ANNUAL REPORT 1984
SEAFDEC Aquaculture Department

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

Contents

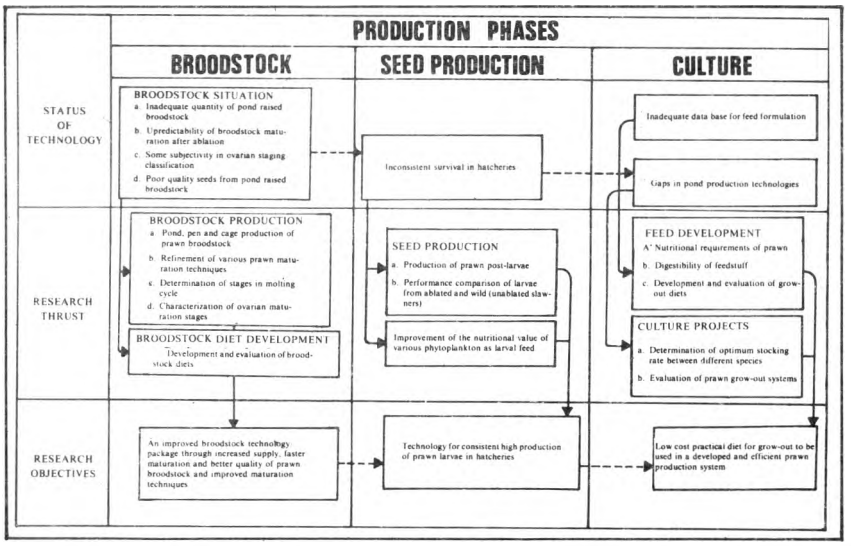
Foreword

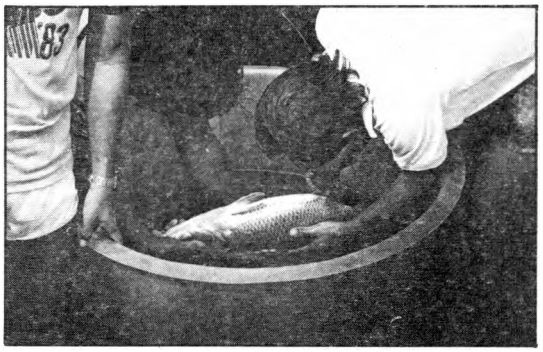
In 1984, the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC AQD) maintained a research and development course designed to make the most of its precious but limited research resources.

World aquaculture production has been steadily increasing, with Asia leading other regions in this field. Aquaculture has become one of the most important fronts in the global drive towards food sufficiency. In view of this, (SEAFDEC AQD) made it the keystone of its program to develop practical technologies that could be transferred speedily to the fishfarmers. These technologies thus became integrated with the productivity projects of member countries particularly the Philippines.

Alfredo C. Santiago, Jr.
Chief

SEAFDEC in 1984



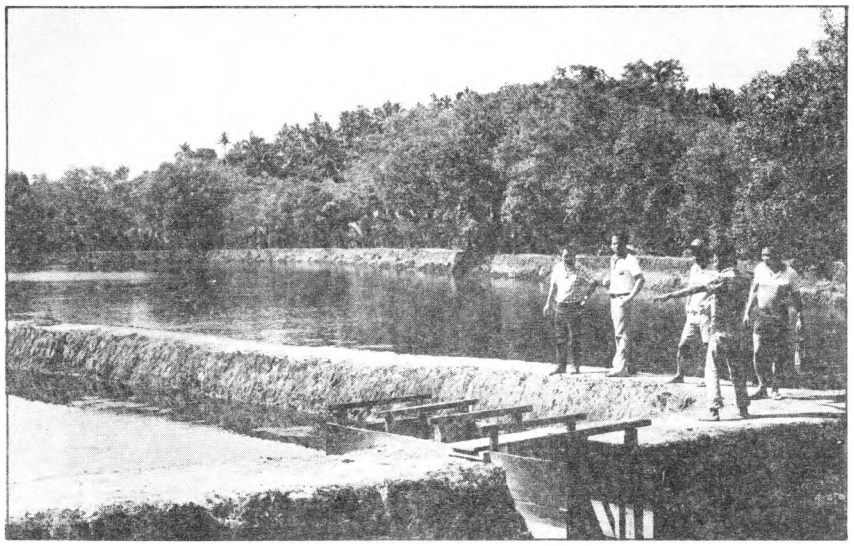


Research Management

The research program gave emphasis to priority problem areas which were identified after consultations with the various sectors of the aquaculture industry. Thus the research effort was brought to bear on the most relevant problems (See chart.)while the capabilities of the staff as well as financial resources were harnessed more efficiently.

Research

While research continued on the traditional species like milkfish, jumbo tiger prawn, tilapia, oyster and mussels, three new species that have shown good promise as food, cash, and export crops were given greater research attention. These were seabass, white shrimp and siganid. Research on Chinese carps, particularly on broodstock development, induced spawning and seed production was also intensified. The economic component was built into some of the commodity studies. Significant findings from completed studies and indications from ongoing research projects are reported here.



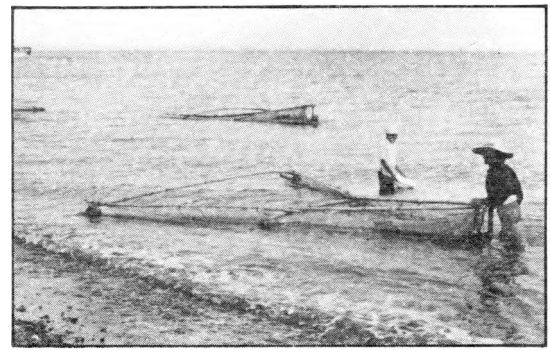
Technology Transfer

A series of three-day aquabusiness seminars was held in the Metro Manila area to show present and prospective aquaculture investors the opportunities in aquaculture as well as the technologies currently available. The aquabusiness concept has also been infused into the in-situ seminars for small fishfarmers. Overall technology transfer effort was anchored on seminars, workshop, and industry-oriented workshops.

Technology verification, a step in the development of technology that field-tests packages of recommendations in the fishfarmers' ponds, yielded encouraging results on the extensive and semi-intensive cage and pen culture of tilapia in lakes and raft culture of mussels and oysters. Four verification studies were completed in 1984.

The technology assessment unit was created in 1984. This unit has developed a methodology to assess the impact of aquaculture technologies on the economy, on the aquaculture sector, and on the various segments that make up the industry, particularly on the fishfarmers' household.

During the year, the Department trained more than 900 individuals from all over the world, most of them from the SEAFDEC member countries.



Information Sharing

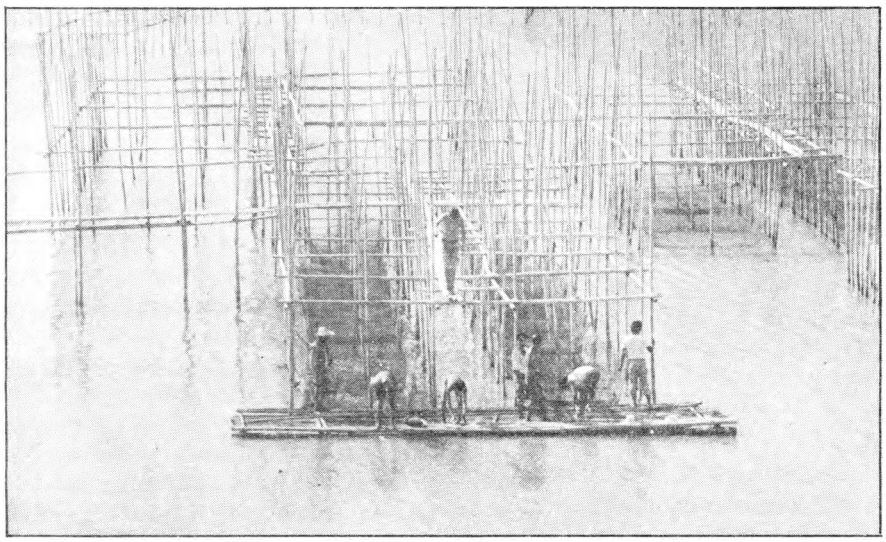
The Brackishwater Aquaculture Information Systems (BRAIS) was established in 1984. It is maintained by the Department with funding support from the International Development Research Centre. The BRAIS immediately serves Asia but it will eventually link up with other global fishery information systems.

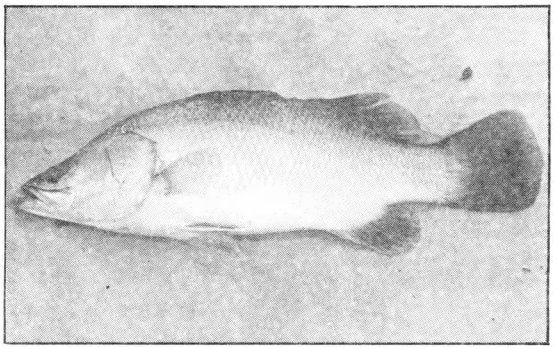
During the year, the Department hosted two scientific conferences, the National Prawn Industry Development Workshop and the First International Conference on the Culture of Penaeid Prawn/Shrimps. More than 900 researchers, technologists and practitioners from some 20 countries attended the global prawn conference.

New Linkages

The Oceanic Institute, a Hawaii-based international marine center, is now actively collaborating with SEAFDEC in milkfish research. The OI has contributed funding and technical assistance to the joint project through a grant from the US Agency for International Development.

Research





Research

There was a reduction in the total number of studies from 1983 to 1984 due to the consolidation of related studies and the deferment of the ones that are relatively basic in nature or not considered priority problems. As a result, 122 studies were approved for implementation in 1984, 68 on finfish, 41 on crustaceans, and 13 on molluscs and seaweeds.

FINFISH PROGRAM

Sixty-eight studies were implemented in 1984. The more significant results follow:

Milkfish Spawning and Rematuration

HORMONAL MANIPULATION TO INITIATE GONAD DEVELOPMENT AND REMATURATION

Four-year old milkfish were implanted with testosterone pellets. In males, the testes became maturing or mature, while both treated and control females had immature ovaries. Differences in the response of testosterone-implanted fish indicate a seasonal effect.

EFFECT OF STOCKING DENSITY AND CAGE SIZE ON THE GROWTH OF JUVENILE MILKFISH

Marketable size milkfish were reared in 3 m and 5 m diameter cages at stocking densities of 1, 2 and 4 kg/m^3 for 12 weeks. The fish were fed with crustacean pellets twice daily at 2% body weight per day. Milkfish reared in 5 m diameter cages grew faster than in 3 m diameter cages even at high stocking density. The fastest growth in both cage sizes was at 1 kg/m^3 while the slowest was at 4 kg/m^3 stocking density (Table 1).

Table 1. Increase in Body Weight (W) and Fork Length (L) and Difference in Condition Factor (W/L^3) of Marketable Size Milkfish Reared for 12 Weeks.

Cage diameter (m)	Stocking density (kg/m^3)	(W) Increase in body weight (g)	(L) Increase in fork length (cm)	(W/L^3) Difference in condition factor (W/L^3)
5	1.0	334	5.30	2.42
5	2.0	283	5.54	1.51
5	4.0	247	6.04	0.50
3	1.0	236	5.18	-0.01
3	2.0	212	5.49	- 0.35
3	4.0	174	5.84	-0.21

REPRODUCTIVE ENDOCRINOLOGY OF MILKFISH

Estradiol 17-β (E2) and testosterone (T) were measured in milkfish serum to determine changes in circulating levels of these hormones accompanying gonad development, possible seasonal fluctuations in E2 and T secretion in immature fish, and possible occurrence of a daily rhythm in secretion of these steroids.

In females, serum levels of E2 and T increase during sexual maturation, while in males, gonad development appears to be associated with increasing T levels alone. Mean E2 and T levels in females were:

Immature – 0.3 ng/ml (E2) and 2.5 ng/ml (T)
Maturing – 2.8 ng/ml (E2) and 10.3 ng/ml (T)
Mature – 7.1 ng/ml (E2) and 33.8 ng/ml (T)
Spent – 1.4 ng/ml (E2) and 1.9 ng/ml (T).

In males, T levels increased from 4.9 ng/ml in immature to 31.5 ng/ml in mature fish.

SEX DIFFERENTIATION IN MILKFISH UNDER DIFFERENT HOLDING CONDITIONS

Milkfish reared in tanks and ponds were sampled at regular intervals and their gonads were examined histologically until the onset of sex differentiation. Results showed that primordial germ cells were present in the newly hatched milkfish larvae. These cells proliferated to form the presumptive gonad (indifferent stage) 51 days after hatching in the tank-reared fish and probably much earlier in the pond-reared fish. Gonadal sex differentiation was observed to occur at 141 days (ave. bodyweight-8.8 g) in the tank-reared fish and 95 days (ave. bodyweight – 99.0 g) in pond-reared fish. Results also indicate that sex differentiation in milkfish may be influenced by environmental factors such as holding structures, food availability, stocking density, size, growth rate, temperature, etc.

BACTERIA ASSOCIATED WITH INFECTION AT HORMONE IMPLANTATION SITES AMONG MILKFISH ADULTS

Milkfish adults implanted with hormone pellet, in a study on hormone-induced gonad maturation, developed localized lesions at the muscular implantation sites. The lesions were characterized by necrosis of the epaxial musculature secreting a whitish exudate resembling pus. To confirm Koch's postulates three isolates, MB1, MB4 and MB5, were screened from the infected fish. Experiments conducted on milkfish juveniles revealed that these bacteria do not singularly reproduce the pus-like lesions while a combination of two isolates, MB1MB5 and MB4MB5, do. No mortalities were attributed to such infection in spite of systemic indications. The three bacterial isolates were identified as closely related to *Vibrio parahaemolyticus* (MB1), *Vibrio anguillarum* (MB5) and *Acinetobacter* sp. (MB4). Drug sensitivity tests were also conducted.

INDUCED SPAWNING OF MILKFISH AND SEABASS *LATES CALCARIFER*

Six wild adult milkfish consisting of four mature females and two ripe running males were induced to spawn using HCG (Human Chorionic Gonadotropin) with or without SPH (salmon pituitary homogenate). The fertilization rates of three batches of eggs produced from one female induced to spawn using HCG + SPH were from 2.38 to 16.66%.

Captive seabass broodstock which sexually matured in tanks four years after initial stocking were induced to spawn using LH-RH-a (Syntex: China) as either IP cholesterol implants or IP injections. Females with initial oocyte diameters of 0.44-0.52 mm spawned 2-4 days after implantation or injection, while control fish did not. Natural fertilization from both treated males and females occurred in tanks with 32 ppt seawater at 26-29°C. Eleven mature females were successfully spawned from July to September. Fertilization and hatching rates ranged from 56.4 to 74.5%, and 3.5 to 43.9%, respectively. Total eggs spawned per female was from 280,000 to 1,340,800.

Broodstock Development of *Lates Calcarifer* and *Epinephelus* Sp.

DEVELOPMENT OF SEABASS BROODSTOCK

Male seabass undergo gonad development and can be used for induced spawning experiments at 2-3 years old. Sixteen males sampled in March were in various stages of maturation. Body weight ranged from 0.85 to 1.95 kg, total length from 39.2 cm to 49.1 cm, GSI from 0.04 to 0.11.

Finfish Fry/Fingerling Production

SEED PRODUCTION OF *SIGANUS GUTTATUS*

Techniques for mass production of *S. guttatus* fry are being developed. In 1984, some 150,000 juveniles were produced on day 45, after a series of experimental runs. Survival rates were from 3.5 to 16.6%. Siganid larvae can tolerate low salinity (20 ppt) within a 21-day culture period after hatching.

STUNTING OF MILKFISH FINGERLINGS IN BRACKISHWATER PONDS

Three stocking rates were tried: 20, 25 and 30 fingerlings/m^2. Stock and harvest data of fingerlings reared for six months in earthen nursery ponds showed that 20 to 25 finger-

lings/m^2 is a significant and economically feasible stocking rate. Average weight was 13.7 g and survival was 82.8%.

Record of stock sampling revealed that the fingerlings reached an average weight of 8.25 g after five months and seven days of stunting.

SCREENING SUITABLE FOOD FOR THE FIRST-FEEDING SIGANID LARVAE

Different planktonic food organisms were screened for their suitability for first-feeding siganid larvae. Higher survival (21%) was observed in larvae fed with mixed phytoplankton species and *Brachionus* than those given single phytoplankton species and *Brachionus* (4%).

Different feeding levels of *Brachionus* were tried. Although the range of 10-15 *Brachionus*/ml gave better fry survival (25%), no significant differences were found between 10, 10-15, 16-20 and 20 *Brachionus*/ml.

EFFECTS OF VARIOUS NATURAL FOODS *(ISOCHRYSIS, CHLORELLA, BRACHIONUS, ARTEMIA)* AND ARTIFICIAL FEEDS ON THE HEPATOCYTES OF SIGANIDS AT DIFFERENT STAGES OF ITS LIFE CYCLE.

The developmental morphology and histology of the digestive tract and accessory organs of the herbivorous fish, *Siganus guttatus,* were studied and compared with that of the carnivorous fish, *Lates calcarifer,* to find out structural as well as functional differences of the organs across stages and between species. The data will be used for subsequent diet experiments. Preliminary results indicate that:

- a. Complete yolk resorption coincides with differentiation of the basic morphological plan of the digestive tract in both species and occurs simultaneously with the onset of active feeding.

- b. Oil globule resorption occurs much later than with the yolk i.e. Day 3 in *S. guttatus* and Day 6 in *L. calcarifer.* Although food ingestion starts earlier, the oil globule persists in diminishing amounts until the onset of active feeding. This suggests that the oil globule plays an important role as an initial energy source for the feeding activity of the larvae when stores from exogenous food have not been accumulated.

- c. The liver in both species develops as primordial cells forming loose aggregates around the anastomosing hepaticvitelline vein to become a multitubular organ towards Day 4 and Day 5. Histological sections, however, reveal that vacuolation of the hepatocytes appears one to two days from the onset of active feeding.

- d. Acidophilic supranuclear inclusions in the columnar absorptive cells of the hindgut in both species similarly develop one to two days after active feeding starts. This coincides with the appearance of vacuoles in the liver.

- e. Electron microscopy of the hepatocytes in *Artemia*-fed Day 37 *S. guttatus* and Day 35 *L. calcarifer* reveal similarities in their ultrastructure. The hepatocytes of both species are polygonal in shape with three typical types of surfaces: (a) those exposed to the liver sinusoids equipped with a microvillous border; (b) those exposed to adjacent hepatocytes; and (c) those exposed to the bile duct. The shape of the mitochondria range from oval to elongated. Some of mitochondria in *L. calcarifer* were aposed to the lipid inclusions, while they occurred singly in *S. guttatus.* On the basis of stores, the *S. guttatus* liver accumulates both glycogen and lipids while that of *L. calcarifer* may store more lipid than glycogen.

SALINITY TOLERANCE OF SIGANID LARVAE

A six-week bioassay was conducted to determine the lower and upper salinity resistance limits of hatchery-bred siganid larvae from hatching to metamorphosis. In weekly tests, groups of 20 larvae were abruptuly transferred from 32 ppt to test salinities of 0 to 56 or 80 ppt and mortalities were recorded at time interval for a maximum period of 72 hours. Based on graphical estimates of the median lethal concentration, (LC50), the following resistance limits in ppt were obtained: (a) at 24 h exposure period: 8-37 (Day 0), 8-16 (Day 7), 16-24 (Day 14), 7-14 (Day 21), 3-52 (Day 28), and 2-55 (Day 35); (b) at 72 h exposure period: 9-39 (Day 21), 3-51 (Day 28), and 3-54 (Day 35).

Younger siganid larvae (Day 0, 7 and 14) were sensitive to abrupt salinity changes. In 72 hours, larval mortalities were between 80% to 100% in all test salinities. Of the three age groups, newly hatched Day 0 larvae showed the highest resistance to both low and high salinity levels after 24 h exposure (8-37 ppt). Both day 7 and 14 larvae showed very narrow resistance zones, the Day 7 larvae showing highest resistance in lower salinities (8-16 ppt) while the day 14 larvae in slightly higher salinities (16-24 ppt). The older larvae (Day 21, 28 and 35) were tolerant to abrupt salinity changes. They showed increasing resistance to both low- and high salinities as they grew and metamorphosed. The varying resistance limits and mortality pattern of siganid larvae indicate that these larvae may have different salinity requirements for survival at various stages of their development.

DIGESTIBILITY OF FEEDSTUFFS FOR MILKFISH

The study sought to explain the differences in digestibility of some feedstuffs that are protein sources in milkfish adapted to freshwater or

seawater. Faster gut transport of feed was observed in seawater-adapted fish and in smaller fish. Soybean oil was the most digestible lipid source for marketsize milkfish raised in seawater and freshwater. The digestibility of beef tallow decreased by 27% in freshwater-adapted fish while that of cod liver oil and soybean oil increased by 20% and 15%, respectively. There was no change on the digestibility of coconut oil and pork lard.

REARING OF SIGANID LARVAE TO METAMORPHOSIS

Practical diet was tested on three-week old siganid larvae reared in 10-liter aquaria using different methods of feed presentation. Abrupt feeding from live diet (*Artemia* nauplii) to artificial diet given at 30% body weight, overlapping on both live (1 Artemia/ml/day) and artificial diet (15% body weight) for five days, and control fed with *Artemia* nauplii alone at 2/ml/day. Results showed that the practical diet was generally acceptable to the larvae. The larvae showed active feeding behavior on the first day artificial diet was introduced. After 10 days of rearing, survival were as follows: abrupt–30%, overlap–45%, control–81%.

On the same day, metamorphosis was observed in 50% of larvae fed artificial diets for abrupt and overlap, and 65% of larvae fed *Artemia* alone. In the case of wild-caught milkfish fry fed with practical diets, metamorphosis coincided with a mortality peak, probably indicating a critical period at which the fish is least tolerant to nutritional and other stresses.

LARVAL FEED DEVELOPMENT FOR MILKFISH

Three practical diets (LFD 841, 842, 843) were developed with a protein base that consisted of an enzyme-modified fish protein. The feed was evaluated for stability, acceptance and growth response using wild-caught fry. *Artemia salina* nauplii was fed to a batch of fish as a live food control. The diets were also evaluated on seabass fry. The feed was readily accepted by both milkfish and seabass. At the end of a 28-day culture period, the milkfish fed with practical diets had a mean body weight ranging from 38.3 to 56.0 mg while the control fish weighed 66.7 mg. Of the practical diets tested, the best mean survival of about 57% was obtained for LFD 843. Survival rate in the live feed control was 67%. A major technical problem was rapid leaching of water-soluble nutrients from the practical feeds, as evidenced by the distortion of macro-nutrient composition after immersion in seawater; nutrient composition of particulate immersed in seawater differed greatly from the initial composition. There was also a significant reduction in protein content. It is presumed that some water soluble vitamins also leached out.

