

# Annual Report 1982



AQUACULTURE DEPARTMENT  
Southeast Asian Fisheries Development Center  
PHILIPPINES

*Cover photo: Tiger prawn fed with mussel meat.*

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SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER  
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## FOREWORD

The Aquaculture Department of the Southeast Asian Fisheries Development Center was established through a treaty agreement involving Japan, Malaysia, Singapore, Thailand, Vietnam and the Philippines. Its purpose is to undertake research, train aquaculturists and disseminate information which shall help provide the needed impetus for tapping Southeast Asia's vast potentials for aquaculture.

Since its establishment in 1973, the Department has consistently pursued its goal of developing appropriate technologies to help increase the production of economically important group of finfishes, crustaceans and molluscs.

This report contains the accomplishments and progress of the Department in research, training and extension and support services for 1982, under the stewardship of my predecessor, Dr. Flor J. Lacanilao.

With the support of the leaders of the aquaculture industry, other international organizations, and the SEAFDEC member countries, particularly the Republic of the Philippines, we are confident that the momentum that has been achieved over the years shall be sustained as the Department continues to play a vital role in the growth and development of the aquaculture industry.

**ALFREDO C. SANTIAGO, JR., Ph.D.**

*Chief  
Aquaculture Department*

March 1983

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## OVERVIEW OF 1982 ACTIVITIES

Structural reorganization in line with the Department's Revised Plan of Operation and Program of Work approved by the SEAFDEC Council of Directors on its 14th meeting last September 1981 was implemented during the year.

The Research and Development Program Committee, responsible for determining research and development directions of AQD, was expanded to include additional representatives from the government, academic and private sectors. More consultative meetings with fishfarmers were held to discuss problem areas and pinpoint technology gaps.

Research on three major aquatic groups – finfishes, crustaceans and molluscs focused on problem areas in production. Encouraging results were attained from related studies on finfish hatchery, crustacean hatchery, seafarming, nutrition and feed development, ecology, pathology and aquaculture economics at the Tigbauan Research Station; and milkfish nursery, tilapia culture, freshwater prawn farming, and limnology at the Bina-ngonan Research Station. At the Leganes Research Station, intensified studies continued on prawn, milkfish, polyculture and aquaculture engineering; and on prawn broodstock and seafarming at the Batan Substation.

Using improved techniques in prawn hatchery operations, production of *Penaeus monodon* nauplii in broodstock tanks and pens and of postlarvae and juveniles in hatcheries and nurseries considerably increased.

More emphasis was put on ecological studies of the Laguna Lake. The results gathered may help other agencies in formulating measures and policies for more effective lake management.

Regular training and extension programs were conducted on Small-Scale Prawn Hatchery Operation and on Cage and Pen Culture of Tilapia in Freshwater. On-site trainings and off-campus practicum for students were also undertaken.

Regular publications, technical reports and quarterly research reports were printed. Scientific papers by regular and visiting researchers were published in local and international journals.

The Department strengthened existing and established new linkages with various national and international agencies and organizations involved in aquaculture development in the country and in the region.

## **TIGBAUAN RESEARCH STATION**

During the year, studies in seven research projects, namely, fish hatchery, crustacean hatchery, seafarming, nutrition and feed development, ecology, natural food, and pathology, aimed at improving existing technologies and generating new ones were conducted at the Tigbauan Research Station.

### **FINFISH HATCHERY**

Studies were conducted in an effort to increase the catch and survival of fry from the wild; induce maturation of captive milkfish through hormonal and dietary manipulation under different holding systems; and develop techniques to induce spawning and rearing of larvae of economically important finfish.

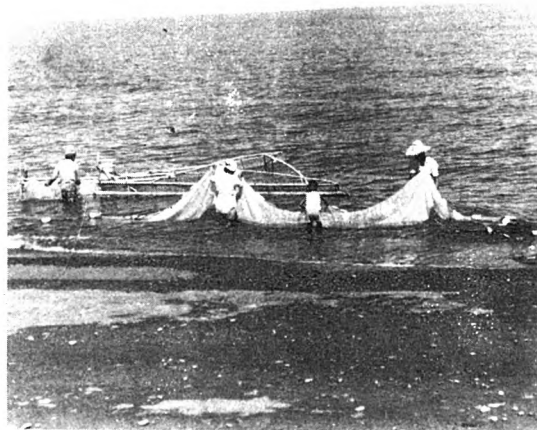
#### **Improvement and development of techniques for catching, handling, transport, and storage of milkfish fry and fingerlings**

A study was conducted to assess existing methods and practices of milkfish fry collection.

The significant findings are the following:

- Milkfish fry can be collected in almost all coastal waters of the Philippines. The time of appearance of milkfish fry varies in different places.
- There are 10 types of milkfish fry fishing gears currently used in the Philippines. The utilization of all the appropriate combinations of fry catching gears in a particular fry ground may result in increased fry collection.
- Although the estimated annual catch of about 1.15 billion fry appears sufficient for the industry's requirement, mean survival of only 38.8% from fry to fingerling size accounts for the fry shortage experienced by the milkfish industry as a whole.





Development of mass production techniques in fry rearing, longer stunting period with minimal mortality and improvement of existing catching, storage and transport methods could lead to increased and continuous supply of milkfish fry for local industry requirements and export.

*The tidal set net and the fry seine net are two of the ten commonly used types of fry fishing gears in the country.*

### **Induced spawning of milkfish, mullet and siganids**

Experiments on induced spawning were conducted on *Siganus guttatus* using clomiphene citrate and HCG as spawning agents. The group injected with 10 mg clomiphene citrate/kg weight of fish spawned after the second injection (1 injection/24 hr), while those given 1 mg/kg spawned after the fourth injection.

In the second run, two females injected with 10 mg/kg and one female injected with 1 mg/kg spawned after the fifth injection. This response difference could be attributed to the difference in the initial egg diameter of the females used.

Experiments to induce spawning of *S. guttatus* using HCG at a dose of 500 IU/fish/injection were successful for 9 mature females. Spawning occurred after two injections in females with an average oocyte diameter of 0.45 mm or bigger. Females with an average oocyte diameter of less than 0.45 needed four to five injections.

One gravid *Mugil cephalus* female was induced to spawn with 5,000 IU HCG and stripped 24 hr after injection. As there

was no running male available, eggs were fertilized with 77-day old cryopreserved sperm of *Valamugil* sp. One hundred seventy four fertilized eggs were collected but only a few larvae hatched.

Another gravid female spawned without injection. Its eggs were collected with a plankton net and were artificially fertilized with freshly collected sperm from a newly caught male. Fertilization rate was 6.74% from 4,000 collected eggs. However, only 84 fry were harvested after 42 rearing days.

### **Pilot-scale production of milkfish and other finfish fry**

Pilot scale production of siganid fry was tried several times using 3-ton circular ferrocement tanks and 600 L circular fiberglass tanks.

Larvae were fed with *Isochrysis* and *Brachionus plicatilis* from day 2-7 and *Brachionus* only from day 8-14. From day 15-35, *Brachionus* and newly hatched *Artemia* nauplii were given to the larvae. Artificial food was introduced on day 20.

Cannibalistic behavior, observed as early as day 14, could have been due to insufficient supply of natural food or high stocking density. This resulted to mass mortality and low survival rates (5.4%-8.37%) on the first trial.

Mass production of *Lates calcarifer* fry was tried twice. On the first run, bacterial infection occurred resulting to mass mortality. This could have been due to stress, weakening the resistance of the larvae which came all the way from Thailand. On the second run, out of 30,000 nine-day old larvae stocked, 3,760 fry were harvested after experiments on feeding, salinity and pH effect on the survival of the larvae had been conducted in three successive runs.

### **Sperm preservation of milkfish and other finfishes**

#### **Milkfish (*Chanos chanos*)**

Milt were preserved at 0-4°C using the following extenders: 0.1 M Na<sub>2</sub>HPO<sub>4</sub> - KH<sub>2</sub>PO<sub>4</sub>, 0.1 M Na<sub>2</sub>HPO<sub>4</sub> - NaH<sub>2</sub>PO<sub>4</sub> and

0.2 M Tris - Citric acid. Milt preserved after 24 hours in the three extenders showed better motility at pH 7.0.

### **Rabbit Fish (*Siganus guttatus*)**

Significant results were obtained on the effect of several factors such as pH, type of extender, dilution rate and concentration of cryoprotectant on sperm viability of *S. guttatus* at 0.4°C and -196°C.

After 24 hours of liquid and cryogenic preservation in 150 mM KCl, 150 mM NaCl and freshwater teleost Ringer's solution adjusted by tris-citric acid, good sperm motility was observed from pH 6.0 - pH 7.0. Using 100 mM Na<sub>2</sub>HPO<sub>2</sub>-NaH<sub>2</sub>PO<sub>4</sub>, sperm motility was greatest at pH 7.0 after 24 hours of liquid preservation. For 125 mM Na-citrate, best sperm motility was at pH 6.5-10.0, while for glucose adjusted by HCl and NaOH, at pH 4.0-10.0.

Several extenders such as 100-200 mM KCl, 100-200 mM NaCl, 200-400 mM glucose, 75-175 mM Na-citrate, freshwater teleost Ringer's solution, and Cortland medium yielded good results for cryogenic preservation of sperm. Sera of tilapia (*Tilapia nilotica*), silver carp (*Hypophthalmichthys molitrix*), and milkfish (*C. chanos*), crab ringer's solution, marine teleost ringer's solution and Mounib medium yielded lower motility scores for cryopreserved sperm at postthawing.

Significant dilution rate of sperm to extender was found between 1:1 and 1:9 ratios.

Cryoprotectant concentrations were best between 5-20% for dimethyl sulfoxide (DMSO) and 5-25% for Glycerine. Ethylglycol as cryoprotectant yielded considerably lower scores than DMSO and Glycerine.

### **Mullet (*Mugil cephalus*)**

Milt were preserved in LN<sub>2</sub> using DMSO and Glycerine as cryoprotectants, with DMSO as the better cryoprotectant. Milk-

fish serum and Ringer's solution as extenders gave better fertilization rates than NaCl, glucose, mullet sera and bighead sera.

Fertilization experiments were conducted on *M. cephalus* eggs and 0.4 ml 32-day old cryopreserved sperm in different extenders. Larvae produced showed no apparent abnormality.

Seventy 7-day old cryopreserved sperm of *Valamugil* sp. were used to fertilize *M. cephalus* eggs. One hundred seventy four eggs were collected but only a few hatched.

### **Catfish (*Clarias batrachus*)**

Significant results were obtained on the effect of freezing speed on catfish sperm viability at  $-196^{\circ}\text{C}$ . After 24 hours of cryopreservation, better sperm motility was obtained for sperm frozen at a slower rate than the others.

Comparatively good results were observed using Cortland medium as extender for cryopreservation of catfish sperm rather than KCl, NaCl glucose, Na-citrate Tilapia, silvercarp and milkfish sera, HF No. 1 medium and modified Cortland medium.

### **The effect of salinity on embryonic development of milkfish and other finfish**

The effect of various salinity levels (8, 16, 24, 32, 40 ppt) on the embryonic development of *S. guttatus* was investigated. An egg collector consisting of a strip of 500 microns bolting silk (subdivided into 2 cm<sup>2</sup> units by black lines) was placed at the bottom of the spawning tank. After fertilization (at one blastomere and at gastrula stage), one subdivision was cut off and transferred to 1 L beakers of the various test salinities. Percent total hatch, percent of viable larvae and mean total length of larvae from fertilized eggs transferred at single blastomere were compared from those transferred at gastrula stage.

Results are presented below.

Salinity Level	% Total Hatch		% Viable Larvae		Mean TL of Larvae	
	From 1 Blastomere	From Gastrula	From 1 Blastomere	From Gastrula	From 1 Blastomere	From Gastrula
8 ppt	25.5	1.13	6.96	0.20	2.095 + 0.11	2.097 + 0.05
16 ppt	38.3	19.54	15.28	4.36	2.01 + 0.08	2.06 + 0.06
24 ppt	50.3	21.10	25.89	7.8	1.91 + 0.18	1.95 + 0.07
32 ppt	33.3	16.37	13.26	1.8	1.91 + 0.14	1.84 + 0.04
40 ppt	36.5	11.95	21.31	1.87	1.64 + 0.21	1.96 + 0.08

The table shows that Mean TL of the larvae in both set-ups is greater at lower salinities than at higher salinities. Percent total hatch as well as percent of viable larvae were highest at 24%. Differences in hatching rates are highly significant ( $F > 3.98$  at 1% level).

#### Feeding biology of larvae and juveniles of milkfish and other finfishes under laboratory rearing conditions

##### Milkfish (*C. chanos*)

Studies on the feeding rhythm, time for maximum feed intake and digestive time of milkfish larvae and juveniles (4th day, 11th day, 18th day and 25 days from catching) were conducted in 300 L fiberglass tanks under natural conditions and fed with *Artemia*.

One feeding peak was observed on 4th day, 11th day and 18th day larvae and juveniles. This peak occurs in the daytime, and as the fish grows becomes more pronounced earlier in the day. The 25th day juveniles had two feeding peaks at 7 AM and at 1 PM.

Food was found in the digestive tract during the night observations, until 5 AM (sunrise), except for 5-53% of the 4th day larvae and 10-90% of the 25th day juveniles.

The time for maximum food intake was 2.0-2.5 hours and digestive time was 2.0 hours for 4th day and 11th day larvae. For 18th day and 25th day juveniles, the time for maximum food intake was 3.0-3.5 hours and digestive time was 2.0 hours.

### **Rabbit Fish (*Siganus guttatus*)**

The maximum amount of feed for *S. guttatus* using rotifers and reared in a 300 L fiberglass tanks is shown by the formula  $fs = 0.07104 L^{3.96501}$  where; fs = number of rotifers in the digestive tract and, L = Total body length of fish.

The time for maximum feed intake to occur was 5-10 minutes from introduction of rotifers in the tank of 9-day and 16-day old larvae (2.5-8.2 mm). From day 19 to day 29 the time for maximum feed intake increased.

The amount of rotifers in the digestive tract decreased after the first maximum feed intake. A second maximum feed intake, more often greater than the first, then occurred.

### **Sea Bass (*L. calcalifer*)**

Experiments on the feeding rhythm of 10-day old sea bass (*L. calcalifer*) larvae fed with rotifers were conducted in 30 L plastic tanks under two light conditions; one with natural illumination and the other with artificial illumination (3000 lux) from 6 PM-6 AM.

Under natural illumination, the amount of rotifers in the digestive tract gradually decreased from 6 PM (sunset) and started to increase at 5 AM (sunrise). From 10 PM to 5 AM, 10-80% of the larvae were found to have an average of 0.30-10.0 rotifers/fish in the digestive tract. No food was found in the digestive tract at 1 AM. The maximum food intake was at 8 AM at 20 rotifers/fish and decreased later on.

