for instance, in the Philippines and Indonesia alone covers only 400,000 hectares but the seeds come entirely from the wild. In 1983, the Asia-Pacific region produced 8.4 million

Production problems in aquaculture (counterclockwise): Disease (plaques of luminous bacterium *Vibrio harveyi* in oral cavity of prawn larva, scanning electron micrograph); controlled hormonal induction of sexual maturation and spawning to meet the need for adequate supply of seeds; maintenance of closed culture systems.



metric tons from aquaculture, and contributed 82% of the total aquaculture production for that year. As the developing countries of the region go into industrialization and coastal pollution is increased, the natural supply of seeds will have to depend largely on artificial breeding.

- Llobrera, A.T. 1988. Effect of farming phase and in-plant processing on the microbiological quality of prawns (*Penaeus monodon*). Seventh Session of IPFC Working Party on Fish Technology and Marketing; 1988 April 19-22, Bangkok, Thailand, *Fish Tech News* 11:2.

The bacteriological loads of farm-raised (brackishwater) prawns at the time of harvest and at different points during processing were determined. The total plate counts of freshly harvested prawns were between $6.8 \times 10^4/g$ to $1.5 \times 10^5/g$. After processing, the counts decreased and ranged from 2.1×10^4 to $6.6 \times 10^4/g$. These counts are within the range of reported levels from temperate countries and are lower than the international standard of $10^6/g$.

The use of animal (chicken) manure during the farming and fertilizing phase is a source of *Salmonella* contamination in prawns and should, therefore, be avoided. Proper handling and quality control immediately after harvest and during processing should result in high quality and safe products which would meet international standards.

- Marte, C.L. 1988. Broodstock management and seed production of milkfish. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988:169-194.

Milkfish (*Chanos chanos* Forsskal) remains one of the cheapest sources of protein for developing countries in Southeast Asia, particularly in the Philippines. The unpredictable supply of wild fry, the only source of seed for the milkfish farmer, contributed largely to the slow growth of the milkfish industry. Research on the artificial propagation of this fish was therefore, given emphasis.

Major research achievements in milkfish breeding of the SEAFDEC Aquaculture Department in the last decade include: (1) successful induced spawning of wild and captive breeders using gonadotropin preparations and gonadotropin-releasing hormone analogues (GnRHa); (2) spontaneous maturation and spawning of captive breeders; (3) completion of the life cycle of milkfish in captivity; (4) development of a simple egg-collecting method; and (5) development of techniques for mass production of milkfish fry.

Information on fry ecology and behavior, larval morphology and physiology were also gathered. These published data constitute the bulk of current knowledge on milkfish biology and natural history.

Milkfish breeding technology is currently being pilot-tested in several breeding sites of the Bureau of Fisheries and

Aquatic Resources (BFAR). Spontaneous maturation and spawning of milkfish have been verified in four sites which differ in environmental characteristics. The economic feasibility of producing milkfish fry and the socioeconomic impact of artificial propagation of milkfish are now being assessed.

- Marte, C.L. and Lam T.J. 1988. Hormonal changes accompanying sexual maturation in milkfish *Chanos chanos* Forsskal. Ohnishi E, Nagahama Y, Ishizaki H, eds. *Proceedings of the First Congress of the Asia and Oceania Society for Comparative Endocrinology (AOSCE)*; 1987 November 4-7; Nagoya, Japan. Nagoya University, 1988: 183-184.

In spite of the economic importance of milkfish to Southeast Asia, relatively little information is available on its reproductive biology and physiology. Milkfish has a prolonged juvenile phase and undergoes first sexual maturation at five years. Steroid hormone profiles during this juvenile phase and the changes accompanying sexual maturation are described.

There were no significant differences in levels of serum estradiol 17-B (E2), testosterone (T) and progesterone (P) of male and female immature fish. In immature fish, E2 ranged from 0.145 to 0.600 ng/ml, T varied from 2.04 to 3.75 ng/ml, and P ranged from 0.472 to 1.16 ng/ml. Serum T, however, was significantly high in 4-year old immature fish while E2 was significantly high in 2-year old fish. Mean E2 level rose from 0.54 and 0.11 ng/ml (E2) in immature females (Stage 1) to 4.53 and 1.16 ng/ml in vitellogenic females (Stage 5) while T increased from 2.06 and 0.28 ng/ml to 38.4 and 9.26 ng/ml. E2 and T levels were positively correlated to egg diameter. Progesterone level, however, remained low throughout vitellogenesis. 17-1-OH-progesterone and 17- α , 20-B -progesterone were not detectable even in fully vitellogenic females. Gonad development in males was accompanied by increased serum T levels only. T level increased from 2.5 and 0.40 ng/ml in immature males to 27.73 and 5.02 ng/ml in spermeating males. Significantly higher T level was found in males with thick but abundant milt (spermiation index, SPI, 2+) compared to males with scanty milt (SPI, 1+) or males with copious, fluid milt (SPI, 3+).

There was no significant seasonal variation in levels of E2 and T of immature 3-5 year old females sampled from July 1981 through February 1983. Serum E2 varied from 0.125 ng/ml to 1.45 ng/ml while T was uniformly low and ranged from 1.16 ng/ml to 2.07 ng/ml. The levels of E2 and T significantly rose during the breeding season (April-June 1983) and accompanied the increase in gonadosomatic index (GSI) at this time (E2, 3.43 and 0.49 ng/ml; T, 40.04 and 16.20 ng/ml). The levels of both steroids dropped to below 1 ng/ml in spent females sampled in the succeeding months. In immature males, mean serum E2 was below 1 ng/ml throughout except for a significantly high level (2.36 ng/ml) found in 3-year old male samples in October to December

1981 while T levels ranged from 1.11 ng/ml to 2.78 ng/ml. As in females, T level significantly rose to 21.52 and 8.38 ng/ml during the breeding season when GSI peaked (April-June

1983). E2 remained low throughout. T level dropped to around 10 ng/ml in the succeeding months when only spent or regressed fish were sampled.

Response of maturing milkfish to mGnRH-A, sGnRH-A and hCG (After Marte et al., *Aquaculture* 73:335.1988)

Treatment	No. per treatment	No. of fish spawned	Initial oocyte diameter (Mean±SD)	Remarks
mGnRH-A pellet implant (100 ug/pellet) ^a	7	3	0.73±0.10	1 fish ovulated 3 showed no response
sGnRH-A pellet impant (100 ug/pellet) ^b	7	1	0.65±0.07	2 fish ovulated; 1 with hydrated oocytes; 3 showed no response
sGnRH-A injection (100 ug/fish) ^c	4	4	0.78±0.02	
mGnRH-A injection (10 ug/kg)	4	3	0.74±0.02	1 fish ovulated
hCG injection (1000 IU/kg)	6	6	0.76±0.02	
Control pellet implant	3	0	0.62±0.10	1 fish escaped
Control saline injection	4	0	0.64±0.14	1 fish escaped

^a20.6-27.4 ug/kg body weight.

^b20.4-35.7 ug/kg body weight.

^c24.4-33.3 ug/kg body weight.

●Marte, C.L. 1988. Milkfish culture and artificial propagation. Idler DR, Crim LW, Walsh JM, eds. *Proceedings of the Third International Symposium on Reproductive Physiology of Fish*; 1987 August 2-7; St. John's, New-foundland, Canada. Memorial University of Newfoundland, 1987:89-93.

Milkfish (*Chanos chanos* Forsskal) is widely distributed in the Indo-Pacific region and one of the most extensively cultured fish in Southeast Asia. In the Philippines, Indonesia and Taiwan, over 400 000 ha of brackish water ponds and fresh-water bodies are used to culture milkfish for food and as bait fish. In recent years, various culture methods have been developed to increase production per unit pond area. These include: 1) improved methods of pond fertilization, 2) stock manipulation, 3) adoption of deep-water pond systems, and 4) supplemental feeding. Fry needed to stock milkfish ponds come largely from the wild. Fluctuation in fry supply due to seasonal, climatic and biological factors, however, has been responsible for the slow growth of the milkfish industry. To augment and stabilize the fry supply, efforts to breed milkfish in captivity were initiated in several institutions. These efforts have resulted in: 1) development of induced spawning techniques by hypophysation and administration of gonadotropin-releasing hormone analogues (GnRH_a); 2) spontaneous maturation and spawning of captive milkfish; 3) hormonal induction of gonad development; and 4) development of larval rearing techniques. While milkfish culture has considerably improved and artificial propagation has been achieved, numerous problems still have to be addressed particularly those related to 1) the development of

new culture techniques and 2) controlled breeding.

●Primavera, J.H. 1988. Training programs of SEAFDEC Aquaculture Department. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988-293-301.

With training as one of its three mandated functions, the SEAFDEC Aquaculture Department offered its first training course in 1974. Since then it has trained some 6519 participants in various degree and non-degree programs. The degree courses are M.S. Fisheries (Aquaculture) and M. Aquaculture in collaboration with the University of the Philippines in the Visayas.

The non-degree programs include regular short-term courses, on-site seminars, internship training and practicum for graduating students. The "hands-on" short-term courses cover Prawn Hatchery and Nursery, Marine Finfish Hatchery, Brackishwater Pond Culture, Sanitation and Culture of Bivalves, Freshwater Aquaculture, Aquaculture Management, Aquaculture Engineering, and Aquaculture for Social Scientists. A profile of 637 1982-1986 training participants shows 82.3% from Southeast Asia, 79% male and 57.5% from government sector.

The paper discusses planning and implementation of training programs, funding support (Japanese Government, International Development Research Centre of Canada FAO Network of Aquaculture Centres in Asia), and future trends.



The Aquaculture Department offers regular short-term hands-on courses. Above, trainor and trainee in Prawn Hatchery and Nursery Operations and Management.

- Sitoy, H.S. 1988. Farming of mussels and oysters. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988:231-248.

This paper reviews the works on mussel and oyster culture conducted from 1975 to 1985 by the Southeast Asian Fisheries Development Center Aquaculture Department at Tigbauan, Iloilo, Philippines. Innovative techniques developed in increasing collection of natural seeds and in improving farming techniques are presented. Results of the work on artificial seed production, bacterial depuration, uptake and elimination of heavy metals by green mussel, investigations on red tides, and microbiology of spoilage are discussed.