VITAMIN C NUTRITION IN MILKFISH

Ascorbic acid-2 sulfohydrolase was purified from milkfish livers by ammonium sulfate fractionation, gel-permeation chromatography, and ion-exchange chromatography. The yield of the enzyme was extremely low probably due to inactivation during the various purification steps. Comparative processing and storage stability of ascorbic acid (C_1) and its sulfated derivative (C_2) was done. Results indicate that C_2 is quite stable under mild processing conditions and during storage even at room temperature. About 50% of C_1 was lost during mild processing and a further loss of 15% was observed after 90 days of storage at room temperature. These suggest that C_2 may be the preferred dietary ascorbate source for milkfish. The ability to metabolize C_2 is evident in the presence of enzyme that could be purified from milkfish liver. The stability of C_2 assures that high quality feed could be obtained after processing or prolonged storage.

LIPID NUTRITION AND FATTY ACID METABOLISM IN MILKFISH: SALINITY EFFECTS

Given identical diets, fish reared in seawater tended to grow faster than those reared in freshwater although the difference, which was not significant, was pronounced only during the first few weeks of rearing.

There were salinity-induced differences in lipid and fatty acid composition in milkfish. This was mainly confined to the gills, liver and kidney during early stages of adaptation. Polyunsaturated fatty acids tended to occur in greater quantities in fish reared in seawater than in freshwater. When fully adapted, the difference became less, which implies that there could be a salinity-dependent nutrient requirement for specific fatty acids for optimal growth and development under different salinity regimes.

DIETARY FAT REQUIREMENTS OF MILKFISH FINGERINGS

Milkfish fingerlings were fed with various single source of fat to determine their dietary fat requirements. The crude protein, crude fat, crude fiber and ash content of the fish were significatnly affected by the fat content of the diet. Survival and growth rates were best in fish fed with cod liver oil.

AMINO ACID REQUIREMENT OF MILKFISH: TRYPTOPHAN

The study was meant to provide a basis for the preparation of test diets to quantify the requirement of milkfish juveniles for some selected amino acids. Essential amino acid-supplemented diets containing white fish meal and gelatin and a control diet containing white fish meal alone were given. Analysis of growth data showed an optimum protein energy (PE) to total metabolizable energy (TME) ratio of 44.3%. In the amino acid-supplemented diets, best growth was observed in diets containing 44.4 PE to TME. High survival rates were observed in all cases (87-92%). Fish body protein did not vary with increasing protein intake while body fat increased with increasing dietary fat. The activities of the hepatic enzymes (pyruvate kinase and glutamate dehydrogenase) increased in response to increasing dietary PE level while the tryptic activity

(pooled sample of pyloric caeca, pancreas and intestines) did not change.

Milkfish juveniles (7.7 g mean weight) were acclimated for one week on a commercial feed preparation prior to feeding with amino acid test diets containing white fish meal, gelatin, amino acid mixture and graded levels of added tryptophan from 0-0.52 g/100 g dry diet. The effect of six levels of tryptophan (49 g protein/ 100 g dry diet) was studied over a 12-week feeding trial at the rate of 40 g/kg biomass/day. Best growth was observed in diets supplemented with 2.2 g tryptophan/kg dry diet. Survival rates were consistently high (92-100%) in all treatments.

DIGESTIVE ENZYMES OF SIGANIDS

Siganid fry and fingerlings were found to have a chymotryptic activity of 0.138 M and 0.022 *M*, respectively. The tryptic activities of siganid fry (0.0444 M) and siganid fingerling (0.1195 M) were found to be inhibited by the Chaetomorpha (lumot) trypsin inhibitor.

DETERMINATION OF GENETIC VARIATION IN MILKFISH

A total of 35 protein loci, 9 of which were polymorphic in all the milkfish population sampled, was recorded. Genetic parameters were calculated for five populations. This included genotypic and allelic frequencies, degree of polymorphism and heterozygosity. A preliminary comparison of similarity indices among the five stocks showed promise in identifying genetically differentiated population for which diagnostic loci have been identified. Results suggest the existence of more than one breeding group of milkfish in the populations investigated.

Development of Culture Techniques of *Lates Calcarifer* in Brackishwater Ponds

CULTURE OF SEABASS *LATES CALCARIFER* IN COMBINATION WITH STOCKING DENSITIES OF *CHANOS CHANOS* AND *TILAPIA MOSSAMBICA* IN BRACKISHWATER GROW-OUT PONDS

Six treatments were used (stocking/ha) as follows:

Treatment I – 5,000 seabass, 2,000 tilapia, 1,500 milkfish
Treatment II – 5,000 seabass, 3,000 tilapia, 1,500 milkfish
Treatment III – 5,000 seabass, 4,000 tilapia, 1,500 milkfish
Treatment IV – 5,000 seabass, 2,000 tilapia, 3,000 milkfish
Treatment V– 5,000 seabass, 3,000 tilapia, 3,000 milkfish
Treatment VI – 5,000 seabass, 4,000 tilapia, 3,000 milkfish

Ponds were prepared using the standard lablab method. Milkfish fingerlings and tilapia broodstock at 1:1 male to female with mean weights of 5.0 g for milkfish and 33.9 g for tilapia were stocked simultaneously in the ponds. Seabass was stocked 90 days later. Milkfish and tilapia were cultured for 180, 210 and 275 days, seabass for 90 days.

Results showed that the average growth and survival of seabass were obtained in Treatment III: 374.5 g and 78.4%, respectively. Treatment V gave the lowest growth, 273.3 g while treatment IV gave the lowest survival, 43.8%. Highest average production was obtained in Treatment III: 1,784.2 kg/ha. The lowest average production of 998.4 kg/ha was obtained in Treatment I.

It was observed that the piscivorous seabass had a synergistic effect on the growth of milkfish and was not affected by the overpopulation of tilapia. Preliminary economic analysis showed that the highest estimated average net income of ₱54,444.25/ha was obtained in Treatment III, the lowest (₱5,997.40/ha) from Treatment IV.

DEVELOPMENT OF CULTURE TECHNIQUES FOR SEABASS

A verification study on the polyculture of tilapia and seabass was conducted at a stocking density of 10,000/ha seabass juveniles and 30,000 pairs/ha tilapia breeders. Average growth rate of seabass after a 30-day culture period was 0.3 g/day.

In growth studies using trash fish and moist diet as feed, 60-day old juvenile seabass were stocked at 20,000/ha. The average growth rate after 30 days of culture using trash fish was 0.9 g/day, for moist diet it was 0.3 g/day. Both treatments gave average survival rate of 80%.

Fry Collection Transport and Screening

THE OCCURRENCE, ABUNDANCE AND FEEDING HABITS OF FISH FRY IN PANAY SHORE WATERS

This study determined the species composition and abundance of the larval and juvenile fish collected in Pandan Bay in 1976-1977 by dragged seine (sagyap) operated on a 50-m stretch of sandy shore, and by Japanese set net (otoshi-ami) operated 500-m offshore in 30-m deep water.

Two to three species of newly metamorphosed mullets (Mugilidae) occurred most frequently (75% of 582 samples) and most abundantly (11,603 individuals of total length 10-40 mm) onshore throughout the year, followed by larval *Ambassis* sp (55%) and milkfish (48%, 3380 individuals of TL 10-17 mm). Also in considerable numbers in the shore samples were premetamorphic barracuda (*Sphyraena* spp.), tiger perch (*Therapon jarbua*), snappers (including *Lutjanus argentimaculatus*) and rabbitfish

(including *Siganus guttatus*), species with aquaculture potential. The availability of wild seeds warrants culture trials of these fishes. Larval to juvenile anchovy, halfbeak slipmouth, damselfish, needlefish and silverside were frequently found onshore. The seasons of abundance of these shore-caught species varied in duration, but occurred mostly in May-October, coinciding with the southwest monsoon.

Predominant species in the offshore samples were larval anchovy, sardines and slipmouth and metamorphosing goatfish. Milkfish and the four potential aquaculture species were found offshore in lower frequency and less quantity (except *Siganus* spp). Offshore specimens of these tended to be at the earlier stages of development than the shore-caught ones. This suggests an offshore spawning and then shoreward migration during growth. Mullets, halfbeaks, damselfish and needlefish were almost absent offshore. Instead, larval lizardfish and juvenile redbait took prominence, together with *Ambassis* sp., eel leptocephali, and larval flatfish, mackerel, silverside and carangids. Abundance patterns were difficult to ascertain and appeared to be highly variable among offshore fish.

THE SWIMMING AND SCHOOLING BEHAVIOR AND REACTION TO FISHING GEAR OF MILKFISH, SIGANID AND SEABASS FRY

The sensory development in early larvae of siganid and seabass follows a similar course, except that siganid larvae develop prominent free neuromasts on the first day after hatching while seabass larvae do not. The high sensitivity of early siganid larvae to mechanical disturbance is stressful and explains their tolerance to handling. In contrast, one-day old seabass larvae could be harvested from hatching tanks and transported with minimal mortality. Siganid larvae seem to be more active (swimming constantly) and more excitable (easily disturbed) than seabass larvae at all stages. Siganid larvae begin to move in schools after metamorphosis while seabass larvae aggregate in patches of variable mass but do not ordinarily form cohesive schools. Fry of both species exhibit stress reactions during crowding prior to packing, which is reversible by oxygenation and thinning out (Figure 1).

THE OCCURRENCE AND ABUNDANCE OF SEABASS (*LATES CALCARIFER*) FRY IN PANAY SHORE WATERS AND COASTAL WETLANDS

Preliminary surveys show that seabass fry juveniles and adults occur in considerable number in the waters of eastern Panay where mangrove, brackishwater, and relatively shallow and protected areas are well developed. The western coast of Panay, which is more exposed, is not a seabass habitat. Wild seabass fry of about 2-10 mm in total length collected in Iloilo (Villa and Oton towns) are morphologically equivalent to hatchery-reated seabass about two weeks of age. The seabass fry season in Iloilo is apparently May to August. Fry are swept in gears (sweeper and *tangab*) used to gather milkfish fry.

INVESTIGATION OF TRANSPORT STRESS RELATED INFECTIONS OF MILKFISH FINGERLINGS

Milkfish fingerlings transported by boat (petuya) for 7 to 8 hours from Bulacan to Laguna Lake fishpens were studied as to transport stress conditions, bacterial levels and post-transprt conditions. Subsequent transport procedure of closing the water exchange were associated with levels of dissolved oxygen, turbidity and ammonia of 2.4 ppm, 79 FTU and 2 mg/1, respectively. Marked change of salinity from 15 ppt to 30 ppt then to 0 ppt within a period of 1 to 3 hours were observed during transport. After stocking, an average of 2.4% mortality was observed. Bacterial counts in the water increased when water exchange during transport was stopped, and also 5 to 7 days after stocking. Among the bacterial isolates, *Aeromonas hydrophila* and two species of bacteria possibly related to *Pseudomonas* spp were identified.

IDENTIFICATION AND PATHOGENICITY OF *VIBRIO* SP. ISOLATED FROM MILKFISH WITH OPAQUE EYES

Bacteria were isolated from the opaque eyes of juvenile milkfish observed to possess varying degrees of eye opacity. Morphological, biochemical, and physio-chemical characterization showed that the isolates are Gram-negative, oxidase positive rods with single polar flagellum which

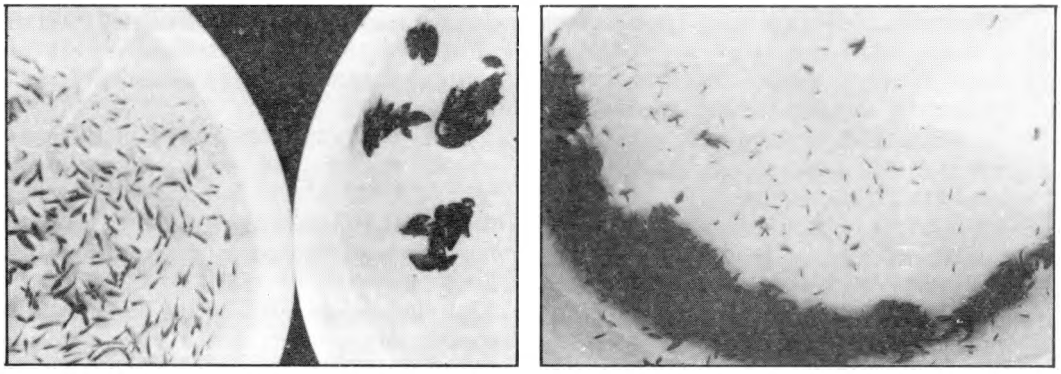


Figure 1. Stress reaction (presumably to lack of oxygen) of 42-day old hatchery-reared siganid "fry." Left photo shows normal behavior in basin with aeration and clumping in basin without aeration. Right photo shows another basin of stressed siganid.

ferment glucose without the production of gas and are sensitive to the vibriostat 0/129. The properties exhibited by the isolates justify their inclusion in the genus *Vibrio*. Table 2 summarises eye abnormalities observed on milkfish juveniles. Figure 2 compares normal eyes from abnormal eyes of the milkfish.

Table 2. Summary of Eye Abnormalities and Average Colony-forming Units Per Gram (CFU/g) observed Among Sampled *Chanos chanos* Juveniles

Eye Condition	Eye covering (CFU/g)	Eyeball (CFU/g)
Eye covering slightly opaque	2.0×10^5	7.0×10^4
Eye covering normal but eyebal damaged	2.5×10^4	1.1×10^4
Opaque eye covering and damaged eyeball	2.0×10^5	2.9×10^4
Normal eye covering and eyeball	2.6×10^4	3.2×10^2

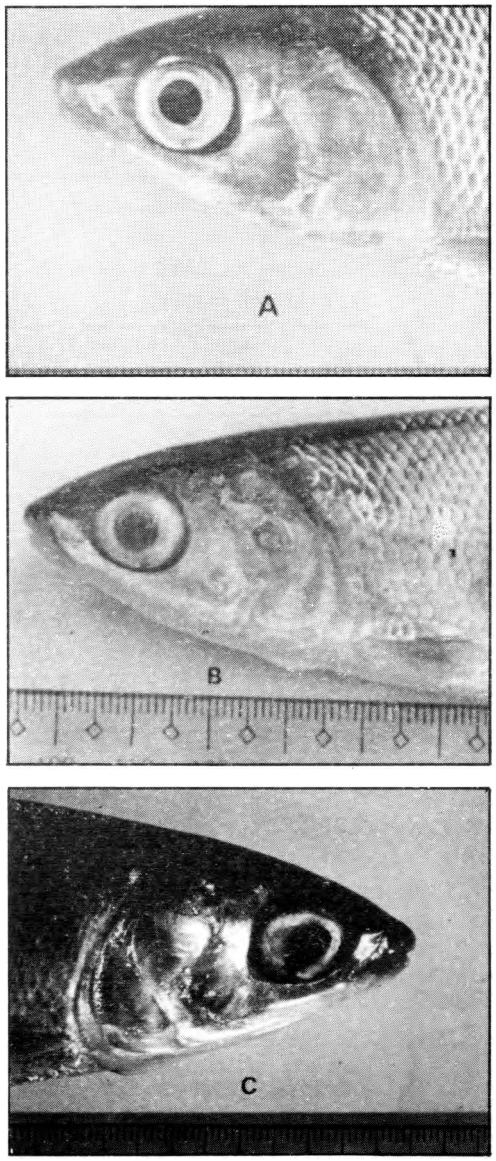


Figure 2.
Milkfish juveniles with normal eye cover and eyeball (A), opaque eye cover but normal eyeball (B), and normal eye cover but damaged and hemorrhagic eyeball (C).

Pathogenicity tests done by both injection and immersion challenge techniques showed a high mortality in fingerlings. On the other hand, juveniles tested by immersion challenge method exhibited varying degrees of eye opacity ranging from eye cover opacity and formation of cataract-like tissue around the lens, to failure of the injured site to heal. There was very low mortality rate of the juveniles.

Dynamics of Brackishwater Ponds in Relation to Milkfish Production

PRIMARY AND SECONDARY PRODUCTIVITY IN SELECTED BRACKISHWATER PONDS

Data collection was concentrated on the effects of different fertilizers on the photosynthesis and chlorophyll values.

The traditional method of fertilization (initial basal application of chicken dung at 2 tons/ha plus a bi-weekly application of 16-20-0 at 50 kg/ha and 45-0-0 at kg/ha) gave the highest values for chlorophyll and gross photosynthesis.

MASA fertilizer (processed from industrial and agricultural wastes) gave promising results at a rate of 1 ton/ha.

Gross photosynthesis was consistently lower in plexiglass samplers than in BOD bottles. This was due to the inclusion of benthic photosynthesis in plexiglass samplers. Gross photosynthesis and chlorophyll values showed remarkably good agreement throughout the study. Gross photosynthesis will be used as an indicator of milkfish production in the succeeding runs of the study.

ALGAL SUCCESSION IN SELECTED BRACKISHWATER PONDS

The response of both planktonic and benthic populations to MASA fertilizer and chicken manure were compared with the regular and half dosages of traditional fertilizers normally applied in ponds. Results indicated that specific groups of organisms respond to particular fertilizer treatments.

Semi-intensive Culture of Milkfish in Brackishwater Ponds

THE EFFECT OF SUPPLEMENTAL FEEDING AND STOCK MANIPULATION ON THE GROWTH, SURVIVAL AND PRODUCTION OF MILKFISH FOLLOWING THE "LABLAB" AND PLANKTON METHODS

Milkfish fingerlings (1.3 g ave. body weight) were cultured by plankton method with water depth ranging from about 65 cm to 110 cm for 123 days. Results showed an average growth rate of 1.4 g/day at a stocking density of 4,000/ha, 1.2 g/day at 5,000/ha, and 1.0 g/day at 6,000/ha.

Results of milkfish fingerlings (15.4 g ave. body weight) cultured by lablab method with supplemental feeding after a two-month culture period showed a higher growth rate than that cultured with lablab only. Among the supplemental feeds, the mixture of trash fish and rice bran showed the best results with 1.7 g growth rate per day, followed by rice bran with 1.2 g, and trash fish with 0.8 g.

THE AMINO ACID COMPOSITION OF FEEDSTUFFS COMMONLY USED AS PROTEIN SOURCES IN AQUACULTURE FEEDS

Forty samples of materials of animal and plant origin were prepared as feed meal and/or TCA or acid concentrate. These were subjected to crude protein analysis and hydrolysis.

Results are shown in Tables 3 & 4. Crude protein analysis showed that % C Protein values of TCS or acid protein concentrates were higher than those of their corresponding meals, except in sap-sap, "aloy" and prawn. The method of protein concentration recommended for plant samples does not seem applicable to copra meals as shown in the % C Protein value of its concentrate.

Table 3. Crude Protein Content of Protein Concentrates and their Corresponding Meal (%)

Sample	Meal	Concentrate
Sap-sap (whole)	65.95	57.39
Sap-sap (edible)	81.91	67.97
Aloy (whole)	77.23	71.04
Aloy (edible)	86.51	72.12
Prawn (stage 1)	83.27	81.38
Prawn (stage 2)	84.64	67.00
Tabagak (whole)	76.91	86.66
Tabagak (edible)	87.54	92.56
Dilis	78.76	86.10
Prawn (stunted)	86.74	89.95
Karajo (whole)	74.10	89.61
Karajo (edible)	86.84	85.94
Squid (whole)	74.12	80.22
Squid (edible)	78.69	82.56
Squid (heads)	71.10	71.96
Rice bran	9.43	16.24
Copra meal	21.82	23.87
Soybean meal, undefatted	38.58	80.35
Meat and bone meal	46.35	64.74
Mungbean, green	27.56	85.74

Table 4. Amino Acid Composition of Prawn (Stunted) Meal and its Corresponding Protein Concentrate (g AA/100 g sample)

Amino Acid	Meal	Propanol Concentrate	TCA Concentrate
ALA	4.79	4.37	5.53
ARG	6.24	7.04	6.30
ASP	6.95	8.89	11.67
CYB	N.D.	N.D.	N.D.
GLU	11.27	14.27	16.48
GLY	6.52	5.65	.07
HIS	2.57	2.21	2.65
ILE	2.75	3.52	4.06
LEU	4.99	6.49	7.56
LYS	5.24	6.67	8.19
MET	1.84	2.35	2.70
PHE	3.77	4.87	4.69
PRO	3.20	3.80	3.26
SER	2.20	2.00	3.51
THR	2.31	2.86	3.86
TRP	.62	.74	.87
TYR	3.24	3.83	3.98
VAL	3.03	3.60	4.32
TOTAL	71.53	84.46	93.69

POLYCULTURE OF MILKFISH AND PRAWN IN A MODULAR POND SYSTEM

Four sets of modular ponds, each set having a ratio of 1:2:4 proportion with corresponding areas of 550, 1,100 and 2,200 m^2 were used. Two stocking rates were followed: 3,000/ha (1:1 and 1:2 milkfish to prawn) based on the area of the last module. Results from two runs showed that milkfish and prawn attained an average weight and survival of 220.19 g and 95.2% and 38.75 g and 83.4%, respectively. There was no significant difference in the growth, survival and production rates of milkfish. In the 1:2 milkfish-prawn ratio, prawn yield increased by 52%, which could have been the effect of high stocking density. Using such stocking combination the modular pond system could produce about 2,064 kg of milkfish and 654 kg of prawn per hectare per year, if six runs can be done.

MILKFISH PRODUCTION IN A MODULAR POND SYSTEM:AN ECONOMIC STUDY

An attempt to assess the social benefits of the study was conducted in 1984 using the ponds of a private fishfarmer in Silay, Negros Occidental. Two sets of modular systems were used representing Zone A and Zone B each zone having a proportionate area equivalent to 1.47 : 2.08 : 3.21 ha; and 0.68 : 0.76 : 1.27 ha, respectively. A total of 9.47 ha grow-out ponds were used excluding about 0.5 ha of nursery pond system.

Since its operation in August 1984, three consecutive monthly harvests have yielded a total of 10.11 tons from Zone A and 2.571 tons from Zone B. Six croppings were likely to be expected in one year.

THE EFFECT OF SOYBEAN TRYPSIN INHIBITOR ON UTILIZATION OF SOYBEAN PRODUCTS AS DIETARY PROTEIN SOURCE FOR MILKFISH AQUACULTURE

Milkfish trypsin was distributed discretely in the digestive tract of the milkfish. The highest activity was observed in the pyloric caeca followed by the pancreas. Slight activity was observed in the intestines, cardiac and pyloric stomach. No activity was observed in the esophagus and epibranchial organ. Milkfish trypsin could be purified from pyloric caeca and pancreas of market-sized milkfish. The purification process included ammonium sulfate fractionation, gel-filtration and ion-exchange chromatography.

