AQUACULTURE DEPARTMENT

ANNUAL REPORT 1978

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

CONTENTS

Summary of Activities

CY 1978 saw further growth and expansion of the SEAFDEC Aquaculture Department in its institutional endeavors. It was a period of significant events which consequently enhanced the Department's image as a center of excellence for aquaculture research and development.

The major development in CY 1978 was the evolution of the Asian Institute of Aquaculture, a unit of the Department which institutionalized a mechanism for the training, education, information and extension functions of the Department. In previous years, emphasis was laid on infrastructure (1973 to 1975) and then research was established and maintained from 1975 to the present. CY 1978 stressed the critical task of building up the manpower and technical expertise needs of aquaculture by way of intensive effort in technology transfer and verification on a regional basis.

The Department activated the Asian Institute of Aquaculture (AIA) on May 23, 1978, a unit which consolidated the former functions of the Training and Extension Division to cover an expanded set of programs. Among the integrated technology transfer programs evolved in this direction were:

- conduct of non-degree training programs on various aspects of aquaculture technology;
- administration of research grants, awards of scholarships and research staff exchange programs;
- planning, organization and implementation of consultancy and advisory services in aquaculture education and training;
- active participation in formal degree programs in cooperation with universities in the region, leading to M.S. and Ph.D. degrees in aquaculture or fisheries and related areas; and
- organization of meetings, conferences, workshops and seminars.

The creation of AIA signalled an attempt to link technology generation, verification, packaging and dissemination activities under the same institutional umbrella thus providing a thoroughly cohesive and streamlined series of channels from the research laboratories to the fishfarmer.

In the pursuit of its objectives, the AIA conducted intensified short-term and long-term training programs both on the international and national level, sponsored promotion of aquaculture technology and disseminated the latest information as it came to hand.

His Excellency, President Ferdinand E. Marcos of the Philippines visited the Aquaculture Department and observed its multifarious activities.

An *in-situ* training program was implemented in selected regions of the Philippines in cooperation with the Bureau of Fisheries and Aquatic Resources, thus introducing an outreach-oriented approach to the training activities of the AIA. A mobile team of lecturers and experts conducted the training at fishpond sites and regional offices instead of the participants travelling to the facilities of the Department in Iloilo.

The enormity of the tasks in aquaculture technology generation and dissemination demanded the continuation and implementation of collaborative projects with national agencies. Among these projects were the SEAFDEC-PCARR Socio-Economic Research Project; UP-SEAFDEC Graduate Aquaculture Study Program; SEAFDEC-UPLB Freshwater Aquaculture Research Project; and the BFAR-SEAFDEC Training and Extension Project.

On research and technology generation itself, the Department continued the refinement and standardization of techniques already pioneered in past years. Research diversified into other cultivable species. Besides prawn, milkfish, mussels and oysters, other species considered were crabs, tilapia and carps. Research priorities focused on the critical areas of nutrition and reproductive physiology.

Institutional tie-ups between international centers of excellence, and development institutions around the world strengthened the technology generation, verification, packaging and dissemination capability of the Department. Foreign scientists on special assignments worked alongside research staff of the Department in many projects in a common desire to solve pressing problems.

The Milkfish Research Program received fresh financial support with the extension of the SEAFDEC-IDRC (International Development Research Centre of Canada) Milkfish Project Phase I from July 1978 to March 1979. This enabled the research community in the project stations of the Department to proceed with their investigations to assist in standardizing techniques of milkfish spawning and breeding. The Freshwater Research Program for its part, evolved technologies on milkfish fry acclimation in freshwater, breeding of tilapia and lake farming of prawns and shrimps.

The President of the Philippines, Ferdinand E. Marcos, visited Tigbauan Main Station in May 1978. The activities and facilities in the Department secured, through the President, a continuing financial commitment from the host Government for the various programs of the Department.

Fishpens and cages of different sizes used for research in Laguna de Bay.