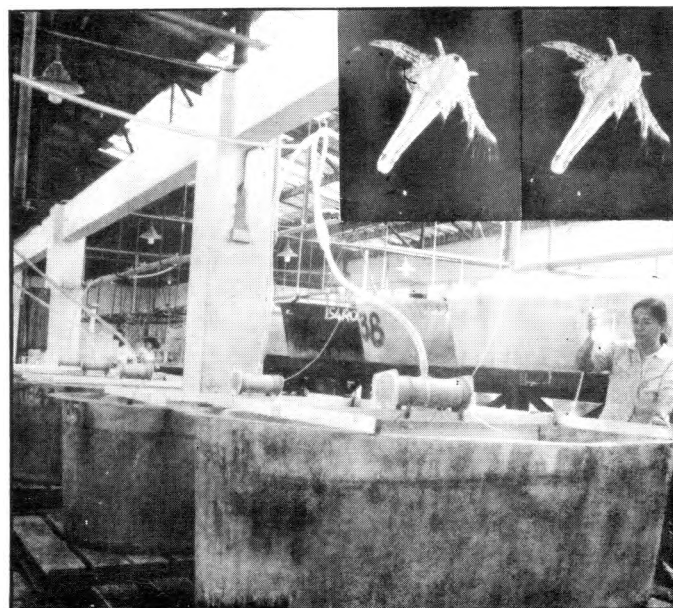
- Subosa, P.F., Rokushika, S., Kihara, K., Hatano, H., Murayama, T., Kubota, T. and Hanaoka, Y. 1988. Trace analysis of nitrite ion in seawater using ion chromatography. *Proceedings of the Symposium on Liquid Chromatography '88*; 1988 August 26-27; Kyoto, Japan; Kyoto University, Japan, 157-160.

Owing to the adverse effects of nitrite ion to the environment, controlled nitrite levels in natural waters gained interest among aquaculture researchers. Nitrite, an intermediate stage in the nitrogen cycle may occur in water as a result of the biological decomposition of proteinaceous materials. When correlated with other forms, the trace amount of nitrite may indicate organic pollution.

Determination of trace level of nitrite in seawater by ion chromatography is complicated because of the interference of high concentration of chloride ion. This paper reports a new type of ion chromatographic system separating and quantitatively determining the specified range of nitrite levels.

- Tuburan, I.B. and Gerochi, D.D. 1988. Nursery and grow-out operation and management of milkfish. Juario JV, Benitez LV, eds. *Perspectives in Aquaculture Development in Southeast Asia and Japan: Proceedings of the Seminar on Aquaculture Development in Southeast Asia*; 1987 September 8-12; Iloilo City, Philippines. Iloilo: SEAFDEC AQD, 1988:269-280.

This paper reviews the results of studies on the pond culture of milkfish *Chanos chanos* Forsskal at the SEAFDEC Leganes Brackishwater Station, Leganes, Iloilo since its establishment in 1973. Substantial contribution to the nursery system includes increased stocking density and survival through the use of nylon substrates, supplemental feeding with rice bran, the use of hatchery-reared and stunted fingerlings as alternative sources of stocks, and improvements in the acclimation process. Studies on monoculture and polyculture in grow-out ponds investigated the use of stunted fingerlings, kitchen or algal nursery ponds, stock manipulation techniques, increased stocking density using the plankton method, frequency and quantity of fertilization, modular pond culture system, and initial findings on fish diseases. Constraints setting back increased production in the Philippines are discussed.



Large-scale tank culture of natural food organisms like the brine shrimp *Artemia* (inset, nauplii) and planktonic algae is a continuing concern in support of prawn and finfish hatchery and nursery operations.

Research Seminars

Date	Title	Speaker
19 February	Biochemical and physiological response of marine phytoplankton to varying nitrogen regimes under diel light periodicity	M. Mulholland
26 February	Colony hybridization: rapid identification method for <i>Vibrio anguillarum</i> in ayu, <i>Plecoglossus altivelis</i>	T.R. de Castro
4 March	The ultrastructure of the hepatocytes of <i>Lates calcarifer</i> during experimental starvation and refeeding with different diets	E. Avila
11 March	Culture techniques for a stable rotifer (<i>Brachionus plicatilis</i>) production	M. de la Pena
18 March	Effect of continuous lighting on growth and survival in first-feeding larval rabbitfish, <i>Siganus guttatus</i>	M.N. Duray
25 March	Osmotic, chloride and calcium concentrations in the hemolymph of <i>Penaeus monodon</i> as a function of molt stage and external salinity	F.D.P. Estepa
8 April	Biomass production of <i>Artemia</i> in intensive culture system	R.F. Bombeo
22 April	Preliminary pathological and histological observations on the hepatopancreas of penaeid prawn (<i>Penaeus monodon</i>) affected with blue syndrome	R.D. Fernandez
6 May	Ingestion and developmental rates of <i>Penaeus monodon</i> larvae as a function of cell concentration	G.L. Javellana
13 May	Status of shrimp nutrition and feed development in Southeast Asia	F.P. Pascual
26 May	Scientific Research	G. Calleja*
3 June	Philippine <i>Gracilaria</i> studies: carpospore germination, growth rate, and gel texture of agar	A.Q.H. Ponce
10 June	Evaluation of the salinity tolerance of <i>Oreochromis mossambicus</i> , <i>O. niloticus</i> and their F ₁ hybrids	C.T. Villegas
17 June	Isolation and identification of luminous bacteria associated with larval mortalities in <i>Penaeus monodon</i> hatcheries	C.L. Pitogo
1 July	An economic analysis of the modular pond system of milkfish production in the Philippines	R.F. Agbayani
7 July	Effect of varying dietary protein and energy levels on growth of rabbitfish, <i>Siganus guttatus</i>	M. Parazo

Research Seminars

Date	Title	Speaker
15 July	Collection handling and transport of naturally spawned milkfish eggs	L.Ma.B. Garica
29 July	Larval production and settlement of the green mussel, <i>Perna viridis</i>	C.C. Baylon*
5 August	Diagnostic and multivariate analysis of <i>Tilapia</i> species and their hybrids	A. Castillo
19 August	Growth and survival of <i>Penaeus indicus</i> at different stocking densities using SEAFDEC-formulated feed	R. Mesa
26 August	Lysine requirement of milkfish (<i>Chanos chanos</i> Forsskal) juveniles	I.G. Borlongan
1 September	Experiences in disease control in intensive prawn ponds	R. Gacutan
2 September	The effect of stress on spawning survival of larvae of rabbitfish, <i>Siganus guttatus</i> (Bloch)	F.G. Ayson
9 September	Ammonia excretion in <i>Penaeus monodon</i> postlarvae during handling and transfer	J.M.E. Almendras
23 September	Ovarian maturation stages in wild-unablated, wild- and pond-ablated <i>Penaeus monodon</i> : histology and oocyte frequency	J.D. Tan-Fermin
28 September	Aquatic fungi as potential threats in aquaculture	I. Dogma*
29 September	Feeding in sea bass larvae as a function of fish size and prey density	J. Llobrera
7 October	The initial process of formation of acid sulfate soil	N. Golez
14 October	Evaluation of organic and inorganic fertilizers in brackishwater milkfish ponds	I. Tuburan
27 October	Status of mollusc culture in Asian countries	A. Lovatelli*
11 November	Fate and location of <i>Vibrio anguillarum</i> in tissues of artificially-infected ayu (<i>Plecoglossus altivelis</i>)	M. de la Cruz
18 November	Use of essential amino acid index in the evaluation of indigenous protein sources as potential component in diet formulation for <i>Penaeus monodon</i>	V. Penaflorida
7 December	BFS ecological studies in Laguna de Bay: Impact and directions	A. Santiago

*Visiting Scientist.

Research Awards

AQD Research Associate Oseni M. Milamena, with Jurgenne H. Primavera, Rosario A. Pudadera and Rosemarie V. Caballero, authored one of the two best papers in aquaculture for the 1988 *Elvira O. Tan Memorial Award for Fisheries Research*. Their paper is entitled *The effect of diet on the reproductive performance of pond-reared Penaeus monodon Fabricius broodstock*. The other best paper was authored by Felicitas Piedad-Pascual, AQD Scientist, and is titled *Effects of supplementary lecithin and lipid sources on the growth and survival of Penaeus monodon juveniles*. Both papers were published in *Proceedings of the First Asian Fisheries Forum*. The authors of both papers received cash awards and plaques of distinction.

Last year, another AQD paper *Studies on the chronic soft-shell syndrome in the tiger prawn Penaeus monodon Fabricius in brackishwater ponds* was chosen best scientific paper for the first *Dr. Elvira O. Tan Memorial Award*. AQD Research Associate Ma. Cecilia Baticados wrote the paper with co-authors Relicardo Coloso and Roselyn Duremdez-Fernandez. The paper was published in *Aquaculture*.

Initiated by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) of the Department of Science and Technology, this annual award is given in memory of the late Dr. Tan, who, in her time, was one of the country's finest and most dedicated fisheries researchers. Nominees for the award are scientists who have in the last five years published in foreign or local scientific journals outstanding research papers on marine and aquaculture/inland fisheries.

Earlier, three junior scientists of AQD won the 1987 *Naga Award* of the International

Research generated at AQD continues to win accolade from the scientific community. A paper by three BFS junior researchers won the 1987 Naga Award by the International Center for Living Aquatic Resources Management (ICLARM). Two others by TRS researchers also garnered the top awards in the 1988 Elvira O. Tan Memorial Award in Fisheries Research sponsored by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD).

Center for Living Aquatic Resources Management (ICLARM). The prestigious annual award is given to the best scientific paper in fisheries and aquaculture written by authors from a developing country. Joint authors of the winning paper are Angelito Gonzal, Emilio Aralar, and Josefina Ma. Ferriols-Pavico. They received a commemorative plaque and cash award for their paper *The effects of water hardness on the hatching and viability of silver carp (Hypophthalmichthys molitrix) eggs* published in *Aquaculture*.

Meanwhile, Relicardo Coloso, another AQD researcher who is taking up doctoral studies at Cornell University on a Fulbright-Hays scholarship grant, won a *Graduate Student Research Award* in an abstract-writing competition sponsored by the American Institute of Nutrition. His winning entry was based on his paper *Metabolism of cysteine by rat enterocytes*. It was one of the 12 winners selected from a total of 1,179 abstracts submitted by participating graduate students from different universities in the United States.

TRAINING

AQD continued to conduct regular long- and short-term training programs as well as workshops, and special training on various areas of interest in aquaculture. Six short-term and one long-term regular training courses were held.

AQD also offered internship training in such study areas as nutrition and feed formulation, plankton culture, and chemical and

proximate analyses, as well as practicum training for undergraduate fisheries and biology students, and special or group training.

The training courses focused on the priorities identified during the *Seminar on Training Requirements in Fisheries and Aquaculture in Southeast Asia* held in Hua Hin, Thailand, March 29-30, 1988. Following are the courses conducted in 1988:



The training program at the Aquaculture Department is in high demand, underscoring the level of expectation both governmental and private sectors of SEAFDEC Member Countries and others place on aquaculture. In 1988, seven regular short- and long-term courses had 163 participants, two workshops with 39, and internship and practicum with 108. Seventeen countries in Asia-Pacific, Middle East, South America and Africa were represented: Brazil, People's Republic of China, India, Indonesia, Kiribati, Kenya, Republic of Korea, Malaysia, Mauritius, Nepal, Philippines, Sri Lanka, Thailand, Tonga, Uganda, United Arab Emirates, Vietnam.