In the artificially illuminated setup, the effect of illumination was evident. From 10 PM to 5 AM, 30-50% of the larvae were

found to have 0.50-11.0 rotifers/fish. It was observed that no food was taken by the larvae at 12 midnight. Maximum food intake was at 1 PM-4PM with an average of 24-27 rotifers/fish.

### **Gonadal development of milkfish under different holding systems and dietary regimes**

Hatchery bred four-year old male milkfish were maturing when sampled in May, 1982. Females were all immature. Gonad development, however, did not proceed and fish sampled in July to September had regressed gonads. Serum estradiol-17 B (E2) and testosterone levels measured from these maturing males were low with levels comparable to those in immature fish.

Completed histological studies on the milkfish pituitaries demonstrated changes in the basophils of the proximal pars distalis, which were correlated with sexual maturation and spawning. Changes in histological characteristics of the pituitary gland are the early indicators of activation of the hypophysial-gonadal axis.

Four-year old milkfish, fed diets containing 40% protein from dried alamang (*Acetes* sp.) and dried alamang + fish meal, had the fastest growth rates (60% and 71% respectively) compared to those fed diet containing fish meal (48.25%).

No differences in growth rates were shown by one-year old fish fed diets containing lipids from different sources (cod-liver oil, soybean oil and cod-liver oil plus soybean oil). Fish, however, held in 6m diameter tanks and fed the same diets grew 1.5 to 2.5 times faster than those in 4m diameter tanks even at similar stocking densities.

Preliminary results indicate that 2-year old milkfish held in 3 or 5 m diameter cages at a stocking density of 2 kg/m<sup>3</sup> had comparable growth rates to those held at lower stocking densities of 0.5 and 1 kg/m<sup>3</sup>.

### **Gonadal maturation through hormonal manipulation**

Preliminary experiments to induce gonad development in three and four year old hatchery-bred milkfish by LH-RH im-

plantation gave negative results. There was no stimulation of estradiol-17B secretion in both treated and control three year-old fish. Steroid levels and histological effect on pituitary gonadotrops will be determined on the four year-old group.

Blood steroid values determined by radioimmunoassay (RIA) at various gonadal stages show differences in levels associated with gonad development. These values may be used to determine gonad stage of maturing broodstock.

Differences in serum protein and lipoprotein patterns have been identified and correlated with the various maturation stages. These are useful indicators of gonad stage in maturing broodstock.

An in-vitro bioassay system using the response of *Tilapia* oocytes to exogenous gonadotropin currently being developed may be used to determine gonadotropin levels in milkfish. Blood gonadotropin levels are indicators of gonad development in fishes.

Preliminary studies using isoelectrofocusing electrophoresis (IEF) to fractionate a protein band in milkfish serum indicate that this method promises to be a useful technique for identifying sex markers in milkfish serum.

## CRUSTACEAN HATCHERY

Experiments were conducted on three penaeid prawn species, namely, *P. monodon*, *P. indicus* and *P. merguensis* with emphasis on *P. monodon*. Studies were aimed at the refinement of broodstock and small tank hatchery technology and the testing of technology developed for larval rearing in the large tank hatchery. In addition, the large hatchery supplied the postlarvae for the experimental needs of the Leganes Research Station and other units of the Department.

### Comparative evaluation of the maturation of ablated *P. monodon* broodstock fed with natural diets vs. pellets

A study comparing the effect of brown mussel, squid and pellets, fed singly or in combination, on maturation of ablated



*P. monodon* was conducted. Preliminary results showed that prawns fed with a mussel-pellet or squid-pellet combination gave the highest number of spawnings, and those given a mussel-squid combination gave the highest mean hatching rate.

#### **The use of artificial/substitute feeds in larval rearing of *P. monodon***

In view of the recent development of chicken egg yolk feeding for *P. monodon* larvae, a study was undertaken to compare survival of larvae on natural food alone and in combination with hard cooked egg yolk. Highest mean survival at postlarvae 2 of 45% was obtained with a *Tetraselmis* + egg yolk + *Brachionus* treatment. These were significantly higher than the non-egg yolk treatments with mean survival of 9.9 % with *Tetraselmis* + *Brachionus* and 5.4% with *Skeletonema* + *Brachionus* + *Tetraselmis*.

Following the success of egg yolk feeding, other feed substitutes for *P. monodon* larvae were screened. The feeds were homogenized, passed through a 40-60 u mesh net to produce small, detritus-like particles and fed in combination with *Tetraselmis* to *P. monodon* larvae in 20 L plexiglass tanks. There was no significant difference in survival at mysis I among the treatments: 48.3% for cooked egg yolk, 47.8% for whole egg (beaten and poured in boiling water), 33.2% for soybean cake, 41.9% for trash fish, 55.9% for mussel meat and 40.1% for control (*Tetraselmis* alone). Significant higher growth rate was obtained by larvae fed with egg yolk.

Optimum feeding levels of the screened feeds were determined in the second phase of the study. Five feeding levels of prepared feed were tested – 10, 20, 30, 40 and 0 g (control) of feed (10 g of feed diluted in one L seawater). Survival was lower in larvae fed the highest level (40 mL) for both mussel and egg yolk. There was no significant difference in growth rate of larvae fed different levels of egg yolk. For mussel feeding, growth was lower at 0 and 40 mL of feed.

#### **Effect of different levels of aeration and mechanical agitation on development and survival of *P. monodon* larvae**

The first phase of the study was to determine the effect of different air flow rates on *P. monodon* survival. Highest mean

survival at postlarva 5 of 29.9% was obtained at an air flow rate of  $1.575 \pm 0.061$  L/min followed by 26.11% at  $1.100 \pm 0.111$  L/min, 25.97% at  $0.454 \pm 0.222$  L/min and 3.22% at 0 L/min (no aeration). There was no significant difference in growth for all flow levels except for a one-day delay in metamorphosis at 0 L/min.

In the second phase, mean survival at postlarva 5 was not significantly different with aeration (29.4%) compared to continuous agitation (23.2%) by means of paddles driven by an electric motor. Survival with intermittent agitation was significantly lower compared to the first two treatments – 14.0% (agitation every 12 hours) and 10.8% (agitation every 6 hours). No significant differences in growth were observed among all the treatments.

#### **Comparison of natural and artificial feeds for *P. monodon* postlarvae in natural tanks**

Different feeds were tested in the rearing of *P. monodon* postlarvae in 1-ton nursery tanks. After 4 weeks, mean survival was highest with trash fish (46.4%) followed by powdered feed (43.1%), frozen adult *Artemia* (37.4%) and mussel (36.3%).

*Researches focused on the refinement of Penaeus monodon broodstock and small tank hatchery technology and the testing of the technology developed for larval rearing in large tank hatcheries.*



## SEAFARMING

Research activities in the Seafarming Project were aimed at the development of methods for predicting mussel and oyster spatfall and of new technology for oyster and mussel culture.

### Spatfall forecasting for mussel/oyster seed collection

#### A. Himamaylan River-estuary, Negros Occidental

Trends of oyster larvae occurrence in the plankton and in actual spatfall of oysters for 1982 closely resemble those of 1981. In June 1982, very good counts of oyster larvae were recorded, indicating a major spawning of oysters in the estuary. Abundance of oyster larvae in the water was maintained throughout the months of July, August and September 1982. In 1981, high counts of oyster larvae were recorded from June to September, and actual spatfall of oysters was good from July to September 1981.

Spawnings of oysters during 1981 and 1982 are closely associated with salinity drops brought about by heavy rains. The salinity at the Himamaylan River-estuary dropped from summer salinities of 29-31 ppt to salinities of 4-15 ppt within June to August 1982.

Considering the trends in oyster spatfall for the last two years, the best season for collecting oyster seed at Himamaylan would be from July to September. It is recommended that seed collection efforts be spread over these three months. Continuous heavy rains and subsequent salinity-drops would signal the start of the seed-collection season.

#### B. Batan Bay and Banga Bay, Aklan

In Batan Bay, high counts of both mussel and oyster larvae occurred on January and February 1982, and actual settlement of mussel and oyster spats were also observed during these two months. Occurrence of both mussel and oyster spatfall in January and February was associated with lowered salinities (8-7 ppt) which occurred in early December. A positive correlation between

salinity-drops and spawning of oysters was observed in Himamaylan. It is important to note that the best season for collecting mussel/oyster seed is different for different regions of the country.

#### Uptake and depuration of mercury in *Perna viridis*

A sample of the natural mussel (*P. viridis*) population of Batan, Aklan, contained a mean mercury tissue concentration ranging from 0.0048-0.093 ppm wet-weight. This level is way below the statutory limits adopted by the US Food and Drug Administration in food organisms, which is set at 0.5 ppm.

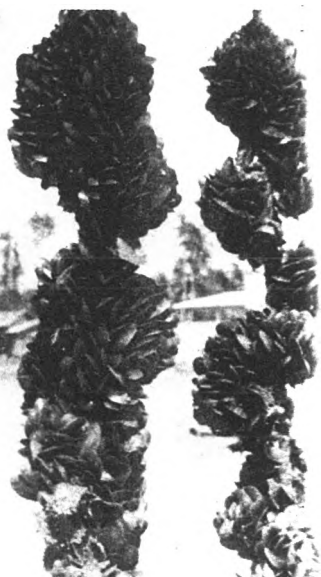
However, *P. viridis* when exposed to higher concentrations of the metal rapidly increased their metal body burden in a very short span of time. When exposed to 10 mg Hg/L concentration for 15 days, the average metal body burden increased to 3.28 ppm. After 45 days exposure, average metal residue increased to 6.31 ppm. Results show that mussels are capable of bio-accumulating mercury.

Self-purging of the metal body burden is a slow process. For 15 days, mercury tissue concentration declined by 43.8% only (to 3.54 ppm). After 151 days of self-cleansing, mercury tissue concentration declined by 83.5% (to 1.012 ppm). The total amount accumulated within 45 days was not completely removed after 151 days. Results show that self-cleansing requires a much longer period than accumulation.

#### Survey and identification of fouling and boring organisms of culture substrates in mussel and oyster farmers

Organisms responsible for the early destruction of shellfish culture substrates have been identified as:

Organisms	Characteristics
Teredinids	
<i>Teredo bartchi</i>	wood-eating borers
<i>Lyrodus pedicellatus</i>	-do-
<i>Bankia carinata</i>	-do-



The appearance of mussels in oyster farms gave rise to the mussel industry that has proven to be as lucrative as oyster culture.

## Pholads

*Martesia striata*

filter-feeding animals  
but bore on wooden  
structures for protection

*Martesia fragilis*

-do-

These species are the principal organisms causing considerable damage to shellfish farms. Holes made by teredinids run parallel to the wood fibers, while those of pholads either run across or are oblique.

Fouling organisms are space competitors of culture substrates, specially in food gathering, as they have similar feeding mechanisms and live within the same biotope. Moreover, foulers increase the deadweight of culture substances causing its early destruction.

Fouling organisms which have been identified are: *Balanus amphitrite*, *B. variegatus cirratus*, *Pteria zebra*, *Pinctada* sp., *Aglophenia* sp., sponges, bryozoans and tunicates.

A bamboo pole vertically placed in water 5-6 m deep showed varying settlement intensity of fouling organisms. After 75 days, 60.1% of the total biomass was two to three meters below the water surface. The foulers were predominantly barnacles of the above genera. Results suggest that this could be the most productive zone within the water column with respect to filter-feeding organisms found in the Batan estuary.

## Potential production and carrying capacity of Batan Bay

Results on the primary production study show a high production value with an average of 200-300 mgC/m<sup>3</sup>/day. The standing stock, through chlorophyll a values, showed an average value of 2-3 mg/m<sup>3</sup>. The area appears promising for a bivalve aquaculture industry.

## NUTRITION AND FEED DEVELOPMENT

Studies were geared towards the development of practical diets for milkfish fry and fingerlings and prawn juveniles.

### Fatty acid composition of *P. monodon* broodstock caught from the wild



*Penaeus monodon* broodstock used in nutrition and feed development studies.

Fatty acid profiles and total lipid levels of broodstock collected from Tigbauan and Batan bays were determined. Analyses were made on the flesh and exo-skeleton of prawn at various stages of maturation.

Results showed that the total lipid concentration reached maximum at the onset of maturation and decreased as maturation continued. Similar trends were observed in both the flesh and exo-skeleton although lipid levels in the flesh (3.9-6.0%) were relatively higher than in the exo-skeleton (1.3-2.3%).

One general characteristic observed in fatty acid pattern was the presence of high levels of long-chain polyunsaturated fatty acids; 20:4w6 (arachidonic), 20:5w3 (eicosapentaenoic) and 22:6w3 (docosahexaenoic) acids regardless of source or location. As the prawn matured, there appeared to be a reduction in 20:4w6 levels in the flesh.

The findings suggest utilization of stored lipids as energy source and of polyunsaturates as essential fatty acid for reproduction.

### The effect of lecithin on growth and survival of prawn juveniles

Four practical diets containing 2% lecithin with cod liver oil or soybean oil were fed to *P. monodon* juveniles for 6 weeks. A completely randomized design with three replicates was followed. Results showed that soybean lecithin at 2% in the diet did not improve growth and survival of juveniles.

### The energy-protein requirement of milkfish *Chanos chanos* Forsskal fingerlings

From previous experiments, semi-purified diets containing 40% protein, 10% fat and 25% carbohydrate gave good growth,

survival and feed conversion rates. These values were used in practical diets for milkfish fingerlings for verification under laboratory conditions.

Results obtained in the first experiment with practical diets showed poor survival, growth and feed conversion. As the amount of vitamin mix was different from that used in the semi-purified diets, another experiment was done using the vitamin mix for semi purified diets at 4 and 6% levels. Survival rate and weight gain were 20 and 35% respectively, higher in those fed the diets containing 6% level of vitamins. Feed conversion was also lower compared to the diet containing 4% vitamin mix. However, further tests are needed.

## NATURAL FOOD

Studies of the Natural Food Project were conducted to isolate various phytoplankton and zooplankton species and to develop techniques for their maintenance and mass culture.

### Techniques for high density culture of selected zooplankton species

Feeding experiments on *Diaphanosoma* sp. were conducted using single algal species like *Tetraselmis* sp., *Chlorella virginica* and *Dunaliella* sp. as food at two feeding levels using 20 liter round flexiglass tanks. The best feed and feeding density level found in the previous experiments were used in the salinity experiments (15, 20, 25, 30 and 35 ppt). A total of three runs were conducted in a completely randomized design with 3 replicates.