Milkfish trypsin is inhibited by soybean trypsin inhibitor (SBTI). The partially purified trypsin from the pyloric caeca was inhibited at about 1:1 molar ratio by SBTA. Specifically, the tryptic was inhibited by aqueous extracts from various soybean meals. The extracts, in the order of decreasing inhibitory activity, were obtained from undertoasted meal, normal soybean meal, overtoasted meal and ruminant bypass meal. The extract from undertoasted and normal soybean meal had comparable inhibitory activity. The overtoasted and ruminant bypass meals had a greatly reduced inhibitory activity.

Milkfish trypsin is extremely unstable in an acidic medium. At 4°C, milkfish trypsin was rapidly and completely deactivated at pH 3.0 and 5.0. Tryptic activity was completely lost after a 1-hr exposure to pH 3.0 at 4°C. About 50% tryptic activity remained after an exposure to pH 7.0 for 24 hours at 4°C. The enzyme appeared to be stable in an alkaline medium at pH 9.0. The high sensitivity of milfish trypsin to soybean trypsin inhibitor may limit the utilization of soybean meal for milkfish diet formulations.

Tilapia Broodstock Development

EVALUATION OF DIFFERENT TILAPIA STRAINS, USING ELECTOPHORETIC GENETIC MARKERS AND HEMATOLOGICAL PROPERTIES

Of the 22 loci investigated, 18 showed no detectable differences between *Tilapia nilotica* and *T. mossambica,* while four displayed interspecific differences between the two species. The hybrid pattern indicated a possible contamination of *T. nilotica* with *T. mossambica.*

DEVELOPMENT OF TILAPIA BROODSTOCK FOR GENETIC STUDIES

The following preliminary crosses were made:

(1) *T. nilotica* x *T. nilotica,* (2) *T. mossambica* x *T. nilotica,* (3) *T. nilotica* x *T. mossambica,* and (4) *T. mossambica* x *T. mossambica.* The purebred and hybrid fry obtained from each cross were reared separately and stocked in cages in Laguna Lake.

The sarcoplasmic protein of nine hybrid fish from a female *T. nilotica* x male *T. mossambica* were investigated. The hybrid pattern showed two bands representing the fast moving allele of *T. nilotica* and the slower allele of *T. mossambica.* The pattern is similar to those obtained from *T. nilotica* contaminated with *T. mossambica.* Some morphological traits of the hybrid were observed to be inherited from the female parent (*T. nilotica*), others from the male parent (*T. mossambica*), and a few intermediate between the parents.

Mass Production of Tilapia Fingerlings

CONTROL OF MORTALITY IN HATCHERIES: REFINEMENT OF EXISTING HATCHERY TECHNIQUES

Two sets of experiments were conducted simultaneously for nine months to determine the effects of stocking densities on egg and fry production in concrete tanks with and without cage net enclosures.

Results showed no significant difference on the total egg and fry production of *T. nilotica* spawners stocked at densities of 5/m^2 and 10/m^2. However, mean egg and fry production per spawner were relatively higher in tanks with spawners

stocked at 5/m^2 than in those stocked at 10/m^2. Higher seed production was likewise obtained in hatchery tanks without net cage enclosures than in tanks with such enclosures. It was also observed that reproduction was affected by temperature of the lake water as demonstrated by the varying egg and fry production levels which decreased during colder months and increased during warmer months.

PEN CULTURE OF *TILAPIA NILOTICA* IN THE DETERMINATION OF OPTIMUM STOCKING DENSITY

Growth of tilapia in all sampling periods was best at stocking density of 5/m^2. Increasing the stocking rate from 5 to 15 m^2 led to a declining growth rate after four months culture period. The differences in growth rate obtained at 10 and 15/m^2 were not significant.

Recovery rates of tilapia in all pens ranged from 23.4 to 31.2%. Higher recovery rates were obtained from pens stocked at 10 and 15/m^2 than in pens stocked at 5/m^2.

Mass Production of Milkfish

MILKFISH FINGERLING PRODUCTION IN FRESHWATER

Milkfish fry were stocked in concrete tanks filled with freshwater and fed for 12 weeks with a combination of natural food (*Anabaena azollae*) and *Moina macrocopa*) and a formulated artificial diet. Growth was generally slow and mean survival rate was 64%. The fry suffered from moderate infestation of the parasite *Trichodina.*

Microscopic observation of the gut of the fry revealed the presence of considerable amounts of the artificial and natural food which consisted predominantly of *Anabaena* and partially digested *Moina.*

Other algae which grow naturally in the rearing water such as diatoms, unicellular green algae and filamentous blue-green algae were also observed in the gut. Another feeding trial was disrupted by the presence of an unidentified bacteria in the gills that resulted in high mortalities.

Carp and Broodstock Development and Hatchery

BIGHEAD CARP BROODSTOCK MATURATION IN CAGES IN LAGUNA LAKE

Two-year old bighead carp broodstock spawned artificially by hormone injection. Twenty were from treatment combinations with no feeding while eight came from treatments with supplementaty feeding. Average fecundity per fish was 147,641, average fertilization rate was 82.5%, and hatching rate was 27.4%. The average fecundity per fish in the treatments with feeding was higher than in those without supplementary feeding. However the latter had higher average fertilization rate (86.5% than the former (76.0%). After one to two months some broodstock from the treatments with no feeding rematured.

GENETIC IMPROVEMENT OF CARP BROODSTOCK

Eleven enzymes, skeletal muscle proteins and hemoglobins were investigated by electrophoresis. Preliminary results showed interspecific differences among common carp, bighead carp and silver carp. Tissue specificity, locus and allele frequencies are being determined.

CARP FINGERLING PRODUCTION

Experiments were conducted to determine the acceptability of different zooplankton and artificial food for growing bighead carp larvae or fry. Results showed that weight increase was highest when fry were fed with 100% *Moina* at a density of 6 fry/liter. Increasing the amount of rice bran as well as the stocking rate resulted in poor growth and survival.

During larval rearing, 3-5 days after yolk absorption, *Brachionus* and the small cells of *Chlorella* and *Oscillatoria* were acceptable. Assimilation rates of ^{14}C-labelled zooplankton and phytoplankton showed that negligible amounts of food are assimilated by bighead carp fry two days after hatching. The assimilation rate of ^{14}C-*Brachionus* was highest on the fifth day of rearing. In general, older – 8-day old – larvae assimilated animal protein. Both zooplankton and phytoplankton were assimilated as the fry grew older.

COMPARATIVE STUDY ON GROWTH AND SURVIVAL OF BIGHEAD AND SILVER CARP FRY FED DIFFERENT TYPES OF FEED FOR FINGERLING PRODUCTION

Bighead carp, 4-5 days old after hatching were stocked at 10/liter, mean initial weight was 2.28 mg and mean initial length was 8.36 mm. After six weeks of culture, marked differences in growth were exhibited by the fry. Growth was highest in the treatment fed with *Moina* plus formulated feed, which gave a mean weight and length of 105.9 mg and 20.1 mm, respectively. This was followed, in decreasing values, by treatment fed with *Moina* alone, green water + formulated feed, and green water + *Moina* + formulated feed. Fry given green water alone died *en masse* after six days. The highest survival of 83% was attained in treatment fed with green water + *Moina* + formulated feed.

Limnological Studies in West Bay of Laguna de Bay

ALGAL POPULATION AND PRIMARY PRODUCTION

Phytoplankton populations were monitored in two stations of West Bay, Laguna Lake. Station

1 is where the BRS cages and pens are located, and Station 2 is the open waters of the Bay.

Members of the Cyanophyta predominated in Station 1 for most of the year. Peak population of blue-green algae occurred in May and July. Algal population fluctuated from January to April. The diatoms were tne next predominant group, constituting the most numerous species in January to April. Members of the chlorophyta showed a population density close to that of diatoms.

The average primary production in Station 1 in 1985 was 1.3 g C/m^2/day or a total annual production of 47 g C/m^2/day. Highest primary production of 3.3 g C/m^2/day occurred in June.

PHYSICO-CHEMICAL PROCESSES AND SECONDARY PRODUCTION

Increase in the levels of NH_4–N then in NO_2–N and NO_3–N took place after the decline or die-off of phytoplankton towards the later part of June when the rains came. Generally, low levels in the nitrogen species took place during high levels in phytoplankton biomass and, conversely, peaked during decline in phytoplankton biomass.

Water level fluctuated by almost 2.5 m in 1984. Levels in Cl^-_1 total hardness, conductivity, and total alkalinity were higher during the sunny, dry, summer season than during the months after the rains.

The zooplankton community consisted of 16 species of Rotifers, 4 species of Copepods, and 5 species of Cladocera. Copepods made up 69.3%, Cladocera 28.0% and Rotifera 2.7% of total annual zooplankton biomass in the West Cove. In the West Bay Station, the same respective groups made up 60.5%, 35.2% and 4.3% of the total annual zooplankton biomass. Annual 1984 averages in total zooplankton biomass for 1984 were 7.036 g/m^2 for the West Cove and 6.313 g/m^3 for the West Bay.

ECONOMICS OF MILKFISH AND TILAPIA PEN INDUSTRY IN LAGUNA LAKE

The ROI in the milkfish pen industry is 142% with a payback period of 0.92 year; that of the tilapia pen industry is 155% with a payback period of 2.4 years. Preliminary analysis of milkfish and tilapia polyculture in pens gave an ROI of 476% with a payback period of 0.91 year.

CRUSTACEAN PROGRAM

To strengthen further the national research system, the AQD has organized, sponsored, co-sponsored and/or hosted numerous scientific and professional meetings with international, regional and national institutions and industry practitioners.

Forty-one studies were approved for 1984. The more significant results, some of which were presented at the First International Conference on the Culture of Penaeid Prawns/Shrimps held in December 1984, are as follows:

Broodstock Development and Gonadal Maturation

REFINEMENTS OF VARIOUS PRAWN MATURATION TECHNIQUES

Marketable size *Penaeus monodon* were reared to broodstock size in brackishwater ponds with the aim of developing appropriate techniques to produce a consistent supply of reared broodstock. Results after six months of culture showed that ten-month old broodstock with average weight of 80-100 g was found to be the right age and size for gonadal maturation.

Maturation techniques using pond reared spawners were tested and verified. One experiment was aimed to verify pond conditions which could enhance gonadal maturation with the use of high protein feeds. Results indicated that ablated broodstock can be induced to mature in pond conditions. However, hatching rate was low and nauplii were weak. The performance of pond-reared broodstock was also found to be inferior to that of wild broodstock in maturation rate, hatching rate, and larval quality.

Another experiment showed that broodstock which are properly selected gave higher maturation rate and higher fertilization and hatching rates (Table 5). The criteria for selection are complete appendages, no broken backs, thelycum full of spermatophore, and body weight exceeding 100 grams.

Table 5. Comparison of Selected and Non-Selected *P. monodon* Broodstock							
	No. of Spawners	Feed	Ave. Maturation Rate	% Spawned Ave.	Total Eggs Produced	No. of Naupili x 10	Hatching Rate
Selected	32	Squid	15.2%	87.5%	5,817	1,511	29.2%
Non-Selected	42	Squid	26.3%	100%	9,195	5,195	55.2%

EFFECT OF PHOSPOLIPIDS ON MATURATION AND SPAWNING

Feeding experiments using diets with different levels of phospolipids using juveniles with an average body weight of 0.5 g were conducted. Results after a 30-day culture showed that a higher ration of arginine/metrionine seemed to give better growth. In addition, lipid level of 8%, 4:4 polar/neutral lipid gave the highest efficiency.

EFFECT OF ESSENTIAL FATTY ACIDS ON MATURATION AND SPAWNING

The tissue lipid content and fatty acid composition in the hepatopancreas, tail muscle and gonad of unablated and ablated *P. monodon* were determined. The hapatopancreas showed the highest lipid content at 15.72 to 25.20% in unablated and 22.47 to 34.90% in ablated females. Flesh lipid levels average 2.60%, with no marked variation throughout the maturation period. Ovarian lipid increased from 5.80% (unablated) and 7.50% (ablated) in immature ovaries, to more than twice in early maturing ovaries. In unablated females, lipid values peaked (17.0%) in late maturing ovaries coupled with a drop in hepatopancreatic lipid, suggesting lipid mobilization to the ovaries. In ablated females, ovarian lipid progressively increased to a maximum of 21.90% in fully mature ovaries with a corresponding rise in hepatopancreatic lipid. Ovarian and hepatopancreatic lipids declined in spent females.

Fatty acid profiles in the tissues consistently showed the presence of polyunsaturated fatty acids (PUFA) 20:4W6, 20:5W3 and 22:6W3. These fatty acids were reflected in the spawned eggs. The lipid level in the hepatopancreas appeared to be inversely related to the total PUFA concentration in the ovaries. Lipid accumulation in ablated females was significantly higher than in unablated females.

The findings suggest storage and subsequent utilization of lipids for maturation and spawning process.

CHARACTERIZATION OF OVARIAN MATURATION STAGES: HISTOLOGY AND HISTO-CHEMISTRY

On the characterization of the ovarian maturation stages in the *P. monodon*, histological results indicated that the maturation stages are classified into: (1) previtellogenic – stage O. (2) vitellogenic – stages I and II, (3) cortical rod – stages III and IV and (4) spent – stage V. The previtellogenic group consists only of perinuclear oocytes (46-72u), the vitellogenic group is composed mostly of yolky oocytes (121-311u), the cortical rod group consists mostly of yolky oocytes (388-408u) with additional rod-like bodies which contain acid and basic mucopolysaccharides but no lipid. The spent group is similar to the previtellogenic group but contains some yolky oocytes, thicker follicle cell layers, or irregularly shaped perinucleolar oocytes. The GSI ranges of the four groups are 0.899-1.937, 3.099-7.598, 5.631-12.00, and 1.848-2.919.

DETERMINATION OF STAGES IN THE MOLTING CYCLE OF *PENAEUS MONODON*

Changes in the formation of cuticle layers and setae bordering the uropods and endopodites of the pleopods of adult *P. monodon* were examined. These internal structures were found to undergo marked changes through the postmolt (stages A & B), intermolt (stage C), premolt (stage D) and molt (stage E) cycles.

The postmolt period has the shortest duration in the molt cycle. Stages A and B are about 2% and 6%, respectively, of the total duration of the molt cycle. This is characterized by changes in the distribution of internal matrix, progressive thickening of the setal wall and its base, and the degree of closeness of the epidermis to the cuticle.

The intermolt stage C which occupies 26% of the molt cycle is best characterized by the complete separation of the epidermis and cuticle and the full development of internal cones and sensory hairs. The premolt phase occupies a greater share of the molt cycle. Stage D_0 is marked by the first sign of apolysis and the appearance of the exuvial space. The formation of the new exoskeleton begins in D_1 with the progressive formation of the new setae. The final stage in preparation of ecdysis is stage D_2, where the ribbed tips and barbules of the new setae become evident. In the pleopods, the cuticle rings are already present in the new cuticle layer. The actual molt or stage E follows immediately. Figure 3 illustrates the terminologies used to describe the different molt stages.

Observations also indicated a general correspondence between the setagenic vents in the pleopods and uropods, and gross exoskeleton

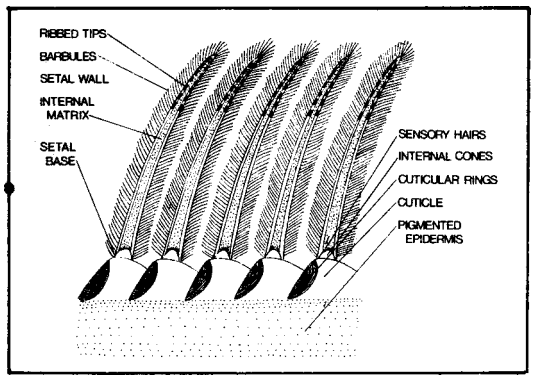


Figure 3.
Diagramatic representation of the setae of the pleopods and unropods of **P. Monodon,** *indicating terminology used in molt stage determination.*

condition during the molt cycle. These changes in the setae are better observed and emphasized in the uropods than in the pleopods.

PRODUCTION OF *PENAEUS MONODON* BROODSTOCK IN PONDS

Juveniles were grown to 80-100 g in 6,000 m^2 earthen ponds, with supplemental feeding, at a stocking density of 3,500/pond. From a body weight of 25-30 g, three different feeding regimes were used, namely, no feed, commercial feed A, and commercial feed B. The highest growth rate was attained in the treatment without supplemental feeding. Females had a relatively higher growth rate than males.

FIELD SURVEY AND MONITORING OF *PENAEUS MONODON* WILD SPAWNERS AND ENVIRONMENTAL CONDITIONS

A monthly 2-day field survey per spawner collection in the Roxas, Batan and Tigbauan areas showed that spawning grounds have the following environmental conditions:

- water depth: 10-30 m
- water temperature (in bottom): less than 30°C
- pH: 8.2-8.4
- salinity: 32-36 ppt
- D.O.: more than 6 ppm
- bottom soil: clay and dark green in color
- fauna (in bottom): polychaeta, bivalvia, gastropoda, crustacea.

CHARACTERIZATION OF OVARIAN MATURATION STAGES: LIPIDS, PROTEINS AND CHOLESTEROL

Seventy-two prawns at different ovarian maturation stages were sampled. Hemolymph protein level estimated by the retractive index method showed no correlation with the Gonadosomatic index (GSI) of the prawns.

Artemia

INTEGRATION OF *ARTEMIA* PRODUCTION WITH SALT PRODUCTION AND MILKFISH/ PRAWN CULTURE IN EARTHEN SALT PONDS

An *Artemia* commercial production study is being conducted in Manjuyod, Negros Oriental. As of December 1984, the following observations were made:

- Growth of *Artemia* adults reached 2 cm or more, with individual weights (wet basis) reaching more than 50 mg. Maximum size was 13 cm and maximum weight was 20 mg even in ponds with higher fertilization rate and with the same *Artemia* inoculum.

- Cow manure alone could support good growth, survival and reproduction of *Artemia.*

- The phytoplankton *Tetraselmis* sp. was shown to be an excellent natural food and could be used to grow higher quality *Artemia.*

- Storage of *Artemia* cysts on nitrogen-flushed cans, after cleaning by differential flotation and drying in a fabricated fluidized bed-dryer, did not significantly lower hatching performance up to 3 months after processing.

PILOT SCALE PRODUCTION OF *ARTEMIA* CYSTS AND BIOMASS IN PONDS

Artemia pond culture in 1984 was not successful due to unfavorable weather conditions. Only 44 kg (wet weight) biomass was harvested from 1,600 m^2 ponds and an inoculum of 228 g. On the other hand, indoor culture produced an average of 3 kg/ton in two weeks.

Evaluation of locally produced *Artemia* cysts revealed that air drying for 22 hours is as effective as oven drying at 40°C. However, less cyst is generally needed with air drying.

Pond/Cage Culture

DEVELOPMENT AND EVALUATION OF GROW-OUT DIETS FOR *PENAEUS MONODON*

Hepatopancreas cells of *P. monodon* post-larvae were investigated by electron microscopy after starvation and refeeding with different diets. The ultrastructure of R-cells changed largely, B-cells showed slight reactions, F- and E-cells were constant. The results indicate that R-cells could be used as monitor cells for the nutritional value of prawn diets in aquaculture.

Leaves of ipil-ipil (*Leucaena leucocephala*) were used as plant protein in some *P. monodon* formulated diets. Results of a four-week feeding experiment (Table 6) showed that unsoaked leaves (20% in the diet in a 40% protein diet) gave good growth and survival compared to diet with soaked leaves, as long as mimosine content of the leaves is less than 2.5%. Growth and survival of postlarvae fed with diets containing soaked and unsoaked ipil-ipil leaves were numerically better (135%) than those fed the 2S or control diet (10%).

Table 6. Percentage Mean Weight Gain and Percentage Mean Survival

	% mean weight gain	% mean survival
Soaked ipil-ipil	135 g	63.9
Unsoaked ipil-ipil	137 g	53.8
Control (2S)	107	44.9

Another experiment was carried out to modify the existing 2S diet which has been used as maintenance diet for *P. monodon*. Twelve different formulations were made, six of which were found to be possible feeds for grow-out culture. These were tried under pond conditions. Preliminary results showed a 16% average survival in all formulations.

Two macrophytes growing in local brackishwater ponds, *Ruppia maritima* (Kusay-kusay, Hiligaynon) and *Najas graminea* (digman, Hiligaynon) were studied to determine their effect on growth and survival of *P. monodon* juveniles. A commercial pellet (40% protein) used as control, was offered to satiety (approx. 100% of body weight) twice daily.

Increase in carapace length was most rapid with decaying *Najas* and slowest in live *Ruppia* (140% vs. 17% after 30 days). Growth in decaying *Ruppia* was comparable to pellets on the 10th and 20th days, but was faster after 30 days. Body weight on all sampling days was highest in decaying *Najas* and lowest in live *Ruppia*. The rapid growth rate of animals on decaying *Najas* was offset by a low survival rate (31%) which is significantly lower than on live *Najas* (100%). Other survival percentages were: decaying *Ruppia*, 65%; live *Ruppia*, 59%; pellet, 50%.

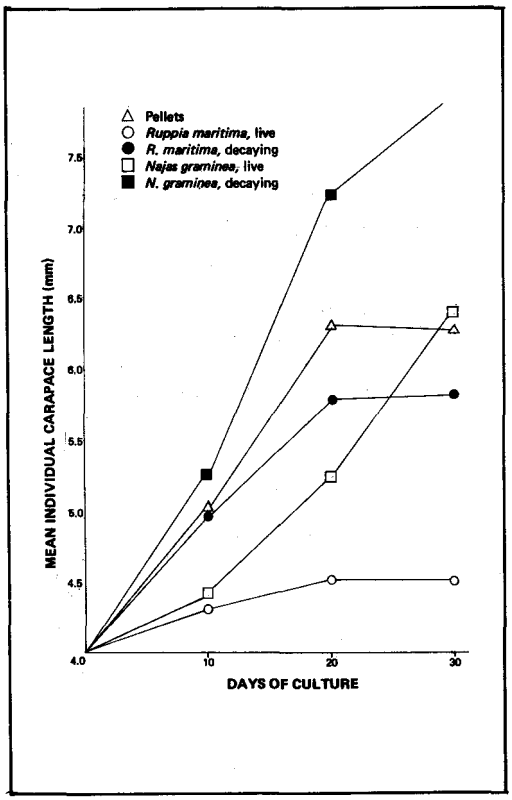


Figure 4.
Mean carapace length of **P. monodon** *juveniles (PL50) fed with a pellet and two macrophytes over a 30-day period.*

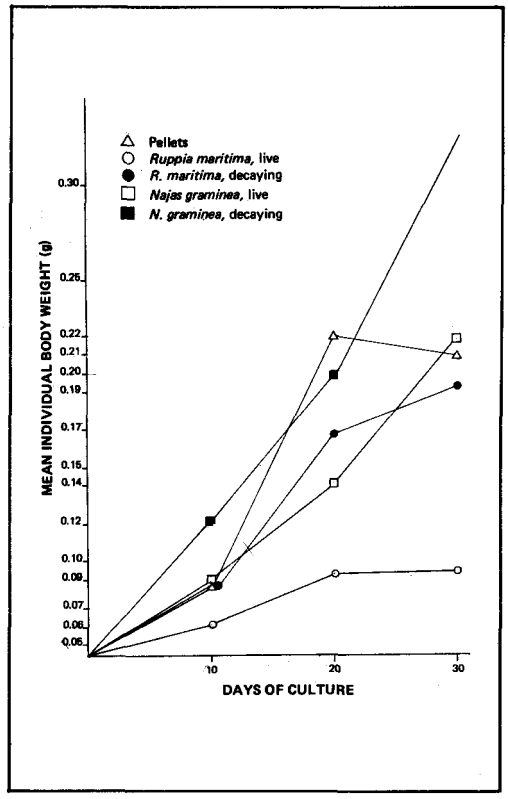


Figure 5.
Mean body weight of Penaeus monodon (PL50) fed with a pellet and two macrophytes over a 30-day period.