Research

MILKFISH PROGRAM

1. Artificial Fertilization. Adult milkfish (sabalo) were successfully spawned through artificial means (hormone injections). The eggs were fertilized and larvae hatched after some 24 hours. Dosage and frequency of hormone injection had been standardized at a combination of 12-33 mg salmon pituitary homogenate (SPH) injected into female, intramuscularly, and 1,000-2,000 I.U. human chorionic gonadotropin (HCG) per kg body weight at 8-12 hours intervals. Results also indicated that Vitamin B complex was beneficial to the fish under the stress of injection. Badly injured spawners injected with Vitamin B complex lived much longer than those which were not. Likewise, through hypophysation, successful natural spawning in captivity on eight separate occassions were observed and the ensuing larvae reared. It was discovered that this response to hormone injection was probably affected by the condition of the fish. All fishes, except those which had eggs with a mean diameter smaller than 0.60 mm, responded to the hormone injection of either SPH alone or a combination of SPH and HCG.

2. Larval Rearing. Rate of fertilization after induced spawning was estimated at 32 percent at salinity of 30-34 ppt. Laboratory-reared larvae were closely similar to wild fry in length measurement and degree of bone development after 18-21 days. Larval rearing was done with a mixture of *Chlorella.* Salinity tolerance tests of newly hatched larvae showed that abrupt changes of salinity from 34 ppt to 10 ppt could be tolerated. It was considered that higher survival could have been obtained if laboratory conditions approximated those in the natural environment.

3. Lablab Culture. Differences were observed between floating and attached lablab which is the primary food of pond-cultured milkfish. The former showed a lower degree of degradation due to its higher organic content with the presence of a higher number of associated organisms, chlorophyll concentration, caloric content, protein and cellulose content than existed in the attached form. It was found out that ash content of lablab was generally high (57-80 percent) compared to that of many fish feeds which was usually below 20 percent when converted to a moisture free basis. This was traced to the incorporation of inorganic matter or sediments into the lablab mats and the predominance of blue-green algae and diatoms. The high ash values suggested that milkfish and other fishes feeding on lablab must have some mechanism that enabled them to subsist on low organic content food.

Soil differences between strata did not always affect the quantity and quality of lablab. It was suggested that future samples for analysis should not consider pond stratification except perhaps when differences in acidity and sedimentation would be great. If differences in the sediment within one pond exist, proper pond management may compensate.

Sampling of eggs from live sabalo with a catheter.

4. Feeds and Nutrition. Results of experiments indicated that milkfish were daytime feeders with peak feeding activity occurring between 0900 and 1200 hours. Specimens collected at 0600 and 2400 hours had empty guts showing that the milkfish did not feed at night.

Studies were carried out on the protein requirement of milkfish fry in a controlled environment. Fry weighing 40 mg stocked in 30-L of filtered seawater at salinity 32-34 ppt and temperature at 25°-28°C were fed diets containing 20, 30, 40, 50 and 60 percent protein with energy at constant level of 2,740 Kcal, digestible energy at a daily feeding rate equivalent to the larval biomass. The highest weight gain after 30 days was achieved with diet containing 40 percent protein. Feed conversion efficiency was best for 40 percent protein diet (1:96) which appeared to be the minimum required for maximum growth, feed conversion efficiency and survival. (Fig. 1)

Animal protein was more efficiently utilized by milkfish than plant protein. Milkfish fingerlings fed diets containing fish meal had the highest growth rate of 48.1 percent. Shrimp meal and meat and bone meal had nearly equal average growth rates followed by soybean meal. Those fed with copra and ipil-ipil leaf meal diets lost weight. (Fig. 2).