Results showed that *Tetraselmis* sp at feeding density of 75-100 x 10<sup>3</sup> cells/ml was the best feed. An increase of 3 times the initial density (1 individual/ml) after 12 days of culture period was observed. There was an insignificant increase in population

density using *Dunaliella* sp. (from 1.0 ind./ml to 1.5 ind./ml) and no increase or reproduction using *Chlorella* sp.

Results further showed that population density of *Diaphanosoma* sp. fed with *Tetraselmis* sp. at feeding density of 75-100 cells/ml was highest at 15 ppt. Initial population (1 ind./ml) was increased by 6 times in 12 days. Increased salinity resulted in a decreased population density or reproduction.

Preliminary results of life support experiment with and without aeration or shelter (nipa leaves) showed better growth or reproduction with aeration and with shelter.

Mass production of *B. plicatilis* in 300 liter round fiberglass tanks using *Chlorella* sp. ( $25-27 \times 10^4$ ), *Tetraselmis* sp. ( $6-9 \times 10^4$ ), and their combination were also undertaken. *Tetraselmis* sp. and *Chlorella* sp. gave the best results. Population increased 13 times in 5 days culture period.

### **Nutritive value of *Artemia* fed with various diets**

Among the different feeds tested (ricebran, copra, corn, soybean, wheat flour) best growth and survival of *Artemia* in air-water-lift operated raceways were obtained with corn and ricebran extracts.

The effectivity of feeding algae (*Dunaliella* sp., *Chaetoceros calcitrans*, *Nannochloris* sp.) with different levels of essential fatty acid (20:5W3) on the growth, survival and biochemical composition of *Artemia* with low percentage of 20:5W3 was tested, with ricebran as control. The fatty acid pattern of adult *Artemia* follows closely those of the feed, with *Chaetoceros* and *Dunaliella*-fed *Artemia* showing significantly better profiles. Best growth was also obtained with *Chaetoceros* and *Dunaliella* as feed while best survival was obtained with ricebran.

For intensive production of *Artemia* in air-water-lift operated raceways, China *Artemia* was found to be the best strain, producing up to 3.5 kg (wet weight) adults per ton in a two-week culture period.



## Preservation and utilization of various locally isolated plankton species

Results of feeding trials using 5-6 month old frozen and dried algae harvested either by centrifugation and chemical flocculation, showed that growth and survival of *P. monodon* larvae fed with preserved algae was inferior to larvae fed live algal cells.

## Exploratory work on the isolation and mass culture of marine yeast

For the mass culture of marine yeast, three culture media were tried on three isolates. 2% molasses, GYEP and coconut water. GYEP medium gave the highest cell count.

Feeding trials using *Saccharomyces cerevisia* and *Rhodotorula aurantica* as food for *B. plicatilis* and *P. monodon* larvae (feeding density  $\times 10^5$ ) suggest that yeast alone cannot support growth and survival of these organisms. They have to be used in combination with other food (i.e., algae) to reinforce their nutrient content. Proximate analyses of 7 isolates show protein values ranging from 25-38%; fat, 1%-6%; carbohydrates 38-69% and ash 6-10%.

## Development of culture techniques for the mass production of selected algal species

The nutritional value and optimum feeding rates of five locally isolated phytoplankton species were determined for the larvae of *P. monodon* ( $N_6$  to  $M_1$ ). The optimum feeding levels ( $\times 10^4$  cells/ml) for each species were as follows: *C. calcitrans* and *Chlorella* sp., 7-10; *Nannochloris* sp., 4-6; *Tetraselmis* sp. and *Dunaliella* sp., 1-3. Data on growth and survival rates indicate that of the five species evaluated, *C. calcitrans*, *Tetraselmis* and *Dunaliella* sp. could be used successfully to rear larvae to the  $M_1$  stage. Poor results were obtained from larvae of *Nannochloris* and *Chlorella*.

### **Suitability of algal/zooplankton species as food for the larvae/fry of milkfish (*C. chanos* Forsskal) and the finfishes**

Preliminary results of feeding trials of milkfish fry using live and frozen *B. plicatilis* and *Moina macrocopa* showed better growth and survival using live *M. macrocopa*. Results also showed better growth and survival of milkfish fingerlings fed with live feed than those fed with frozen feed. Proximate analyses of both live and frozen feed are in progress.

### **Maintenance and mass production of selected algal zooplankton species**

A total of 191,054.75 L or 191 tons of quality starters of algal and zooplankton species have been produced and served to the various projects of the department including private sector, graduate students, research institutions and trainees of the department.

## **PATHOLOGY**

Research studies in the Pathology project were geared towards the isolation and identification of pathogens affecting cultured fish species, development of prophylactic and therapeutic procedures for combatting various diseases, and determination of tolerance limits of aquatic animals to various therapeutic agents.

### **Pathogenicity and control of gram negative bacteria isolated from wild and hatchery-reared milkfish fry and fingerlings**

*C. chanos* fry mortalities associated with the appearance of pinkish to reddish bottom tank sediments were investigated.

Two species of Gram negative bacteria, *Vibrio alginolyticus* and *Banckia* sp, were identified. Preliminary pathogenicity tests using *V. alginolyticus* manifested nonvirulence to healthy milkfish fry. This is opposed to pathogenicity experiments using *Vibrio* bacteria isolated from previous cases which manifested mortalities with increasing concentrations of bacterial inoculum.

#### **Tolerance level and histopathological effects of chemotherapeutic agents to milkfish fry and fingerlings**

Two experimental runs on the tolerance of milkfish fingerlings to formalin and chloramphenicol were conducted. Statistical analyses for the median lethal concentration are ongoing. Histopathological analyses of selected tissues were done.

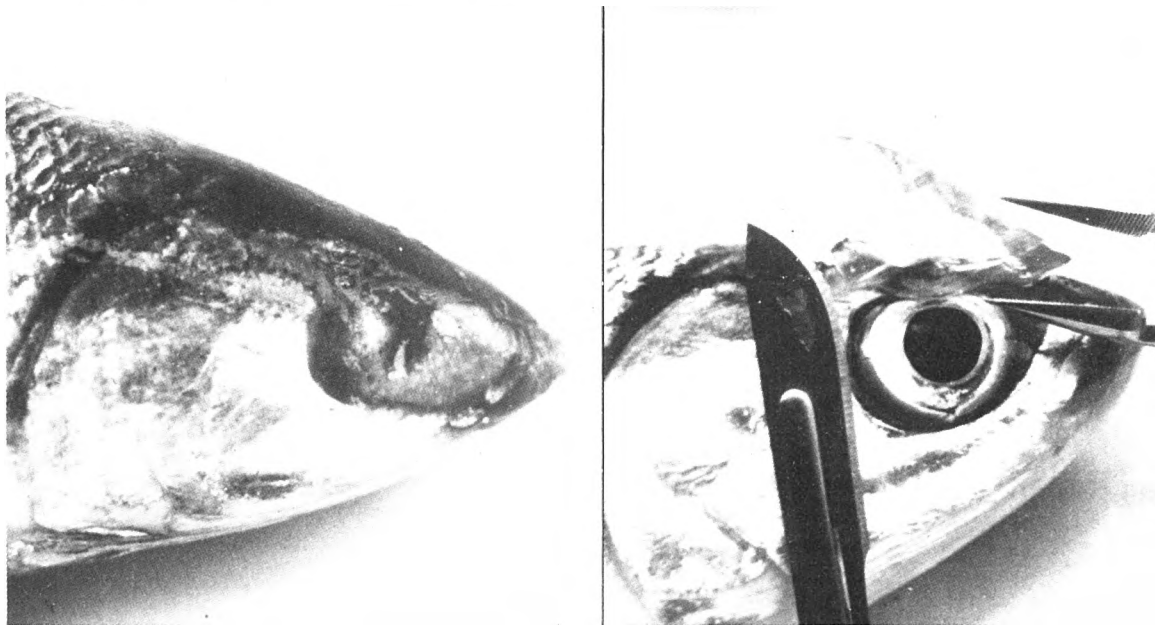
Analyses of gill tissues of oxytetracycline-exposed milkfish revealed significant and extensive damages on the morphological structure. Gill lesions observed were: lamellar detachment, clubbing of the lamellar tips, hyperplasia, fusion, disruption of the gill filamental system, and bending/twisting of the lamellae into abnormal positions.

#### **Bacteriological examination of the milkfish**

*Chanos chanos* with opaque eyes

Milkfish juveniles manifesting eye abnormalities were bacteriologically examined. Results indicated a higher population

*Left photo shows milkfish with opaque eyes; at right, normal-eyed milkfish.*



of bacteria in milkfish with opaque-eye abnormalities in comparison to normal-eyed milkfish. Bacteria associated with opaque-eye abnormalities predominantly consists of *Vibrio* sp. Pathogenicity experiments were conducted using one *Vibrio* sp isolate on milkfish fingerlings with healthy eyes. The opaque eye syndrome was demonstrated experimentally in all test fishes.

### **Investigation of soft-shelled disease among penaeid shrimps in grow-out ponds and culture tanks**

The pathology of soft-shelled disease among penaeids was studied. Data revealed 13 chitinoclastic bacteria isolated from soft-shelled shrimp in contrast to two isolates from hard-shelled ones. The bacteria isolated were identified as *Vibrio* and *Aeromonas* species. Two infectivity experiments using a chitinoclastic *Vibrio* isolate did not result in soft-shelling. Histological examination of soft-shelled shrimp showed disrupted cuticle layers and heavier *Zoothamnium* infestation in comparison with hard-shelled shrimp. There was no significant difference in the thickness of the epicuticle and endocuticle.

No significant deterioration of water quality parameters (pH, NO<sub>2</sub>-N, NH<sub>3</sub>-N, PO<sub>4</sub>-P, hardness, turbidity and Ca<sup>++</sup> concentration) was noted. Protein, fiber and ash contents were slightly higher among hard-shelled shrimps, while moisture was higher in soft-shelled shrimps. No significant difference was found between the Ca: P ratios.

### **Identification and pathogenicity of bacterial pathogens of hatchery-reared penaeid larvae**

Weak and moribund penaeid larvae, *P. monodon*, at mysis 3 to postlarvae, from barangay hatchery were examined for the presence of bacteria. From the investigations gathered, rearing tanks for this batch of larvae contained pinkish debris coloration attached to the bottom and sides of the fiberglass tanks. The debris were scraped and microscopic examination showed a cong-

lomeration of diatom and pink debris with bacteria, some protozoans and amoeba. Further microscopic examination of the larvae showed pinkish coloration on the gut while others were empty. Water medium used in rearing was also seen to contain motile bacteria, four of which were identified to belong to the genus *Vibrio* and one species of *Flavobacterium*.

In a separate study, cultured *P. monodon* postlarvae (stage 15) from big hatchery tanks were submitted for diagnosis. Clinical signs showed the larvae becoming whitish and mostly weak. Microscopic examinations revealed the presence of *Leucothrix*-like filamentous bacteria attached heavily to the pereopods, pleopods, and gills of the larvae. Attempts were made to isolate the bacterium, but failed to grow in both Cytophaga and Saboraud Agar.

#### **Investigation on intestinal bacterial flora of milkfish, *C. chanos* and prawn, *P. indicus* cultured in ponds with poultry**

The total population of intestinal bacteria of milkfish and *P. indicus* cultured in ponds with poultry were determined. Results showed that the mean bacterial colony forming units from prawn are slightly higher than those from milkfish. No significant differences, however, were noted among samples taken from ponds with 25 heads poultry, 50 heads poultry and 75 heads poultry and without poultry. Also, no human pathogenic bacteria were isolated from all fish/prawn samples.

#### **Identification and characterization of the physiological properties of *Pseudomonas* sp. isolated from cultured *Sarotherodon niloticus***

Morphological and biochemical characterizations were done to identify the species of the *Pseudomonas* sp. isolated from *S. niloticus* fry. The test bacterium is identified as an undescribed strain of *Pseudomonas fluorescens*.

Physiological responses of the bacterium to various environmental conditions were tested in varying levels of temperature, NaCl and pH. Its viability was further tested in different types of water. Optimum growth temperature requirement is 25°C to 30°C with growth inhibited at 4°C and at 42°C. Temperature tolerance ranged from 10°C to 41°C when incubated for 11 days. Optimum NaCl requirement for growth is 0 to 15 ppt with growth prevented at 70 ppt. Tolerable NaCl concentrations ranged from 0 to 50 ppt when incubated for 11 days. pH requirement for growth was optimum from 5.0 to 8.4. pH 4.6 and 10.6 were inhibitory with tolerable ranges of 5.0 to 9.7 at 11 days incubation period. Furthermore, the test bacterium, *P. fluorescens*, remained viable and multiplied in freshwater sources i.e. shallow well, MIWD drinking water, freshwater pond, dam, cold and hot spring, and river up to 148 days incubation period. Growth in brackishwater is limited to 50 days. Seawater is a detrimental medium for its growth.

#### **A study on bacterial purification of oysters using different sterilizing methods for seawater**

Two preliminary runs on oyster purification were conducted from August to September 1982. Polluted oysters high in coliform bacteria were depurated using treated seawater in a flow-through-water system.

The first preliminary run conducted showed good results after 72-hour purification. A level of 13 MPN/100 gm was attained for oysters depurated under UV-treated seawater; 46 MPN/100 g for filtered seawater; 79 MPN/100 gm for chlorine; 79 MPN/100 gm for control; 110 MPN/100 gm for iodine treated seawater and 170 MPN/100 gm for ozone treatment. The oysters used had an initial coliform count of 2400 + MPN/100 gm.

The results of the second preliminary run were quite erratic and showed poor results. Results indicated no significant difference among the various treatments and although it showed that the oysters were depurating, the levels attained were not within the accepted values.

## ECOLOGY

Research activities of the project were geared towards the identification and characterization of milkfish fry grounds, and nursery and spawning grounds of *P. merguiensis* and *P. indicus*.

### Characterization of milkfish fry grounds

Field data were gathered in Hamtik, Antique in 1981 and 1982 to characterize milkfish fry grounds. Results showed that:

- fry occur in Hamtik waters almost all year round but are collected intensively from March to December;
- fry occur most abundantly from March to June while fry occurrence is low during the months of July to December; and
- physical and hydrographic conditions play important roles in fry abundance.

Further, the lunar cycle, tide, time of the day and wind direction have indirect influences on fry but these do not significantly determine fry abundance at any particular period. Peak milkfish fry collections were observed in the months of April and May. Fry records obtained this year indicate a drop in the number of fry gathered compared to last year.

### Identification & characterization of prawn nursery and spawning grounds (especially *P. merguiensis* and *P. indicus*)

Studies to identify and characterize prawn nursery and spawning grounds at Batan and Banate Bay yielded the following results:

- small-size *P. merguiensis* and *P. indicus* spawners appeared throughout the year with varying monthly abundance in



*Milkfish fry occur almost all year round but are collected intensively from March to December.*

Batan Channel and Banate Bay shoreline but were absent in rivers from December to February;

- larval stages of penaeids were found in interior bays but more abundantly in the channel and offshore areas.