Regular Training Courses

● Seventh UNDP/FAO NACA-UPV-SEAFDEC AQD Senior Aquaculturists Training Course

This one-year course which began on 17 March 1988 had 18 participants from nine countries - People's Republic of China (2), India (1), Indonesia (1), Republic of Korea (1), Malaysia (1), Philippines (8), Sri Lanka (2), Thailand (1), and the Socialist Republic of Vietnam (1). The course was conducted at the Tigbauan and Leganes Stations of AQD, the University of the Philippines in the Visayas (UPV), and the Network of Aquaculture Centres in Asia (NACA) regional lead centers in India, Thailand, and China.

From July to September, the participants undertook a study tour of various aquaculture research institutes and private enterprises in the Philippines, India, Thailand, and China. Qualified participants received the M. Aquaculture degree from UPV.



Seventh UNDP-FAO-NACA-SEAFDEC/AQD Senior Aquaculturists Training Course, 17 March 1988-16 March 1989.

● Fish Health Management

The course was conducted 3-28 March 1988 at Tigbauan Research Station (TRS). Eight participants from four countries as follows attended the course: Philippines - 3, Malaysia - 2, Thailand - 2, United Arab Emirates - 1. The Government of Japan provided fellowship support to six participants from SEAFDEC Member Countries.

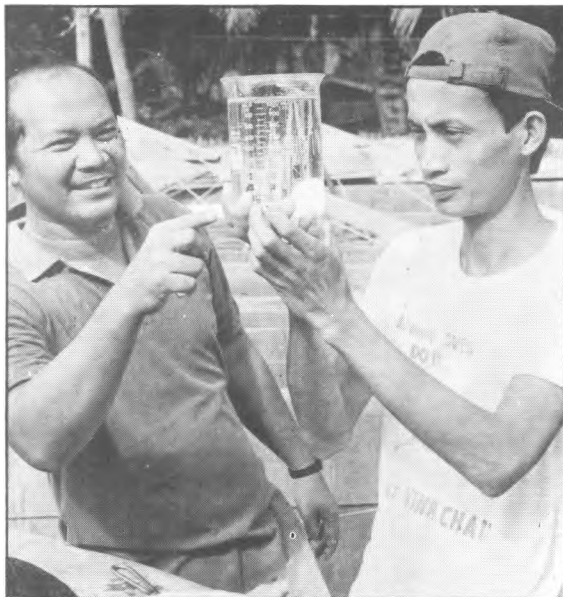
The course covered the isolation and identification, etiology, prevention and control aspects of fungal, bacterial, viral, parasitic, nutritional and environmental diseases.

● *Artemia* Culture

Conducted at TRS 8 April-3 May 1988, the training course was sponsored jointly by AQD and the *Artemia* Refer-

ence Center (ARC) of the State University of Ghent, Belgium. Fifteen participants attended the course - 2 from Malaysia, 2 from Thailand, 6 from the Philippines, 2 from the People's Republic of China, and 1 each from India, Indonesia, and Mauritius.

The training course covered *Artemia* biology and ecology; strain selection and characterization; extensive production in salt ponds; extensive culture of biomass in batch and flow-through systems; decapsulation and other techniques for harvesting, processing and storage of cysts and adult biomass; and use of *Artemia* products in hatchery, nursery and maturation feeding.



Artemia Culture, 8 April-3 May.

Fish Health Management, 3-28 March.

● Brackishwater Pond Culture

The first session was conducted 5 May-14 June 1988 with 23 Philippine participants from the private sector and 1 from the government.

The second session was conducted 6 October-16 November 1988, with 22 participants from eight countries as follows: Malaysia - 2, Thailand - 1, Tonga - 1, Vietnam - 1, Sri Lanka - 1, Kiribati - 1, Uganda - 1, Philippines - 14.

The course, conducted at AQD's Leganes Brackishwater Station (LBS), was aimed at developing skills and techniques in the nursery and grow-out pond culture management of finfish (milkfish and sea bass) and crustaceans (prawn, shrimp); pond design and construction; harvest and post-harvest technology; marketing and economic assessment.

● Prawn Hatchery and Nursery Operations and Management

The first session was held 11 May-30 June 1988 at TRS. It was attended by 18 Philippine participants from the private sector.

Twenty-four Philippine participants also attended the second session of the course for local farmers, 5 July-24 August 1988.

The third session was conducted 30 August-19 October 1988 with 13 participants from seven countries: Malaysia - 1, Thailand - 1, Philippines - 7, Vietnam - 1, India - 1, Sri Lanka - 1, and Brazil - 1.

The seven-week course aimed to develop skills in operating a prawn hatchery including broodstock and nursery of *Penaeus monodon*, *P. indicus*, and *P. merguensis*. The course also included such topics as site and species selection; design and construction of hatchery and nursery tanks; larval and post-larval rearing and feeding; harvesting, packing and transport of fry; and hatchery economics.

● Hatchery of Marine Finfishes

Eleven participants attended the course from 13 July to 31 August 1988 at TRS and Igang Substation, with 1 participant each from Malaysia and Thailand, 8 from the Philippines, and 1 from Kenya. This seven-week course covered seed production of marine finfishes (milkfish, sea bass and siganids) from broodstock development to spawning; hypophysation and other induced spawning techniques; fish breeding and larval rearing; and transport of fry and fingerlings.

● Freshwater Aquaculture

The course was conducted at AQD's Binangonan Freshwater Station (BFS) 1 September-4 October 1988. One participant came from Malaysia, 5 from Thailand, 3 from the Philippines, and 1 from Tonga.

This four-week course was geared toward the development of technical skills in land-based hatchery and nursery systems for milkfish. Pond, pen and cage grow-out culture of tilapia and carp were also covered. The course also included broodstock selection and development; farming operations and management including harvest, transport and marketing;

cage and pen design and construction; natural and artificial feeds; ecology of freshwater lakes particularly Laguna Lake; parasites and diseases; fish storage and processing; and economic analysis.



Brackishwater Pond Culture, 5 May-14 June, 6 October-16 November.



Prawn Hatchery and Nursery Operations and Management, 11 May-30 June, 5 July-24 August, 30 August-19 October.

Workshops

● Artemia Workshop

The *Workshop on the Production and Use of Artemia in Marine Shrimp and Fish Farming* was conducted at TRS 26-27 April 1988 in order to provide the local aquaculture industry with updated information on the proper utilization of the brine shrimp in aquaculture operations. The workshop was



Workshop on Teaching Strategies for Adult Learners (left and bottom left), 28 September-11 October. Trainee in Internship Training (Water Quality Control) (bottom).



held through the collaboration of AQD which provided workshop; and laboratory facilities, logistics and technical support, and ARC of the State University of Ghent, Belgium which provided technical expertise. Sixteen participants from the Philippine government and private sector joined the workshop.

- Workshop on Teaching Strategies and Curriculum Development for Adult Learners

The workshop was conducted 28 September-11 October 1988 at TRS with financial assistance from IDRC. It was designed to provide adult learners with training on how to plan, design, and conduct training programs in fisheries research. Its focus was on teaching methodologies and the preparation of audio-visual materials. Twenty-three participants attended the workshop - 1 from Malaysia, 4 from Thailand, 13 from the Philippines, 2 from Indonesia, 1 from India, and 2 from Nepal.

Practicum Training

AQD extended practicum training to students from various colleges and universities. A total of 49 students availed of the program in 1988.

Internship Training

Internship training in various areas of specialization in aquaculture was offered by AQD. In 1988, 59 trainees were accepted (Malaysia - 2, Philippines - 57). Fields of training included phycology, nutrition and feed development, water quality control, instrumentation, and laboratory equipment maintenance.

Instructional Materials

Four instructional video tapes as follows were revised based on improved and updated technology: *Prawn Fry Production*, *Prawn Feed Preparation*, *Prawn Processing*, and *Biology and Ecology of P. monodon*.

EXTENSION SERVICES

Extension services were focused on the local small fish farmers and the poor fisherfolks. Activities were carried out in coordination with the Philippine Department of Agriculture (DA) and other government agencies, and non-government organizations (NGOs), through a series of aquaculture outreach seminars, consultations, and on-site lectures.

The extension activities were made part of an umbrella program, Aquaculture Technology Outreach Program (ATOP). A national program, ATOP was a joint undertaking between AQD and the Philippine Technology and Livelihood Resource Center (TLRC). ATOP aimed to hasten countryside development through the conduct of a series of aquaculture seminars, and production and dissemination of

manuals, pamphlets, leaflets, and audio-visual materials on fish farming techniques.

ATOP comprised four major activities, namely: *Technology Training* which is subdivided into outreach seminars for the small fish farmers, aquabusiness seminars for business and development workers, and on-site consultation; *Technology Publications* which aims to disseminate technologies to the target audience in simple language in order to facilitate their widespread adoption; *Technology Films and Video* involves recording of complete training course (maximum of 15 hours) in a video tape; and *Technology Correspondence* using the postal communications system in the transfer of technology and livelihood skills to entrepreneurs, farmers, workers, and other users.

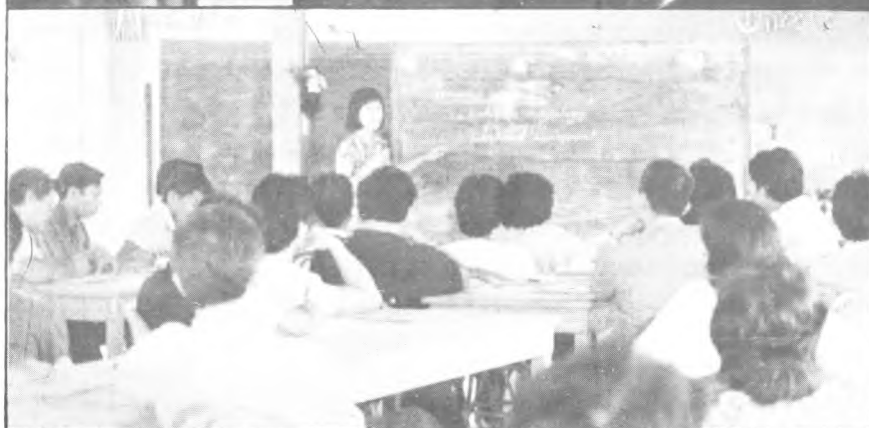


Extension services of the Aquaculture Department are geared not only to provide in the long term fish protein to the Filipino fish farmers and fisherfolks nationwide (right) but also to share during Christmas its blessings to neighbors in Tigbauan, Iloilo (top).





ALAY PALAISDAAN (Outreach Seminars for Small Fish Farmers) in 1988 brought over long distances by land and sea the technologies researched and packaged by the Aquaculture Department to its direct beneficiaries in 27 cities and provinces in 10 of 12 regions of the Philippines. (Session photos on this page and locator map on facing page.)



Technology Training

- Outreach Seminars for Small Fish Farmers (Also known as *Alay Palaisdaan*)

Alay Palaisdaan is a series of aquaculture outreach seminars which seeks to bring the benefits of modern and improved aquaculture technologies to the countryside through on-the-spot farm consultations, lectures, and informal discussions with the fish farmers.