To determine the optimum daily feed allowance for milkfish fry and therefore maximize growth while minimizing wastage and subsequent decay of uneaten feed, fry with an average weight of 7.7 mg were fed diets containing 40 percent protein and 3,450 metabolizable energy, per kg at daily rates of 4, 8, 12, 16, 20, 24 and 28 percent of the biomass for a period of 19 days. The survival rates and weight gains of fish and the ammonia-nitrogen content of the water were directly related to the feeding level. After one week, survival rate of fish in all ration treatment were high, ranging from 92.5-99 percent with an average

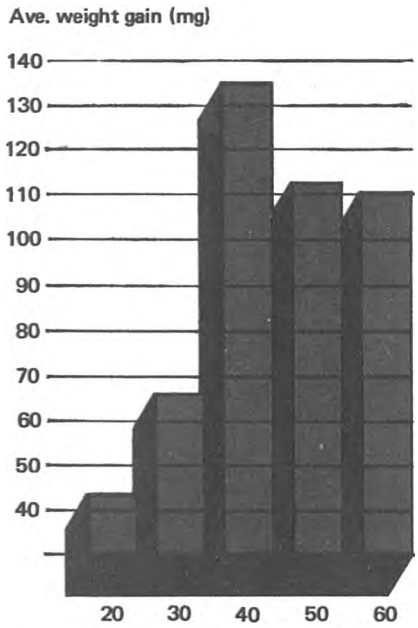


Fig. 1a Weight gain of milkfish fry fed various dietary levels of protein.

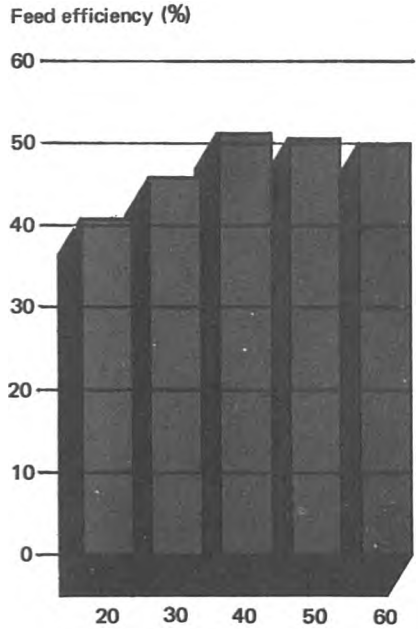


Fig. 1b Feed efficiency ratio of milkfish fry fed various dietary levels of protein.

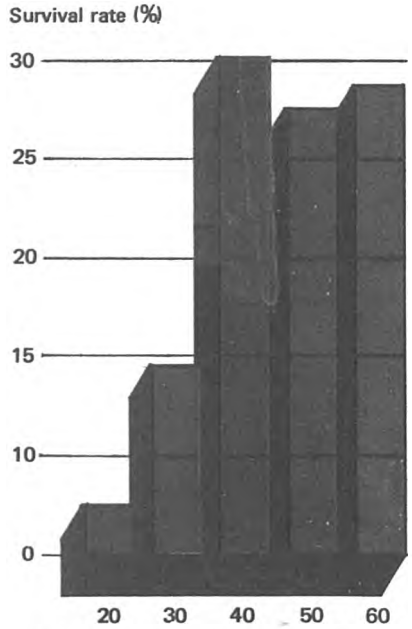


Fig. 1c Survival rate of milkfish fry fed various dietary levels of protein.

A Preliminary Study on the Protein Requirement of Chanos chanos (Forskal) Fry in a Controlled Environment.

value of 96.4 percent. Optimum daily feed allowance varied with species, age, size, frequency of feeding, culture procedures, quality of feed and water. A feeding rate of 16-20 percent of biomass was found best. Increasing the feeding level beyond 28 percent of their body weight did not prove beneficial to the fish because the ammonia-nitrogen concentration in the water increased to a level harmful to the fish.