Postlarval stages of penaeids are abundant in the shoreline rather than in water edges of mangrove swamps, which indicate that channels and offshore waters may be primary spawning grounds, while interior bays and rivers are secondary spawning grounds. Peaks of abundance of *P. merguiensis* were observed during the new moon periods while those of *P. indicus* followed no definite trend.

However, abundance of *P. merguiensis* spawners differ according to location. In inner bays, spawners were abundant during the quarter moon periods while in shoreline and offshore areas, spawner peaks were during the new and full moon phases.

It was further observed that there was an abrupt decrease in catch of *P. merguiensis* adults in rivers and inner bays from January to June. A gradual rise was observed in swamps. Moreover, size distribution of carapace lengths of *P. merguiensis* suggest that the channel and offshore areas are utilized as primary spawning grounds while the inner portions of the bay as nursery grounds and secondary spawning grounds. Tide, temperature, salinity, transparency and time of day may have indirect influences on postlarvae but these do not seem to significantly determine fry abundance at any particular period.

## LEGANES RESEARCH STATION

The activities of the Leganes Research Station strongly complement those of the Tigbauan Research Station. Research studies focused on monoculture and polyculture of prawn and milkfish and other forms of integrated farming.





*Research activities at the Leganes Station are focused on monoculture and polyculture of prawn and milkfish.*

## Finfish Culture

### Increased surface area using substrates for milkfish fingerling production

A study was conducted to determine the effectivity of nylon screen substrates in increasing surface area attachment of fishfood organisms and its effect on growth and survival rates of milkfish fingerlings in brackishwater nursery pond.

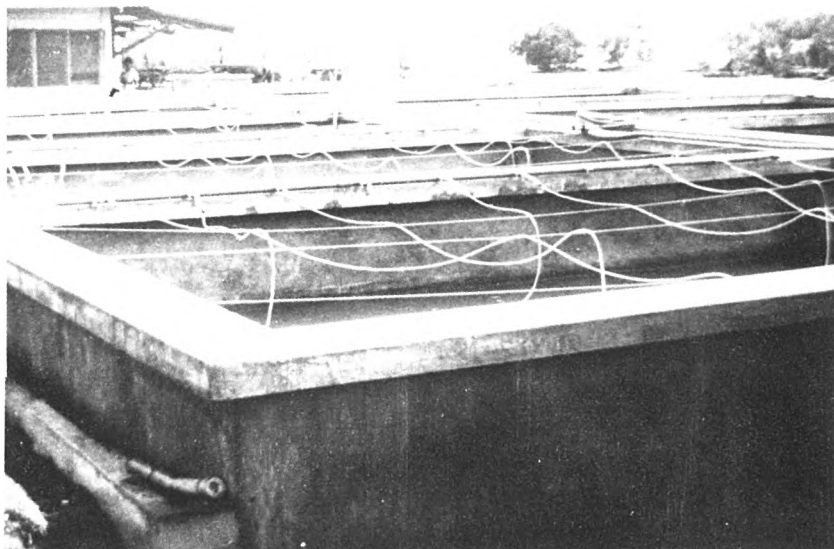
Prior to stocking, one-1,500 m<sup>2</sup> pond was prepared following the lab-lab method. Nylon screen substrates were installed across the pond bottom to increase the area by 60%. Milkfish fry from the wild (0.0066 g) were stocked at the rate of 50 fry/m<sup>2</sup> and cultured for 60 days. Periodic stock sampling and monitoring of physico-chemical parameters were done.

Results, after three runs, showed considerably high survival rate of 81.20% with final mean weight of 4.04 g and mean length of 74.92 mm. Lab-lab growth (attached and floating) appeared abundantly at the start but started to decline towards end of

the culture period. However, nylon screen substrates kept an abundant periphyton growth upon which the stocks fed until the end of the culture period.

### **Multiple stocking and selective harvesting of milkfish in grow-out ponds with different sizes of algal nurseries**

The study was conducted to determine the most suitable algal nursery pond size and its effect on the growth and survival of milkfish. The following treatments were tried on twelve 350 m<sup>2</sup> earthen ponds: Treatment I – 3% of the culture area as algal nursery; Treatment II – 6%; and Treatment III – 12%. Ponds with no algal nurseries served as the control. Fingerlings ranging from 7-13 g were stocked at 3,000 fish/ha and later



*The newly constructed facilities of the Integrated Prawn Production Research Project at the Leganes Research Station.*

increased to 6,000 fish/ha after 45 days. Culture period for the two batches was 135 days.

No significant difference was observed in growth and survival rates of milkfish in all treatments. Results, for the first batch of fish stocked, showed that the control group had the highest growth of 135.0 g/fish while Treatment II had the lowest (110.7 g/fish) with survival rates of 99.1 and 93.0%, respectively. With the second batch, the control group still had the highest growth rate (203.9 g/fish) while Treatment III had the lowest (176.6 g/fish). Highest survival rate was obtained in Treatment I and II (100% each) while the control had the lowest (93.3%).

In spite of lab-lab abundance, growth was lower for the second run. This could be due to the different seasons during which the runs were conducted.

There was no significant difference observed among treatments for the third run. The control group yielded the highest growth (126.91 g/fish) and the lowest was that of Treatment III (122.77 g/fish) for the first batch. With the second batch, however, Treatment III gave the highest growth (157.97 g/fish), and treatment I gave the lowest (137.11 g/fish). Survival rates for the third run were: 99.5% for control; 98.3% for Treatment III; 93.8% for Treatment I; and 89.8% for Treatment II. Poor growth of fish for the third run could be due to unfavorable weather conditions (rains & storms) which prevailed during the culture period, limiting natural food production in ponds.

## CRUSTACEAN CULTURE

### Optimum stocking density of tiger prawn in intensive culture

An experiment on intensive (grow-out) culture of *P. monodon* was conducted using nine 600 m<sup>2</sup> earthen ponds. Three stocking densities of 4, 8 and 12/m<sup>2</sup> was tried with three replicates. Formulated crustacean diet (45% crude protein) was given twice daily at 10% body weight.

Results showed that juveniles ( $P_{35-37}$ ) stocked at 4 and 8/m<sup>2</sup> with an initial average weight of 0.5984 g had an average weight gain of 7.405 and 6.191 g, respectively. Those stocked at 12/m<sup>2</sup> with an average weight of 0.4564 g had a weight increment of 4.815 g.

### **Feed and feeding scheme of prawn postlarvae**

Rearing experiments on postlarval stages of *P. monodon* ( $P_5$  to  $P_{36}$ ) in 200 m<sup>2</sup> earthen nursery ponds were conducted.

Phase I of the study was the evaluation of the postlarva's preference to supplemental diets. Two types of locally available feeds were tested: meat of the shellfish, *P. viridis*, and a commercial pellet. The control group was initially inoculated with newly hatched *A. salina* nauplii prior to stocking. Three replicates were provided for each treatment. A stocking density of 150 m<sup>2</sup> was maintained in all nursery ponds. Feeding was twice daily at the rate of 30% total biomass.

Results showed that while the diet consisting purely of minced mussel gave better weight gain, survival from  $P_5$  to  $P_{35}$  was inferior after 30 days of culture period. Weight gain and survival rates for  $P_5$  (initial weight = 0.00473 g) were 0.834 g and 3.6% from mussel meat diets and 0.740 g and 7.2% for the commercial pellet. Those in the control ponds had an overall weight increment of 0.673 g and a survival rate of 7.2%. The major constraint to increased production was the difficulty in maintaining good water quality. This could have been due to lower pond elevation resulting in lower water depth.

Phase II of the experiment was conducted to verify the postlarvae's preference for the commercial pellet. Diet effectivity was tested in three 600 m<sup>2</sup> earthen ponds. Stocking density was reduced from 150 to 110/m<sup>2</sup>. Final weight gain average after 30 days was 0.2492 g and survival rate was 32%.

### **Intensive culture of *P. monodon* at different stocking densities using an aquamill**

The effect of aquamill on the growth and survival of *P. monodon* stocked at 10 ind./m in four-200 sq m concrete

dikes for four and a half months was studied. Two of the ponds were provided with an aquamill, while the other two served as control.

Higher survival and production rates of 61.9% and 23.71 kg respectively were obtained in the control ponds compared to those of the experimental ponds (51.6% and 21.01 kg, respectively). However, growth rate in the experimental ponds (20.70 g) was higher than those in the control (18.54 g) ponds. Bigger marketable sized prawns (25 g) were also obtained from the aquamill ponds.

## **POLYCULTURE**

### **Growth and survival of milkfish and prawn fry at varying stocking ratios**

Twelve 144 sq m ponds were used for the following treatments: I – Monoculture – 7,200 milkfish; II Polyculture – 2: 1 (7,200 milkfish + 3,000 prawn fry); III – Polyculture – 3: 1 (7,200 milkfish + 2,400 prawn fry); and IV – Polyculture – 5: 1 (7,200 milkfish + 1,450 prawn fry).

Initial data analysis showed an overall survival rate of 86.62% for milkfish and 24.31% for prawns. Treatment IV and III gave favorable survival rates of 85.96% and 85.83% for milkfish and 27.37% and 24.31% for prawn fry, respectively.

### **Polyculture of *P. monodon* and *P. indicus* with milkfish**

Growth, survival and production rates of *P. monodon*, *P. indicus* and milkfish in a polyculture system were evaluated in four-1 ha ponds provided with peripheral canal. Ponds were prepared using the lab-lab method of preparation. Stocking of *P. monodon* (6,000/ha) and *P. indicus* (12,000/ha) fry was done simultaneously. Milkfish fingerlings were stocked one month

later. As it was assumed that milkfish and *P. indicus* feed on lab-lab, only *P. monodon* was fed with formulated crustacean feed, every other day, at 5-10% body weight, adjusted every month at an assumed survival rate of 100%. Culture period for *P. monodon* and *P. indicus* was 120 days and 90 days for milkfish.

Results, after three runs, showed that during rainy season, *P. monodon* attained an average weight, percentage survival, and production of 23.3 g, 64.6% and 80.8 kg/ha; *P. indicus* reached 14.3, 67.7% and 97.7 kg/ha; and milkfish at 228.7 g, 98.2% and 447.2 kg/ha, respectively. During summer *P. monodon* attained an average weight, percentage survival and production of 21.0 g, 15.3% and 19.1 kg/ha; *P. indicus* at 11.6 g, 14.5% and 19.7 kg/ha, and milkfish reached 369.3 g, 97.3% and 718.1 kg/ha, respectively.

#### **Production and economics of integrated farming of *P. indicus*, *C. chanos* and poultry in brackishwater ponds**

The production and economics of polyculture integrated with poultry was started in twelve 1,000 sq m earthen ponds. Treatments consisted of varying densities of chicken layers at 0, 25, 50 and 75 heads with 1,100 *P. indicus* and 225 *C. chanos* per pond. Results of the second run indicated a significantly higher production of both milkfish and shrimps at the ponds with poultry. Results of the recent monthly stock sampling showed better growth rate of shrimps with poultry with no significant difference on milkfish growth rate.

## **ARTEMIA CULTURE**

### ***Artemia* production in earthen ponds**

A series of experiments and production trials were conducted during the dry season (February-June) of 1980-1982 to develop

or modify techniques for *Artemia* production in shallow earthen ponds. Area of pond ranged from 42 to 60 sq m for experimental compartments and 825 to 3,960 sq m for production compartments, with water depths averaging 0.2-0.3 m. A PVC-corer type sampler was designed for *Artemia* population studies. The best strains tested as inoculum were Brazil and San Pablo Bay (Batch 1628) *Artemia*, with the most stable population obtained at a stocking density of 40 individuals/L. Fertilization of the ponds once in two weeks with inorganic fertilizers at a rate of 50 kg/ha, composed of 2/3 monoammonium phosphate (16-20-0) and 1/3 urea (46-0-0) greatly increased growth and survival of *Artemia*. Under suitable conditions, cyst harvest reached 7.45 kg/ha/month for Brazil *Artemia* – inoculated pond and 3.23 kg/ha/month for that with San Pablo Bay – mother strain. Maximum *Artemia* biomass was 154.30 g dry weight/m<sup>3</sup>. Quality of locally-produced cysts was significantly better than the mother strains.

### Nutritive value of *Artemia* fed with various diets

Among the different feeds tested (ricebran, copra, corn, soybean, wheat flour), best growth and survival of *Artemia* in air-water-lift operated raceways was obtained with corn and ricebran extracts.

The effectivity of feeding algae (*Dunaliella* sp., *C. calcitrans*, *Nannochloris* sp.) having different levels of essential fatty acid (20:5W3) on the growth, survival and biochemical composition of *Artemia* having low percentage of 20:5W3 was tested, with ricebran as control. The fatty acid pattern of adult *Artemia* followed closely those of the feed, with *Chaetoceros* and *Dunaliella*-fed *Artemia* showing significantly better profiles. Best growth was also obtained with *Chaetoceros* and *Dunaliella* as feed while best survival was obtained with ricebran.

For intensive production of *Artemia* in air-water-lift operated raceways, China *Artemia* was found to be the best strain, producing up to 3.5 kg (wet weight) adults per ton in a two-week culture period.

*Production trials are conducted to develop and/or modify techniques for Artemia production in shallow earthen ponds.*



## **AQUACULTURE ENGINEERING**

Studies were conducted to develop standard pond engineering designs and to develop and improve pond engineering techniques.

A study was conducted to develop a standard secondary gate design. Prefabricated panels were installed in newly constructed ponds. Results showed that the design is of a better structural material than the traditional wooden gate and is more economical than the cast-in-place concrete.

The performance characteristics of the axial flow pumps for aquaculture was evaluated. An axial flow pump prototype using the standard small boat propeller (21.6 cm diameter) with a 5.6 KW electric motor prime mover was mounted on a wooden flotation. Minor adjustments were made after several test runs.



## **BINANGONAN RESEARCH STATION**

Research activities at the Binangonan Research Station are centered on three main areas, namely, Ecology, Fish Culture and Socio-Economics.

### **ECOLOGY**

Studies were conducted to evaluate factors affecting turbidity and productivity of Laguna de Bay; determine the limnological parameters of selected lakes in Luzon for pen and cage culture; and establish the major groups of benthic fauna in Laguna de Bay.

#### **Primary and secondary production studies in West Bay, East Bay and Central Bay and its relation to fish production**

Water samples were collected weekly in Central Bay and every second week in East and West Bays. The samples were analyzed for plankton composition and biomass. The production of phytoplankton was determined with C-14 and chemical parameters were determined using standard procedures.