In 1988, aquaculture outreach seminars were conducted in 10 of 12 regions throughout the Philippines, involving 28 sessions and benefitting more than 1,200 small fish farmers.

- Aquabusiness Seminars

In 1988, three seminar courses involving four sessions were conducted in Metro Manila. The courses offered were *Prawn Hatchery and Nursery Operations*, *Prawn Culture (Grow-out) and Management*, and *Freshwater Aquaculture*.

- On-Site Consultation

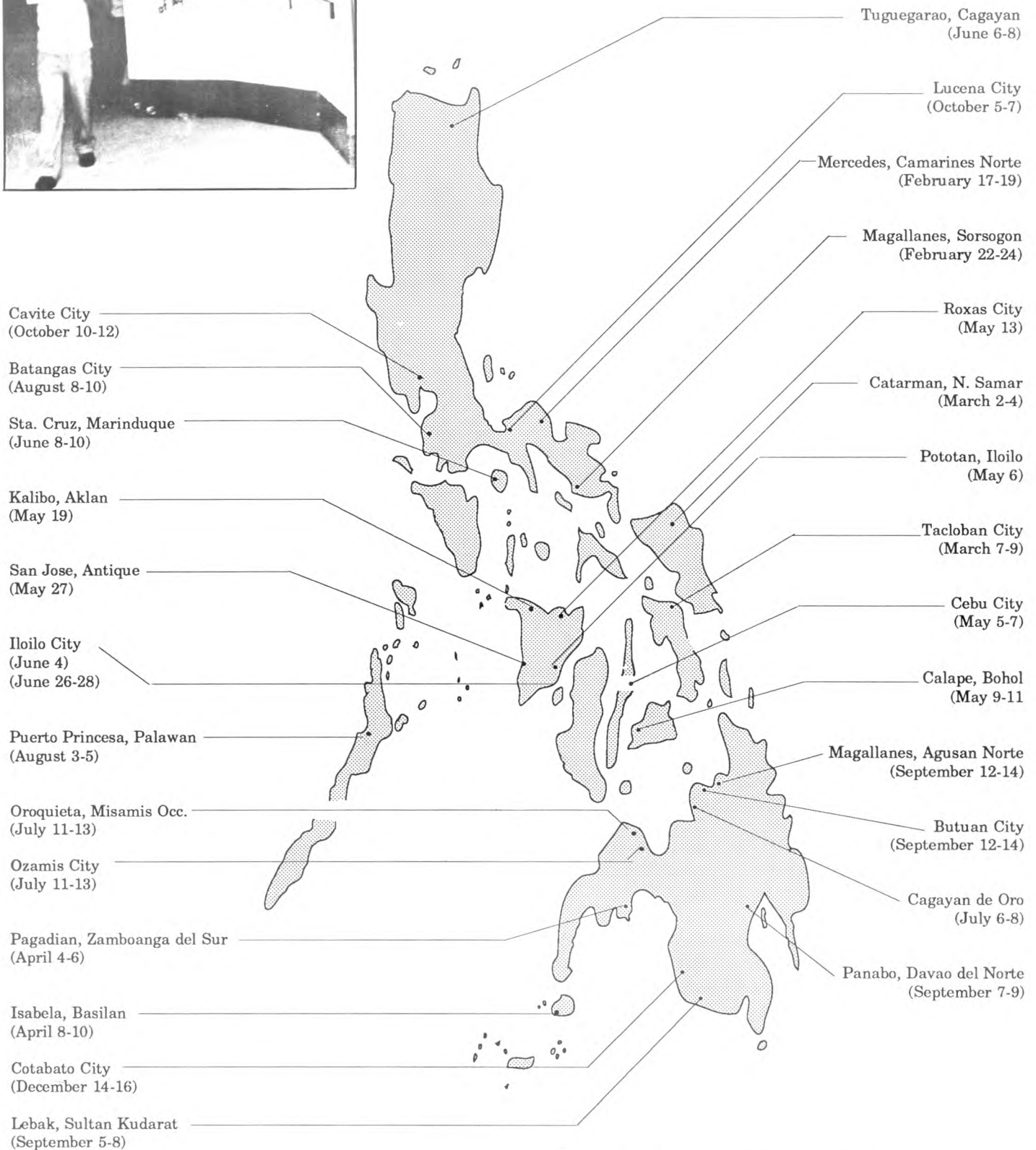
AQD provided resource persons during a seminar on prawn culture conducted by the Bureau of Small and Medium Business Development of the Philippine Department of Trade and Industry (DTI) in Sultan Kudarat, September 5-9, 1988.

AQD also provided one resource person on prawn culture during the launching of the DTI project *From Davao to the World* in Davao City on September 28, 1988; and another resource person during a technical consultation with the AQUASUR, Inc. in Davao City to observe and discuss with its farmer-members the occurrence of red disease in prawn ponds.





Aquaculture Technology Outreach Program 1988



On-site consultation service to private and governmental clientele.



● Caravan Fair

AQD participated in two legs of *Agri-Aqua Livestock and Poultry Caravan Fair '88*, in Metro Manila (May 29-June 5, 1988) and Iloilo City (June 25-28, 1988). The fair was organized by DA and the Philippine Center for International Trade and Exhibitions (PHILCITE).

AQD also participated in the *Panay Expo Caravan '88* organized by DA and the Regional Agricultural and Fishery Council (RAFC) of Region VI from May 5 to June 6, 1988.

The participation of AQD in the caravan fair included conduct of aquaculture seminars, demonstrations on feed formulations, and consultation.

Technology Publications

Three extension manuals were scheduled for publication, whereas two pamphlets and five leaflets were being readied for publication.

Technology Films and Video

Five video coursewares were scheduled for production in early 1989, and another five in the second half of 1989.

Technology Correspondence

Production of initial five coursewares were finalized. Each courseware consists of modules. Each module is subdivided into lessons which contain self-testers and corresponding answers.

Aquaculture seminar by SEAFDEC/AQD researcher during the Department of Agriculture 1988 Agri-Aqua Caravan Fair.



Aquaculture video tapes in Beta format produced by the Department are used extensively in training seminars and made available to the private sector.



INFORMATION

AQD undertook a coordinated system of information gathering, processing, and dissemination to ensure effective transfer of technologies developed at AQD and other agencies to the fish farmers and other special agencies. AQD's extension services were provided with strong communication support through production of techno-packages and intensification of the acquisition and processing of related information materials.

Library Services

Accessioned in 1988 were 332 monographic volumes, 224 pamphlets, and 61 SEAFDEC publications. Checklisted were 1,783 journal issues (918 from Gifts and Exchanges, 765 as paid subscriptions). Also received from Gifts and Exchanges were 416 monographs, 28 theses, 411 reprints, 74 pamphlets, and 108 annual reports and brochures.

Documentation Services

• Brackishwater Aquaculture Information System (BRAIS)

One of the major activities of BRAIS is information networking. Project networks were established in Indonesia in September 1985 (IndoBRAIS) at the Brackishwater Aquaculture Development Center, Jepara, Indonesia); in Malaysia in May 1985 (MalayBRAIS at the Fisheries Research Institute, Fisheries Division, Ministry of Agriculture, Malaysia); and in Thailand (ThaiBRAIS at the Brackishwater Fisheries Division, Department of Fisheries, Kasetsart University, until June 1988; and at the Fisheries Science Society of Thailand, Kasetsart University, beginning July 1988). PhilBRAIS, the national center for the Philippines is based at AQD. The lead center for BRAIS is located at TRS.

The following materials were received from the national centers in 1988:

- From IndoBRAIS - 2 conference proceedings, 1 monograph, 12 journal articles, 6 technical papers, 5 theses, 48 input sheets.
- From MalayBRAIS - 2 monographs, 2 pamphlets, 2 other materials.
- From ThaiBRAIS - 150 input sheets.
- From PhilBRAIS (through the Literature Collection Travel conducted in the Visayas on 4 April-May 7, 1988 and in Mindanao on 23 July-21 August 1988) -210 monographs, 625 journal articles, 175 reprints,



Aquaculture booth consultation, 1988 Agri-Aqua Caravan Fair, PHILCITE, Manila, 29 May-5 June.

34 pamphlets, 29 theses, 17 assorted materials.

The MalayBRAIS Project Coordinator (Nor Hadzirah Ramli) joined the PhilBRAIS literature collection travel in Central Visayas 2-16 April 1988 as did the IndoBRAIS Project Coordinator (Euis Salamoen) in Northern Mindanao 23-30 July 1988.

BRAIS also conducted a series of seminars for BRAIS staff and other AQD staff on CDS/ISIS program in the computer systems of all national centers and also at the lead center. The BRAIS data base now contains about 5000 entries.

Another important activity of BRAIS is document delivery. In 1988, 148 queries from 34 countries were handled by BRAIS.

In order to examine the extent of utilization of BRAIS products and services, a utilization assessment survey was conducted in 1988 with the technical assistance of BRAIS Consultant Prof. A. Neelameghan.

The survey covered utilization of products and services since the start of the project in March 1984. Two types of questionnaires were used - one for institutions (mailed to 323 foreign and 106 Philippine institutions), and another for individuals (100 questionnaires). About 41% of the sampled institutions responded to the survey; 90-98% were government institutions and majority (55% in Asia-Pacific Region and over 86% in Europe-North America) were involved in research. Academic/teaching activities, information services and data base preparation, and extension work were the next most important areas of activity.

Majority of the institutions receiving BRAIS products indicated specialization in aquaculture (57% in Africa-Middle East region, 75% in Asia-Pacific, 90% in Europe-North American region).

Training courses and joint meetings were the main channels of contact with AQD BRAIS for other institutions

especially in the Asian region. BRAIS announcement brochures and information provided by colleagues accounted for the highest percentage from among the sources of information about BRAIS. In the Asia-Pacific region, responding institutions indicated other library and literature citations as important source of information on BRAIS products and services.

In exchange for BRAIS products, SEAFDEC AQD also received materials from various institutions. Europe, North America and Africa had more to offer than the Asia-Pacific region. SEAFDEC AQD Library also received about 345 foreign and 100 national periodical titles either free of cost or through publications exchange agreements. Of these, 12 foreign titles and 75 Philippine serials were received since BRAIS publications and services became available.

Majority of the institutions apparently considered *Brackishwater Aquaculture Abstracts* (BAA) and *BRAIS Newsletter* as useful sources of information in brackishwater aquaculture particularly in the Asian region.

The special bibliographies on *sugpo* and sea bass received relatively higher ratings in the Asia-Pacific region, while the special bibliography on grouper gets the highest rating in the Europe-North American region. The special bibliographies on mud crab and mussel also got relatively higher ratings in the Asia-Pacific region. Most institutions indicated that they either circulated, notified in their current awareness service, or included in their publications a special bibliography when this was received.