5. Digestive Physiology. Regarding carbohydrate digestion, the milkfish showed a wide distribution of amylolytic enzymes in the various regions of the digestive tract. High concentration of amylase at approximately 2.0, 0.5 and 0.6 milli moles glucose/mg moist tissue were detected in the intestines, pyloric caeca and pancreas, respectively. The amylase activity increased rapidly soon after peak feeding. In contrast, a build-up of amylase in the pancreas was observed when the fish was not actively feeding.

A study of the skeletal system of milkfish larvae revealed that the feeding mechanism (i.e., mouth and mobility of the head) developed and became functional earlier than the cranium which protects the brain, emphasizing the importance of feeding in early life.

6. Chemistry. To determine the amount of residue accumulated by milkfish in brackishwater ponds and to evaluate the effect of various pesticides in milkfish, gas chromatography analyses were carried on pond soils and on the flesh of milkfish reared in the ponds for two months. Results showed the presence of Thiodan, Heptachlor, Endosulfan, DDT, DDD, Endrin and Aldrin in milkfish flesh and soil samples (Fig. 3).

7. Fry Storage. At constant density of 366 fry/L in a 2-week period storage, it was found that survival was high (95.9 percent) at a salinity of 8 ppt. In stocking density manipulations, wherein the fry in each container were divided equally into two groups every three days within the first ten days, survival was highest at 32 ppt and lowest at 16 ppt.

8. Farming Methods. Two different farming methods were tested to raise milkfish with the objective of maximizing pond production: the modular progression system and the multi-sized stocking system. The first offered the highest minimum production at 583.7 kg/ha based on five crops a year since the culture period was short in the harvest pond. The second method, lowest minimum yield was 530.8 kg/ha due to prolonged rearing period. At this stage of research, it could not be ascertained which of the two methods was more desirable; both however were clearly superior to mono-sized stocking which had a net production of 450 kg/ha.

9. Polyculture. Milkfish fingerlings and *Scylla Serrata* (mud crab) juveniles were stocked in three separate ponds singly (98 days culture period) and in polyculture combination of crab with milkfish (110 days culture period). At harvest, milkfish in monoculture weighed an average 208.4 g with 95.5 percent survival whereas at polyculture, average weight of 147.4 g and 68.5 percent survival. Crabs in monoculture weighed an average of 154.1 g with 62.2 percent survival as compared with polyculture with an average weight of 188.89 g and 68 percent survival.

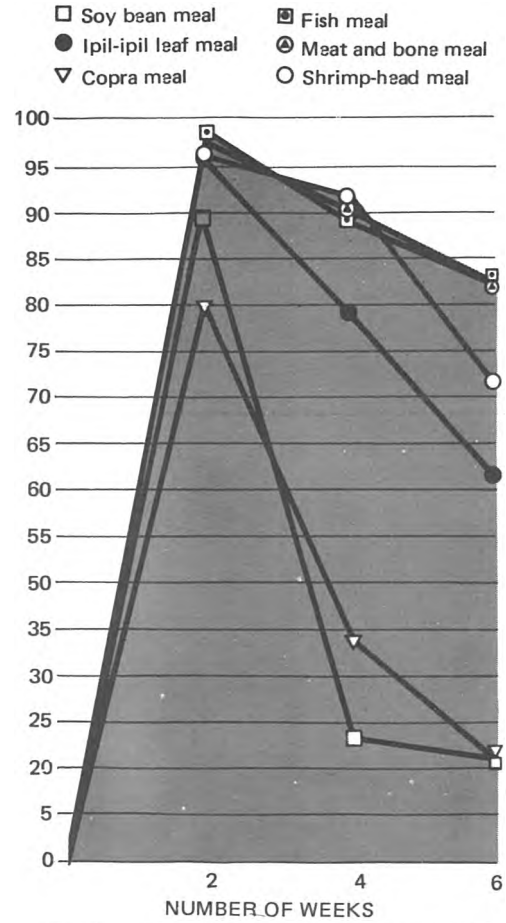


Fig. 2 Survival Rate of Milkfish Fingerlings at Various Periods, Fed Diets Containing Various Sources of Protein.