Production of plankton followed the same pattern in 1982 as described earlier for 1981. All these bays experienced low production before April and after October. The seawater intrusion took place in April and production and biomass of plankton increased following this phenomenon. Primary production for this year was: West Bay, 857; Central Bay, 937; and East Bay, 847 gm C/m<sup>2</sup>/yr. These figures are higher than the figures for 1981 with: West Bay, 19.6%; Central Bay, 55.1%; and East Bay, 34.8%. Results show that primary production, as measured with C-14, has not declined despite an increase in the number of fishpens and cages in the lake.

### **Preliminary study on the determination of conversion factor between natural food and fish growth**

A two-horsepower electrical pump supplied water to five aquaria, with water flowing continuously for 24 hours. Inflowing and outflowing water were analyzed for chemical and plankton biomass. Weight increments of tilapia fingerlings stocked in the aquaria were measured monthly using a mettler balance.

Despite many problems with the setup (flow of water) one set of good data was obtained. From September 13 to October 11, 1982, two aquaria were stocked with fingerlings. In 28 days, the fish increased in weight – 25% in aquarium one and 25.4% in aquarium two. A conversion factor was computed based on the amount of zooplankton retained by the system which gave a value of 2.2 in aquarium one and 2.3 in aquarium two. The inflowing water is still being analyzed for other potential sources of food as the values indicated a very efficient conversion of natural food to fish flesh.

*Studies are conducted to determine the limnological parameters of selected lakes in Luzon for pen and cage culture of tilapia.*



### **Limnological survey of some lakes in Luzon Island, Philippines for pen and cage culture potentials**

Taal, Naujan, Paoay, and Buhi and Bato Lakes were visited at least twice and in two different seasons. Secondary data were collected from BFAR, U.S. Peace Corps Volunteers, fishermen and local municipal offices. Primary data were collected on the spot: Morphometry, inflowing rivers, outflowing rivers, depth, water chemistry, physical data and collection of plankton samples and measurement of production.

Naujan Lake was found to have a good potential for tilapia cage culture. The same is the case for Buhi and Bato Lakes. Taal Lake has potentials for cage culture of fish, but if tilapia is considered, the food production in this lake appears to be too low. Feeding is probably required. Paoay Lake has a potential for culture of grass carps directly in the lake, but the production of plankton is too low to support any substantial production of plankton-eating fish.

## **FINFISH CULTURE**

### **Milkfish**

Studies on milkfish were conducted to determine factors affecting survival of fry during acclimation from brackishwater to freshwater; fry to fingerling production in tanks and cages; and, efficiency of plankton as natural food in rearing milkfish fry to fingerling.

#### **Factors affecting survival of milkfish fry during acclimation to freshwater**

Four separate batches of wild milkfish fry were acclimated to freshwater in white basins with a continuous inflow of fresh water and outflow of brackishwater over 60, 24, 18, 12, 9, 6 and 3-hour acclimation periods at ambient temperatures ranging from 26 to 28°C. Flow rate of freshwater was dependent on the acclimation period. Survival rates of the fry immediately after acclimation and after 10-days rearing in aquaria were determined.

Survival rates immediately after acclimation did not indicate optimum duration of acclimation. Survival rates after 10 days of rearing was highest at 12-hour acclimation period for the second, third and fourth batches of fry (Table 2). The 3-hour acclimation period had variable results. Although it gave the highest survival rate for the first batch of fry, the 3-hour acclimation gave much lower survival rates than the 12-hour acclimation for the second, third and fourth batches of fry. A similar trend was obtained when the overall survival rates were computed. Survival rates obtained at 6-hour and 9-hour acclimation periods were lower than the survival rate at 12-hour acclimation. Longer acclimation periods did not necessarily increase survival rates above those obtained at 12-hour acclimation. Water quality parameters (D.O., pH, total NH<sub>3</sub>-N and temperature) were very similar for all treatments per batch and there was no indication

that water quality based on the measured parameters deteriorated with longer durations of acclimation.

There is evidence that the performance of the four batches of fry was not the same. This could be due to the physiological state of the fry as influenced by the diverse conditions they may have been subjected to in the process of collection, sorting, counting, storage and transport.

Types of feeds, feeding rates and frequency, and stocking rates during a 12-hour acclimation were assessed. Boiled egg yolk and artificial dry diets were suitable food for the fry. With the use of an artificial dry diet, a minimum feeding rate of 5% of fish biomass with two feedings a day was sufficient. A stocking rate of 500 fry/L during acclimation gave the best survival rate.

**Table 2A. Mean survival rates (%) of the four batches of milkfish fry immediately after acclimation. Initial salinities were 30, 34, 22 and 24 ppt., respectively.**

Duration of acclimation (hrs)	1 n.s.	B A T C H			
		2*	3*		4*
60	96.9	92.8 <sup>c</sup>	92.1 <sup>b</sup>		93.2 <sup>ab</sup>
24	96.7	93.9 <sup>bc</sup>	97.4 <sup>a</sup>		93.5 <sup>ab</sup>
18	**	95.9 <sup>abc</sup>	97.4 <sup>a</sup>		93.5 <sup>ab</sup>
12	95.3	95.1 <sup>abc</sup>	97.9 <sup>a</sup>		93.3 <sup>ab</sup>
9	94.8	96.8 <sup>ab</sup>	98.8 <sup>a</sup>		91.5 <sup>b</sup>
6	94.8	96.3 <sup>ab</sup>	97.6 <sup>a</sup>		95.9 <sup>a</sup>
3	96.9	98.1 <sup>a</sup>	91.1 <sup>b</sup>		94.4 <sup>ab</sup>

n.s. Means are not significantly different ( $P > 0.05$ ).

\* Means with the same superscript are not significantly different ( $P > 0.05$ ).

\*\* No data. Water flow was too fast.

**B. Mean survival rates (%) of the four batches of milkfish fry 10 days after acclimation.**

Duration of acclimation (hrs)	1*	2 <sup>n.s.</sup>	3 <sup>n.s.</sup>	4*
60	96.2 <sup>ab</sup>	90.0	89.2	87.2 <sup>a</sup>
24	95.3 <sup>b</sup>	91.8	94.0	87.5 <sup>a</sup>
18	**	92.7	93.5	77.5 <sup>ab</sup>
12	97.2 <sup>ab</sup>	93.5	94.7	87.7 <sup>a</sup>
9	98.0 <sup>a</sup>	90.5	93.5	81.0 <sup>ab</sup>
6	96.3 <sup>ab</sup>	90.2	89.0	79.8 <sup>ab</sup>
3	98.5 <sup>a</sup>	92.0	87.3	70.2 <sup>b</sup>

<sup>n.s.</sup> Means are not significantly different ( $P > 0.05$ ).

\* Means with the same superscript are not significantly different ( $P > 0.05$ ).

\*\* No data.

**Effect of feeding different algal species  
on growth and survival of milkfish fry**

Acclimated milkfish fry were continuously fed unialgal cultures of five species of freshwater algae. Results showed that growth and survival of milkfish fry were greatly enhanced when given natural feeding of *Oscillatoria quadripunctulata* (Figure 1). The other species of blue-green alga tested, *Chroococcus dispersus*, gave a minimal increase in weight of fry up to 20 days of rearing. As the milkfish fry grew older, *Chroococcus* became more acceptable based on the increase in weight. On the other hand, milkfish fry fed with *Navicula notha*, *Chlorella ellipsoidea* and *Euglena elongata* showed heavy mortality throughout the growing period.

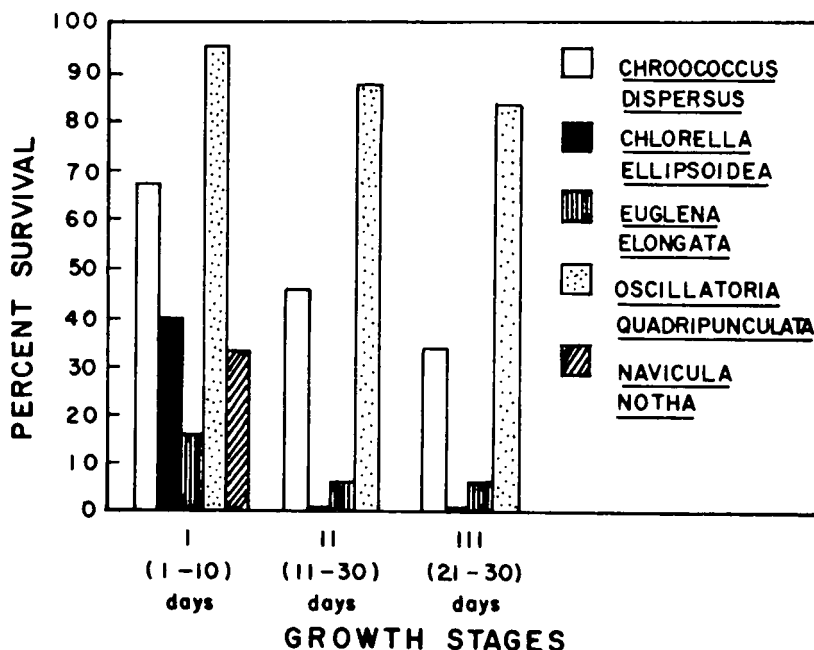


Fig. 1. Survival of milkfish (*Chanos chanos*) fry given different algae as natural food.

Another experiment was conducted using three species of algae only, fed singly or in combination, to milkfish fry. Growth rates and survival values were high when fry were fed with *Oscillatoria* alone or a combination of *Oscillatoria* and *Chroococcus*. The diatom, *Navicula* seemed to be unacceptable because of the poor growth and survival of fry given this type of natural food.

#### Culture of *Oscillatoria quadripunctulata*

Unialgal cultures of *Oscillatoria* were established in the laboratory in synthetic media. Larger volume of cultures were also prepared for semi-large scale production using 1) organic

medium consisting of equal amounts of ipil-ipil leaf meal and duck manure extract and 2) inorganic medium consisting of NPK (14-14-14).

Results showed that growth of *Oscillatoria* outdoors was visible earlier in the inorganic (NPK) medium than in the organic medium. Peak harvest of 1.17 g dried *Oscillatoria* was obtained after 15 days in the inorganic medium. On the other hand, the highest value of algal biomass was obtained after 20 days in the organic medium. The yield of 1.5 g dried *Oscillatoria* was sustained for another five days in this treatment, compared to an immediate collapse of culture using the NPK fertilizer.

Outdoor production of *Oscillatoria* seems very promising based on the high yield obtained in both types of media tested. Compared to recent reports on the laboratory culture of *Chlorella* in the Philippines, which gave a value of 0.12 g, possible production from *Oscillatoria* is about twelve times more. The feasibility of *Oscillatoria* being used as a direct food for milkfish fry to fingerling production depends on the relative ease and cost of sustaining growth of the species under varying environmental conditions.

#### **Comparative effects of green water and manure on growth of *Moina macrocopa***

*M. macrocopa* was grown in six rectangular tanks (25 x 36 ¼ in) in two types of media: cow dung and green water (fertilized Laguna Lake water). No additional fertilization with manure was done after the inoculation of *Moina* in tanks. For the green water medium, weekly replenishment of the culture tank was made to maintain the desired phytoplankton concentration.

Growth of *Moina* in green water was sustained throughout the 24-day culture period. However, it took a longer time for *Moina* to reach peak growth compared to those in the cow dung medium. The maximum population observed in green water was 6,120 individuals/L.

In the cow dung medium, growth of *Moina* reached its peak on the 9th day with a population density of 3,825 animals/L. A sudden decrease in population was noted after three days of

peak growth. However, growth was resumed later, reaching a maximum density of 5,878 animals/L on the 15th day.

Aside from food availability, temperature fluctuations seemed to be one of the critical factors in growing *Moina*. Correlation between temperature and growth of *Moina* will be investigated later.

Due to the relative ease of producing green water compared to handling animal manure, large-scale culture of *Moina* with algae seems to be a better alternative.

#### Comparative effects of *Moina* and *Chlorella* fed singly or in combination to milkfish fry

Milkfish fry (5 mg) were given: a) *Moina*; b) *Chlorella*; and c) *Moina-Chlorella* combination as natural feed.

Results of the experiment showed the acceptability of the zooplankton, *Moina* as feed even at the early stages of develop-

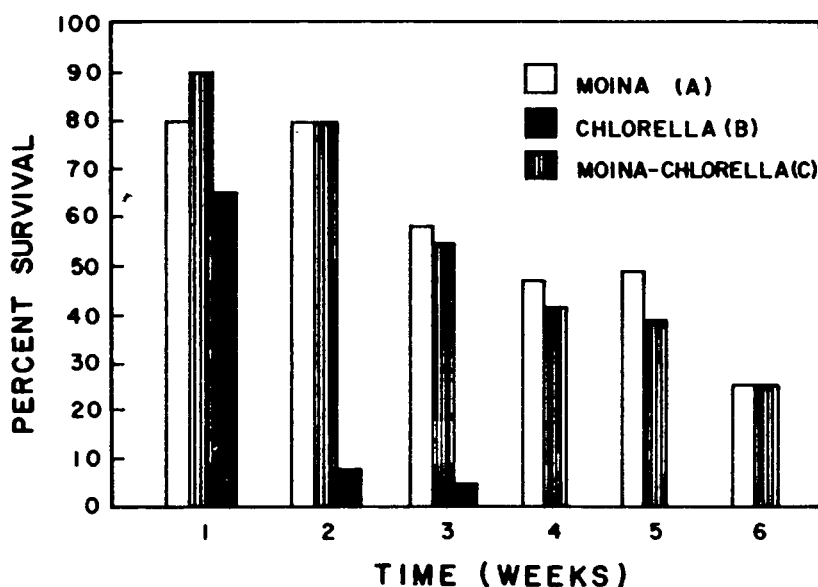


Fig. 2. Percent survival of milkfish fry in various treatments.



ment. This can be observed in the percentage of survival during the first two weeks of rearing in Treatments A and C (Fig. 2). Based on weekly percentage of weight increment of bangus fry during the six-week rearing period, growth was highest in the *Moina-Chlorella* combination (Table 3). This may be attributed to the presence of *Chlorella* in the water which is eaten by *Moina* thereby maintaining its population. Numerous gravid females were observed in the treatment *Moina-Chlorella* combination compared to the treatment *Moina* alone.

Feeding *Chlorella* alone to milkfish gave very poor survival which lasted only up to the third week of rearing.

Gut content analysis showed that *Moina* can be ingested wholly by the fry, as revealed by the presence of fully packed and intact *Moina* in the stomach. However, some parts of *Moina* such as the filtering setae, legs and antennae appeared indigested. They were shown intact in the posterior of the gut down to the anus.