Institutions mainly in Asia, particularly those in the Philippines, used the referral, document delivery, and query-answer services of BRAIS. The general feeling was that their requests were responded to adequately.

Almost all responding institutions received other secondary periodicals - abstracting and indexing periodicals covering aquaculture (e.g., ASFA). The institutions which responded to the question on the usefulness of BRAIS in relation to the other secondary periodicals considered BRAIS products as useful.

Publications

The following information materials were published in 1988:

- Annual Reports, 1986, 1987
- Perspectives in Aquaculture Development in Southeast Asia and Japan (Proceedings of the Seminar on Aquaculture Development in Southeast Asia held in Iloilo City, Philippines, September 8-12, 1987)
- Research Publications: Collected Reprints 1976-1986 (Second Printing)
 - Vol. 1A. Finfishes
 - Vol. 1B. Crustaceans and Bivalves
- Poster 1: Important Penaeid Prawns/Shrimps of the Philippines (Reprinting)

Publications produced through the project Brackishwater Aquaculture Information System (BRAIS).



SEAFDEC/AQD in-house publications such as shown above are circulated worldwide.

- SEAFDEC Asian Aquaculture (Quarterly)
 - Vol. X, Nos. 1-2, January-March, April-June
- Aqua Farm News (Bimonthly)
 - Vol. V, Nos. 9-10, September-October 1987, November-December 1987
 - Vol. VI, Nos. 1-5, January-October 1988
- Internal Newsheets
 - Aqua Dep't News*, twenty fortnightly issues and one December issue
 - Information Alerts*, five issues, after which printing was discontinued
- BRAIS Publications
 - Brackishwater Aquaculture Abstracts*, Vol. 4, No. 1, July/August 1987; Vol. 4, No. 2, September-October 1987; and Vol. 4, No. 3, November-December 1987
 - BRAIS Newsletter* (Quarterly), Vol. 3, Nos. 1-3, January-September 1988



ADMINISTRATION

AQD continued to streamline its operations in order to minimize management cost. Assignment, deployment and functions of personnel were restructured to maximize output and efficiency of workforce and ensure effective use of facilities and resources.

Personnel

As of 31 December 1988, personnel of AQD totaled 537 regular employees distributed as follows: 212 in Research, 19 in Training, 37 in Information, 240 in Administration, and 29 in Finance.

AQD also availed of the services of the following foreign and local experts: **Mr. Satoru Fukumoto**, Department Deputy Chief, for another two years beginning June 10; **Dr. Tsuneo Kume**, Scientist, for two years from 17 March; **Mr. Yoshibumi Yashiro**, Researcher and Coordinator for JICA, on his second year assignment until 14 September 1989; **Mr. Akimasa Nagai**, Researcher, for two years beginning 22 November; **Mr. Philippe Dhert**, Research Associate, on his second year until 6 April 1989; **Ms. Margaret Mulholland**, Research Associate, on her second year assignment until July 1989; **Ms. Brigitte Moffaert**, Research Assistant, on her second year assignment until 12 July 1989; **Prof. A. Neelameghan**, Consultant-on-Call for BRAIS Project; **Dr. Gavino A. Trono, Jr.**, Consultant for Seaweeds Project; and **Atty. Eduardo Rondain**, Legal and Personnel Consultant.

Staff Development

As a commitment to human resource development, AQD continued to send members of its staff to various post-graduate studies and training programs. AQD also facilitated the attendance of its staff to conferences, seminars and workshops in collaboration with various funding agencies.

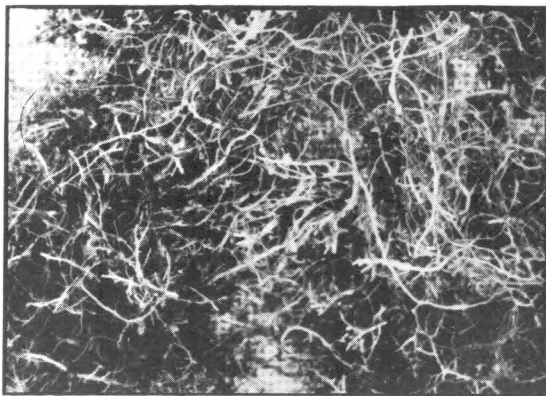
The AQD personnel as follows benefitted from this program:

- For Degree Training
 - N. Aquino** - M.S. (Fisheries)
 - A. Castillo** - M.S. (Fisheries)
 - N. Golez** - M.S. (Fisheries)
 - R. Buensuceso** and **J. Saliente** - one year UNDP/FAO NACA-UPV-SEAFDEC AQD Training for Senior Aquaculturists, and also for M. Aquaculture
- For Non-Degree Course
 - A. Gallego** - one-year training on bivalve culture in France
 - E. Cruz** - eight-month fish disease diagnostics training at Universiti Pertanian Malaysia
 - F. Palisoc, Jr.** - one-year training in aquatic pathobiology at University of Stirling, U.K.
 - R. Bombeo** - two-month training on *Artemia* research methodology at *Artemia* Reference Center, Belgium
- Attendance in Conferences, Workshops, Seminars
 - F. Pascual**, **C. Santiago**, and **I. Borlongan** - Finfish Nutrition Workshop, Bangkok, Thailand, 6-10 June 1988



JICA Coordinator Yoshibumi Yashiro (left) and SEAFDEC/AQD Deputy Chief Satoru Fukumoto (top).

- C. Villegas and Z. Basiao** - Aquaculture Genetics Symposium, Trondheim, Norway, 18-26 June 1988
- E. Aldon, M. Surtida, D. Zamora, and C. Unggui** - Technical Writing Program, Development Academy of the Philippines, Tagaytay City, 15-19 February 1988; and **P. Acosta, Jr., W. Gabuelo, L. Pacino, and N. Calvez**, 9-13 May 1988
- N. Primavera, Jr.** - Second ASEAN Regional Training Workshop in Instructional Media Development, organized by the Philippine Human Resources Development Center (PHRDC) and Japan International Cooperation Agency (JICA), Metro Manila, 7 November-9 December 1988
- F. Pascual, E. Avila** - International Foundation for Science Workshop on Fish Culture-Management Techniques and Nutrition, Malang, Indonesia, 14-19 November 1988.
- R. Agbayani, L. Garcia** - Regional Workshop on Milkfish Culture Development in the Pacific, Tarawa, Republic of Kiribati, 21-25 November 1988
- C. Marte, J. Primavera, D. Gerochi, M.C. Baticados, M. Catacutan, K. Corre, E. Gapit, R. Ortega, N. Golez, E. Rodriguez, Jr., A. Trino, I. Tuburan, P. Subosa, V. Sunio** - First National Congress of the Philippine Prawn Industry, Bacolod City, 25-27 November 1988.
- C.L. Marte** - Synthesis Workshop on Marine Science Programs in the Philippines, Metro Manila, 30 November-2 December 1988
- A. Ponce** - Fourth Seaweed Industry Conference, "Facing the Challenges of the 90's", Cebu City, 9-10 December 1988
- R. Tenedero, R. Ortega, and R. Buensuceso** - Seminar-Workshop on Communicating Government Programmes; Development Academy of the Philippines, Tagaytay City, 7-11 May 1988
- E. Gapit and J. Lagoc** - Seminar-Workshop on Communications Research Development, Development Academy of the Philippines, Tagaytay City, 18-22 April 1988
- A. Arisola and R. Ealdama, Jr.** - Media Relations Workshop, Development Academy of the Philippines, Tagaytay City, 4-8 June 1988
- S.R. Tillo, W. Barros, J. Quines, and V. Travina** - Seminar of the Society of Aquaculture Engineering Practitioners, Iloilo City, 25-26 June 1988
- A. Santiago** - First National Consultative Workshop, organized by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), Los Banos, Laguna, 1 July 1988
- R. Agbayani** - First Short Course on Aquaculture Management, Semarang, Indonesia, 11-23 July 1988
- W. Barros** - Safety Training Methods Seminar, Metro Manila, 28-29 July 1988
- P. Acosta, Jr.** - Training-Workshop on Basic Print Production Techniques; Metro Manila, 15-26 August 1988
- P. Subosa** - Symposium on High Performance Liquid Chromatography, organized by the Research Group on Automatic Liquid Chromatography of Kyoto University, Kyoto, Japan, 25-27 August 1988
- W. Gabuelo** - Data Communication Workshop, Metro Manila, 7-9 September
- V. Alava, D. Baticados, J. Ladja, R. Ortega, and V. Tambasen** - International Workshop on Teaching Strategies and Curriculum Development for Adult Learners, SEAFDEC/AQD, Tigbauan, Iloilo, 28 September-12 October 1988
- E. Avila** - Workshop on Rural Fisheries and Applied Mariculture, Silliman University, Dumaguete City, 15-22 October 1988
- F. Pascual** - ASEAN Workshop on Shrimp and Finfish Feed Development, organized by ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development Project, Johor Baru, Malaysia, 25-29 October 1988



Unstocked floating cages at Igang Research Substation, Guimaras Island (right) double up as platforms for hanging rope culture of the seaweed *Gracilaria* (top).

SEAFDEC AQD researcher Rogelio Gacutan (left) pioneered the establishment of the country's first fish health laboratory in Bacolod City sponsored by the aquaculture industry (Negros Prawn Producers Marketing Cooperative, Inc.).



FACILITIES

Service Laboratories

● Larval Food Laboratory

Artemia cysts (318 kg) and biomass (163.7 kg) were processed to supply the research needs of the Department. The laboratory also produced 54,650 liters of phytoplankton starters for the Department and 1,107 liters of phytoplankton and zooplankton starters for the private sector. Fifty-seven sets of enriched media were prepared for the private sector at minimal cost.

● Centralized Analytical Laboratory

A total of 1,401 water and 413 feed samples were analyzed. Determinations of water pH, ammonia-nitrogen, nitrite-nitrogen, and dissolved oxygen were frequently requested. Proximate analyses of feeds were done for crude protein, moisture, and crude fat content. Analytical services were extended to fish farmers at minimal fee to defray cost of chemicals.

● Microtechnique Service Laboratory

A total of 1,960 samples of liver, gills, kidney, hepatopancreas, and gonads of finfish and crustacean species were histologically processed. Whole-mount processing of *P. monodon* larval stages and typical sectioning of seaweeds were also done.

● Diagnostic Services

Eighty-two cases were processed: 53 prawn, 11 finfish, and 18 molluscs, seaweeds, water, sediments, and chemicals. Chemical samples were bioassayed, whereas sediment samples were processed for bacterial identification. Another seven samples were submitted by DA for determination of "red tide" organisms. About 54% of the cases came from the private sector, the rest from various AQD studies.

● Other Services

AQD fielded one of its researchers, **Mr. Rogelio Gacutan**, to initially set up a fish health laboratory, and provide prawn disease detection and control services for a fish farmers' cooperative. The fish laboratory was put up by the

Negros Prawn Producers Marketing Cooperative, Inc. in Bacolod City, Negros Occidental, after the cooperative noted a steep rise in the occurrence of diseases affecting cultured prawns in hatcheries and rearing ponds.