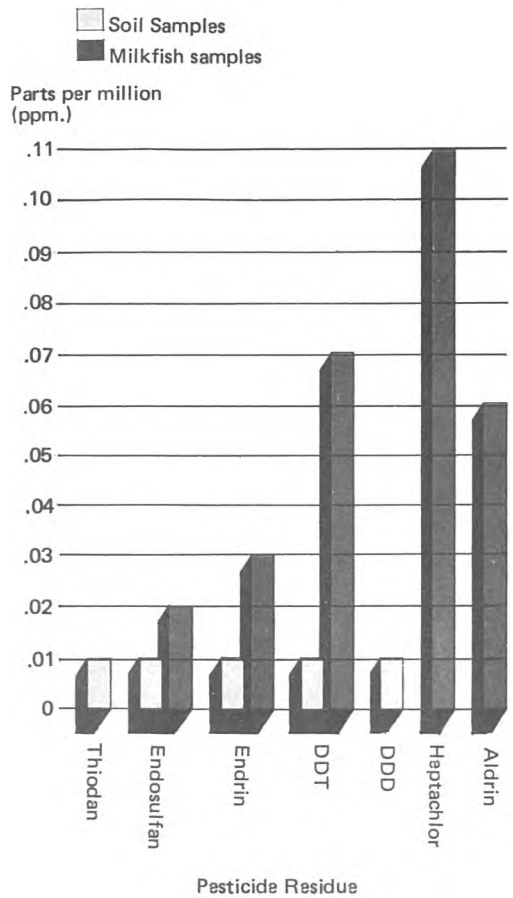
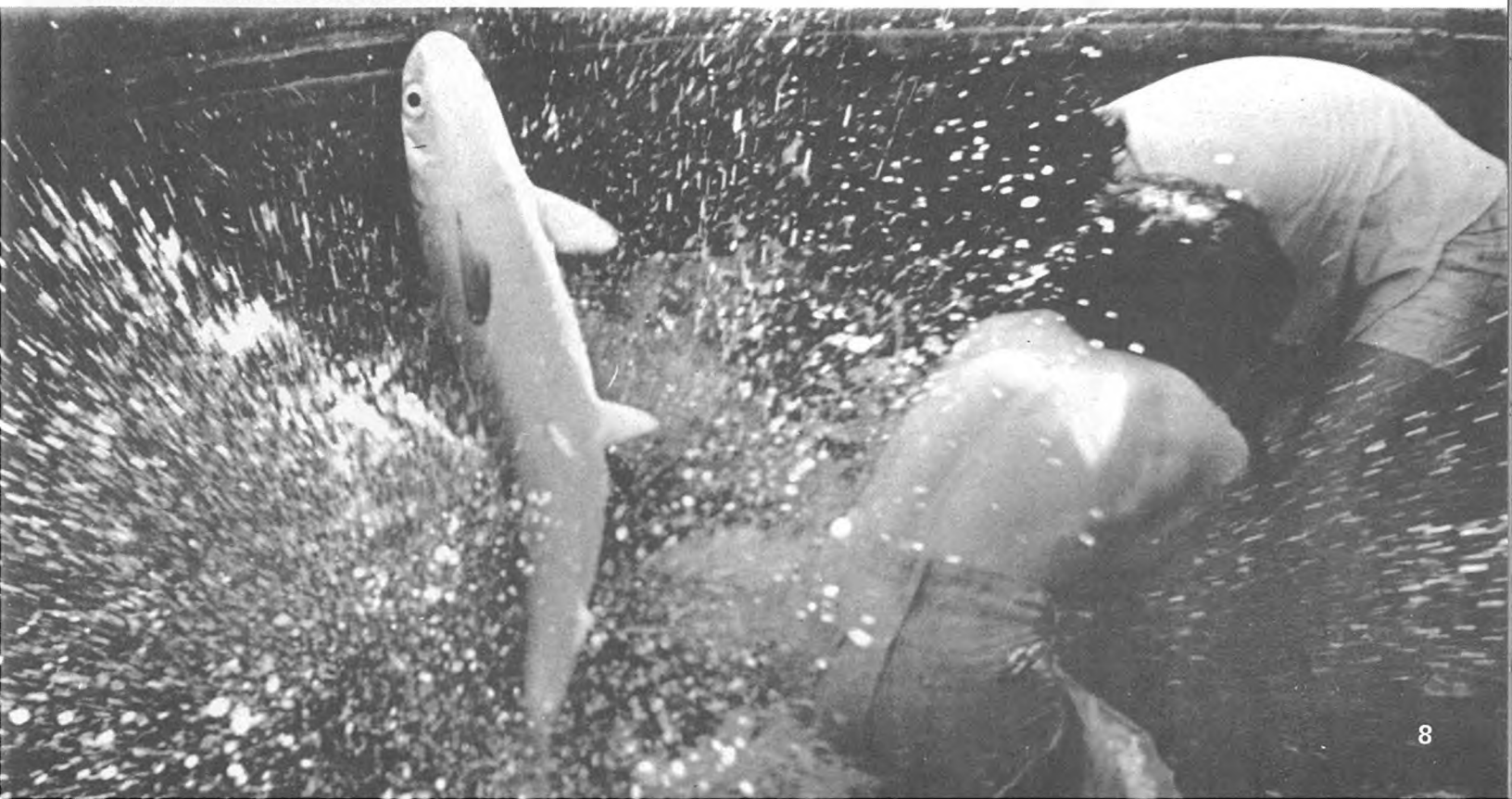