**Table 3. Weekly percentage of weight increment of bangus fry given *Moina*, *Chlorella*, *Moina-Chlorella* combination as food.**

Treatments	Initial Wt. (mg)	Final Wt. (mg)	% Wt. Increment
A. Feeding with <i>Moina</i>	5	121	386.7%
B. Feeding with <i>Chlorella</i>	5	0	0
C. Feeding with <i>Moina-Chlorella</i>	5	136	436.7%

#### **The growth and nutritional relationships between *C. dispersus* and its associated bacteria in culture**

To determine the benefits derived from each other in terms of growth, *C. dispersus* and three types of bacteria isolated from

Laguna lake water were grown singly or in combination in the laboratory. Growth measurements were done every three days for both algae and bacteria.

In the other experiment, the percentage of metabolic products released by *C. dispersus* and bacteria in the medium were monitored through  $^{14}\text{C}$ -labelling. Moreover, the assimilation of algal metabolic products by bacteria and the assimilation of bacterial metabolites by *C. dispersus* were determined by  $^{14}\text{C}$ -labelling.

Growth of *C. dispersus* was greatly enhanced in the presence of bacteria. The growth curve of *C. dispersus* with bacteria showed an increase of about 100% in algal population. A short lag period, a distinct logarithmic phase giving rise to a rapid increase in the algal population within 12-15 days, was also seen. It also showed a long stationary phase followed by a decline in cell density, usually after 21 days.

On the other hand, the growth curve of *C. dispersus* without the bacteria showed a pronounced lag phase lasting for as long as nine days and a short stationary phase.

When the different bacteria were grown in the presence of *C. dispersus*, a less pronounced effect of the algae on the bacteria was observed. The three types of bacteria grown singly gave lower population counts than those grown in association with the blue-green algae.

The percentage release of assimilated inorganic labelled carbon ( $^{14}\text{C}$ ) in the form of excretory metabolites by *C. dispersus* was 19.44%. Bacteria assimilated 6.68% of these algal metabolites of its own cellular functions. On the other hand, bacteria released 11.26% of its assimilated ( $^{14}\text{C}$ ), *C. dispersus* assimilated 47.43% of the bacterial excretory metabolites (Table 4).

**Table 4. Computation of % assimilation of algal/bacterial excretory metabolites.**

	<u>By Chroococcus</u>	<u>By Bacteria</u>
1. Corrected LSC counts (cpm) after 12 hrs incubation with $\text{Na}_2\text{h } ^{14}\text{CO}_3$	122577.62	14198.5
Biomass (dry wt, mg)	30.8	3.12

2. Corrected LSC counts (cpm) after 3 days excretion Biomass (dry wt, mg).	96196.37 29.65	12312.22 3.17
3. % $^{14}\text{C}$ excreted (determined from media)	19.44	11.26
4. % $^{14}\text{C}$ retained in cells	78.48	86.71
5. Corrected LSC counts (cpm) of algal excreted products assimilated by bacteria Biomass (dry wt, mg)		1592.73 3.28
6. Algal excreted products assimilated by bacteria in %	—	6.68%
7. Corrected LSC counts (cpm) of bacterial excreted products assimilated by <i>Chroococcus</i> Biomass (dry wt, mg)	904.85 35.55	— —
8. Bacterial excreted products assimilated by <i>Chroococcus</i> in %	47.43%	—

\* Data are means of 6 replicates.

The growth and nutritional relationships between *C. dispersus* and bacteria can now be explained in terms of the benefits they derive from each other. Enhanced growth of *C. dispersus* in the presence of bacteria may be due to the algal assimilation of organic nutrients produced by bacteria in the form of excretory metabolites. Similarly, enhanced bacterial growth may be due to the assimilation of algal excretory metabolites by bacteria.

## TILAPIA

Studies were geared towards production of high quality fingerlings through: determination of appropriate sex ratio and stocking density of breeders; supplementary/artificial feeding

of breeders; and, strain identification by electrophoretic separation of serum patterns.

### **Sex ratio and stocking density of *Tilapia nilotica* breeders**

Experiments on sex ratio and stocking density of breeders were simultaneously conducted in 2 x 2 x 1.5 m concrete tanks. The treatments used for the sex-ratio experiment were 1:4, 1:7, and 1:10 male to female ratio. The stocking density treatments were 4, 7 and 10 females/m<sup>2</sup>.

The fry/egg production in concrete tanks, as indicated by four harvests from July to September, increased as the sex ratio of male to female was decreased to 1:4. Moreover, the fry/egg production per concrete tank increased as the stocking density was increased. However, increasing the stocking density to seven or ten/m<sup>2</sup> greatly reduced the individual spawner seed production to almost 50%.

### **Effect of artificial feeds on fry production and growth of *T. nilotica* breeders**

Feeding trials were conducted in cages as well as in tanks to determine the effect of pelletized dry diets containing 20 and 40% crude protein (CP) on fry production and growth of the breeders. For each trial, 12 fine-mesh cages measuring 1.5 x 1.5 x 1.5 m or 12 outdoor concrete tanks filled with 1 m<sup>3</sup> Laguna Lake water were used. Stocking rates in cages were 12 females and two males (trial 1) or 12 females and four males (trial 2). In tanks, five females and two males (trial 1) or six females and two males (trial 2) were stocked. Breeders with supplemental diets were fed at 1% of fish biomass daily for 21 to 24 weeks. Sampling of breeders and collection of fry and eggs were done at three-week intervals. Except for the first cage trial, eggs released by brooding females were incubated artificially.

In cages, the control (no supplemental feeding) had the least number of fry produced, and breeders fed with 40% CP

diet had significantly high ( $P > 0.05$ ) fry production (Table 5). Fry production of breeders fed with 20% CP diet was variable. In terms of growth, highest final total weights were attained by breeders fed with 40% CP diet followed by those fed with 20% CP diet. The controls either gained some weight (trial 1) or lost weight (trial 2).

In tanks, fry production was highest for breeders fed with 40% CP diet and lowest for the controls (Table 6). Fry production of breeders fed with 20% CP diet was comparable with that of breeders fed with 40% CP diet in trial 1, but was significantly low ( $P > 0.05$ ) in trial 2. Growth of breeders was enhanced considerably by supplemental feeding. Among those given supplemental diets, females fed with 40% CP diet attained much higher total weights from those fed with 20% CP diet; the total weights of fed males, however, were not significantly different (Table 6).

**Table 5. Fry production and growth of tilapia breeders in cages after 21 weeks (Trial 2).**

Treatment	Average total fry production per cage*	Average Total Weight (g)*				Feed Conversion*	Total amount of feed given per cage (kg)
		Female		Male			
		Initial	Final	Initial	Final		
Control (supplemental feeding)	2916 <sup>b</sup>	142.2	122.9 <sup>c</sup>	145.5	119.6 <sup>c</sup>	—	—
20% CP supplemental diet	7009 <sup>ab</sup>	146.7	197.4 <sup>b</sup>	150.8	269.4 <sup>b</sup>	6.2 <sup>a</sup>	4.1
40% CP supplemental diet	8068 <sup>a</sup>	148.8	252.3 <sup>a</sup>	151.4	394.8 <sup>a</sup>	2.3 <sup>b</sup>	4.9

\* Means with the same superscript are not significantly different ( $P > 0.05$  for fry production, and  $P > 0.01$  for total weights).

**Table 6. Fry production and growth of tilapia breeders after 24 weeks in concrete tanks (Trial 2).**

Treatment	Average total fry production per tank*	Average Total Weight (g)*				Feed Conversion *	Total amount of feed given per tank (kg)
		Female		Male			
		Initial	Final	Initial	Final		
Control (no supplemental feeding)	4103 <sup>b</sup>	182.0	131.9 <sup>c</sup>	186.9	147.5 <sup>b</sup>	—	—
20% CP supplemental diet	4861 <sup>b</sup>	183.9	200.4 <sup>b</sup>	181.5	278.7 <sup>a</sup>	10.2 <sup>a</sup>	2.6
40% CP supplemental diet	10,088 <sup>a</sup>	185.0	268.7 <sup>a</sup>	179.9	308.5 <sup>a</sup>	4.1 <sup>b</sup>	3.0

\* Means with the same superscript are not significantly different ( $P > 0.05$  for fry production,  $P > 0.01$  for total weights).

The advantage of giving artificial dry diets as supplemental feed in cages and tanks has been shown. Between the two dry diets, the 40% CP diet consistently gave the highest fry production and growth, particularly at a low feeding rate (1%) and under natural brooding conditions. Furthermore, the 40% CP diet gave better feed conversion values.

#### Electrophoresis of *T. nilotica* strains

Samples of *T. nilotica* breeders were obtained from the Binangonan Research Station; Freshwater Fisheries Investigation Center, BFAR Los Baños; Laguna; Butong, Batangas; and Central Luzon State University, Muñoz, Nueva Ecija.

Blood samples were withdrawn by caudal puncture from the hemal arc and allowed to coagulate inside an ice box with crushed ice. Clear sera were collected by microcapillary tubes and stored below -10°C before analyses.

Electrophoresis was done on a Beckman Model R-100 Microzone Electrophoresis System using cellulose acetate as supporting medium.

Preliminary results showed that the overall electrophoretic serum patterns of the different samples analyzed were very variable. These variations could be attributed to the physiological condition of the fish. Studies have shown that fish serum proteins are affected by sex and degree of sexual maturity, method of sampling and changes in diet. The isoenzyme study will be conducted in 1983. Enzymes are more useful for discriminating loci by the substrate through specific staining techniques than blood serum.

#### **Growth and survival of inbreds and crossbreds of *T. nilotica*, *T. mossambica* and Taiwan Red Tilapia in cages**

Selection of bigger fingerlings among brothers and sisters was not an effective method to improve growth. The culture of hybrids/crossbreds produced higher yields compared to the F<sub>3</sub> inbreds. The stocking of 35 per m<sup>2</sup> increased production and reduced mortality. The inbred lines of the cross between Taiwan red tilapia and *T. mossambica* segregated resulting in the production of tilapia having variable growth patterns.

#### **The effects of methyl parathion on the chromosome pattern of male *T. nilotica*.**

Forty eight mature *T. nilotica* males were exposed to varying levels of methyl parathion for 96 hours without feeding. The animals were weighed, measured, scrutinized for morphological information and acclimated prior to exposure to the pesticide.

After the 96 hours semi-static assay, the fish were weighed and sacrificed, their testes were then removed and weighed. The fish and water were processed for gas chromatographic determination of pesticide residues. The testes were processed for microscopic investigation of chromosomal aberrations. Two trials were conducted in a completely randomized design.

Gas chromatographic analysis is still being done at the Bureau of Plant Industry. Chromosomal investigation is still on-going.

### **Culture and utilization of *Moina* as feed of *Oreochromis niloticus* fry**

Culture of *Moina* under laboratory conditions in three varying concentrations of *Chlorella*, yeast and chicken manure showed a maximum population growth of 1.04/mL, 2.5/mL and 9.86 mL, respectively.

Increase in the *Moina* population was proportional to the increase in *Chlorella* concentration. Growth of *Moina* in varying levels of yeast showed an abrupt increase in the population in all treatments with a maximum growth on day 2 in 100 mg/L and 200 mg/L yeast. Among the three concentrations of chicken manure used in the experiment, a fifty-fifty combination of filtered lake water and stock solution of chicken manure with replenishment every three days was found to be ideal for growth of *Moina* reaching a maximum density of 36.7/mL on the seventh day of culture. However, this was followed by a decrease in the population in all treatments up to the 14th day.

Based on the results of the culture experiment, *Moina* was mass-produced in bigger volumes of 120-250 L using chicken manure. Likewise, *Chlorella* was inoculated with *Moina macrocopa* in a separate rectangular tank and maintained for feeding purposes.

Tilapia fry (9.6 mm average size) stocked at 4/L in 60 L cap aquaria were fed with the following: a) *Moina*, b) *Chlorella*, c) *Moina* + *Chlorella*, d) *Moina* + *Chlorella* + rice bran, e) rice bran + *Chlorella*, f) *Moina* and rice bran, and g) rice bran (50% of body weight).



Figure 3 shows the growth of *O. niloticus* fry given single *Moina* and *Chlorella* diet, its combination, and in combination with rice bran. Growth of tilapia fry in all treatments during the first three weeks of rearing showed no difference. However, during the third to the sixth week of rearing, tilapia fry fed with either *Moina* + *Chlorella* or *Moina* + *Chlorella* + rice bran showed similar favorable effects compared to other treatments. On the other hand, those fed with rice bran + *Chlorella* showed a low increase during the first four weeks. However, growth accelerated during the fourth to 6th such that during the 6th week, weight gain was comparable to those fed with either *Moina* + *Chlorella* or *Moina* + *Chlorella* + rice bran.

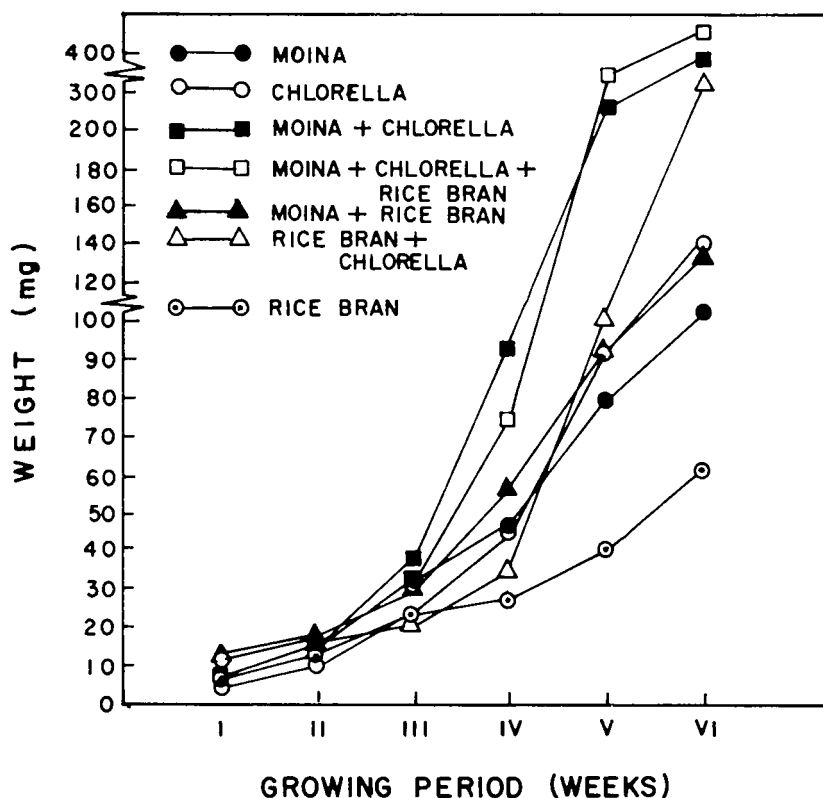


Fig. 3. Weight of *Sarotherodon niloticus* fry given *Moina* and *Chlorella* in single diet or in combination with rice bran.