STUDIES ON AMINO ACID PATTERNS AND REQUIREMENTS OF *PENAEUS MONODON*

From the amino acid pattern of postlarvae and other available feedstuffs previously determined, a semi-purified diet and ten other diets were formulated, each lacking in one essential amino acid. The diets were fed to *P. monodon* postlarvae for 28 days. Results showed that the diet with complete amino acid gave the least survival rate (less than 50%).

LECITHIN REQUIREMENTS OF *PENAEUS MONODON* JUVENILES

An eight-week feeding experiment was carried out to determine the lecithin requirement of *P. monodon* postlarvae. Three sources of lipid, cod liver oil, crude degummed soybean oil and purified soybean oil, were used with three levels of lecithin, namely, 0, 1 and 2% in the diet. Results indicate that the source of lipid significantly affected survival rates. The crude degummed soybean oil diet did not provide for good survival at all levels of lecithin, while diets that contained either cod liver oil or purified soybean oil gave generally higher survival rates. Levels of lecithin in the diet did not significantly affect survival rates. Mean weight gains increased significantly when levels of lecithin increased from 0 to 2.0% in all dietary treatments except those given the 2.0% lecithin with the crude degummed soybean oil.

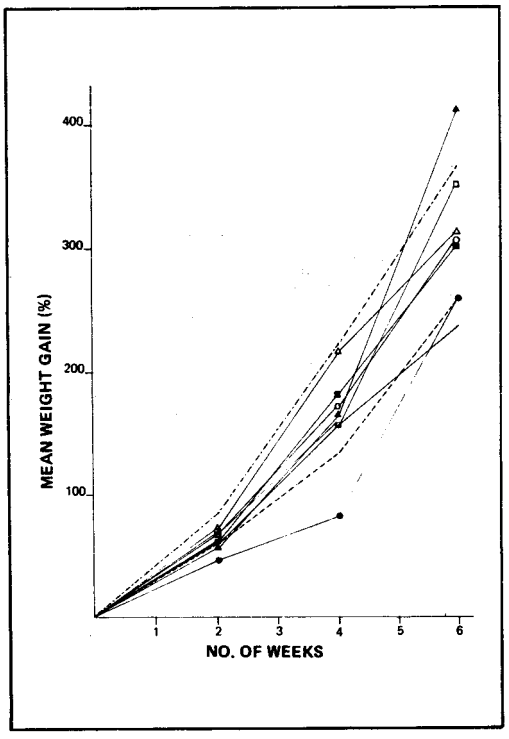


Figure 6.
Percentage weight gain of **P. monodon** *juveniles fed various sources of lipid with and without soy lecithin.*

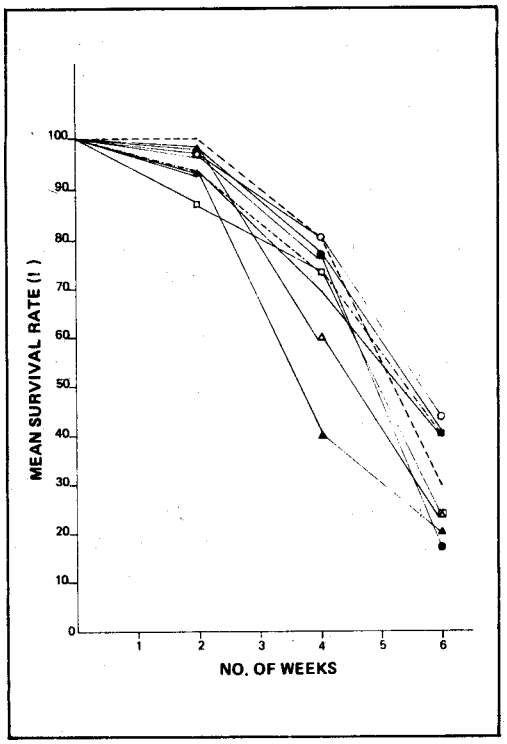


Figure 7.
Percentage survival of **P. monodon** *juveniles fed various sources of lipid with and without lecithin added to the diets.*

Legend:

- COD LIVER OIL + 0% SOY LECITHIN
- COD LIVER OIL + 1% SOY LECITHIN
- COD LIVER OIL + 2% SOYLECITHIN
- CRUDE DE GUMMED SOYBEAN OIL + 0% SOY LECITHIN
- CRUDE DE GUMMED SOYBEAN OIL + 1% SOY LECITHIN
- CRUDE DE GUMMED SOYBEAN OIL + 2% SOY LECITHIN
- PURIFIED SOYBEAN OIL + 0% SOY LECITHIN
- PURIFIED SOYBEAN OIL + 1% SOY LECITHIN
- PURIFIED SOYBEAN OIL + 2% SOY LECITHIN

EVALUATION OF SHRIMP GROWOUT SYSTEMS

This study was aimed at increasing farm production output through manipulation of the traditional extensive culture technique.

a. Extensive Culture

The first run employed the conventional methods of pond preparation and liming. Fertilizers were organic and inorganic. Ponds were stocked with hatchery-bred fry at 1, 2 and 4/m^2. No supplementary feed was given during the first two months. Feeding rate was 6% of the total biomass on the third month and 4% on the fourth months.

Resulting yields follow:

Stocking rate	Growth Rate	Survival Rate	Production
1/m^2	0.16 g/day	85%	171 kg/ha/crop
2/m^2	0.15 g/day	84%	317 kg/ha/crop
4/m^2	0.11 g/day	74%	382 kg/ha/crop

The second run used the optimum first run stocking rate of 2/m^2. Modification was made by transferring the animals to a newly fertilized pond after a culture perod of 45 days, 60 days, and control (no transfer). The highest growth and pond production rates were obtained when the prawn were transferred after a 60-day culture period.

After a rearing period of 60 days in the first four series of pond modules (600 m^2 per module) at a stocking rate of 6 PL_{25}/m^2, harvested prawns reached an average weight of 5.8 g apiece.

The harvested prawns were randomly stocked in six series of 600 m^2 ponds at 2 and 4 pcs/m^2. Average production/ha after 105 days were: for 2/m^2 stocking, 205 kg/ha at 90% survival rate; and for 4/m^2 stocking, 352 Kg/ha at 90% survival rate. A commercial diet with 35% protein was given everyday at the rate of 6% total body weight. Water management was done only during spring tides.

In a related experiment, results after a four-month culture period showed higher weight gain in prawns stocked in ponds fertilized with chicken manure at 2.0 tons/ha.

Fertilizer Used	Ave. Weight Gain
Chicken manure (2.0 t/ha)	8.8 g
Chicken manure (500 kg/ha) + Mud press 4.5 t/ha	6.3 g
Mud press (5.0 t/ha)	6.0 g

Semi-intensive Culture

Stocking Density. Experiments conducted to determine an optimum level of stocking of *P. monodon* which could maximize output showed that the optimum stocking rate is 4 pcs/m.^{2} Stocking rates of 4, 8 and 12/m^2 were tried. The shrimp were fed with commercial pellets at 3-10% of biomass per day.

Feeding Rate and Alternate Culture. After four months rearing in grow-out ponds the prawn showed the following mean weights. Treatment I 16.4 g; Treatment II 12.3 g; Treatment III 7.7 g; and Treatment IV 13.5 g. Prawns stocked at 2/m^2 with decreasing feeding regime at 10%, 8%, 6%, and 4% total body weight (Treatment I) gave better weight gain than those stocked at 4/m^2 with the same feeding scheme (Treatment IV). No significant difference in weight gain could be found between prawns stocked at 2/m^2 (Treatment II) and 4/m^2 (Treatment IV) as both had the same feeding regime at 6% total body weight.

For the alternate culture study, *P. indicus* stocked at 4/m^2 with decreasing feeding regime attained a mean weight of 5.3 g after 4 months of rearing.

The slow growth rate of both species may be attributed to the pond water quality. Water replenishment in each pond could not be conducted efficiently due to the lower elevation of the pond bottom than the drain canal.

Modified Extensive Culture. Prawns were reared without supplementary feed for the first two months, after which feeding started on the third harvest. A commercial diet with35% protein was given every other day at the rate of 6% total body weight. Water management was conducted only during spring tides. Results after 105 culture days showed that prawn reared for 60 days then transferred to newly prepared ponds, and, after another 45 days, were again transferred to other newly prepared ponds, yielded 230 kg/ha at 83% survival rate; prawns which were not transferred yielded 233 kg/ha at 83% survival rate.

Intensive Culture

Six ponds with concrete dikes were stocked with P_{25} *P. monodon* at 100,000 fry/ha. Results after one month culture period are as follows:

No.	Treatment	Ave. Weight Gain
1	Chemical fertilizer (urea and 16-20-0), aerated by blowers	1.4 g
2	Pellets (aerated)	1.2 g
3	Manure and pellets (aerated)	1.0 g
4	Manure (chicken dung)	0.8 g
5	Initial fertilization (no subsequent fertilization, no feeding), paddle wheels for aeration	1.0 g
6	SEAFDEC pellets (paddle wheel-aerated, same schedule as Treatment 5)	1.7 g

INTEGRATED POLYCULTURE OF SHRIMPS *(P. INDICUS/P. MONODON),* MILFISH AND *TILAPIA NILOTICA* WITH POULTRY IN BRACKISHWATER PONDS

The following stocking densities were used per 1,000 m^2 pond:

	P. indicus	*C. chanos*	*T. nilotica*
1	5,000	200	500
2	5,000	200	1,500
3	5,000	200	1,500
4	5,000	200	2,000

Each pond was provided with 4 m x 8 m poultry house, stocked with 90 heads of broilers. The droppings fell directly into the pond water.

Results after a 120-day culture period showed that treatment 3 gave the highest net production of 93.6 kg/pond, while treatment 1 gave the lowest production of 68.0 kg/pond. Broiler production after 35 to 45 days had an average minimum live weight of 1.2 kg. Gut analysis showed that the chicken droppings were eaten directly by the shrimp, milkfish and tilapia.

Table 7. Mean Growth, Survival and Production of *P. indicus, C. chanos* and *T. nilotica* in 1,000 sq m ponds with poultry droppings over 120-day culture period

P. indicus

Treatment	Initial BW (g)	Final BW (g)	Survival Rate (%)	Net Prod'n (kg)
I	0.007	6.94	66.5	23.01
II	0.007	8.05	69.3	23.38
III	0.007	8.62	46.4	19.15
IV	0.007	7.40	67.7	24.93

C. chanos

Treatment	Initial BW (g)	Final BW (g)	Survival Rate (%)	Net Prod'n (kg)
I	2.56	133.4	56.3	11.33
II	2.56	78.83	79.5	11.74
III	2.56	100.51	40.3	7.51
IV	2.56	94.25	40.3	7.61

T. nilotica

Treatment	Initial BW (g)	Final BW (g)	Survival Rate (%)	Net Prod'n (kg)
1	8.8	118.41	67.1	33.68
II	8.8	81.95	44.1	34.91
III	8.8	91.00	57.6	66.97
IV	8.8	70.16	44.3	44.32

Treatment	TOTAL NET Prod'n (kg /per pond)
1	68.02
II	75.03
III	93.63
IV	76.86

INVESTIGATION OF SOFT-SHELLING AMONG PENAEID SHRIMPS IN GROWOUT PONDS

Experimental evidence showed that an organostannous pesticide which is commonly used in ponds as snail-killer, could induce soft-shelling in 47 to 60% of 10-15 g prawns. Feeding experiments were conducted on soft-shelled prawns in order to find out if soft-shelling could be reversed by dietary manipulations. Frozen mussel meat (3, 8, 14 g per 100g prawn body weight per day) was fed for four weeks. Successful reversal of soft-shelling, general improvement in shell characteristics, good growth and survival rates were observed only in prawns fed with the 14% diet.

ECONOMICS OF PRAWN CULTURE SYTEMS

The extensive monoculture of prawns (*P. monodon* or *P. indicus*) and the extensive polyculture of *P. monodon* and other shrimps with milkfish were found to be profitable. ROI for the extensive monoculture system ranged from 10% to 65% with a payback period of 1.4 years to 8.6 years. For the polyculture systems, ROI is 8% to 85% and payback period is 1.1 years to 10.5 years.

The semi-intensive culture of *P. monodon* or *P. indicus* gave moderate results. This is largely due to higher capital requirements than the extensive systems.

Larval Rearing

IMPROVEMENT IN THE NUTRITIONAL VALUE OF VARIOUS PHYTOPLANKTON SPECIES BY MEDIA ENRICHMENT

Various media used in growing six phytoplankton feeds (*Skeletonema costatum, Chaetoceros calcitrans, Isochrysis galbana, Tetraselmis chuii, Chlorella vulgaris,* and *Chlorella virginica*) gave the following results. Better growth was observed in all cultures grown in F, F/2 and Conway. The agricultural fertilizers, 14-14-14 and a formulation composed of 16-20-0, 21-0-0 and urea, appeared to be poor media especially for *S. costatum.*

Low cell counts were obtained with *T. chuii, C. virginica* and *C. vulgaris* grown in 14-14-14. However, high protein and fat values were observed on *S. costatum* and *C. calcitrans* grown with the agricultural fertilizers, while 14-14-14 resulted in low values for the same nutrients for *T. chuii.*

DEVELOPMENT OF FEEDING TECHNIQUES USING SELECTED NATURAL FOODS IN THE ZOEAL STAGES OF SELECTED EDIBLE CRABS

The suitability of various natural food types on survival and development of the zoeal stages of *Portunus pelagicus* was investigated using *Artemia* nauplii and *Brachionus* as primary rations, and *Tetraselmis* and *Chaetoceros* as algal supplements.

Brachionus, fed alone or in combination with algae, gave the highest survival (average of 67.8%) up to Zoea-4. *Artemia* nauplii, fed alone or in combination with algae, were superior in enhancing development from Z-1 to Z-2 and Z-4 to megalopa. Results suggest that algal supplementation may not be necessary for the promotion of survival and development to megalopa.

EFFECT OF STOCKING DENSITY ON GROWTH AND SURVIVAL OF *P. MONODON* IN NURSERY TANKS

The stocking density of 5,000 postlarvae/ton resulted in the highest survival rate (68.5%) followed by 10,000 postlarvae/ton (56.4%0, and 15,000 postlarvae/ton (33.7%). Weight gain and length were not significantly affected by stocking density.

DEVELOPMENT OF HOLDING AND STUNTING TECHNIQUES FOR *P. MONODON* JUVENILES

The study was conducted in fiberglass tanks provided with aeration and bamboo substrates. Stocking densities used were 3,000, 5,000, 8,000, and 10,000 PL25/ton. The postlarvae were fed alternately with finely chopped trash fish and shelled brown mussel meat adjusted according to the amount of available food in the tanks and corresponding growth of postlarvae.

After four weeks, high survival rates of 74.0% and 61.5% were attained at stocking densities of 3,000 and 5,000/ton, respectively, while low survival was obtained at higher stocking densities of 8,000 and 10,000/ton. Comparable growth ranging from 24-27 mm and 0.08-0.10 g were attained at different stocking densities.

EVALUATION OF MICROENCAPSULATED DIET TO THE LARVAL STATE OF PENAEID PRAWNS/SHRIMPS

The efficiency of the artificial diet (Carrageenan Micro-Binded Diet or CMBD) on *P. monodon* and *P. indicus* larvae indicated results comparable with that of *Artemia* nauplii for mysis to postlarval stages. For the zoea stage, the result was not stable.

ECONOMICS OF AN INTEGRATED PRAWN HATCHERY-FLOATING NURSERY

The study showed that an integrated hatchery-floating nursery project is profitable. The ROI ranges from 29 to 47% while payback period is from 1.8 to 2.6 years.

On the other hand, the ROI for the floating nursery is 23 to 78% with payback period of 1.1 to 3.0 years, while for hatchery, the ROI is 20 to 36% and payback period is 2.3 to 3.7 years.

SOME ASPECTS OF THE BIOLOGY AND REPRODUCTION OF *MACROBRACHIUM NIPPONENSE* (DE HAAN)

Some aspects of the biology and reproduction of *M. nipponense* were studied in the laboratory. Fecundity measured by the number of eggs in the brood pouch ranged from 162 to 3,500 eggs and was shown to become higher with increasing weight and length of the organism. Hatchability rate was estimated at 83.3%. *M. nipponense* rematured in about 29 days at an average water temperature of 25.8°C. The incubation period averaged 13.1 days. Larval development took 28 days to complete and was characterized by eight distinct stages. The results indicate that *M. nipponense* has good potential for aquaculture.

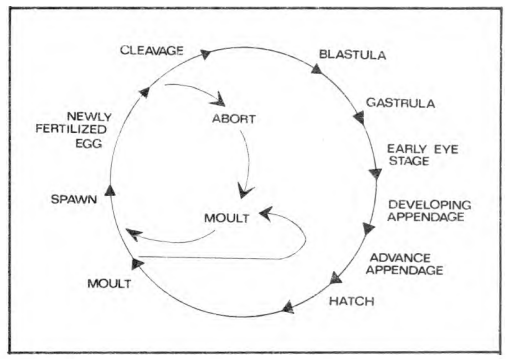


Figure 9.
Spawning cycle of a sexually Mature Female of **M. nipponense.**

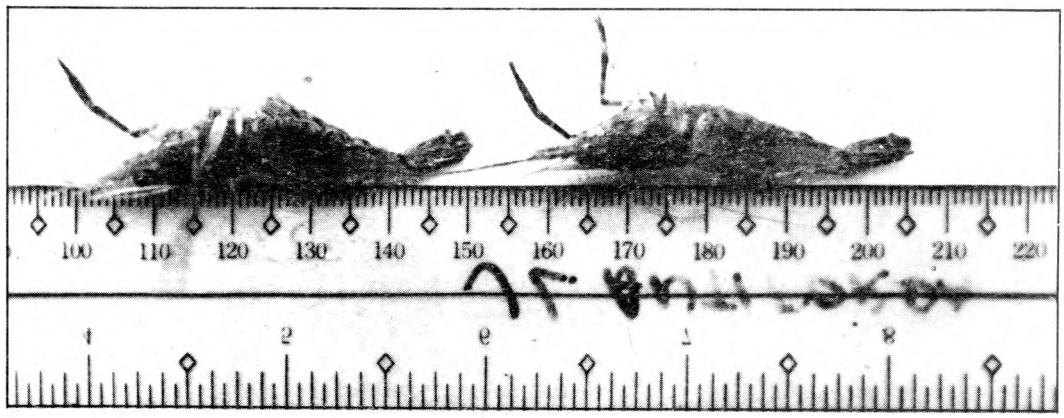


Figure 8.
Berried females of **Macrobrachium nipponense (de Haan)**

CAGE CULTURE OF *P. MONODON* IN LAGUNA LAKE

Acclimated prawn postlarvae were stocked in 5 x 10 x 2 m B-net cages in March 1984 at 250 prawns/cage. Acclimation survival increased from May-July 1984 from 19.7% to 32.4%. No significant results were obtained as the cages were damaged by a strong typhoon.

MOLLUSCS AND SEAWEEDS PROGRAM

Thirteen studies were approved but only ten were conducted. Two were considered low priority while one study could not be started until arrival of necessary equipment acquired from abroad.

Development of Appropriate Technology

DEVELOPMENT OF MASS PRODUCTION TECHNIQUES AND ON-SITE SETTLEMENT OF MUSSELS AND OYSTERS LARVAE

Adult green mussels were induced to spawn and the larvae successfully reared to metamorphosis stage using high-density and low-density stocking methods. The best stocking management and survival was attained with high-density method. This yielded an average of 2.36 million ready-to-settle (5.3% survival) larvae in 20 days. Table 8 shows the results of larval rearing in 750-liter tanks and 3-ton tanks. Experiments are now underway for rearing larvae at higher survival rates.

Larval mortalities in oyster were examined. A series of bioassays were conducted to evaluate each of the primary ingredients of oyster larval cultures. Present routines for producing and handling oyster eggs were found to be suitable without adverse effects. Ten-liter cultures of *Isochrysis galbana* (Tahiti strain) were identified as the single most serious source of contamination in larval culture. Subsequently, a simple routine for producing bacteria-free cultures of *Isochrysis* was developed. Unaerated axenic cultures of *Isochrysis* were maintained in ambient conditions in progressively larger volumes, these were used to inoculate 10-liter production units.

Results of oyster larval rearing indicated best growth at salinities from 17 to 27 ppt. Settlement of larvae on shell collectors was most intense at 22 ppt to 32 ppt, suggesting the corresponding salinity range for rearing oyster larvae. These results indicate the possibility of routine production of small batches of mussel and oyster seeds.

Table 8. Results of Larval Rearing in 750-L Tanks and in 3-Ton Tanks.

	In 750-L Tanks		In 3-Tons Tanks	
Day of Culture	No. of Larvae (Ave. in Millions)	Mean Survival (%)	No. of Larvae (Ave. in Millions)	Mean Survival (%)
0	3.60	–	44.40	–
1	–	–	–	–
2	–	–	–	–
3	2.84	79%	–	–
4	–	–	–	–
5	–	–	–	–
6	2.54	70.5%	–	–
7	–	–	–	–
8	1.72	47.6%	42.80	96.6%
9	–	–	–	–
10	1.45	40.2%	22.08	49.7%
11	–	–	–	–
12	–	–	–	–
13	0.67	18.7%	11.84	26.7%
14	–	–	–	–
15	–	–	–	–
16	–	–	–	–
17	0.11	3%	–	–
18	settlement		–	–
19			–	–
20			2.36	5.3%
21				settlement

PATHOGENIC BACTERIA AUTOCHTHONOUS ON THREE PHYTOPLANKTON USED AS FEED FOR SHRIMPS AND OYSTER LARVAE

The morphological, physiological and biochemical characterization of 26 bacterial strains isolated from growing cultures of *Isochrysis galbana* was completed. A total of 255 characters were coded using a binary system. The isolates were clustered based on overall similarity.