Infrastructure Development

Construction of two pre-filtered seawater systems at TRS and 20 concrete tilapia breeding tanks, 4 cage frames for 10-m dia cages and 4 cage frames for 6-m dia cages at Igang Substation were completed. Renovation and repair of 1.5-ha milkfish ponds and construction of wooden frames for culture of *Gracilaria* at Igang, and construction of three 30-ton concrete seawater reservoirs for prawn hatchery verification project at TRS were started.

OTHER ACTIVITIES

Cooperation with Non-Member Governments and Other Organizations

- International Development Research Centre (IDRC) of Canada

Research Projects

(1) Fish Gametes - Phase III (2 years: 1986-1988) (Also in collaboration with the University of Victoria, B.C., Canada, and Memorial University of Newfoundland, Canada)

(2) Bangus Breeding Project (3 years: 1986-1989) (Also in collaboration with DA-Bureau of Fisheries and Aquatic Resources, Philippines)

(3) Genetic Evaluation and Selective Breeding of *Oreochromis niloticus* for Broodstock Development (3 years: 1986-1989)

Training Activities

(4) Workshop on *Teaching Strategies and Curriculum Development for Adult Learners* (6 months: 1988)

Information

(5) Brackishwater Aquaculture Information System (BRAIS) - Phase II (2 years: 1987-1989)

- Artemia Reference Center (ARC) of Belgium

Research Projects

(1) *Artemia* Applied Technology Programme (3 years: 1987-1990)

(Also in collaboration with Belgium Ministry of Foreign Affairs - ABBOS)

Training Activities

(2) Training in *Artemia* Culture (one month: 8 April-3 May 1988)

(Also in collaboration with the Belgian Administration for Development and Cooperation - BADC)

(3) Workshop on the *Culture and Use of Artemia salina* (two days: 26-27 April 1988)

Staff Development

(4) Fellowship grant for MS degree program awarded to AQD staff **Demetrio Estenor** beginning August 1987

(5) Two-month training grant on *Artemia* research methodologies at ARC awarded to **Ruby Bombeo** 17 August-17 October 1988

- Food and Agriculture Organization (FAO)/UNDP

Training Activities

(1) *Training Course for Senior Aquaculturists in Asia and the Pacific Region* (7 years: 1981-1987; 1988-1989)

Staff Activities

(2) Attendance of **L. Ma. B. Garcia** and **R.F. Agbayani**

in the *Regional Workshop on Milkfish Culture Development in the Pacific*, Tarawa, Republic of Kiribati, 21-25 November 1988

- International Foundation for Science (IFS)

Research Studies

(1) Effect of temperature and ration size on growth and energy utilization of sea bass: Food consumption, feeding rate, salinity and temperature tolerance of sea bass fry and fingerlings

(2) Isolation and characterization of a female-specific plasma protein (vitellogenin) in milkfish, *Chanos chanos* Forsskal

(3) Prevention of *Aeromonas hydrophila* infection among *Chanos chanos* (Forsskal) by vaccination

(4) Improvement of extensive prawn culture using aquatic macrophytes as food organisms in brackishwater ponds during wet season

Staff Activities

(5) Attendance of **F. Pascual** and **E. Avila** in the IFS *Workshop on Fish Culture-Management Techniques and Nutrition*, Malang, Indonesia, 14-19 November 1988.

- University of Rhode Island (URI)

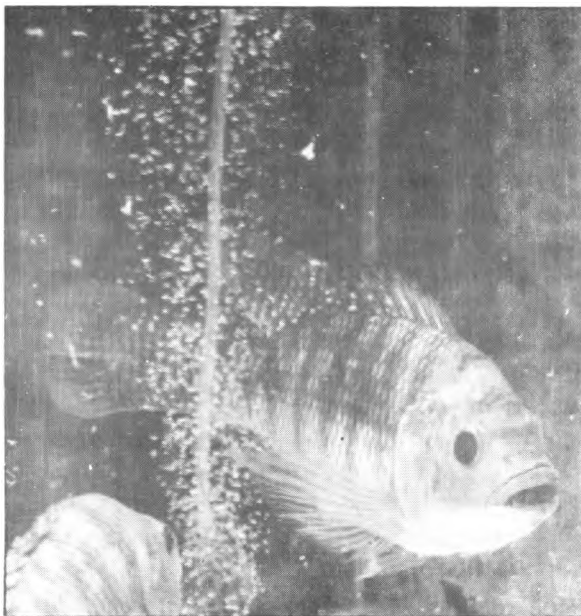
Research Activities

(1) Exchange of expertise and information (1987-present)

- International Center for Living Aquatic Resources Management/Asian Fisheries Social Science Research Network (ICLARM/AFSSRN)

Research Project

(1) Investigation on the energy requirement of milkfish during starvation and growth (under negotiation)



Array of concrete breeding tanks for Genetic Evaluation and Selective Breeding of *Oreochromis niloticus* (tilapia) sponsored by the International Development Research Centre (IDRC) of Canada.



- Government of the Netherlands

Training Project

(1) Fellowship grant of US\$18,456 through the Direct Aid to Educational Establishments in Developing Countries (DSO) Programme for six participants from ASEAN in the Fish Health Management Training Course to be held at TRS 16 February-14 March 1989

- Philippine Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR)

Research Project

(1) National Bangus Breeding Program (NBBP) (1980-present)

- Technology and Livelihood Resource Center (TLRC)

Information Dissemination

(1) Aquaculture Technology Outreach Program (5 years: 1987-1992)

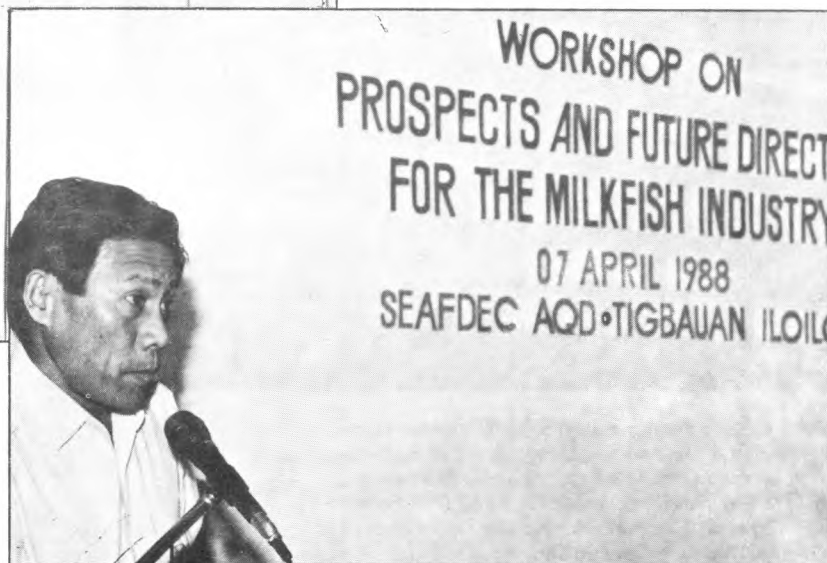
- University of the Philippines in the Visayas (UPV)

For collaboration in research, training, extension, and information activities

- Government of France

Staff Development

(1) One year non-degree training grant on bivalve culture in France awarded to AQD Research Associate **Amalia Gallego**, beginning January 1988



Training courses (top photos), workshops proper (right photo) and proceedings, in addition to research studies, are sponsored in part through collaboration with SEAFDEC non-member countries and other local and foreign research-educational institutions.

AQD VISITORS AND GUESTS

The Department received around 4,000 visitors and guests in 1988 at its Tigbauan Research Station, Leganes Brackishwater Station, and Binangonan Freshwater Station; at least 96% were from the Philippines, the rest from 14 other countries. Around 73% of AQD visitors were students and teachers, 24% the general public including fish farmers, 2% administrators and policy makers, and 1% researchers and scientists.

Among the dignitaries and scientists who visited AQD in 1988 were:

Amb. Joe Suk Ahn, Embassy of South Korea, Manila, Philippines

Mr. Richtje Altinej and **Mr. Birk Zviderveld**, TV Delft, Holland

Mr. Arne Andreasson, Programme Manager, FAO Aquaculture for Community Development Programme, Lusaka, Zambia

Mr. Zhang Baoyi, Deputy Director General, Beijing Review, Beijing, China, and Chinese journalists

Mr. Bernard Barron, President, PRO AQUA, Yandina,

Australia

Mr. Apolonio Bautista, Undersecretary for Regional Operations, Department of Agriculture, Quezon City, Philippines

Mr. Fawzia Begucu, Research Officer, Department of Fisheries, Bangladesh

Mr. Joselito Bernardo, Senior Development Specialist, National Economic Development Authority (NEDA), Metro Manila, Philippines, and other officials from NEDA

Mr. Han C.J. Blom, Coordinator Asia Desk Projects Department, Education, Training and Research, Netherlands Universities Foundation for International Cooperation, The Hague, The Netherlands

Mr. Andrew Burst, U.S. Agricultural Attache, American Embassy, Manila, Philippines

Messrs. Sostenes L. Campillo, Jr., Walfrido Reyes, Dominador Reyes, and **Ms. Narzalina Lim**, Department of Tourism, Manila, Philippines

Mr. Honorio Carandang, Philippine Agricultural Attache to Rome, Italy

Dr. Cataudella, Biology Professor, Rome University, Rome

Ms. Srisunan Chankao, SEAFIS Project Coordinator, SEAFDEC Secretariat, Bangkok, Thailand

Mr. Tim Clark, Producer-Director, Australian Broadcasting Corporation, Sydney, Australia, and TV Documentation Crew

Mr. Ivor J. Clucas, Overseas Development, Natural Resources Institute, London, U.K.

Amb. M. Dahinden, Embassy of Switzerland, Manila, Philippines



Mr. Apolonio Bautista (top left), Undersecretary for Regional Operations, Department of Agriculture, Quezon City, in a briefing on finfish culture, and Dr. Veravat Hongskul (left), SEAFDEC Secretary-General, Bangkok, during the Department's 15th Anniversary Celebration.