Tilapia fry given *Moina* alone, *Chlorella* alone, and *Moina* + rice bran gave similarly low weight gain. Among the treatments, tilapia fry fed with rice bran alone gave the lowest weight increment.

It was observed that tilapia fry given *Chlorella* in their diet showed high weight gain. However, fry with *Chlorella* in their diet showed the lowest percentage of survival. Highest survival rate was observed in tilapia fry fed with *Moina* alone, rice bran or the combination of *Moina* and rice bran (Fig. 4).

#### Acceptability of selected freshwater algae to tilapia (*O. niloticus*) fry

Newly-hatched tilapia fry were given unialgal cultures of selected algae: namely: *Chroococcus*, *Oscillatoria*, *Navicula*,

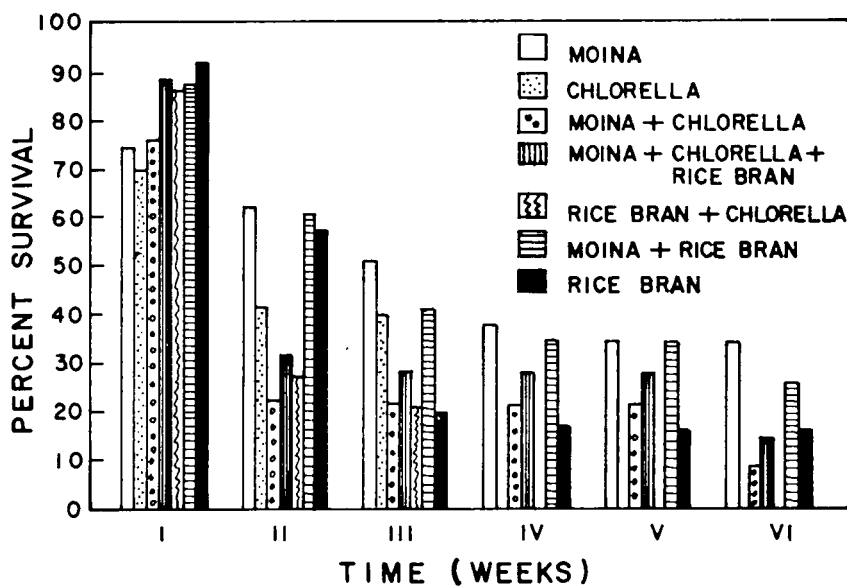


Fig. 4. Survival of *Sarotherodon niloticus* fry given different treatments.

*Chlorella* and *Euglena*. Growth and survival were taken at 10-day intervals.

Of the five species tested, the diatom, *Navicula*, and blue-green alga, *Chroococcus* were the most acceptable. Highest mean weights of tilapia fry were obtained in these two treatments. However, *Oscillatoria*, a filamentous cyanophyte showed limited acceptability to tilapia fry. *Chlorella* and *Euglena* did not support the growth of tilapia.

C<sup>14</sup> -labelled algae of the five species were fed to tilapia fry at varying stages of growth. Assimilation rates per fry after feeding for 24 hrs with unialgal cultures of algae increased with age of fry as expected. Forty-day old tilapia fingerlings assimilated (on a dry weight basis) 4.23 mg *Navicula* and 4.94 mg *Chroococcus*. Amount of label was negligible for the other treatments.

Survival of tilapia fry showed the same trend as above, that is, fry fed with *Chroococcus* and *Navicula* gave high percent survival of 90% and 86% respectively. Feeding with *Oscillatoria* resulted in 43% survival of tilapia fry. Mortality was very high seen as early as the second week, in treatments given *Chlorella* and *Euglena*.

## Carp

### Culture of bighead carp in pens by periodic harvesting with and without replenishment in Laguna de Bay

A preliminary study on the culture of bighead carp (*Aristichthys nobilis*) in pens by periodic harvesting with and without replenishment was started. Twelve units of pens (5 x 5 m) were stocked with 200 bighead carp fingerlings. Four treatments were used: A – harvesting of 1 kg fish without replenishment every four months; B – selective harvesting of 1 kg fish with replenishment every four months; C – selective harvesting of 1 kg fish without replenishment every six months; and D – total harvesting after 12 months.

After a four month growing period, results showed that the highest mean weight (215.4 g) was obtained in treatment C where 1 kg fish were harvested selectively without replacement of stock. On the other hand, treatment D (total harvesting after 12 months), gave the lowest mean weight of fish (142.9 g).

The computed mean growth rates per day were 1.44 g, 1.53 g, 1.56 g and 1.01 g for treatments A, B, C, and D, respectively. In all the treatments, the fish exhibited a steady but slow growth rate from August to December. This may be explained by the relatively low primary productivity ( $0.8 \text{ g C/m}^2/\text{day}$ ) of the lake during the experimental period.

## SOCIO-ECONOMICS

Studies were initiated to assess the viability of fish farming and evaluate the technology practised in production and marketing.

Studies were conducted to document existing tilapia cage farming techniques, assess the financial and economic performance of tilapia cage farmers as well as evaluate the production techniques employed, and identify existing socio-economic constraints in tilapia cage farming.

Studies evaluating the socio-economics of tilapia cage farming in Laguna de Bay, income profiles of sustenance fishermen and related aquaculture development policies are in progress.

### Methodology for economic analysis of tilapia cage farming

Two towns of Rizal Province representing two different water zones of Laguna Lake were selected to compose the study



*Cage culture of tilapia has increased the income of sustenance fishermen in Laguna Lake.*

area. For West Bay, Binangonan was chosen and for Central Bay, Cardona.

Construction of cross-sectional farm-level data covering production period of November 1981 to October 1982 was done through personal interviews with 25 tilapia cage farmers from Binangonan and 25 from Cardona. Total enumeration was done in both sampling sites because there were barely just as many cage farmers as the targetted sample sizes.

Both descriptive statistics and quantitative economic techniques will be employed in the study. The main thrusts of the research is focused on profitability in relation to resource availability and use.

To assess the financial and economic viability of tilapia cage farming in Binangonan and Cardona, estimations of Benefit-Cost ratio and Internal Rate of Return will be done.

#### **Income profiles of sustenance fishermen, milkfish pens and tilapia cages at Limbon-Limbon, Binangonan, Laguna de Bay**

Preliminary results showed that the average disposable income of fishermen household in Limbon-Limbon is P4,149.83 per year, where average gross annual income is P6,438.61 while average annual cost of operations is P1,770.30. This level of annual disposable income has considerably gone down by almost 50% from the base survey done last 1977.

The average fixed assets holdings per fishermen household only amount to P1,724.29. The average number of fishing years is 10.78 which varies because of the difference in age groups. Average household size is 5.28. Lastly, there are 16 families that use gill net, 6 "sakag" or trawl, 1 "bubo" and 1 "bikatot."

Data on milkfish pens and tilapia cages are being gathered.

*Trainees from other Asian countries undergo practical training in small scale hatchery operations at Batan.*



## TRAINING AND EXTENSION

Two hundred twenty two people with varied aquaculture interests availed of the Department's training and extension program in 1982.

### Training Programs

The Department conducted the following training programs during the year:

The second 12 month graduate training course for Senior Aquaculturists in Asia and the Pacific Region, offered by the Network of Aquaculture Centres in Asia (NACA) in collaboration with SEAFDEC and the University of the Philippines in the Visayas, with 16 participants from Indonesia, Malaysia, Nepal, Singapore, Sri Lanka, Thailand, Vietnam and the Philippines;

The 16 participants come from Indonesia, Malaysia, Nepal, Singapore, Sri Lanka, Thailand, Vietnam and the Philippines;

A formal graduate degree program in fisheries offered in collaboration with UPV with 8 graduate students out of 52 enrollees successfully defended their theses for M.S. in Fisheries.

Two sessions on Small-Scale Hatchery Operations at the Tigbauan Research Station and Batan Substation with 31 participants from Thailand, Indonesia, Malaysia and the Philippines.

A training course on Cage and Pen Farming of Tilapia in Freshwater at the Binangonan Research Station with participants from Thailand, Sri Lanka, India, Guyana, Malaysia, Indonesia and the Philippines.

### **Extension Programs**

A total of 176 participants attended the two On-Site Training Workshops on Brackishwater Pond Culture held at Misamis Occidental and Masbate in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR).

Sixty-nine students from various institutions in the country participated in the off-campus practicum program designed to develop technical skills and practical knowhow in aquaculture.

A practical training in aquaculture for the government and/or private sector was initiated this year. Seven fishfarmers and technicians completed the training.

### **Library and Documentation Services**

Library materials were increased during the year.

There are at present 6,000 monographs, 5,000 reprints, 3,900 pamphlets, 2,000 bound journals, 1,000 SEAFDEC publications, 330 microfiches and 30 reels of microfilm.

Gift/exchange agreements were intensified: 191 foreign and 82 local institutions were included in the library's mailing list; 144 foreign and 21 local institutions sent their publications; and 185 foreign and 33 local journals were received regularly.

During the year, 1,287 abstracts were compiled and published in four quarterly issues of the *Aquaculture Abstracts*. Relevant aquaculture materials found in the Library were abstracted, published and distributed. The *Acquisitions List* and the *Catalog of the Library* are current.

A *Serial Holdings of the Library*, preliminary edition, compiled during the year, lists some 1,000 titles, arranged alphabetically by distinctive titles with standard abbreviation of titles and a corporate author index at the end.

In the Selective Dissemination of Information activity, 2,192 titles were sent to the 14 programs/projects at the Tigbauan Research Station. In the Scientific Literature Service activity, 589 were sent to the Binangonan Station, government agencies, schools, research institutions and individuals.

A total of 27,531 photocopies were produced for the SDI, SLS and for library purposes during the year.



## PUBLICATIONS

Three technical reports were published:

- *The Economics of the Milkfish Fry and Fingerling Industry of the Philippines* by Ian Smith published by the International Center for Living Aquatic Resources Management as ICLARM Technical Report 1 in collaboration with the Department;
- Technical Report No. 9, *The Milkfish Fry and Fingerling Industry of the Philippines: Methods and Practices* by Antonio Villaluz, William Villaver and Ruby Salde published in collaboration with IDRC;
- Technical Report No. 10, *A Guide to Induced Spawning and Larval Rearing of Milkfish* *Chanos chanos* (Forsskal) by Jesus Juario and Marietta Duray was published in collaboration with IDRC.

Four issues of the *Quarterly Research Report* containing extended abstracts of the results of studies undertaken by the Department were printed.

## RESEARCH PUBLICATIONS

Thirty scientific papers were contributed by Department staff to various international and national journals and/or presented at scientific meetings and conferences.

### International Publications

#### A. Scientific Journals

Alaya, V.R. and C. Lim. The qualitative dietary protein requirements of *Penaeus monodon* juveniles in a controlled environment. *Aquaculture* (in press).

Benitez, L.V. and Halver J.E.\* 1982. Ascorbic acid sulfate sulfohydrolase (C2 sulfatase): "The modulator of cellular levels of L-ascorbic acid in rainbow trout". *Proceedings of the National Academy of Sciences USA*. 79: 5445-5449.

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\* visiting scientist/researcher

- Benitez, L.V. and Tiro, L.B. 1982. Studies on the digestive proteases of milkfish, *Chanos chanos*. Marine Biology (in press).
- Buri, P. and Kawamura, G.\* 1982. The mechanics of mass occurrence and recruitment strategy of milkfish fry *Chanos chanos* (Forsskal) in the Philippines. Memoirs of the Kagoshima Univ. Res. Center for South Pacific, 1982.
- Juario, J.V., M. Duray, V. Duray, J. Nacario and J. Almendras. 1982. Induced spawning and larval rearing experiments with milkfish *Chanos chanos* (Forsskal) in the Philippines. Aquaculture (in press).
- Marte, C.L. 1982. Seasonal variation in feed and feeding *Penaeus monodon* Fabricius. Crustaceana, 42(3): 250-255.
- Nacario, J.F. 1982. The effect of thyroxine on the larvae and fry of *Sarotherodon niloticus*. Aquaculture (in press).
- Nielsen, B.N. 1982. Laguna de Bay is born again. Aquaculture (in press).
- Quinitio, E.T. and C.T. Villegas. 1982. Growth, survival and macronutrient composition of *P. monodon* larvae fed with *Chaetoceros calcitrans* and *Testraselmis chuii*. Aquaculture (in press).
- Santiago, C.B., M. Banes-Aldaba and E.T. Songalla. 1982. Effect of artificial diet on growth and survival of milkfish fry in freshwater. Aquaculture (in press).
- Storch, V.\* and J. Juario. 1982. The effect of starvation and refeeding on the hepatocytes of *Chanos chanos* fingerling and fry. J. Fish. Biol. (in press).

## B. Abstracts and Scientific Papers Presented

- Benitez, L.V., L.B. Tiro and Y.N. Chuii\*. The digestion process of milkfish in relation to its natural food. Second International Symposium on Marine Biogeography and Evolution in the Pacific, 1982. Sydney, Perth, Australia, p. 6.
- Gabasa, P.G., Jr. 1981. Recent developments in design and management of small-scale hatchery technology for *Penaeus monodon* in the Philippines. Paper presented at the FAO/UNDP Working Party on Small Scale Shrimp/Prawn Hatchery. Semarang, Central Java, Indonesia, November 15-22, 1982.
- Macaranas, J.M.\* and Benitez, L.V. Developmental genetics of lactate dehydrogenase isozymes in *Siganus guttatus*. First International Symposium on Genetics in Aquaculture. Galway, Ireland, 1982.
- Pantastico, J.B. Algal production in wastewater: progress and problems. Proceedings of the Regional Workshop on Limnology and Water Resources Management in the developing countries of Asia and the Pacific, Kuala Lumpur, Malaysia, Nov. 29-Dec. 5, 1982 (in press).
- Tiro, L.B. and L.V. Benitez. A trypsin inhibitor is detected in a filamentous algae. First International Phycological Congress. St. John's Newfoundland, Canada, 1982.
- Young, A.L. 1982. Shell Fisheries of the Philippines. Paper presented at the IDRC Bivalve Culture Workshop, Singapore, February 9, 1982.

## National Publications

- Baticados, M.C. and G.L. Enriquez\*. Developmental stage of a microsporidian parasite of the white prawn *Penaeus merguensis* de Man, 1888. Nat. App. Sc. Bull. 34(2-3) (in press).