Fifty-two bacterial strains from *Spirulina platensis* were recovered and purified, and 71 characters were studied and catalogued.

Improvement and Refinement of Seed Collection and Spawning of Oysters and Mussels

HANGING METHOD OF FARMING MUSSELS AND OYSTERS

The main objective of the project was to establish a breeding population of *Crassostrea iredalei* transplanted from another area at Gui-gui Creek near LRS. Breeders in culture trays spawned throughout the year with peak periods in March and September. Salinity varied from 17 to 35 ppt while temperature varied from 25.2°C to 32.5°C.

Results also showed an average count of six oyster spats per culture with a maximum number of 32 spats per shell during the months of July and August. Settling-stage oyster larvae were abundant in July.

Depuration, Sanitation and Storage Techniques for Post-Harvest Handling of Oysters and Mussels

DETECTION AND QUANTIFICATION OF PATHOGENIC BACTERIA IN OYSTERS BEFORE AND AFTER DEPURATION

One depuration run was completely studied. Below are the presumptive identification of bacteria before and after depuration:

Bacterial Genus	Number of Isolates Before Depuration	Number of Isolates After Depuration
Salmonella	0	0
Shigella	0	0
Vibrio	5	5
Yersinia	7	1
Pseudomonas	7	8
Staphylococcus	3	9
Streptococcus	15	0

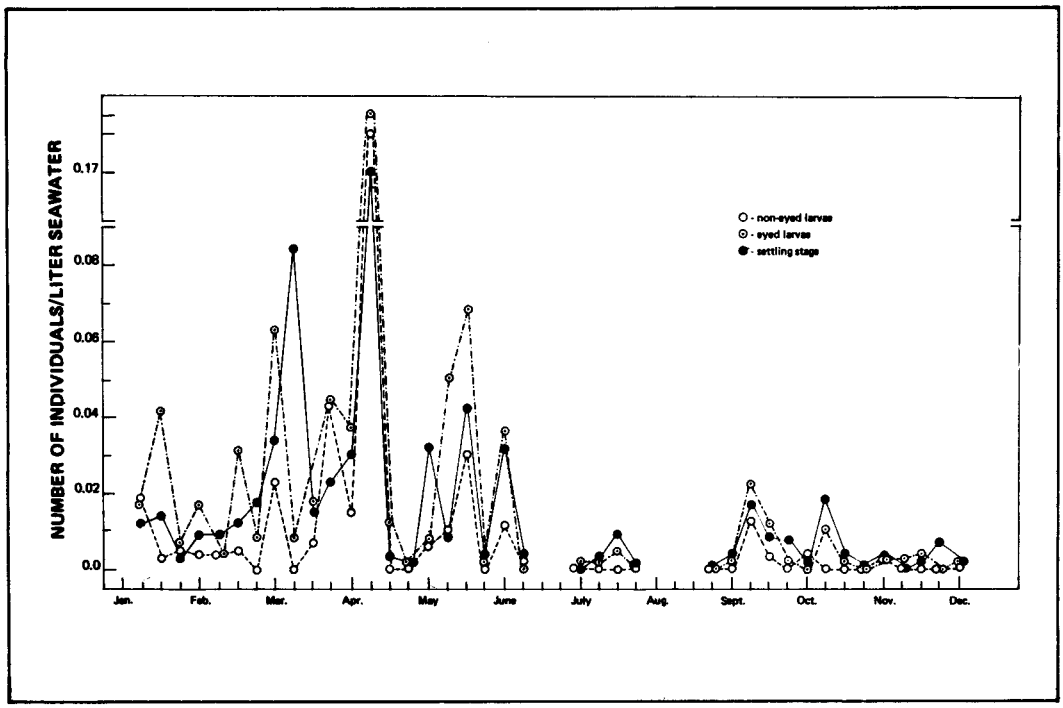


Figure 10.
Relative abundance of three larval stages of slipper-oyster, **Cressosiera iredalei** *at high tide in Gui-gui Creek, Leganes, Iloilo during the period January to December, 1984..*

DEVELOPMENT OF WET STORAGE TECHNIQUES FOR OYSTERS AND MUSSELS READY FOR THE MARKET

Preliminary testing of cold-stored pasteurized (65°C internal temperature for 5 minutes) shucked oysters packed in glass jars or plastic pouches showed good to acceptable quality in both odor and taste after eight days of refrigerated storage.

TESTING THE EFFICIENCY OF VARIOUS DEPURATION TECHNIQUES FOR TROPICAL CONDITIONS

Oysters, *Crasssostrea iredalei,* with initial coliform levels of 2400+MPN/100 g were depurated using UV-treated seawater. Results showed that satisfactory and efficient depuration to acceptable levels was achieved after a 24-hour period. Reduction in total and fecal coliforms at ambient conditions gave successful cleansing results after 24 hours of depuration. This indicates that they could have been within the optimum requirement of the oysters.

Since mortality was most likely triggered by stress, it is recommended that oysters prepared for depuration should be properly handled, should not be exposed to extreme temperature (heat), and should not be taken out of water for an extended period before depuration.

Table 9. Total Coliform (MPN) Reduction in Oysters Depurated After 24, 48 and 72 Hours.

Treatment	Initial Count 0 – H	24 – H	48 – H	72 – H
T_1	2400 +	79	33	13
T_2	2400 +	49	7.8	49
T_3	2400 +	2400 +	17	79
T_4	2400 +	22	23	7.8
T_1	2400 +	130	17	17
T_2	2400 +	540	2400 +	17
T_3	2400 +	120	48	23
T_4	2400 +	79	9.3	23
T_1	1,600	58	2400 +	350
T_2	1,600	110	49	350
T_3	1,600	79	33	27
T_4	1,600	49	79	2400 +
T_1	920	49	23	9.2
T_2	920	26	29	11
T_3	920			
T_4	920			

Acceptable level for total Coliform = 230 MPN/100 gm.

T_1 – 2-7 1/min/300 oysters T_3 – 7.4 1/min/300 oysters

T_2 – 3-7 1/min/600 oyster T_4 – 7-4 1/min/600 oysters

Table 9a. Fecal Coliform (MPN) Reduction in Oysters Depurated After 24, 48 and 72 Hours.

Treatment	Initial Count 0 – R	24 – HR	48 – HR	72 – HR
T_1	220	13	23	13
T_2	220	23	4-5	13
T_3	220	–	–	–
T_4	220	–	–	–
T_1	920	33	23	4-5
T_2	920	26	33	4-5
T_3	920	–	–	–
T_4	920	–	–	–
T_1	2400 +	310	2-0	17
T_2	2400 +	350	31	17
T_3	2400 +	120	27	23
T_4	2400 +	49	6-8	23

Acceptable level of fecal coliform = 50 MPN/100 gm.

MICROBIOLOGY OF SPOILAGE IN COLD-STORED OYSTERS AND MUSSELS

Changes in the microbial load of oysters, *Crassostrea iredalei,* during cold storage were determined. Oysters were stored either as shellstock or as shucked and chlorinated (processed) meat, at room temperature (24°C), chilled (4°C), iced (–4°C or frozen (–25°C for shellstock, –15°C for processed meat) up to the time they began to spoil. Total aerobic plate counts, using standard methods or TGYE agar, for oysters stored at room temperature or chilled and iced increased by 2 or 3 log cycles during storage. Counts for frozen oysters either increased by 1 log cycle (processed) or decreased by 2 log cycles (on shellstock). Molds and yeasts were enumerated using potato dextrose agar. The presence of organisms adverse to public health including total and fecal coliforms, fecal streptococci, *Staphylococcus aureaus, Shigella, Salmonella, Vibrio cholerae* and *V. parahaemolyticus* was also determined. Bacterial typing (up to genus level) of randomly picked colonies was done every four days. Characterization of the bacterial isolates is ongoing. Chemical indicators of spoilage, TVN (total volatile nitrogen) and TMA (trimethylamine) were determined during each sampling.

Development of Farming Techniques for *Placuna Placenta*

SETTLEMENT BEHAVIOR OF *Placuna PLACENTA.*

Placenta adults obtained from Hinigaran, Negros Occidental were induced to spawn using thermo-stimulation by which the larvae were reared to the ready-to-settle stage. Actual settlement of larvae on the bottom mud was not observed but presence of long byssal threads indicates that the larvae undergo a crawling stage involving byssal secretion and attachment before settling in the bottom. This suggests that in nature, *Placuna* larvae attach bysally to any available object after which it detaches and lives on the bottom mud to start adult life.

Special Project

DEMONSTRATION OF OYSTER AND MUSSEL RAFT CULTURE

Twenty-six rafts were set up in Batan Bay and stocked with growing ropes for oysters (*Crassostrea iredalei*) and growing ropes for mussels (*Perna viridis*). Some rafts were stocked with spat collector ropes. Size ranges during stocking were as follows: mussels 6-10 cm long and 11-34 g; oysters 3.3-9. cm long and 2.7-6.2 cm wide. About 250 3 m long collector ropes heavily loaded with mussel spat were collected and transplanted in February 1984. By October, more than 2,000 kg of *P. viridis* and 1,000 kg of *C. iredalei* were harvested. However, the farm was destroyed by typhoon.

Research Management

POLICIES

In order to intensify the monitoring and evaluation of research studies, Technical Evaluation Teams were created.

The Technical Documentation Team was organized to monitor progress and results of ongoing research studies, prepare consolidated research quarterly progress and annual reports, and prepare scientific commodity technical reports.

The External Evaluation Committee for AQD was convened in Tigbauan in July 1984 to evaluate ongoing research and training activities of the Department and determine priority problem areas to be undertaken in 1985.

A number of key officers in the Research Division were designated while some research personnel were transferred to strengthen other stations or units.

PERSONNEL

For the year 1984, the Research Division had a total work force of 409 distributed as follows: 152 at TRS, 107 at LRS, 89 at BRS, 36 at Batan, 21 at Igang, and 4 at Naujan.

Staff Movement

Major designations in the Research Division include: **Rolando R. Platon**, Director of the Research Division, effective 16 February. **Jesus V. Juario**, Head of Tigbauan Research Station, effective 16 February. **Angelito T. Vizcarra**, Head of Leganes Research Station, effective 16 February. **Romeo C. Mesa**, Head of Igang Substation, effective 8 March. **Hermenegildo Sitoy**, Head of Batan Substation concurrent with his appointment as Molluscs and Seaweeds Program Officer, effective 16 February.

Ronaldo P. Ferraris, Program Officer for Finfish effective 16 February, and Radiation Health and Safety Officer effective 20 February, concurrent with his appointment as Physiology Discipline Team Leader. **Arthur Sanchez**, Assistant Program Officer for Finfish effective 1 February. **Flor Apud**, Assistant Program Officer for Crustacean, effective 1 February.

Alcestis Llobrera, Team Leader for Pathology and Microbiology Discipline, effective 1 February. **Emmanuel Cruz**, Team Leader for Nutrition and Feed Development Discipline, effective 15 March and Program Officer of Finfish vice R.P. Ferraris. **Oseni Millamena**, Head of Centralized Analytical Laboratory, effective 1 February.

Vicente Bañada, Officer-in-Charge of the Naujan Substation, effective 1 February. **Fernando Suñaz**, Project Leader of Artemia Project vice N. Jumalon. **Jose A. Llobrera**, IDRC Project Coordinator vice J.V. Juario, and Team Leader Physiology Team vice R.P. Ferraris. **Jonathan Nacario**, Project Leader of Finfish Fry/Fingerling Production vice J.V. Juario.

Josefa Tan, Head of the Microtechnique Laboratory vice C. Marte. **Pastor L. Torres, Jr.**, Coordinator of the National Bangus Breeding Program vice J.V. Juario. **Renato Agbayani**, Acting Head Batan Station vice H. Sitoy. **Rufil E. Cuevas**, Officer-in-Charge of the Tigbauan Research Station, vice J.V. Juario who is on leave.

The following personnel were reassigned from one station/unit to another:

V. Peñaflorida and **I. Borlongan** from the Centralized Analytical Laboratory to the Nutrition and Feed Development Discipline. **Zenaida Suayan** of the Natural Food Discipline at TRS to LRS Chem-Bio Laboratory. **Marlo Tabbu** from the Molluscs and Seaweeds Program at TRS to the Finfish Broodstock Project at Naujan Substation, and **Nilda Tabbu** from LRS to BRS.

Cyrus Regalado from the TED to the Integrated Prawn Production Research Project at LRS. **S.C. Alojipan** from the Molluscs and Seaweeds Program to the Research Management Services (RMS). **V.T. Sulit** from BRS to the Research Management Services at TRS.

S. Solen from Crustacean Broodstock Project to RMS to take charge of fry disposal and research infrastructure and facilities maintenance. **A. Catedrilla** from Igang Substation to TRS, as Administrative Assistant to the Station Head. **Rodolfo Bravo** from TRS *Artemia* Project to LRS *Artemia* Project. **Jesse Banno** from LRS to Naujan Substation.

The following personnel were either reappointed or appointed to various positions in the Division:

Melchor Lijauco as Training Officer for BRS and Technical Assistant for Collaborative Projects. **Espiritu Abuan** as Research Assistant at the Leganes Research Station.

The services of the following experts were availed of:

Dr. Kazutsugu Hirayama, one-month assignment in finfish larval rearing under JICA, in March. **Dr. Mariano de Ramos**, one-year consultancy in biometrics, beginning February. **Mr. Goro Nezaki**, two-year assignment in prawn broodstock development under JICA, beginning 31 March.

Mr. Gunther Vogt, a Ph. D. candidate under Prof. Volker Storch of the University of Heidelberg, for a six-week collaborative work on the effect of different diets and environmental factors on the hepatopancreas of prawns. **Mr. Shiro Hara**, for another year assignment in fish culture under JICA, beginning June. **Dr. Gerald Schroeder**, one-month collaborative work on tracing food webs in ponds, beginning June 28.

Dr. Hiroshi Kohno, one-month work on larval development of fishes under JICA, in July. **Dr. Akio Kanazawa**, one-month assignment in nutrition and feed development under JICA in August. **Mr. Michael Yunker**, one-month collaborative work on *P. monodon* larval rearing using microencapsulated feeds versus standard techniques. **Dr. Ken Roger Uwate**, as Researcher assigned with the Aquaculture Economics Unit for 6 months.

Staff Development

R. Ferraris attended the Sixth Session of the Indo-Pacific Fisheries Council Working Party of Experts in Aquaculture in India on January 19-25. While in India, he also attended the Joint Workshop on the Role of Stocking and Introduction on the Improvement of Production in Lakes and Reservoirs (January 23-25) and the Second Session of the IPFC Working Party on Inland Fisheries (January 23-27).

L. Tiro Jr. of the LRS underwent at one-month training on grouper breeder selection, seed production and larval rearing at the Thailand Satul Fisheries in January.

M. de la Cruz of TRS Microtechnique Laboratory was awarded a two-year Monbusho Scholarship grant for an M.S. in Nutrition Pathology minor in Aquaculture Biology at Hiroshima University.

M. Dimaano of LRS successfully defended his masteral thesis for an M.S. in Aquaculture degree at the Univeristy of the Philippines in the Visayas.

D. Gerochi, LRS, and **P. Valera** and **R. Lacierda**, BRS, completed the one-year Training Course for Senior Aquaculturists.

G. Quinitio, TRS, was awarded a two-year Monbusho scholarship grant for Ph.D. in Aquaculture major in Fish Physiology at Kochi University, Japan, beginning April.

D. Reyes, Jr. and **Manuel Laron** undertook a four-month training on integrated fish farming at the NACA-Regional Lead Centre in China, Wuxi, China from April 13 to August 19.

R. Pudadera returned in May from a five-month training on aquaculture in France, where she studied the influence of hormone, temperature and photoperiod on the maturation of various shrimp species, under the sponsorship of the French Government.

J. Antiporda, BRS, successfully defended her masteral thesis for M.S. in Zoology at the University of the Philippines, Diliman, Quezon City.

B. Acosta, BRS,defended her masteral thesis for an M.S. in Fisheries degree major in Aquaculture at UP in the Visayas.

J. Primavera and **E. Reyes** were invited as visiting experts by the Government of Cuba for two weeks in May.

C. Marte left for Singapore to attend to the final stages of her doctoral work. She also went to France to confer with Dr. Breton on gonadotropin assay developed by Breton.

C. Villegas attended a four-month genetics course in Nova Scotia, Canada in May-September.

R. Ferraris, J. Llobrera, J. Pantastico and **E. Gapit** attended the management enhancement course for Project Leaders of IDRC-assisted projects in the Philippines at the UP Los Baños on May 11-June 9.

K. Corre of LRS, **R. Mesa** of Igang Substation, and **N. Tabbu** of BRS attended a one-month Fisheries Economics Course at the Universiti Pertanian Malaysia on May 14-June 15.

E.M. Cruz attended the International Conference on Confined Animal Production Systems in Beijing, China, 4-13 June 1984. He read a paper entitled "Fish Production in Ponds Fertilized with Fresh Animal Manure in the Philippines."

L. Ver of the TRS Molluscs and Seaweed Program undertook a four-month training course in algae culture at Ariake Fisheries Station, Sega Prefecture beginning September.

V. Travina of TRS Aquaculture Engineering Discipline underwent a six-month training course at the Institution of Aqua-Engineering of the Ministry of Fisheries in Tokyo beginning September.

C. Dueñas underwent a four-month training course on radio immuno-assay techniques and sperm cryo-preservation in Canada, beginning August.

D. Baliao and **T. Bagarinao** served as consultants for the Sri Lankan Government for one month beginning August 30. Mr. Baliao was responsible for nursery and grow-out brackishwater pond culture, Ms. Bagarinao handled fry collection, transport and survey.

F. Pascual attended the International Symposium on Feeding and Nutrition in Aberdeen, Scotland on 10-13 July. She presented a paper entitled "Energy-protein requirement of *Chanos chanos* fingerlings."

C. Baticados presented a paper entitled "Histopathology of microsporidian infection in white prawn, *Penaeus merguiensis* de Man 1888" during the International Seminar on Fish Pathology of Fisheries, Tokyo. She also read the paper by R. Duremdez and G. Po entitled "Studies on the causative organisms of *Sarotherodon niloticus* (Linn) fry mortalities. 2. Identification and characterization of the physiological properties of *Pseudomonas flourescens.*"

R. Gacutan, A. Llobrera and **R. Platon** attended the Shellfish Toxicity (Red Tide) Workshop in Singapore on 11-14 September 1984. They presented two papers entitled "Detoxification of *Pyrodinium*-generated paralytic shellfish poisoning toxin in Perna viridis from Western Samar Philippines" and "Paralytic shellfish poisoning due to *Purodinium bahamense* var *compressa* in Mati, Davao Oriental, Philippines."

R. Romana was awarded a one-year scholarship for a master's degree in Genetics at Swansea University, U.K. beginning September.

A. Castillo, E. Rodriguez and **M. Parazo** were awarded two-year Monbusho scholarships for the masters degree program in Japan, beginning October.

C. Casalmir and **C. Alojipan** undertook a one-month training in HP 3000 mini computer, beginning July 11.

C. Casalmir continued the HP 3000 Comprehensive Program Training Course to include Systems Operation and Systems Management from July 30 to August 17.

E. Aldon and **N. Tibubos** of the Research Management Services attended the Familiarization Course on AQUIS Projected on 22-24 October sponsored by TED.

Sixty-six research stafff attended the First International Conference on the Culture of Penaeid Prawns/Shrimps held in Iloilo on 4-7 December, either as presentor-participants or observers.

INFRA-STRUCTURE DEVELOPMENT AND OTHER FACILITIES

Leganes Research Station

The Department has leased 9.4 hectares of municipal ponds reserved by the Municipality of Leganes, bringing the total LRS pond system area to 85.4 hectares. Major pond works in LRS were completed and pump repairs and maintenance were undertaken.

An Apple IIe micro-computer system was installed at LRS. The computer is being used for storage/retrieval of information on research operations and development of customized programs for statistical methods of analysis and research data testing, evaluation and application.

Binangonan Research Station

The development of the BRS pond system is ongoing. Phase I involves 3.2 ha of experimental and demonstration ponds, and Phase II covers 5.7 has. These ponds will complement the present land- and lake-based facilities of the station at Tapao Point.

The Training and Extension Building and the Trainees' Dormitory were completed in July. The Training and Extension building includes staff offices, an audiovisual/conference room, lecture rooms and laboratories. The dormitory has 10 rooms and related facilities.

Igang Substation

The following facilities were constructed and completed in 1984:

- Aqua Lab Building – to house the finfish hatchery complex.
- Guest House – Station Head's quarters.
- Research Quarters – for eight resident researchers.
- Administrative and Research Office.

In addition, the following facilities were developed in 1984:

- A 1.5 ha fishpond for grow-out of milkfish and prawns for broodstock and genetic studies.
- A freshwater system.
- Power system using two generators, 55 KVA and 5 KVA.
- Suction facilities for the hatchery.

Batan Substation

The facilities in Batan Substation needed total reconstruction after these were destroyed by a powerful typhoon in November.

Naujan Substation

A resident of sitio Buloc-Buloc, Naujan donated a parcel of land of about 1,846 sq m to AQD for the expansion of the Naujan Substation site. The construction of various facilities was continued.

RESEARCH EQUIPMENT

Through technical assistance, mainly from the Government of Japan, the following equipment for AQD research purposes were acquired in 1984:

- Chloridometer
- Spectrophotometer
- Thermo Electric Cuvette Temp. Controller
- Amino Acid Analyzer
- Coulter Counter
- Gas Chromatograph

Research Support Units

CENTRALIZED ANALYTICAL LABORATORY

The CAL, located at TRS, continued to lend support to the research activities of the AQD by providing researchers with analytical services on water, feed and feed ingredients. During the year, a total of 4,236 samples were analyzed, of which 84.1% were water samples and 15.9% were either feed or feed ingredients. The overall sample distribution according to research program was: Crustacean, 59.6%; Finfish, 32.2%; Molluscs and Seaweeds, 3.0%; others, 5.2%.

For faster and more precise analyses of feed samples, two major semi-automated equipment were installed and made operational in the early part of the year.

In feed analysis, the CAL extended its analytical services to serve the needs of the private sector.