- Amb. Russel Davidson**, Embassy of Canada, Manila, Philippines
- Mr. Marciano de la Cruz, Jr.**, Agricultural Specialist, American Embassy, Manila, Philippines
- Mr. Carlos Tome de Silva**, DOULOUS, Brazil
- Dr. Salvador Dolar**, Chairman, Provincial Agricultural and Fishery Council (PAFC), Iloilo, Philippines
- Dr. Jesus Estanislao**, Chairman, Development Bank of the Philippines, Metro Manila, Philippines, and DBP Provincial Managers
- Mr. Bill Festin**, TLRC-COA Auditor, TLRC, Metro Manila, Philippines
- Messrs. Wajiro Fujisawa, Hiroiyuki Yanagawa, Sujinn Saw-Ung, Tdoey Sikacha, and Hiroaki Yonesaka**, SEAFDEC Training Department, Bangkok, Thailand
- Mr. Maris Gavino**, Philippine Agricultural Analyst, Rome, Italy
- Dr. Francis Henderson**, FAO, Rome, Italy
- Mr. Armando Hernandez**, Consultant, IDRC Aquaculture Program for Latin America, Colombia
- Mr. Peter Herrera**, Technology Transfer Board, Department of Trade and Industry (DTI), Metro Manila, Philippines, and other officials from DTI
- Dr. Veravat Hongskul**, Secretary-General, SEAFDEC, Bangkok, Thailand
- Messrs. Zou Bentong, Yang Chen De, Sun Hongzhang, Yan Guangna, Wang Naisheng, Wang Xiaoyan, Li Xinghai, and Sun Sheng Xu**, EEC Assistance Programme for Dalian, China Prawn Farm Development, People's Republic of China
- Mr. Alain Edden Huckle**, First Secretary, Embassy of Great Britain, Manila, Philippines
- Mr. Zahid Hussain**, Lipton (Pakistan) Ltd., Karachi, Pakistan
- Mr. Shanidul Islam**, Ministry of Fisheries and Livestock, Bangladesh
- Mr. David Kinly**, Division of Information, United Nations, New York, U.S.A.
- Amb. Eberhard Kunz**, Embassy of the German Democratic Republic, Manila, Philippines
- Mr. Perry Kwan**, Charge d' Affaires, Embassy of Papua New Guinea, Manila, Philippines
- Mr. Romeo Ledesma**, Assistant Secretary, Department of Agriculture, Quezon City, Philippines
- Mr. Paoletti Macello**, Agristel, Italy
- Dr. John MacManus**, University of the Philippines Marine Sciences Institute (UPMSI), Quezon City, Philippines
- Mr. Guergui Mladenov**, Charge d' Affaires, Embassy of Bulgaria, Manila, Philippines
- Amb. Pengiran Mustafa**, Embassy of Brunei Darussalam, Manila, Philippines
- Mr. Yasuhide Nakamura**, Second Secretary, Embassy of Japan, Metro Manila, Philippines
- Dr. Colin Nash**, Aquaculture Department Coordinating Programme, FAO, Rome, Italy
- Prof. A. Neelameghan**, UNESCO Consultant and Consultant for BRAIS, Bangalore, India
- Amb. U Bo Ni**, Embassy of Burma, Manila, Philippines
- Dr. Detlet Noffz**, University of Hohenheim, Stuttgart, F.R. Germany
- Messrs. O. Ohata, T. Osaka, and H. Ayabe**, Seafarming Research and Development Center (PHRDC), Dagupan City, Philippines
- Mr. Jovito Ong, Jr.**, Mindanao Aquaculture and Development Corporation, Metro Manila, Philippines
- Mr. Giash Uddin Pathan**, Ministry of Fisheries and Livestock, Bangladesh
- Dr. Lydia Pedernal, Ms. Lydia Francisca Brown, Ms. Roela Rivera**, Technology and Livelihood Resource Center, Makati, Metro Manila
- Dr. T.V.R. Pillay**, Adviser for NACA, Rome, Italy
- Ms. Zenny Ponce**, Medical Research Assistant, SANOFI Research Asia, Metro Manila, Philippines
- Mr. J.V. Raamsdonk**, Project Officer, Section for International Education and University Development, Ministry of Foreign Affairs, The Hague, The Netherlands
- Dr. M.D.S. Rahman**, D.P.D., Department of Fisheries, Bangladesh
- Messrs. Habibur Rahman, A.V.M. Maminul Islam, Rafiqul Islam, Rezaul Karim**, Shrimp Culture Project, Department of Fisheries, Bangladesh
- Ms. Lillian Rahman**, Nacan Research Center, Toronto, Canada
- Dr. G. Subha Rao**, The Marine Products Export Development Authority (MPEDA), Taspari, India
- Rev. Fr. Bernardino Ricafrente**, Rector, University of San Agustin, Iloilo City, Philippines
- Mr. Ronald Roldan**, Manager, Aquaculture Products Industries, Metro Manila, Philippines
- Mr. John Rowntree**, Program Director, Fisheries Stock Assessment, Maryland, USA
- Dr. Eusebio Sabalvorro**, Regional Director, Department of Science and Technology (DOST)-Region VI, Iloilo City, Philippines
- Mr. Euis Salamoen**, IndoBRAIS Project Coordinator, Jepara, Indonesia
- Dr. V.R.P. Sinha**, NACA, Bangkok, Thailand
- Dr. Gerard Sledsens**, Belgian Embassy, Makati, Metro Manila, Philippines
- Mr. Manuel Soliven**, Executive Vice-President, Philippine National Bank (PNB), Metro Manila, Philippines, and several PNB officials
- Mr. John Stellwagen**, Senior Biologist, DAI, Singapore
- Mr. Benjamin Tapiador**, Appropriate Management Consultancy Ltd., Zambia
- Mr. Donald Taylor**, Director, ACCESS ASIA, Metro Manila, Philippines

Mr. Teodoro Topacio, Univet Agricultural Products, Inc., Manila, Philippines
Dr. Lamarr Trott, USAID, USA
Mr. Tengku Ubaidillah, FAO Representative in the Philippines, Makati, Metro Manila
Mr. Alex Umadhay, Regional Director, NEDA Region VI, Iloilo City, Philippines

Mr. Torben Vindelov, Consultant, CIC-Marine, Denmark
Mr. Abdul Wahed, Administrative Office, Department of Fisheries, Bangladesh
Mr. Chen Foo Yan, NACA Coordinator, FAO/UNDP NACA, Bangkok, Thailand
Ms. Haydee Yorac, Commissioner on Elections (COMELEC), Manila, Philippines

SEAFDEC COUNCIL MEETING

The Twenty-First Meeting of the Council of SEAFDEC was held in Kuala Lumpur, Malaysia November 29-December 2, 1988. The Meeting was attended by the Council Directors for Japan, Malaysia, Philippines, Singapore and Thailand, and by their respective delegations. The Meeting was also attended by observers from France and such international organizations as the ASEAN Food Handling Bureau, the Food and Agriculture Organization of the United Nations, IDRC, the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in Asia and Pacific Region (INFOFISH), and NACA.

The representatives of the official auditors of SEAFDEC, Messrs. Ernst & Whinney, and of the auditors of the Aquaculture Department, Sycip, Gorres, Velayo & Co., also attended the Meeting.

The Council at this Meeting approved the Progress Reports for the period from January to June 1988, the Three-Year Plans (1989-1991), and the Proposed Programs of Activity for 1989 of the SEAFDEC Secretariat and the three Departments. The Council also approved the revised Administrative and Financial Regulations of the Center which were to supersede the Regulations approved by the Council at its Thirteenth Meeting in 1980. The Council also adopted the Budgetary Requirements of the

Secretariat and the three Departments of the Center for 1989, in accordance with Article 6, Paragraph 2 (ii) of the Agreement establishing the Center.

The Council during this Meeting also agreed that participating fees shall be charged for trainees from non-member countries in the region and outside, and that participating fees shall be applied not only for the SEAFDEC training courses but also for SEAFDEC seminars and workshops when applicable.

The Council also agreed that administrative overhead charges shall be imposed at the rate of 15% of the total project cost for all activities and services provided to external agencies, with the proviso that no administrative overhead shall be charged on the following: collaborative programs with other organizations when these programs are part of the activities of the Center as approved by the Council; assistance to the private sector in Member Countries which had been endorsed by the respective Council Director; and collaborative projects/activities with ASEAN.

The Council also agreed to charge the private sector for assistance rendered by the SEAFDEC Departments at full cost plus 15% administrative overhead charges, subject to the recommendation of the respective Council Director and subject to availability of financial and manpower resources.

APPENDICES

Bibliography of Research Publications

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Presented in Scientific Meetings

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Subosa P. Pond fertilization for milkfish grow-out. *Workshop on Prospects and Future Directions for the Milkfish Industry*, Tigbauan, Iloilo, 7 April 1988.

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Pascual FP. Status of shrimp nutrition and feed development in Southeast Asia. *Third Asian Aquaculture Nutrition Workshop*, Bangkok, Thailand, 6-10 June 1988.

Santiago CB, Reyes OS. Effect of feeding regimes on growth and survival of bighead carp (*Aristichthys nobilis*) fry. *Third Asian Aquaculture Nutrition Workshop*, Bangkok, Thailand, 6-10 June 1988.

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- Garcia LMaB. Fisheries biology of milkfish (*Chanos chanos* Forsskal). *Regional Workshop on Milkfish Culture Development in the Pacific*, Tarawa, Republic of Kiribati, 21-25 November 1988.
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MANAGEMENT STAFF

Lacaniño, Flor	Ph.D. Zoology/Comparative Endocrinology & Fish Physiology) University of California at Berkeley 1971	Chief
Fukumoto, Satoru	B.S. (Fisheries) Kagoshima College of Fisheries 1949	Deputy Chief
Marte, Clarissa	M.S. (Zoology) University of the Philippines 1971	Head, Research Division
Primavera, Jurgenne	M.A. (Zoology) Indiana University 1969	Head, Training Division
Cuevas, Rufil	B.S. Agriculture (Agricultural Economics) University of the Philippines 1970	Head, Administrative Division
Sulit, Virgilia	M.A. (Statistics) University of Bombay 1974	Head, Information Division
Alger, Rene	B.S. Commerce (Accounting-CPA/Economics) University of Iloilo 1964/1965	Head, Finance Division
De los Reyes, Ben	B.S. Commerce (Accounting-CPA) Bachelor of Laws (Lawyer) Western Institute of Technology/ University of San Agustin 1971/1985	In-House Legal Counsel

RESEARCH STAFF

Acosta, Belen	M.S. Fisheries (Aquaculture) University of the Philippines 1984	Fish Hatchery
Agbayani, Renato	MBA (Business Management) University of the Philippines 1972	Aquaculture Economics
Alava, Veronica	M.S. Fisheries (Aquaculture) University of the Philippines 1979	Aquaculture Nutrition