- Cruz, E., and G. Enriquez\*. 1982. Gill lesions associated with acute exposure to ammonia. *Natural and Applied Science Bulletin*. 34(1): 1-13.
- Pantastico, J.B. Fry to fingerling production of *Tilapia nilotica* using phytoplankton as natural feed. *Fish. Res. J. Phil.* (in press).
- Pudadera, B. and C. Lim. Evaluation of milkfish *Chanos chanos* and prawn *Penaeus monodon* in polyculture system. *Fish. Res. J. Phil.* (in press).
- Santiago, C.B., M. Aldaba and M. Laron. 1982. Dietary crude protein requirement of *Tilapia nilotica* fry. *Kalikasan Philipp. J. Biol* 11(1).
- Young, A.L. and W.G. Yap. *Perna viridis* (L) 1958 as the correct name for the South-east Asian green mussel (Bivalvia: Mytilidae). *Fish. Res. J. Phil.* (in press).

## Abstracts

- Juario, J. 1982. Artificial propagation of siganid, *Siganus guttatus*. Paper presented at the Convention of the Fisheries Research Society of the Philippines, Philippine Science High School, Quezon City, January 29-30, 1982.
- Marte, C.L. 1982. Gonadotropin profiles in serum of milkfish *Chanos chanos* injected or implanted with salmon pituitary homogenate. Paper presented in the Phil. Biochemical Society Annual Convention, Manila, Nov. 6, 1982.
- Mesa de, I. 1982. Fitting a bivariate normal regression model (BNRM) when both variables are subject to measurement errors with application in aquaculture research. Paper presented at the 3rd National Statistical Convention, PICC, Manila, December 14-15, 1982.
- Pascual, F. 1982. Recent advances in nutrition and feed development of *Penaeus monodon* in the Phil. Paper presented in the Seminar on Status of Prawn Research and Prospects for Development, Fourth Fisheries Forum for 1982, Quezon City, October 12, 1982.
- Primavera, J. 1982. Recent Advances in Prawn Seed Production Research. Paper presented at the Convention of Fisheries Research Society of the Philippines. Phil. Science High School, Quezon City, January 29-30, 1982.
- Primavera, J. 1982. Research development in penaeid prawn maturation and larval rearing. Paper presented in the Seminar on Status of Prawn Research and Prospects for Development, Fourth Fisheries Forum for 1982, Quezon City, October 12, 1982.
- Po, G. 1982. Characterization of *Edwardsiella tarda* in *Tilapia nilotica*: biochemical histopathological analyses. Paper presented in the Annual Meeting of the Philippine Society for Microbiology, UP Los Baños, May 7-8, 1982.

## RESEARCH SEMINARS

Seventy five seminars on a broad range of subject matter which included completed and ongoing research projects of the Department as well as topics of interest to the management and research staff were conducted by the staff and visiting experts at the three stations.

## ADMINISTRATION

Reorganized to effectively support the research, training and extension divisions, the Administration Division consists of four supportive services: General Affairs, Personnel Management, Finance and Physical Plant.

## PERSONNEL DEVELOPMENT

The Department had 691 personnel as of December 31, 1982. Of this total, 56% are in Research, 40% in Administration and 4% in Training and Extension.

The research capability of the Department was strengthened with the completion of graduate studies by 10 of its staff in 1982. One finished his doctoral degree and 9 personnel completed their masteral programs.

### Ph. D. Degree

- Ferraris, Ronaldo, University of Hawaii at Manoa (USA), *Glucose Alanine Transport in Herbivorous and Carnivorous Marine Fish Intestines*

### Master's Degree

- Almendras, Jesus, University of the Philippines, Diliman, *Changes in Ionic and Osmotic Content in Milkfish (Chanos,chanos Foraskal) Fry and Fingerlings During Abrupt Transfer to Different Test Salinities*
- Bagarinao, Teodora, University of California, San Diego (USA), *Visual Threshold and Spectrum for Feeding of Anchovy, Egraulis mordax, larvae*
- Castro, Ma. Teresa de, University of the Philippines in the Visayas, *A Study of Copper and Zinc Contents of Green Mussel Collected near industrial and Rural Areas*
- Catacutan, Mae, Kagoshima University (Japan), *Feeding Experiments on Two Penaeid Shrimps, Penaeus japonicus and P. monodon*
- Duremdez, Roselyn, University of the Philippines in the Visayas, *Identification and Characterization of the Physiological Properties of Pseudomonas fluorescens isolated from Sarotherodon niloticus fry*

- Gorriceta, Ilda, University of the Philippines, Diliman, *Studies on the Digestive Lipases and Lipid Composition of Milkfish, Chanos chanos Forsskal*
- Palisoc, Fermin, Jr., University of the Philippines, Diliman, *Observations on Certain Aspects of Epimeron Ingens Nobili Isopoda: Bopyidae in Penaeus semisulcatus de Haan from Navotas Port, Navotas, Metro Manila, Philippines.*
- Puton, Gloria, University of the Philippines in the Visayas, *Qualitative Dietary Cholesterol Requirements of Penaeus monodon Juveniles*
- Vizcarra, Angelito, University of British Columbia (Canada), *A Comparison of Growth Rates of Rainbow Trout in Culture Tanks with Different Hydraulic Characteristics*

## NON-DEGREE PROGRAM

During the year, the Department sent 57 staff members to various non-degree training programs, 8 of them abroad.

## INFRASTRUCTURE DEVELOPMENT

Major infrastructure developments, in support of research activities, included the following:

Completion of the Nutrition and Reproductive Physiology Building, its Utility Building and the Scientific Supply House at the Tigbauan Research Station. Other laboratories and facilities were renovated and more cages, pens and tanks were constructed.

*The Nutrition and Reproductive Physiology Building was completed this year.*



Excavation and improvement of the pond systems were completed for milkfish, prawn, *Artemia*, mud crab and *Gracilaria* studies at the Leganes Research Station. The Jalaud Flood Control Dikes were constructed and the access road riprapped. Freshwater system was improved; building, offices and laboratories were renovated. Additional facilities were constructed for the NACA Integrated Prawn Production Research Project.

At the Binangonan Research Station, construction of the Natural Feeds and Tilapia Electrophoretic laboratories, land-based pens and cages, two staff housing duplex units and a motorized boat were completed. Lake-water distribution lines to the hatchery building, fire-fighting facilities, staff houses and grounds were also completed. Another laboratory for the Ecological Studies and another staff house duplex are nearing completion.

At the Batan Substation, rafts, tanks, pens and cages for seafarming and crustacean studies were constructed. A two-storey building housing a bio-chem and phycology laboratory, a wet laboratory for hatchery and other experimental units, the office of the Substation Head, a Conference Room that doubles as a library, and a radio room was completed. A four-room living quarters equipped with kitchen for staff members was also constructed.

## **MEDICAL SERVICES**

In 1982, the Medical Services Unit accomodated 12,292 medical and dental consultancies in the different stations and substations.

The Unit continued to implement the Department's medical policies contained in the Comprehensive Medical Benefit Plan, and the Medical Health and Safety Program. It also works closely with the Physical Fitness and Sports Development Committee on programs aimed at maintaining the employee's safety and well-being. The Unit continued to serve the community under its Community Health and Development Program.



*Prime Minister Cesar E. A. Virata and Minister of Natural Resources Teodoro Q. Peña are briefed by AQD researchers on Department research activities.*

## **NATIONAL BOARD FOR SEAFDEC AQD**

A National Board for the SEAFDEC Aquaculture Department was created by the President of the Philippines through Executive Order No. 834 dated 14 October 1982.

The creation of the Board will link the Department with the national and international agencies to implement the government's Integrated Fisheries Development Plan.

## **WVSC-SEAFDEC LABORATORY SCHOOL**

One hundred ninety three pupils were accommodated in the kindergarten, non graded and intermediate classes of the Laboratory School for the academic year 1982-83. Jointly established in 1977 by the Department and the West Visayas State College, the school primarily serves children of the Department staff with a significant proportion of pupils coming from Tigbauan and nearby municipalities.

The curriculum, faculty, and academic standard of the school are supervised by WVSC. On the other hand, the Department provides physical facilities, equipment, operating expenses, as well as salaries and/or honoraria of personnel. These expenses are reflected in an annual budget prepared upon mutual agreement by the WVSC and the Department.

## **INSTITUTIONAL LINKAGES**

Since 1973, the Aquaculture Department has been working with various international and national institutions towards the promotion of aquaculture research and development.

In 1982, more projects were initiated and implemented.

### **International Linkages**

#### **SEAFDEC-IDRC**

The International Development Research Center approved the implementation of Phase III of the SEAFDEC-IDRC Milkfish Research Project for a three-year period (beginning April 1) with a total funding of Cdn \$423,600.

Training/travel grants were also awarded to qualified researchers of the Department.

#### **SEAFDEC-JICA**

The following Japanese experts/scientists were assigned to the Department:

- Dr. Takeshi Murai, Chief of Nutrition Section, National Research Institute, Ministry of Agriculture, Forestry and Fisheries, Tokyo, Japan as nutrition consultant;
- Dr. Kiyokuni Muroga, Associate Professor, Hiroshima University, as consultant in the Pathology Project;
- Dr. Ryusuke Kado, Japanese expert in Fishpond Ecology was assigned to the Department for three months;
- Mr. Kunio Katsutani, Japanese expert, as Deputy Chief;
- Mr. Mitsuru Yamasaki as JICA coordinator;
- Mr. Shiro Hara, Japanese expert, Fish Hatchery Project;
- Mr. Masanori Suemitsu, Japanese expert, Prawn Culture in Ponds; and
- Mr. Yoshibumi Yashiro, Japanese expert, Indoor Prawn Hatchery.

#### **SEAFDEC-UNDP/FAO/NACA**

Various training and research equipment, to include the \$100,000 Hewlett Packard Computer (HP 3000) were procured by NACA for the implementation of its projects at AQD.



The second NACA training course is being implemented at AQD.

The services of four NACA experts were availed of: Dr. Chua Thia Eng, Senior Aquaculturist, assisted in the research and development projects of the Department; Mr. Pinij Kungvankij, Aquaculturist, headed the Coordinating Team of the IPPRP; Dr. Hong Woe Khoo and Mr. Ulf Wijkstrom lectured on site selection and aquaculture economics, respectively.

## **SEAFDEC-FRANCE**

The government of France, through SEAMEO and the French Embassy, granted the following assistance to AQD:

Mr. Patrick Soletchnik to work on the Department's fish production project for 14 months (beginning November);

Two teams of French specialists in filtration, recycling systems and limnology visited AQD.

Three-month training grants were scheduled for 1983.

## **SEAFDEC-UNITED KINGDOM**

The Overseas Development Administration of the United Kingdom, through the British Council, donated various research equipment and books to AQD. Postgraduate scholarship grants were awarded to two members of the Department's research staff.

## **SEAFDEC-URI**

Mr. Kenneth Simpson of the University of Rhode Island (URI) evaluated the accomplishments of the Department's *Artemia* research project and assessed areas for further cooperation between AQD and URI.

## **SEAFDEC-NEW ZEALAND**

The seafarming (mussel and oyster) research and training project received funding inputs from the New Zealand government.

## **SEAFDEC-UNIVERSITY OF HEIDELBERG**

Dr. Volker Storch of the University of Heidelberg, Germany undertook collaborative work with AQD researchers on some basic problems related to the effect of salinity, types of food and starvation on milkfish.

## **SEAFDEC-IFS**

Two researchers were awarded research grants by the International Foundation for Science of Sweden. The grant on feeds and nutrition was on the *Optimum protein energy requirement of milkfish (Chanos chanos Forsskal)* while the one on *Artemia* was on the *Integration of Artemia production with salt production and milkfish-prawn culture in earthen ponds*.

## **SEAFDEC-BELGIUM**

The *Artemia* Reference Center provided the Department with literature, references and other materials on *Artemia*.

## **SEAFDEC-DANIDA**

The Danish International Development Agency (DANIDA) extended the services of Mr. Bent Nielsen to assist in the development of the limnology project of the Binangonan Research Station.

## **SEAFDEC-BIOTROP**

The Southeast Asian Ministers of Education Organization (SEAMEO) through the Regional Center for Tropical Biology (BIOTROP), appointed the Chief as member of the BIOTROP governing Board for a period of three years starting July.

## **National Linkages**

### **SEAFDEC-BFAR**

The Ministry of Natural Resources (MNR) and the Bureau of Fisheries and Aquatic Resources (BFAR) collaborated with the Department on the implementation of the plans and programs of AQD, particularly the National Bangus Breeding Program and On-site Mobile Training Programs.

### **SEAFDEC-TRC**

A joint project on tilapia cage culture in Laguna de Bay was implemented by the Department and the Technology Resource Center (TRC).

### **SEAFDEC-UPV**

The University of the Philippines in the Visayas (UPV) collaborated with the Department in the implementation of the graduate degree program leading to M.S. Fisheries (major in Aquaculture) and the NACA training program.

### **SEAFDEC-MSI**

The Department assisted the *Masaganang Sakahan, Inc.* (MSI) in prawn and milkfish culture projects for agrarian reform farmer-beneficiaries.

### **SEAFDEC-PSPC**

Aquaculture field testing projects were implemented with the cooperation of the Panay State Polytechnic College (PSPC) in Capiz. The projects include: milkfish broodstock in brackishwater ponds and floating cages; prawn broodstock in brackishwater ponds; and pond testing of AQD developed diet for *P. monodon* from juveniles to marketable sizes.

## **SEAFDEC-KKK**

AQD's relationship with the *Kilusang Kabuhayan at Kaunlaran* (KKK) was intended for the development of an integrated program for subsistence fishfarmers near Buhi-Bato Lakes in the Bicol Region. The program also involved other government agencies: the Human Settlements Development Corporation, BFAR, National Food Authority, and the Bicol River Basin Development Program.

## **SEAFDEC-CIADPI/CSU**

The Department provided technical assistance to the prawn hatchery project of the Cagayan Integrated Agricultural Development Project, Inc. (CIADPI) and the Cagayan State University (CSU).

## **SEAFDEC-ZRIFT**

A joint program between the Mindanao Regional School of Fisheries - Zamboanga Regional Institute of Fisheries Technology (ZRIFT) and the Department was implemented. The program was set up to speed up the development of fisheries and aquatic resources in Western Mindanao through the establishment of Pilot Demonstration Projects; and conduct research pilot testing and extension/training programs to equip fishfarmers and extension workers with the technology needed in the development of the aquaculture industry.









#### Research Stations

Tigbauan Research Station  
Tigbauan, Iloilo

Leganes Research Station  
Leganes, Iloilo

Binangonan Research Station  
Tapao Point, Binangonan

External Affairs Office  
Suite 901, State Financing Center  
Ortigas Ave., Mandaluyong,  
Metro Manila

Iloilo Liaison Office  
B & C Square Building  
Iloilo City