The integration of the Scientific Supply House (SSH) with the CAL has added to its functions materials management, programming of stock procurement and issuance of stocks for the various stations, substations or research units of the Department.

MICRO-TECHNIQUE SERVICE LABORATORY

During the year 1,291 samples from different specimens were submitted for slide preparation. Some 3,826 slides were prepared for the histological and histrochemical analyses. The cryostat which is used in the lipid analysis of *P. monodon* ovaries is also being made operational. This will allow researchers to do lipid and enzyme histochemistry studies.

LABORATORY EQUIPMENT MAINTENANCE UNIT

To provide efficient maintenance services for all AQD laboratory instruments, the LEMU designed and implemented periodic adjustment, calibration and verification of machines and instruments as to accuracy and consistency. A preventive maintenance program is also being done on all equipment and instruments of the various stations and substations of the Department.

COMPUTER AND STATISTICAL SERVICES

Statistical Analyses

Making use of the IBM computer of the Agricultural Resource Center at UP Los Baños and the Apple IIe Microcomputer at the Leganes Research Station, the unit did 105 computer runs. These included analysis of means and frequency, analysis of variance, analysis of covariance, regression and correlation, probit, cluster analysis, and response surface analysis.

The Unit also provided assistance in the experimental design requirements of the researchers and in the analysis and interpretation of research results.

Computer Software Development

The Unit developed a program for accounting, payroll and statistical analyses for Apple IIe microcomputer. In addition, software for data base information and retrieval systems for research data for the HP3000 mini-computer is being developed.

An intermediate-range plan is the total computerization of all operations using the Apple IIe microcomputer and the HP3000 minicomputer.

Research Coding System

Coding systems for research studies were established in coordination with the RMS to facilitate rapid and accurate retrieval of data, to monitor status of ongoing studies, and to evaluate the performance of research staff.

Coding of research studies started with those conducted in 1974. The studies are classified according to program/area or phase of development/discipline/year started and location.

CENTRAL CHEMISTRY LABORATORY OF BRS

The CCL is the service arm of the research activities at BRS for water, soil and feed analysis. In 1984, 4,178 samples were received and 9,305 analyses were performed.

CHEM-BIO LABORATORY OF LRS

The main functions of the CBL includes monitoring of the total hardness and chloride content of the water from the GUA-an Freshwater Station which supplies fresh water to LRS. The CBL also analyzes soil and water samples from the LRS ponds and those submitted for analysis by the private sector. Fertilizers and feeds also undergo thorough investigation before these are utilized in the ponds. A daily routine is the analysis of physico-chemical and biological properties of Guigui Creek, main source of water for the LRS ponds.

In 1984, 11,895 water samples, 684 soil, 6 fertilizer and 7 feed samples were analyzed.

RESEARCH MANAGEMENT SERVICES

Fry Disposal

Fry of *P. monodon*, *P. indicus*, siganids and seabass which were not used for research purposes were dispersed to the private sector. As of December 1984, 768,000 *P. monodon*, *267,500 P. indicus*, 312,400 seabass, and 110,000 siganid fry were disposed of.

Museum

Forty-five species of penaeid prawns, representing 9 genera in 3 families collected from 1975 to 1980, were identified and catalogued. The catalog number has reached 453 specimens.

Two hundred fifteen species of fishes in 87 families collected from 1976 to 1984 were also identified. The catalog number is now 1,475 specimens.

Documentation

Recording and coding of research studies and results from 1974 to 1984 were completed in December 1984, while indexing is now 90% complete. Retrieval of research data was started. Research reports in 1984 were compiled, abstracted and bound into quarterly, semi-annual and annual reports.

Research Budget Allocation

The Unit is responsible for planning and allocating research budget to the various stations, substations, projects, and studies. Expenditures for research purposes are monitored. The Unit facilitates the maintenance and repair of research infrastructure. It provides clerical services to the research staff of TRS.

Research Seminars

Date	Title	Speaker
January 14	Taxonomic work on British marine and brackishwater algae	I. Tuburan
February 23	Artificial breeding of milkfish	J. Juario
February 28	The culture of grass carp for weed control in ponds	Johannes Van Zon
March 7 & 8	Grouper seed production: Thailand experience	L. Tiro, Jr.
March 20	Computer appreciation	C. Casalmir

March 28	The effect of growth phases of *Tetraselmis tetrahele* (Butcher) on the early feeding stages of development of *Penaeus monodon* Fabricius	M. de la Peña
April 5	Biology of the rotifer, *Brachionus plicatilis* as a food of fish larvae	K. Hirayama
April 6	a) Present status of mass production of the rotifer in Japan	K. Hirayama
April 18	b) Modern hatchery system in Japan	
April 18	Water control by filtration in closed culture systems	K. Hirayama
May 7	Penaeid culture of CNEXO-COB France	Hantal Cahu
May 10	The effects of stocking densities on the the growth, survival and production, of seabass *(lates calcarifer* Bloch) impounded in brackishwater ponds	M. Dimaano
May 16	Seed production of marine fish in Thailand	P. Kungvankij
May 17	NACA experience	D. Gerochi
June 7	Shrimp maturation development in France	R. Pudadera
June 13	Ultrastructure studies of hepatopancreas and its applications in aquaculture research	Gunther Vogt
June 21	Biological components of brackishwater	Z. Suayan
July 3	Tracing food webs in acquaculture: a new method	Dr. G. Schroeder
July 9	Integrated animal-fish farming	Dr. G. Schroeder
July 12	Manuring warm-waterponds	Dr. G. Schroder
July 17	Observations on shrimp culture and travelogue in Cuba, Panama, Japan, and Ecuador	J. Primavera and E. Reyes
July 27	Guidelines in presenting results in statistical analyses	M.B. de Ramos
August 3	Fish production in ponds fertilized with fresh manure in the Philippines	E.M. Cruz
August 9	Shrimp culture iin Ecuador	Jose Salvador John Gumbs
August 10	Aspect of the early life history of Seabass, *Lates calcarifer*	T. Bagarinao
August 15	The natural history of the Galapagos Islands, Ecuador	Jose Salvador
August 22	Training in aquaculture economics: Malaysian experience	R. Mesa/K. Corre

August 29	Lipid metabolism in fish	Dr. A. Kanazawa
September 12	Pathogenicity of a bacterial isolate from the eyes of juvenile milkfish exhibiting varying degrees of opacity	C.L. Pitogo
September 19	The energy-protein requirement of *Chanos chanos* fingerlings: Aberdeen experience]	Dr. F.Pascual
September 20	Prawn broodstock development and gonadal maturation	B. Pudadera, Jr.
October 1	Crustacean seed production	L. Tiro, Jr.
October 3	Comparative economics of different aquaculture production systems	N. Franco and D. Israel
October 11	Finfish Program at AQD	R. Ferraris
October 11	Artemia production	D. Estenor
October 17	Chemistry of submerged soils	L. Briones
October 30	Milkfish spawning and rematuration	D. Baliao
	Semi-intensive culture of milkfish in ponds	
October 31	Aspects of feeding behavior correlated with growth rate in *O. mossambicus*: possibilities of indirect selection	C. Villegas
November 12	Carbohydrate requirements of *P. monodon* Fabricius juveniles	V. Alava and F. Pascual
November 14	Osmotic, total protein and chloride regulation in *P. monodon*	R. Ferraris, F. Estepa, J. Ladja and E. de Jesus
November 14	Effect of temperature and salinity on the hatching of eggs and larval development of sugpo.	E. Reyes
November 14	Influence of temperature and salinity on oxygen consumption of *p. monodon* postlarvae	S. Licop
November 14	Response of *P. monodon* juveniles to varying protein/energy ratios in test diets	M. Bautista
November 14	Earthworm, marine annelids and squid as feed ingredients in formulated diets for juvenile *P. monodon*	F. Pascual
November 15	Effect of vitamins on the growth of *P. monodon* juveniles	M. Catacutan, and A. Kanazawa
November 19	Variation in tissue lipid content and fatty acid composition during ovarian maturation of unablated and ablated *P. monodon* Fabricius	O. Millamena, R. Pudadera, and M. Catacutan

November 19	Effects of diet on reproductive performance of ablated *P monodon* broodstock	O. Millamena, R. Pudadera, and M. Catacutan
November 22	Nutritional value of marine yeast fed to the larvae of *P. monodon* in combination with algae	E. Aujero, E. Tech, and S. Javellana
November 22	Floating cage: an alternative nursery system for *P. monodon* postlarvae	D. de la Peña and A. Young
November 22	Evaluation of microencapsulated diet during the larval stage of penaeid prawns	Y. Yashiro
November 26	*Ruppia maritima* L. and *Najas graminea* Del. as natural foods for *P. monodon* juveniles	J. Primavera and R Gacutan
November 26	The tolerance of *P. monodon* eggs and larvae to fungicides against *Lagenidium* sp. and *Haliphthoros* sp.	G. Po and E. Sanvictores
November 26	Survival, growth and production of white shrimp *P. indicus* in brackishwater ponds	F. Apud, D. Javellana and R. Jomes
November 28	Finfish fry/fingerling production	L. Tiro, jr.
November 29	Lecithin requirements of *P. monodon* juveniles	F. Pascual
December 12	Effects of dietary fatty acids on the fatty acid composition of *P. monodon* juveniles	M. Catacutan and A. Kanazawa
December 19	Chanos and Sri Lanka	T. Bagarinao

Harvest From Conduct of Research

Incidental products from several research studies conducted at the different AQD Stations and substations during the year are as follows:

Perna viridis	3,279 kg	*M. ensis* (marketable)	135 kg.
Crassostrea iredalei	1,417 kg	Mudcrab (marketable size)	280.4 kg
Penaeus monodon (marketable size)	1,329.7 kg	Milkfish (marketable size)	7,674.5 kg.
P. monodon (broodstock)	274.8 kg	Milkfish fingerlings	28,100 pcs.
P. monodon (spent spawners)	181.0 kg	Tilapia (marketable)	368.6 kg.
P. monodon (postlarvae)	6,811,000 pcs.	Seabass (fry)	566,300 pcs
P. monodon (juveniles)	421,235 pcs.	Seabass (marketable size)	420 kg.
P. indicus (marketable size)	1,335.3 kg.	*Siganus* sp., (juveniles)	76,363 pcs.
P. indicus (postlarvae)	1,646,690 pcs.	Artemia (biomass)	39.8 kg
P. indicus (spent spawners)	6.5 kg.	Chicken, dressed	2,264 kg.
Metapenaeus ensis (fry)	150,000 pcs.	Salt	26 sacks

Research Coding System

A 13-digit coding system for research studies was developed for all studies undertaken at the Department's various stations and substations from 1974 to the present. The studies are classified according to program/area or phase of development/discipline/year started and location.

Legend: X X X X X X X - X X X X X X
1 2 3 4 5 6 7 8 9 10 11 12 13

1 2 3 – program
4 5 – Area/Phase
6 7 – Discipline
8 9 – Year started
10 11 12 – Study Control Number
13 – Location/Cost Center

Discipline

AE	Aquaculture Engineering	MI	Microbiology
CH	Chemistry	NF	Natural Food
CU	Culture	NU	Nutrition
EC	Economics	PA	Pathology
EL	Ecology/Limnology	PH	physiology
GE	Genetics	OT	Others

Program

FINFISH		CRUSTACEAN	
FOO	Finfishes (General)	COO	Prawns (General)
FO1	Milkfish	CO1	*Penaeus monodon*
FO2	Tilapia	CO2	*Penaeus indicus*
FO3	Carp	CO3	*Metapenaus ensis*
FO4	Sea Bass/Sea Perch	CO4	Other Penaeids
FO5	Mullet	CO5	*Scylla serrata*
FO6	Siganids/Rabbit Fish	CO6	Other Crab Species
FO7	Grouper	CO7	*Macrobrachium*
		CO8	*Artemia Salina*
		CO9	Crustaceans (General)

MOLLUSCS/SEAWEEDS		OTHERS	
MOO	Molluscs (General)	GOO	Crustacean/ Finfish
MO1	Mussels	HOO	Crustacean/ Finfish/Molluscs
MO2	Oysters	YO1	Others
MO3	Other Bivalves		
SEW	Seaweeds		

Area/Phase of Developments

A1 Broodstock Development
A2 Seed Production
A3 Culture in Pond/Cage/Pen/Tank/etc.
A-4 Post-harvest Handling/Processing
A5 Others

Location/Cost Center:

T – Tigbauan	A – Batan
L – Leganes	I – Igang
B – Binangonan	N – Naujan

Example: F01A1PH-83G62T – Gonadal maturation through environmental manipulation

F01 – Milkfish
A1 – Broodstock
PH – Physiology
83 – Started 1983
G62 - Study Control No. G62
T – Tigbauan

TRAINING AND EXTENSION

1984 saw advancements in the conduct of the Aquaculture Department's training and extension activities. The programs were firmed up and efforts were intensified for more extensive technology diffusion to meet increasing demands of the private sector and government production campaigns.

The most significant events of the year were the approval by the International Development Research Centre (IDRC) of the Brackishwater Aquaculture Information System (BRAIS) Project and its implementation at the Department's Tigbauan station; and the steps taken to increase the effectiveness of the training program through improved curricula, training materials, and methods.

Some 990 participants from the Philippines and other countries availed of the training courses and extension services conducted by the Department. They participated in 10 short-term and 1 long-term training courses, 11 in-situ seminars and symposia, special individual training, student practicum, and consultative meetings.

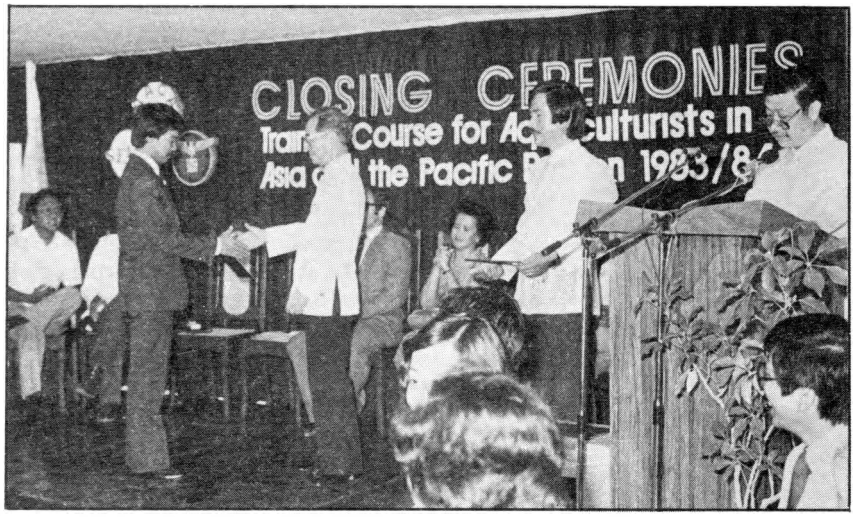
The Department continued to undertake verification projects on selected technologies. Four field-testing projects were completed this year; three were done in cooperators' farms in Panay and Negros while one was conducted at the Leganes Research Station. Joint projects of the Bureau of Fisheries and Aquatic Resources and the Department also continued to be undertaken on such aquatic commodities as prawn, white shrimp, milkfish, seabass, and tilapia. The extension services conducted here and abroad by AQD research and extension staff benefited numerous recipients. The Department continued to reply to inquiries and accommodate requests from various individuals and groups regarding different aspects in aquaculture.

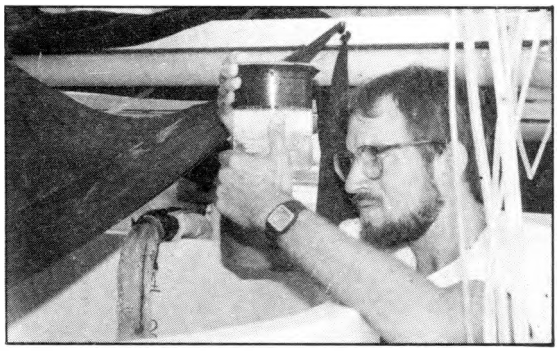
The Technology Assessment Section was created this year to undertake studies on the impact of technologies generated and disseminated so far by the Department. A TED Publications Review Committee was organized to facilitate the classification and review of training and extension publications. In 1984, 1 extension manual, 1 extension leaflet, several posters, and 4 training and extension handbooks were completed. A new series of AQD publication, *Aquaculture Technology Series,* was launched. Its first issue was on "Tilapia Cage Farming in Lakes."

The Library has strengthened its Department-wide library system. BRAIS became operational this year. Additional staff and equipment were acquired to support its information services. The AQUIS Project, another information dissemination activity, was integrated with BRAIS.

More instructional support materials were produced by the Audio-Visual Production Unit. Video tapes on various aquaculture topics were made available to other agencies, institutions and individuals.

The Department, has further strengthened its linkage with FAO/UNDP specifically in support of the training course for senior aquaculturists, IDRC and the Government of Japan for funding international training courses, and the West Visayas State College for maintaining the elementary laboratory school at the Tigbauan Research Station.





Training

Ten short-term training courses (six national and four international) and one long-term training course (the fourth NACA-SEAFDEC-UPV Training for Senior Aquaculturists in Asia and the Pacific Region) were conducted in 1984. In support of the Information Dissemination Program of the Department, the training staff conducted a special training fro BFAR extension workers held at the Tigbauan station and three aquaculture seminars held in Metro Manila.

Improvements were made on the conduct of short-term training courses particularly in the curricula, training materials, and instructional methods. New topics on other finfish species were introduced and new subjects incorporated. Some instructional support materials were developed in the form of training handbooks and audio-visual aids such as video tapes, video clips, slides and transparencies.

Group dynamic sessions were introduced and conducted at the start of each training course to promote better rapport between trainors and trainees. A thorough evaluation of the curriculum and training activities was done after each session.

AQUACULTURE PROJECT DEVELOPMENT AND MANAGEMENT (APDEM VII)

The seventh session of the Aquabusiness Project Development and Management Seminar-Workshop was held from 8 to 28 February at the Tigbauan main station. Twenty-five participants including two observers from the Department registered for the training program.

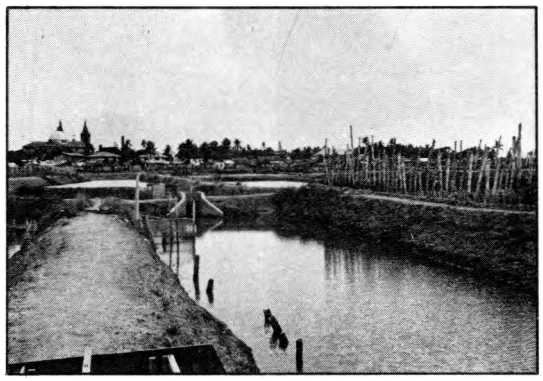
Three foreign participants – one each from Malaysia, Holland and the U.S.A. joined the course. Fifteen were businessmen and middle-to-senior level executives, 2 were school administrators, 2 were fishfarm managers, one was a senior fishery biologist, one was the head of his government's extension service, and another was a senior aquaculturist and hatchery manager of a consultancy firm.

HATCHERY AND CAGE CULTURE OF TILAPIA

The first session (national level) of the training course on Hatchery and Cage Culture of Tilapia was held from 4 to 30 April at the Binangonan Research Station (BRS). Eight participants including one aquaculture research officer from Bahrain, Middle East, participated in this program.

The second session (international) was conducted from 3 Sept. to 2 Oct. also at BRS. Six trainees from Malaysia, Thailand and the Philippines participated and gained technical skills in seed production and cage culture of tilapia in freshwater.

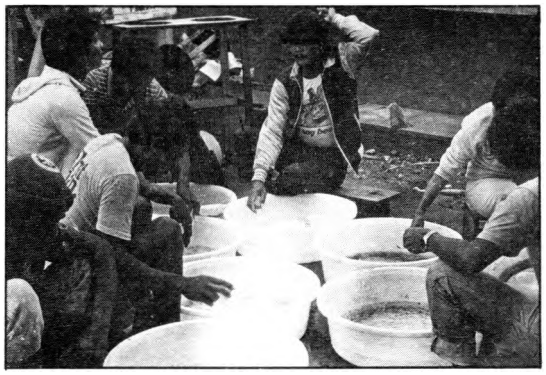
BRACKISH—WATER POND CULTURE



Twenty-four participants from six regions of the country and one foreigner completed the first session of this technician-level training course. The foreign participant was Abdulredha J. Shams from Bahrain in the Middle East. Lecture and practical work were conducted from 9 May to 15 June at the Tigbauan (TRS) and Leganes Research Stations (LRS).

The second session was held from 19 Sept. to 30 Oct. mainly at LRS with fifteen participants coming from five countries, namely, 3 from Thailand, 3 from Malaysia, one each from Burma and Sri Lanka, and 7 from the Philippines.

SMALL-SCALE PRAWN HATCHERY AND NURSERY OPERATIONS



Two sessions of the course on prawn seed production and nursery culture were conducted simultaneously from 4 July to 6 Sept. One session was held for 24 local participants while another was conducted for 15 trainees from eight countries which included 3 each from Ecuador, Thailand, and the Philippines, 2 from Malaysia, and one each from Bahrain, Brazil, Burma and India.

The third session was held from 17 Sept. to 16 Nov. for applicants who were not accommodated in the first two sessions. Of the thirteen participants 1 was from Cuba, 1 from Panama and the rest from the Philippines. Five were from BFAR who are at present detailed to the Asian Development Bank-assisted project on aquaculture development. Introduction to basic hatchery work was held during the first two weeks at TRS while actual work on larval rearing, floating nursery operation, and other laboratory activities were conducted at the Batan Substation.

DEPURATION AND SANITATION TECHNIQUES FOR MUSSELS AND OYSTERS

The first of its kind to be conducted by the Department, the training course was offered to 12 government and private agencies and institutions presently catering to the needs of the mussel and oyster industry in the country. Seven participants attended the course from 17 to 30 Oct. at Tigbauan main station. Five of these participants came from BFAR and one each from the University of the Philippines in the Visayas and Mariano Marcos State University.

Objectives of the course include the acquisition of skills in post-harvest handling processing of oysters and mussels particularly for long-distance transport and long-term storage, and curent market practices. Relevant topics such as red tides and paralytic shellfish poisoning and their associated phenomena were taken up.

ARTIFICIAL PROPAGATION OF CARP

An intensive one-week training course on artificial propagation of carp was conducted from 9 to 15 Oct. at the Binangonan Research Station. This was actually a dry-run of one of the short "how-to" courses slated to be conducted in 1985. Emphasis of the course was on the techniques of artificial propagation, hatchery systems, genetics and carp culture practices.

The course was conducted mainly for government personnel. Participants included 2 from Farm Systems Development Corporation (FSDC), one from Laguna Lake Development Authority (LLDA), 3 from the Ministry of Human Settlements, 3 instructors from fishery schools, and 1 fishpen operator.