Almendras, Jesus	M.S. (Marine Biology) University of the Philippines 1982	Fish Hatchery
Antiporda, Jocelyn	M.S. (Zoology) University of the Philippines 1984	Crustacean Culture
Aquino, Nieves*	M.S. (Fisheries) Kagoshima University 1988	Crustacean Breeding
Avila, Enrique	Ph.D. (Biology) University of Heidelberg 1987	Fish Hatchery
Bagarinao, Teodora*	M.S. (Marine Biology) (Marine Oceanography) University of California-San Diego 1982	Larval Ecology
Baldia, Susana*	M.S. (Biology) University of the Philippines 1984	Larval Pond Culture
Basiao, Zubaida*	M.S. (Zoology) University of the Philippines 1976	Aquaculture Genetics
Baticados, Ma. Cecilia	M.S. (Biology)/M. Aquaculture University of the Philippines 1980	Fish Health
Bautista, Myrna	M.S. (Food Science) University of the Philippines 1980	Aquaculture Nutrition
Bombero, Ruby	M.S. Fisheries (Aquaculture) University of the Philippines 1983	Larval Food Culture
Borlongan, Ilda	M.S. (Chemistry) University of the Philippines 1982	Aquaculture Nutrition
Castillo, Antonio	M.S. (Fisheries) Miyazaki University 1988	Fish Hatchery
Catacutan, Mae	M.S. (Fisheries) (Marine Animal Nutrition) Kagoshima University 1982	Aquaculture Nutrition
Coloso, Relicardo*	M.S. (Biochemistry) University of the Philippines 1980	Aquaculture Nutrition

Corre, Kaylin	M.S. Fisheries (Aquaculture) University of the Philippines 1983	Pond Culture
Cruz, Erlinda	M.S. (Marine Biology) University of the Philippines 1981	Fish Health
Cuvin, Ma. Lourdes	M.S. (Biology) University of Glasgow 1985	Lake Ecology
De Castro, Ma. Teresa	M.S. (Environmental Engineering) University of the Philippines 1982	Shellfish Farming Seaweed Culture
De la Cruz, Margarita	M.S. Fisheries (Fish Diseases) Hiroshima University 1986	Fish Health
De la Pena, Milagros	M.S. (Marine Biology) University of the Philippines 1983	Larval Food Culture
De Mesa, Imelda*	M.S. (Statistics)/M.A. (Economics) University of the Philippines 1980/1985	Statistics
Dhert, Philippe	M.S. (Hydrobiology) University of Ghent 1986	<i>Artemia</i> Culture
Dogma, Irineo, Jr.	Ph.D. (Botany/Protozoology, Biochemistry) University of Michigan 1970	Fish Health
Duray, Marietta	M.S. (Biology) University of San Carlos 1977	Fish Hatchery
Estepa, Fe Dolores	M.S. Fisheries (Aquaculture) University of the Philippines 1982	Crustacean Physiology and Hatchery
Fermin, Armando	M.S. (Aquaculture) Central Luzon State University 1985	Fish Hatchery
Fermin, Josefa Tan	M.S. (Zoology) University of the Philippines 1982	Fish Breeding
Fernandez, Roselyn	M.S. Fisheries (Aquaculture) University of the Philippines 1983	Fish Health

Ferraris, Ronaldo*	Ph.D. Zoology University of Hawaii at Manoa 1982	Fish Physiology
Gacutan, Rogelio	M.S. (Botany) University of the Philippines 1974	Fish Health
Gallego, Amalia	M.S. Fisheries (Aquaculture) University of the Philippines 1986	Fish Hatchery
Garcia, Luis Maria	M.S. (Zoology) University of Alberta 1984	Fish Breeding
Gerochi, Dante	M. Aquaculture University of the Philippines 1984	Pond Culture
Golez, Nelson	M. Agriculture (Agriculture Chemistry) Kyoto University 1988	Soil Chemistry
Gonzales, Ernesto*	M.S. (Economics) Asian Social Institute 1981	Aquaculture Economics
Javellana, Gilda	M.S. (Zoology) University of the Philippines 1985	Crustacean Hatchery
Kume, Tsuneo	D. Agriculture (Fisheries/Microbiology) University of Tokyo 1977	Feed Development
Lacaniiao, Flor	Ph.D. Zoology (Fish Physiology) University of California at Berkeley 1971	Fish Breeding
Licop, Ma. Suzette	M.S. (Zoology)/M. Aquaculture University of the Philippines 1981/1982	Crustacean Hatchery
Llobrera, Jose	Ph.D. (Fisheries Science) Texas A&M University 1983	Fish Physiology
Marte, Clarissa	M.S. (Zoology) University of the Philippines 1971	Fish Breeding
Mesa, Romeo	M.S. Fisheries (Aquaculture) University of the Philippines 1986	Pond Culture

Millamena, Oseni	M. Engineering (Environmental Engineering) Asian Institute of Technology 1968	Aquaculture Nutrition
Nagai, Akimasa	B.S. Fisheries (Aquaculture) Nihon University 1965	Fish Breeding
Palisoc, Fermin*	M.S. (Zoology) University of the Philippines 1982	Fish Health
Parazo, Monina	M.S. Fisheries (Nutritional Chemistry) Kagoshima University 1987	Aquaculture Nutrition
Pascual, Felicitas	Ph.D. (Nutrition) Iowa State University 1968	Aquaculture Nutrition
Penaflorida, Veronica	M. Agriculture (Animal Science) West Visayas State College 1979	Aquaculture Nutrition
Pitogo, Celia	M.S. (Marine Biology) University of the Philippines 1984	Fish Health
Po, Gilda*	M. Public Health (Microbiology) University of the Philippines 1973	Fish Health
Ponce, Anicia	D. Agriculture Kyoto University 1988	Seaweed Culture
Primavera, Jurgenne	M.A. (Zoology) Indiana University 1969	Crustacean Breeding
Quinitio, Emilia*	M.S. Fisheries (Aquaculture) University of the Philippines 1980	Crustacean Hatchery
Quinitio, Gerald*	Ph.D. Fisheries Hokkaido University 1988	Fish Breeding
Rodriguez, Eduard	M. Fisheries Sciences Nagasaki University 1987	Pond Culture
Romana, Ma. Rowena	M.S. (Genetics) University of Wales 1985	Aquaculture Genetics

Santiago, Alejandro	M.A. (Zoology) Indiana University 1978	Lake Ecology
Santiago, Corazon	Ph.D. (Fish Nutrition) Auburn University 1985	Aquaculture Nutrition
Solis, Noel	M.S. (Biology)/M. Aquaculture University of San Carlos/University of the Philippines 1976/1983	Ecology and Pond Culture
Tamse, Catherine*	M.S. Fisheries (Aquaculture) University of the Philippines 1979	Fish Health
Tiro, Lillian*	M.S. (Marine Biology) University of the Philippines 1980	Aquaculture Nutrition
Trino, Avelino	M.S. Fisheries (Aquaculture) University of the Philippines 1986	Pond Culture
Tuburan, Isidra	M.S. Fisheries (Aquaculture) University of the Philippines 1980	Pond Culture
Ver, Leo Michael*	M.S. (Marine Biology) University of the Philippines 1981	Shellfish Culture
Villegas, Cesar	Ph.D. Agriculture (Plant Breeding) Iowa State University 1970	Aquaculture Genetics
Young, Paciencia*	M.S. (Biology) University of San Carlos 1978	Fish Physiology

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Amar, Edgar	M. Aquaculture University of the Philippines 1987	Training Officer
Lacierda, Rodrigo	M. Aquaculture University of the Philippines 1984	Training Officer
Ladja, Jocelyn	M. Aquaculture University of the Philippines 1987	Training Officer

Ortega, Marubeth	M. Library Science University of the Philippines 1986	Head, Library
Roldan, Raul	M. Aquaculture University of the Philippines 1983	Training Officer

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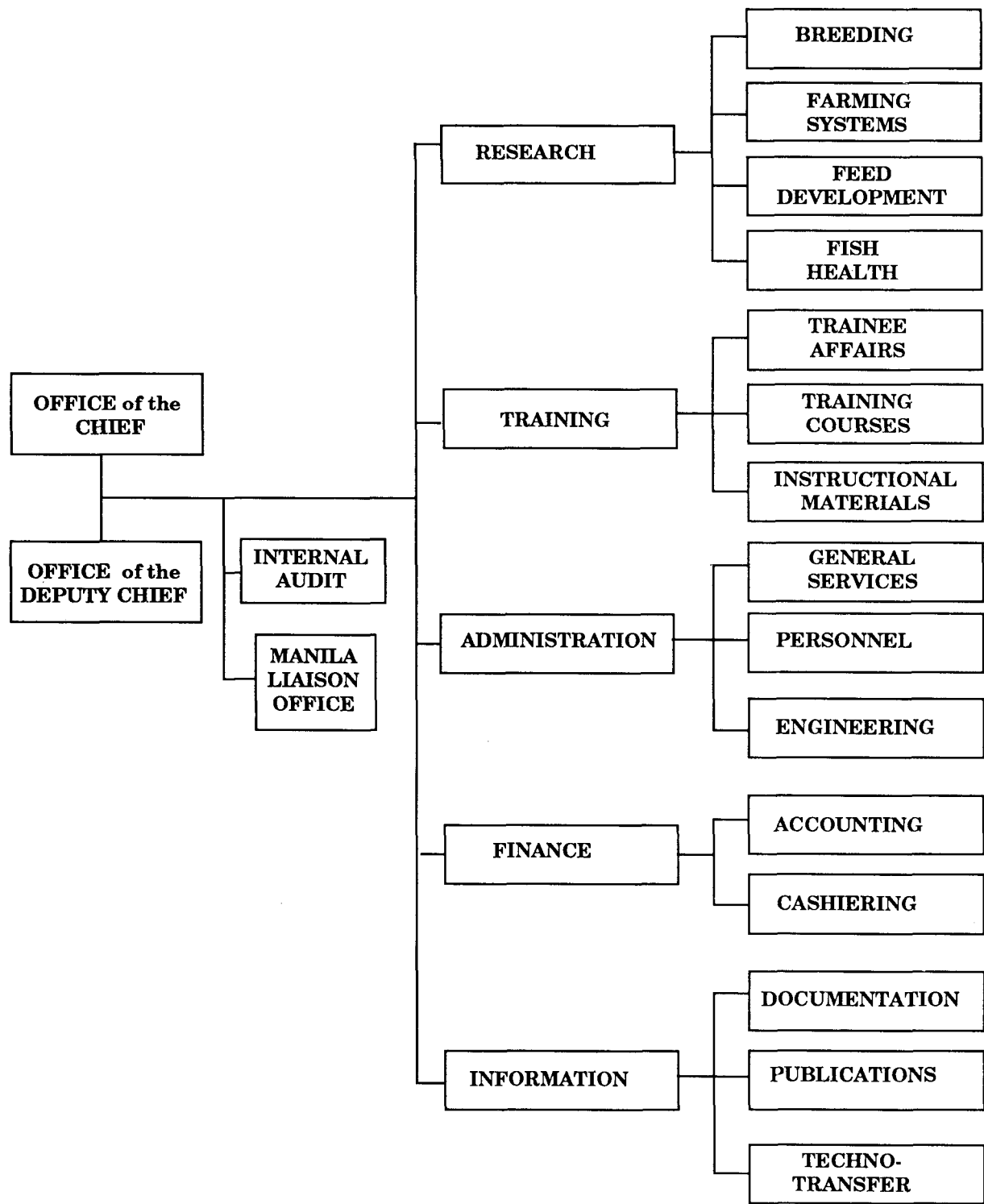
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AQD Organizational Chart





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