PRAWN DEVELOPMENT TRAINING FOR BFAR PERSONNEL

The last phase of the special training course on prawn development operations which started in July 1983 was completed in May 1984. The course was offered in answer to the request of BFAR and as a part of AQD's commitment to train the fishery bureau's technicians and extension specialists.

The first phase of the course included lecture sessions and practical work at the Tigbauan, Leganes and Batan stations while the second phase of the training was conducted in three BFAR demonstration and training centers where actual grow-out operations of prawns (*Penaeus monodon*) were carried out. Twenty-seven participated in the program.

The training activites included pond preparation, handling and stocking of prawn fry, monitoring of physico-chemical parameters, stock sampling, water management, feeds and feeding, and post-harvest handling. The participants were supervised and evaluated by the BFAR training centers' project managers and the training staff of SEAFDEC AQD.

STUDENT PRACTICUM

Fifteen graduating students from various fisheries schools in Iloilo, Cebu and Mindanao underwent off-campus practical training from January to March under different research projects at the Tigbauan main station.

For summer off-campus practicum, 55 graduating students in fisheries and other related courses from universities and colleges in Manila, La Union, Iloilo, Antique, Cebu and Mindanao, participated in various research projects at the three main stations. Of this number, 10 students from the Don Mariano Marcos Memorial State University in La Union participated in carp spawning and fingerling production, tilapia hatchery, broodstock selection and development, nutrition and feeding, and ecological studies at Binangonan station. In addition, 16 graduating students in Inland Fisheries from the Malolos Marine Fishery School and Laboratory trained at Binangonan Research Station from 12 Nov. to 18 Dec. Each spent 320 hours doing different research-related tasks.

SPECIAL INDIVIDUAL TRAINING

Twenty-five local and 6 foreign private individuals and government employees availed of various short-term special training on selected areas.

The foreign participants included an aquaculture officer from Cuba, Angel Raul Leon Perez, who completed a 3-month special training in tilapia cage culture at BRS under a FAO/UNDP-SEAFDEC collaborative training program; Aung Kyi, a UNESCO fellow and Senior Demonstrator in marine biology from Burma, who trained in plankton culture, natural food production, and in various laboratory techniques; two from Tel Aviv, Harel Moti and Michael Frumkin, who did practical training in prawn hatchery operations at Batan substation; and an aquaculture research officer from Bahrain, Abdulredha J. Shams, who observed feed analysis, seed production of siganid and various laboratory practices.

Six other foreign trainees took special training in specific aquaculture areas at different schedules and venues this year: Atshushi Ishikawa and Yasuhiro Nakayama of Japan in prawn hatchery and nursery operations; three trainees from Ecuador, namely, John Gumbs, Jose Salvador and Carlos Prieto, who earlier attended the international training course on prawn hatchery and nursery operations, on various laboratory activities at TRS; and Lui Kwong Yu of Hong Kong for a special training in finfish culture under TRS researcher Shiro Hara.

POST-TRAINING SURVEY OF SEAFDEC AQD TRAINING PARTICIPANTS

A follow-up study on the performance of the former participants to various training courses conducted by the Department has been undertaken, for the first time, starting the last quarter period this year. This post-training survey aims to gauge the relevance and effectivity of the training program of the Department in the development of the aquaculture industry. The survey would also determine the work performance of the training participants and assess the utilization and applicability of the knowledge and skills they gained from the training and the problems they encounter in the field. Information from the survey will serve as a basis for reviewing, planning and implementing improved research, training and extension programs.

Respondents include those who have attended not less than 120 hours of any training course conducted from 1978 to 1983. They include 298 local trainees and 239 international participants from 30 countries.

Technology Verification and Extension

In the middle of 1984, a more coordinated technology transfer program was launched. This is the National Aquaculture Technology Transfer Program of the Department which is envisioned to harness technologies generated by research and extension specialists and facilitate their diffusion to various end-users.

The program will be anchored on three activities, namely, technology verification, technology packaging, and technology dissemination through extension work and information dissemination. AQD's main cooperators in these activities are the national network of regional offices and demonstration training centers of the Bureau of Fisheries and Aquatic Resources, the schools and colleges of fisheries of the Ministry of Education, Culture and Sports, and the Philippine Federation of Aquaculturists, Inc. as well as local fishfarmers' associations.

TECHNOLOGY VERIFICATION

Four technology verification projects (TVP) were completed this year. Three were done in cooperators' farms in Panay and Negros and one at Leganes Research Station (LRS). In addition, a joint project with BFAR involving several technology verification projects was continued.

Crab-Milkfish Polyculture

This was conducted in Dumangas, Iloilo. Polyculture of mudcrab with milkfish was carried out at the rate of 5,000 crab juveniles and 2,000 milkfish fingerlings/ha with supplementary feeding. The production obtained after a 6-month culture period of mudcrab and milkfish were 562 kg and 380 kg while the survival rate was 60% and 100%, respectively. The return on operating cost was 78%.

Viable results of the crab-milkfish polyculture technology verified in the private pond were demonstrated at the Leganes station from March 13 to September 17. A one-hectare pond was stocked in April with 5,000 pieces of crab juveniles each with an initial average weight of 40 g and 2,000 milkfish juveniles in May each with an initial average weight of 75 g.On June 29, partial selective harvesting was done on crabs (only gravid females and fat males were taken). A total of 184 kg of marketable size crabs was harvested on September 17 with average size ranging from 143 g (7 pcs/kg) during partial harvesting to 200 g (5 pcs/kg) during total harvesting.

Semi-intensive Prawn Culture

Semi-intensive culture of *P. monodon* at a stocking density of 20,000 to 30,000/ha was tried at Leganes Research Station. Results indicate that survival as high as 80-90% with production rate of 500-600 kg/ha/crop can be achieved. However, it was observed that *P. monodon* stocked at a density higher than 20,000/ha failed to grow to the desirable uniform size of 30-35 g apiece. This may be attributed to feed and feeding system and also to maintenance of optimum water quality. Similar results were obtained by private operators in Pontevedra, Capiz where the technology was tested. They harvested smaller prawns as they raised the number of stock. So far, the most successful results from supplemental feeding, as claimed by fishfarmers operating under average conditions, are those with a stocking rate of 10,000-15,000/ha. Analysis has shown that a density of 20,000/ha could be economically and successfully produced with appropriate facilities and feed and water management.

Tilapia Monosex Culture

This verification project was undertaken in a 0.4 ha pond in Mandurriao, Iloilo. Stocking was done using 40,000/ha all-male *T. nilotica* juveniles provided by the BFAR Molo Demonstration Farm. Rice bran was used as supplementary food for tilapia with daily feeding ration based on 3% body weight. Monitoring of water temperature and salinity and growth rate sampling were done every two weeks throughout the culture period. After four months of culture, the pond yielded 182 kg at 91% survival rate.

Extensive Polyculture of Prawn and Milkfish

Three private farms in Iloilo and Negros Occidental conducted verification studies on extensive polyculture of *P. monodon* and milkfish in a cooperative venture with AQD. These three projects were conducted for 5 months each between September 1983 and April 1984. A low stocking density of 3,000-6,000 prawns/ha and 50-3,322 milkfish/ha was observed. Natural food was provided through propagation of lablab, "lumot" or filamentous algae and "kusay-kusay" (*Rupia maritima*) throughout the culture period of 4 months. Water temperature ranged from 25-32°C and salinity from 6-26 ppt throughout. Water exchange was done every spring tide. In the best trial, production was 160 kg of prawns from two hectares at 72% survival rate with a return on investment of 55% for a 5-month crop. The trial also yielded 1000 kg of milkfish. In the two other sites, an average of 44 kg of prawns (17.3 g apiece of 58 pcs/kg) and 106 kg of milkfish were obtained.

An initial trial run using this technology was conducted in three Leganes Research Station ponds. However, results were not conclusive as there were constraints.

BFAR-SEAFDEC Technology Verification Projects

A joint project between the Bureau of Fisheries and Aquatic Resources and the SEAFDEC Aquaculture Department along the concept of a national technology transfer program was launched in mid-1983 and is being continued. The program started with a special training program on prawn development for 27 BFAR extension workers at AQD Tigbauan station. Practical grow-out culture activities were conducted in four BFAR demonstration and training centers (DTC's). These prawn verification studies include (1) extensive prawn culture, (2) semi-intensive prawn culture, (3) prawn-milkfish polyculture and (4) extensive shrimp (putian) culture. In addition, two more verification projects were undertaken, namely, Seed Bank Project and Seabass-Tilapia Polyculture.

PRAWN VERIFICATION

Three pond culture systems, the Extensive Culture I (traditional), Extensive Culture II (modular), and Semi-intensive Culture were employed at the four BFAR Demonstration and Training Center at Pagbilao (Quezon), Calape (Bohol), Lala (Lanao del Norte) and Paombong (Bulacan). The Extensive Culture I method was likewise implemented at four BFAR farm sites in Dagupan, Malaubang (Ozamis), Masao (Butuan), and Sorsogon. The methodologies followed in all three culture systems were patterned after those developed at the SEAFDEC Leganes Research Station.

Of the eleven runs under extensive Culture I four were completed, one was terminated as ponds were damaged by typhoons, while six are ongoing. Three runs on Extensive Culture II (modular) at Pagbilao DTC and four runs on Semi-intensive Culture at Pagbilao, Lala and Calape were completed.

In the Extensive Culture I method (at stocking rate of 4,000-5,000/ha), survival rates ranged from 74%-80%. For Extensive Culture II where stocking rate is about 10,000-14,000/ha, the survival rates ranged from 42%-69% while for Semi-Intensive Culture where stocking rates were within the range of 10,000-30,000/ha, survival rate fluctuated from 46%-79%.

On-going runs on Extensive Culture I at the four DTC's are now adopting a 10,000/ha stocking rate. A 5,000/ha stocking rate is carried out in other BFAR farm sites covered under the collaborative program on prawn culture technology between SEAFDEC and the 12 BFAR regions.

MOLO AQUACULTURE SEED BANK

This is a joint project of the AQD and the Bureau of Fisheries and Aquatic Resources (Region VI) in line with the implementation of the technology transfer program of the Department. Started in mid-1984, the project is being implemented in 12 demonstration ponds at the BFAR regional office in Molo, Iloilo City. It aims to maintain a steady supply of ready-to-stock juveniles all year round. It involves the earthen pond nursery system of AQD hatchery-bred species such as seabass (*Lates calcarifer*), prawn (*P. monodon*), white shrimp (*P. indicus*), and rabbitfish or siganid (*Siganus guttatus*).

Stocking was done during the third quarter Trash fish was fed at the early stage, after which tilapia fry was fed to the seabass while putian fed mainly on natural food. Tidal water management was utilized to freshen the pond water. Water depth ranged from 45-100 cm.

During the last quarter, both seabass and putian were harvested on a staggered basis. A total of 2,140 pcs were collected from seabass nursery, 278 pcs from transition pond, and 69 pcs from growout culture. With putian, a total of 11,084 pcs. were harvested.

Survival of seabass in the nursery ranged from 0.04% to 9.82%. The transition phase yielded a higher survival rate of 5.19% to 28.08%. Survival rate for grow-out was 42.33%. Survival rate of putian ranged from 10.25% to 13.35%.

SEABASS – TILAPIA POLYCULTURE PROJECT

Seabass culture has been gaining the interest of local pond operators. With the successful spawning of seabass at the SEAFDEC Leganes and Tigbauan research stations, pond culture techniques developed in Thailand are being adapted.

The success of SEAFDEC AQD in seabass spawning and pond culture brought about the need to verify the existing culture technologies in other areas of the country. The four BFAR demonstration and training centers located at Pagbilao (Quezon Province), Calape (Bohol), Lala (Lanao del Norte), and Paombong/Hagonoy (Bulacan) represent four climatic zones, thereby making them desirable sites for seabass pond culture verification studies.

Tilapia breeders at the rate of 2,500 pairs/ha were stocked one month prior to stocking of seabass fry at 10,000 pcs/ha. Water and feeding scheme is regularly monitored. Like other verification projects with BFAR, this project is being coordinated by BFAR and SEAFDEC AQD staff.

TECHNOLOGY PACKAGING

A Training and Extension Publications Review Committee (TED-PRC) was constituted to facilitate the review of all manuscripts of aquaculture extension manuals, modules, leaflets, posters, and similar training and extension-inspired publications prior to final review by the Department Publications Committee.

The publications that were completed during the year were as follows:

An aquaculture extension leaflet entitled "Soil Sampling and Preparation for Laboratory Analysis", 8 pp., illustrated.

Aquaculture Extension Manual No. 9, A Guide to Prawn Hatchery Design and Operation, 42 pp., illustrated.

Training and Extension Handbooks. Four handbooks, two for training courses and two for *in-situ* seminars, were prepared: (1) *Handbook for the Training Course on Prawn Hatchery and Nursery Operations,* 135 pp; (2) *Handbook for the Training Course on Brackishwater Pond Culture,* 258 pp; (3) *In-Situ Seminar Handbook on Brackishwater Pond Culture* which includes brief current awareness materials on improved pond culture systems for prawn, milkfish, tilapia and crab, 178 pp; and (4) *Business Aspects of Aquaculture,* which deals mainly on the business prospects of selected aquaculture systems. It consists of Part I – Techno-Economic Studies, and Part II – Costs and Returns Estimates. This handbook was produced for the FINEX-SEAFDEC Aquaculture Seminar.

Plans are under way to transform these materials into handy learning modules for training and extension purposes.

A new series of AQD publications was launched in 1984. The series, called AQUACULTURE TECHNOLOGY, consists of extension modules, each dealing with a particular subject matter and designed for self-study. The first issue is *Tilapia Cage Farming in Lakes,* 28 pp., illustrated, authored by Dr. A.M. Bautista of the Binangonan Research Station.

Four other manuscripts on various aquaculture topics have been prepared by individual authors and compilers. These have been reviewed and approved for publication by the AQD Publications Committee and are being pre-tested with fishfarmers.

Aquaculture Posters. A 24 x 36-inch color poster on the *Important Penaeid Prawns/Shrimps of the Philippines* was printed. It contains a brief description of each species.

TECHNOLOGY DISSEMINATION

In support of the Department's program for technology dissemination, the following *in-situ* seminars, symposia, consultative meetings and workshops were held:

In-situ Seminars

Usually held for 3-5 days, these seminars are scheduled based on requests by local fishfarmers' associations in collaboration with the regional office of the Bureau of Fisheries and Aquatie Resources.

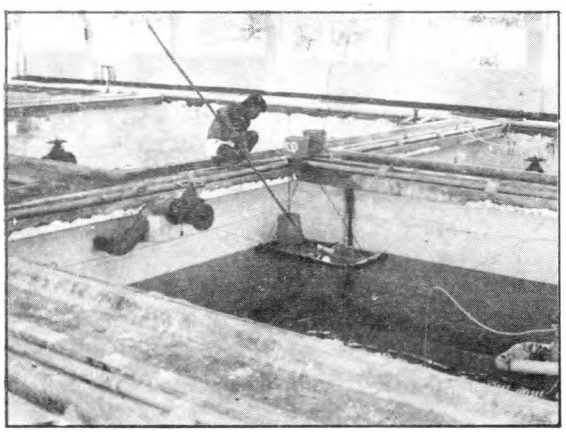
• **Prawn Pond Culture.** This was conducted on January 15-28 in Vitali, Zamboanga del Norte upon the request of the Southern Philippine Development Authority (SPDA), a government corporation under the Ministry of Human Settlements, for 41 prawn pond managers, technicians and caretakers.

• **Brackishwater Pond Culture and Management.** The seminar was held on September 5-8 in Hagonoy, Bulacan. Some 40 fishfarmers, pond owners, caretakers and prospective fishfarmers attended. It was co-sponsored by the Bulacan Provincial Government and BFAR Regional Office (Region III).

• **Prawn Culture.** A 2-day follow-up *in-situ* seminar on prawn culture was conducted for 31 participants on September 27-28 also at the Hagonoy BFAR DTC.

• **Business Aspects of Aquaculture.** Thirty-four participants attended the seminar on the Business Aspects of Aquaculture held October 10-12 at Makati. This was sponsored by the Financial Executives Institute of the Philippines (FINEX) in cooperation with SEAFDEC AQD. The 3-day seminar aimed to bring to the attention of the business community the recent aquaculture practices and their possible business applications. It also provided a forum for the business community to discuss trends in aquaculture development for business planning.

• **Prawn Culture and Management.** This was conducted on October 19-21 in Davao City. Co-sponsored by the Philippine Federation of Aquaculturists, Inc. (Region X) and the Bureau of Fisheries and Aquatic Resources (Region X), the seminar centered on prawn hatchery and nursery operations, grow-out culture and marketing techniques. Some 112 participants from Davao City, Davao del Sur, Davao del Norte, Davao Oriental, Surigao del Sur, and General Santos City attended.

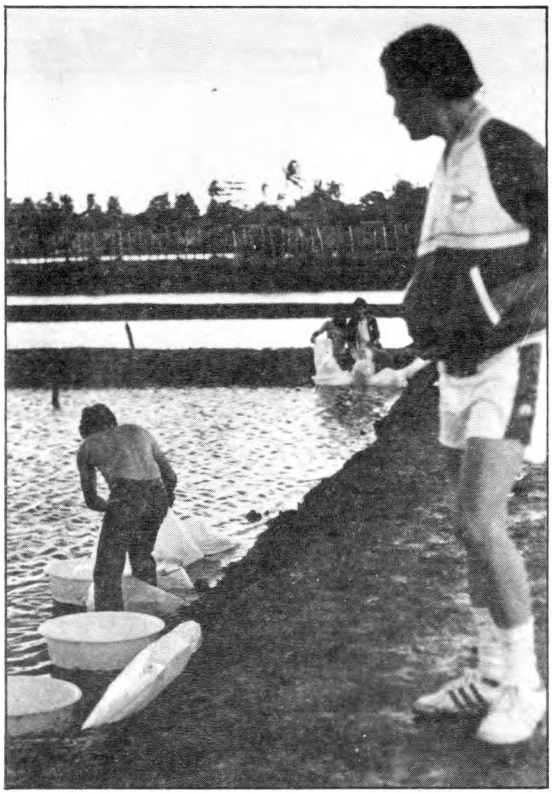


• **Business Aspects of Aquaculture.** This was held on October 25-27 in Butuan City. Forty-one businessmen, prospective fishfarmers, government personnel, teachers and students attended the 3-day seminar conducted in collaboration with the Financial Executives Institute of the Philippines (FINEX) with the Guaranty Fund for Small and Medium Enterprises which sought to design a prototype financial package for prawn farmers. Topics on aquaculture technologies were discussed by the AQD staff while the business aspects were handled by the FINEX financial experts.

• **Selected Aquaculture Technologies.** This was held on November 14-16 in Naga City. Sixty-two fishpond owners, operators, technicians, caretakers, teachers, students and businessmen from Albay, Camarines Sur, Catanduanes, Masbate and Sorsogon attended the 3-day seminar. It was co-sponsored by the Bicol Federation of Fishfarm Aquaculturists and BFAR Region V. The seminar served as a catalyst to induce the local fishfarmers to revitalize their organization.

Aquaculture Seminar Series

A series of aquaculture seminars was held in Metro Manila for pond owners, private investors, extension specialists, teachers, and students based in Metro Manila and nearby provinces. Three of



With an intensified national, as well as, regional interest in aquaculture, the AQD enthusiastically responded by constantly verifying firsthand experiences and methods evolved by fishfarmers and fishpond operators.

these, attended by 177 participants, were conducted during the period.

Current issues and the latest technology and techniques in prawn hatchery and nursery operations were discussed. Field trips to the BFAR Demonstration and Training Center and private prawn ponds in Quezon, Bataan and Cavite were held.

Symposium

A symposium on Brackishwater Pond Culture was held on February 18-19 in Tacloban City for some 100 participants. The activity was held in collaboration with the Philippine Federation of Aquaculturists, the Bureau of Fisheries and Aquatic Resources (Region VIII), and the local fishpond owners' association.

Consultative Meeting

The Department TVES staff met last July 28 with some 30 members of the Capiz Fishpond Operators' (CAFOA) in Roxas City. The association is considered one of the strongest and most active in the country. Some CAFOA members expressed interest in becomeing AQD cooperators in verification projects.

Extension Services

The Aquafarmers' Assistance Unit, with the Department's training and research staff, continued to answer inquiries from fishfarmers, businessmen, technicians, teachers and students.

An extension project on prawn hatchery operation was undertaken this year by the Department in collaboration with the Mindanao Regional School of Fisheries and Regional Institute of Fisheries Technology (MRSF-RIFT) in Zamboanga City to activate the MRSF-RIFT prawn hatchery. Two AQD prawn hatchery experts were deputized and took turns in conducting trial runs and training the fishery staff of the school in hatchery operations. The latest 6 consecutive trial runs conducted from July 18 to August 24 yielded 124,000 postlarvae ($P_4 - P_5$) which were then raised in several 1-ton wooden tanks and, later, in hapa nets for nursing.

Former TVES Head Jurgenne H. Primavera and Training Officer Edgar Reyes were invited as visiting prawn experts by the Government of Cuba on May 11-June 6. They gave lectures on various aspects of penaeid biology and culture at several universities and research institutions. They also observed and did practical work on induced maturation and larval rearing of local penaeid species and assisted their South American counterparts in solving problems related to prawn culture. They visited and exchanged technical information with researchers and aquaculturists in selected prawn hatcheries, grow-out ponds, and other research facilities in Panama and Mexico City for Ms. Primavera and in Japan for Reyes.

Technology Assessment

In view of recent developments in the aquaculture industry, the technology assessment section was created in March 1984. The section would make comprehensive assessments of the technologies generated and disseminated by the Department, and coordinate the planning and organizing of aquaculture conference, workshops, technical consultations, and other related activities.

To start the work, the Technology Assessment Section (TAS) developed a concept paper on technology assessment, followed by a paper on technology assessment methodology which discussed the organizational structure and function of TAS including (a) policy studies, impact studies, and socio-economic studies; and (b) program/project evaluation and development.

The activities of TAS started only on the last quarter. It completed a state-of-the-art report on the socio-economic studies of the aquaculture industry and formulated five proposals.

Library and Documentation Services

The significant events of the year were the approval of the Brackishwater Aquaculture Information System (BRAIS) Project by the International Development Research Centre (IDRC) and the strengthening of the Department-wide library system.

The Library and Documentation Services and the Information Services Office implement the BRAIS Project for the Department. IDRC-support for the 3-year Project totals ₱3.9 million while the Department contribution is ₱2.007 million. Based and organized at Tigbauan main

station, BRAIS is a specialized information analysis center involving five Southeast and South Asian countries. It will provide a mechanism to acquire, analyze, store, and retrieve relevant information in the service of brackishwater aquaculturists and development workers.

A Department-wide library system is being established. The expansion of the Binangonan Research Station Library was started early this year. The Leganes Station librarian was encouraged to coordinate with the Tigbauan main library for the information needs of the Station staff. Centralized acquisition and processing now maximize personnel activities and avoids duplication of requested literature.

LIBRARY COLLECTION AND SERVICES

The collection now stands at 7,358 monographs, 6,000 reprints, 3,560 pamphlets, 2,510 bound journals, 1,390 SEAFDEC publications, 440 microfiche titles, and 26 microfilm rolls.

For the period 680 titles (820 volumes) were classified and catalogued. Some 3,820 cards were added to the public catalogs.

The Unit maintains exchange agreements with 317 (224 foreign and 93 local) aquaculture and fisheries research and educational institutions; 982 serial issues (representing 288 serial titles), 98 monographs, 303 reprints, and 27 microfiches were received from 189 foreign and 31 local exchange partners.

This year, 277 complete journal volumes were bound and accessioned; 49 issues were claimed; and 1,009 journal issues were checklisted.

DOCUMENTATION SERVICES

Documentation activities centered on the compilation, organization and publication of abstracts and bibliographies; the servicing of outreach information through the Selective Dissemination of Information (SDI) and the Scientific Literature Service (SLS); and the strengthening of the document delivery capability.

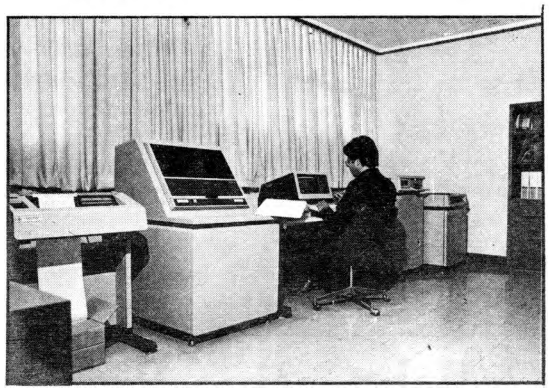
- **Aquaculture Abstracts.** For the year, the 4th Quarter issue (Vol. 4, 1982) and the 1st and 2nd Quarter issues (Vol. 5, 1983) of *Aquaculture Abstracts* were published and distributed.

- **Brackishwater Aquaculture Bibliography.** Vol. 1, Nos. 1 & 2 came out during the year. The second issue is in progress. The title will be changed to *Brackishwater Aquaculture Abstracts.*

- **Sugpo Bibliography.** This bibliography titled *Sugpo and Other Philippine Penaeids* was published in time for the First International Conference on the Culture of Penaeid Prawns/Shrimps on December 4-7 and in connection with the requirements of the BRAIS Project.

- **Selective Dissemination of Information (SDI) and Scientific Literature Service (SLS).** SDI is addressed to the Department Project and Program Leaders while SLS is addressed to 26 research and educational institutions in the country; this year, 185 titles were photocopied comprising a total of 2,043 pages.

- **Computer Work.** Computer storage of bibliographic information began during the year. There are now 1,800 bibliographic data stored.



AQUIS PROJECT

The Aquaculture Information System (AQUIS) is a computer-based system designed by the Aquaculture Development Coordinating Programme (ACDP) of the FAO/UNDP. AQUIS has an inter-regional network for aquaculture centers in Africa, Asia, Europe and South America. The Asian network is composed of lead centers in China, India, the Philippines and Thailand. The SEAFDEC Aquaculture Department hosts the Regional Lead Centre in the Philippines (RLCP).

The AQUIS Project was integrated with the Brackishwater Aquaculture Information System (BRAIS) this year. Both projects are supervised by the Training and Extension Division and implemented by the Library and Documentation Services.

Acquisition of materials for analysis and data entry into the AQUIS Data Base are made in consonance with the BRAIS Project's acquisitions effort. There are now available 460 data units in the Data Base, including those collected from FAO (Rome) and the Regional Lead Centre in Thailand.

A Familiarization Course on AQUIS Project was held on 22-24 October 1984 to introduce to 12 participants the philosophy and requirements of the Project including data collection processes and basic computer terminal operations.

BRAIS PROJECT

The Brackishwater Aquaculture Information System (BRAIS) is a regional network of libraries and information centers that support research and development in tropical aquaculture with emphasis on brackishwater culture system. The project will be implemented by national centers initially to be established in five Southeast and South Asian countries. So far, the Philippine and Thai national centers have been identified while BRAIS centers in India, Indonesia and Malaysia are in various stages of selection.

To run for three years, the Project has five components, namely: (1) acquisitions; (2) organization and documentation; (3) publication and reprography; (4) clearing house for brackishwater aquaculture information; and (5) information networking.

The Department, acting also as the Philippine National Center for the Project, began acquisitions and literature survey covering Iloilo province and Los Banos during the last quarter of the year. Some 426 articles, 37 monographic serials, 13 serial issues, and 2 theses were collected in this initial survey.

New computer and printing equipments have been acquired. Some 1,800 bibliographic data have been stored in the computer. Pretesting for computer generation of bibliographies and indices is scheduled early next year when memory enhancement shall have been effected. Monographic and analytic data definition have been programmed and will also be pretested early next year.

Volume 1, Nos. 1 & 2 of the *Brackishwater Aquaculture* Bibliography were printed while Nos. 3-6 were in progress. The *Sugpo and Other Philipppine Penaeids* bibliography was published during the period.

Audio-Visual Production

The Audio-Visual Production Unit is the Department's arm in the production of communication materials for training, extension and public relations. These materials include sound slides, photo exhibits, and video tape production in collaboration with NACA-RLCP and JICA.

For instructional purposes, short video clips or slide shows are produced as learning aids in various training courses. Transparencies were improved with the use of color and quality material.

Collaborative Program

NACA-SEAFDEC UPV TRAINING PROGRAM

The training for Senior Aquaculturists in Asia and the Pacific Region, now on its fourth year of implementation, is a collaborative program of FAO/UNDP Network of Aquaculture Department and the University of the Philippines in the Visayas. (UPV).

Twenty-one participants from eleven countries completed the third training course and received their Diploma in Aquaculture on March 23, 1984. Twenty of the participants were awarded the Master of Aquaculture degree by UPV.

The fourth training course started also on March 23 with 21 participants from eleven countries: 3 each from Indonesia and Thailand, 4 from the Philippines, 2 each from Sri Lanka, India and Bangladesh, and one each from China, Pakistan,

Panama, Malaysia and Kiribati. The sponsoring agencies are SEAFDEC, IDRC, FAO/UNDP, World Bank, Asian Development Bank, FAO Country, IFP, and Commonwealth Secretariat (COMSEC).

The training course places more emphasis on practicum which covers aquaculture systems that have immediate application to the region such as field surveys, laboratory work, hatchery work, and farm training. Part of the program was a study tour conducted to the NACA Lead Centres in Thailand, India and China from July to September to observe and participate in various aquaculture systems being practised in these areas.

Statistical Summary

For the year 1984, the Aquaculture Department continued to serve interested individuals from the SEAFDEC-member countries and more than 30 other countries. Some 990 participants to various training and extension programs conducted by the Department were registered/recorded during the year. There is, however, an undetermined number of government technicians and extension workers, private businessmen, pond operators and caretakers, financiers and other entrerpreneurs who availed of the Department's various aquafarmer services in its different stations and substations. The figure indicated herein brings to a total of 6,207 the number of registered participants the Department has served to date.

Total as of December 1983		5,217
1. APDEM VII	25	
2. Hatchery & Cage Culture of Tilapia	14	
3. Brackishwater Pond Culture	40	
4. Small-Scale Prawn Hatchery and Nursery Operation	52	
5. Depuration and Sanitation of Mussels & Oysters	7	138
6. Artificial Propagation of Carp	10	10
7. Special Training		76
7.1 Prawn Development for BFAR Personnel	27	
7.2 Individual Training	36	
7.3 Trainors' Training	13	
8. Student Practicum	86	86
9. *In-Situ* Seminars		361
9.1 Vitali, Zamboanga	41	
9.2 Hagonoy, Bulacan (2 seesions)	71	
9.3 Davao City	112	
9.4 Metro Manila	34	
9.5 Butuan City	41	
9.6 Naga City	62	
10. Aquatic Seminar Series in Metro Manila (3 sessions)		177
10.1 Prawn Pond Culture I	79	
10.2 Prawn Pond Culture II	59	
10.3 Prawn Hatcher/Nursery Operation	39	
11. Symposium on Brackishwater Pond Culture, Tacloban City	100	100
12. Consultative Meeting with CAFOA Members in Roxas City	30	30
13. Seminar on Familiarization on AQUIS Project	12	12
Sub-total		990
GRAND TOTAL AS OF DECEMBER 1984		6207

ADMINISTRATION

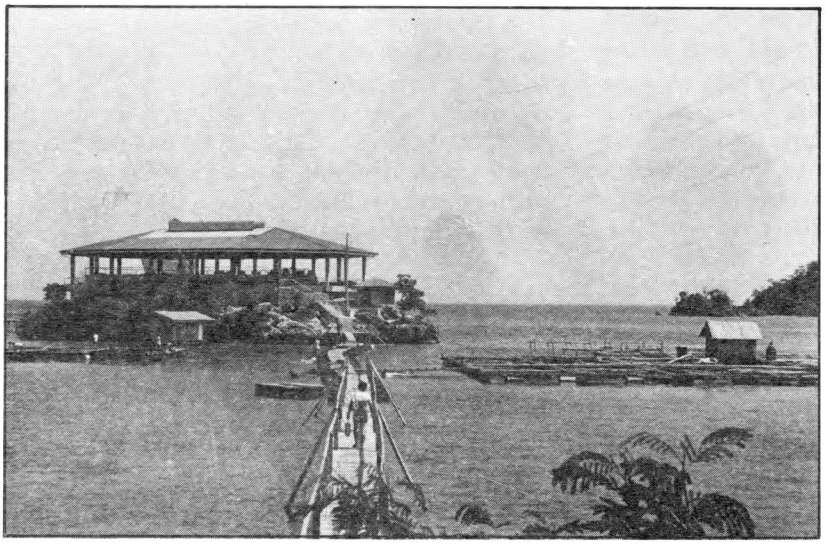
During the year, activities were focused on the provision of adequate services in support of the research, training and extension activi- the Department. A review of existing systems and procedures is continually undertaken in order to streamline operations.

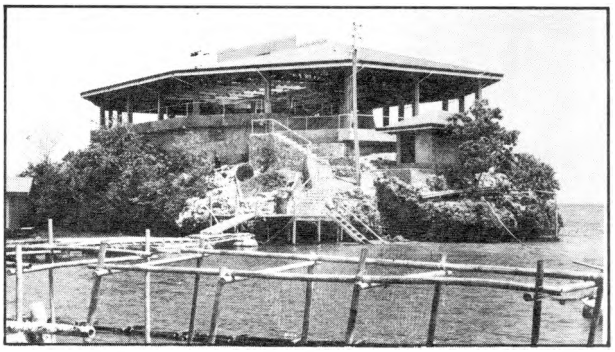
The Collective Bargaining Agreement with the Union of SEAFDEC Employees was signed by the Chief of the Department effective January 1, 1984. Provisions of the Agreement were implemented, guidelines were established and, with constant dialogues with union officials, improvements were made on certain provisions.

A committee to Review Administrative Rules and Regulations created in the last quarter of 1983 submitted a draft of the Manual on Administrative Policies, Guidelines and Procedures of the Aquaculture Department to various Divisions for review. This Manual is a comprehensive compilation of policy issuances on administrative matters with policy innovations and updating.

A cost reduction program was undertaken in line with efforts to minimize operating costs. Measures undertaken include strict control of expenditures by elevating approving levels of authority for some cost-related activities, control of travel of substation personnel, utilization of less expensive paper, among others. At the latter part of the year, the flexible "airconless" hours policy was adopted. Around 218 thousand kwh was saved with this measure.

The Department granted the benefit of automatic conversion of fifteen days sick leave credits in addition to the provisions of the CBA to Department personnel whose houses were damaged during typhoon "Undang."





Operations

PERSONNEL MANAGEMENT

During the year, the programs and activities of the Personnel Management Section were centered on the effective utilization of personnel. As of December 31, 1984, the personnel complement of the Department totalled 730 regular employees, distributed as follows: 408 in the Research Division, 275 in the Administrative Division and 47 in the Training and Extension Division. Twenty-five employees resigned during the period while 11 new employees were hired.

Personnel Wage and Salary Administration

The New Compensation Scheme as initially developed in 1982 was approved and implemented effective April 1, 1984. Every employee was issued a new appointment based on the evaluation of functions and qualifications for the position. Some 321 employees were upgrated as a result of the implementation of the New Compensation Scheme. Wage Order Nos. 4 and 5 were implemented. A total of 394 employees were covered by Wage Order No. 4 and 564 by Wage Order No. 5.

Employee Benefits and Development Service

Various forms of benefits were given during the year. All regular employees were covered by the group term life insurance, accident and dismemberment benefit.

A total of 59 staff development grantees were sent to local and foreign institutions. Twenty-one underwent formal degree scholarship. Thirty-eight were sent on non-degree sholarship grants to 19 local and 19 foreign institutions.

Safety Unit

With the reconstitution of the Safety Committee in 1984, road safety signs were placed in strategic locations within the compound and along the national highway in collaboration with the local PC/INP stations. All employees were required to wear Department IDs while at work or within Department premises. Only accredited food vendors were allowed to serve foodstuff inside the compound. A safety circular was issued entitled "Emergency Procedures in the Event of Natural Disasters."

Security Services

The Security Unit oversees the performance of the security agency. Strict implementation of Department policies bearing on various aspects of operation was done in coordination with the security agency. The movement of personnel, visitors and vehicles was monitored and controlled. A security reinforcement team was organized for the payroll service. Security is provided visitors and guests of the Department.

FINANCE

The Finance Section provided the financial support to the various projects and units of the Department in all stations and offices. A complete set of books of accounts is maintained at the Tigbauan Research Station, Binangonan Research Station and External Affairs Office. The Tigbauan main office consolidates periodic reports of other stations and offices.

Assistance was provided to the external auditors during the conduct of the interim financial audit for the quarter ending September 30, 1984. Discussions were also held with foreign external auditors of the SEAFDEC and a uniform format for financial reporting was adopted. Similar discussions were conducted with the IDRC Controller for IDRC-funded projects.

PHYSICAL PLANT

The section provided and maintained vital support facilities for various offices and units. During the year, about 172 jobs were started at a cost of P1.5M of which 156 were completed. About 1,178 work orders were accomplished. Among the major infrastructure projects were:

- Completion of the WVSC-SEAFDEC Kindergarten School.
- Improvement of the access road to Batan Substation.
- Improvement and partial completion of Igang substation facilities.
- Completion of the washrack at Motor Pool.

Other projects undertaken by PPS were:

- Installation of the new telephone system donated by JICA.
- Installation of power capacitors and implementation of other energy conservation measures.

Energy conservation measures were undertaken to bring down operating costs. The adoption of airconless hours and improvements in power generation and distribution resulted in savings of 217,884 kilowatt-hours during the year.

PROPERTY AND SUPPLY MANAGEMENT

In support of the various activities of the Department, the PSMS undertakes the purchasing, receiving, warehousing, property and equipment management.

A purchasing office at Iloilo City was established to speed up the process of procurement. Buyers of supplies and materials were assigned to specialize in certain items in order to fully aquaint them with materials regularly purchased, facilitate purchases from similar establishments, and minimize time lost due to returned goods. The Manual on Requisitioning, Purchasing, Receiving and Equipment Management was prepared. The accreditation of suppliers was partially implemented.

Close coordination among property custodians regarding acquisition, recording and retirement of Department equipment was implemented. A periodic monitoring of the whereabouts and the operating conditions of equipment was undertaken in order to maximize their utilization. All property ledger cards were revised and updated. Brands of office equipment were standardized to simplify work and minimize operating expenses.

An added innovation was the personalized door-to-door delivery of requisitioned materials and supplies to operating units. Inventory levels of fast-moving items stocked at the warehouse were closely monitored.

AUXILIARY SERVICES

The Auxiliary Services Section operates three units, namely, Housing Management, Visitors' Service, and Printing, Mailing and Messengerial Services/Radio Communications. It monitors the operations of the Cafeteria and manages Department-acquired lands.

Housing Management

During the period, the unit adequately provided housing requirements for 142 international and national trainees of the Department. Housing facilities were maintained and repaired. Five senior

staff members were awarded staff houses based on a point system adopted. Ten employees were accommodated in the apartment units as permanent residents while 9 staff members were housed at the dormitory.

Housing rates were increased for trainees and transients in view of the increased cost of providing adequate facilities, services and amenities.

Printing, Mailing and Messengerial Services/ Radio Communications

This unit provides supportive services specifically in printing, mailing, messengerial and radio communications activities.

The unit also printed all Department forms in order to minimize costs. A new Belcom VHF radio transceiver was acquired.

Visitors' Service

The VSO is responsible for providing efficient and adequate services for the various needs of visitors of the Department. During the period, 55 dignitaries, 33 researchers and scientists, 2,691 students and teachers, 27 fish-farm operators, and 864 others visited the different stations.

MEDICAL SERVICES

During the period, the Medical Services attended to 611 regular employees, conducted pre-employment medical examinations to 46 persons, and completed the annual physical examination of 489 employees (164 employees had incomplete physical examination).

In peso equivalent, medical expenses incurred by the Department amounted to P39,920 for diagnostic check-up, P281,710 for hospitalization, P346,403 for medicines and P106,215 for optical expenses. Total medical benefits granted by the Department more than doubled in 1984 from the previous year's. Trainees, WVSC Laboratory School students and other parties were also extended medical assistance during the year.

ILOILO LIAISON OFFICE

Functioning as the liaison office of the Department at Iloilo City, the ILO facilitated transactions with the various public, clients and suppliers of the Department, communications with various offices, and reloading of the postal meter machine. A bookshelf was installed at the office to contain various publications of the Department. The ILO also assisted in the transport of fry to various BFAR centers all over the country. Assistance in arranging accommodations, billeting and plane bookings of visitors and employees of the Department was provided by the ILO staff.

WEST VISAYAS STATE COLLEGE LABORATORY SCHOOL AT SEAFDEC

Established primarily as a school for employees' dependents the West Visayas State College Laboratory School at SEAFDEC has been in operation since 1977. From a small kindergarten class, it has grown to an elementary school with a total enrolment of 226 in 1984-85. Six teachers are detailed from the West Visayas State College while three teachers and a teacher aide for kindergarten are employed by the Department.

In 1984, 21 pupils graduated from Grade VI while 39 students moved up to the non-graded level from kindergarten.

Employee Movement

Important appointments, transfers and other movements effected during the year include the following:

Mr. Ignacio D. Salutan was designated Chief Accountant, Finance Section, effective April 23, 1984. Mr. Salutan was formerly Head, Finance Unit of the Leganes Research Station.

Mr. Peter Cachopero was designated Head of the Motor Pool and Automotive Services Unit last April 2, 1984.

Mr. Venerio Gasataya was appointed Administrative Assistant of the Physical Plant Section effective April 2, 1984. Mr. Gasataya was formerly with the Naujan Substation.

Atty. Jose A. Agbayani, Jr., Administrative Officer of the Binangonan Research Station, retired from the service last September 30, 1984.

Mr. Anselmo Catedrilla, Administrative Assistant of the Igang Substation, was reassigned to the Research Management Services effective September 16, 1984.

Mr. Antonio Lagmay was appointed Administrative Assistant of the Naujan Substation effective July 2, 1984.

Mr. Alfonso Gamet was designated Scientific Illustrator of the Binangonan Research Station effective July 2, 1984.

Mr. Pedro B. Bueno, Communications Officer of the Information Services Office, resigned from the service last October 15,1984.

Mr. Ben de los Reyes, Financial Officer, was detailed to the Leganes Research Station as Finance Coordinator effective December 12, 1984.

Mr. Jessie Banno, Research Associate, was transferred to the Naujan Substation effective December 17, 1984. He was formerly with the Leganes Research Station.

Visitors of the Department

During the year, the following dignitaries visited the Department:

Hon. Ernest Leung
Deputy Minister of Trade and Industry
People's Republic of China

Dr. Raymond W. Lansford
President
Kiwanis International
Columbia, Missouri

Dr. Onil Perera
Director
National Aquatic Resources Agency
Sri Lanka

Mr. Sunder Shrestha
Ministry of Agriculture
Kathmandu, Nepal

Dr. W. Dall
Assistant Chief
CSIRO, Australia

Mr. W. Keerthi Viswanatha
Senior Assistant Director
Ministry of Fisheries
Sri Lanka

Mr. Nanyakkara N.J.W.
Fisheries Extension Officer
Sri Lanka

Mr. I. Liyana Aratchyge Munasinghe
District Fisheries Extension Officer
Sri Lanka

Mr.Marcelino Fajardo
Charge D' Affaires
Cuban Embassy, Manila

Mr. Bertrand Thullier
Scientific Attache
Cultural Section, French Embassy
Manila

Mr. Remie Sibelle
Assistant French Consultant to SEAMES
French Embassy, Bangkok

Mr. Tony Moens de Hase
Aquaculture Project Engineer
Belgium

Mr. Kenneth Osborn
Fisheries Adviser
USAID, Washington

Dr. Jaques Moreau
National Polytechnic Institute
Toulouse, France

Mr. Usamu Saehi
JICA, Japan

Mr. Akihiro Matarai
JICA, Japan

Mr. Yasuhisa Kato
JICA, Japan

Mr. K. Hiramatsu
JICA, Japan

Mr. Angel Raul Leon Perez
FAO/UNDP, Cuba

Dr. Hayase
Staff Assistant
SEAFDEC, Thailand

Mr. Soemarno
Directorate General of Fisheries
Jakarta, Indonesia

Mr. Motoda
Embassy of Japan

Gen. Simeon Ver
Armed Forces of the Philippines

Mr. Rogelio Posada
First Secretary
Cuban Embassy, Manila

Ms. Ana Maria Gonzales
Ambassador of Cuba

Dr. Kathleen Matics
Information Officer
SEAFDEC, Thailand

Dr. Ramon Valmayor
Executive Director
PCARRD, Manila

Hon. Abdullah Dimaporo
Assemblyman, Lanao del Norte

Hon. Antonio Gatuslao
Assemblyman, Negros Occidental

Mr. Ernesto Viquiera
Director
Bureau of Lands, Region VI

President Consuelo Blanco
MMSU, Batac, Ilocos Norte

Atty. Jaime Blanco
MMSU, Ilocos Norte

Ms.Gloria Mallare
Director, MSSD
Region VI

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
Tigbauan, Iloilo, Philippines