Fig. 3. Concentration Levels of Pesticides in Five-Month Old Milkfish kept in Experimental Ponds.

Collection of milkfish fry along Iloilo coast.

Milkfish feeding time in the marine broodstock pens at Igang.

Sabalo eludes technicians inside canvas tanks.



PRAWN PROGRAM

1. Ecology and Life History. Basic biological data and ecological parameters for prawn culture, including hatchery activities were determined during the year. It was found out that spawners and fry occurred the whole year round with various peak seasons depending on locality. Fecundity was estimated at 500,000 eggs with each female spawning an average of twice within their life span.

2. Broodstock Development. Adult size female *P. monodon* (about 100 g) from fishponds were subjected to treatments to determine the effect of light quality and ablation on ovarian maturation. Unablated prawns held under blue and natural lights developed Stage III ovaries while those exposed to red light reached only Stage II ovaries. With ablation, fully mature ovaries and spawning irrespective of light quality resulted. Histological examination revealed narrow ovum diameter distribution and the presence of a large number of atretic cells in Stage III ovaries under blue light compared with those under the other light color treatments. (Fig. 4)

To determine the effect of tank depth and area on survival and maturation of ablated *P. monodon* females, wild and ablated *P. monodon* were stocked in three circular broodstock tanks with different depth area combinations: (1 x 4m diameter, 1.5 x 4m and 1.5 x 6m). Total number of spawnings, egg and nauplii produced and hatching rate was highest on a unit area basis for the 1.5 x 4m tank.

More than 200 individuals belonging to four species were stocked in a tank over a 4-month period of experiments in induced maturation and spawning of penaeids in captivity. Twenty-three spawnings were obtained from wild gravid females and 16 from females that had subsequently attained maturation in captivity without ablation. *P. indicus and P. merguiensis* were the species most responsive to maturation without ablation.

The application of the ablation technique has led to the ability to produce spawners throughout the year thus ensuring the hatcheries of the Department in Tigbauan, Iloilo a relatively reliable supply of spawners for seed production. In Batan Substation, eight maturation pens completed were able to produce spawners at a minimum of 150 per week. Thus, the need for wild spawner collection has been supplanted.

Prawns prepared for ablation.

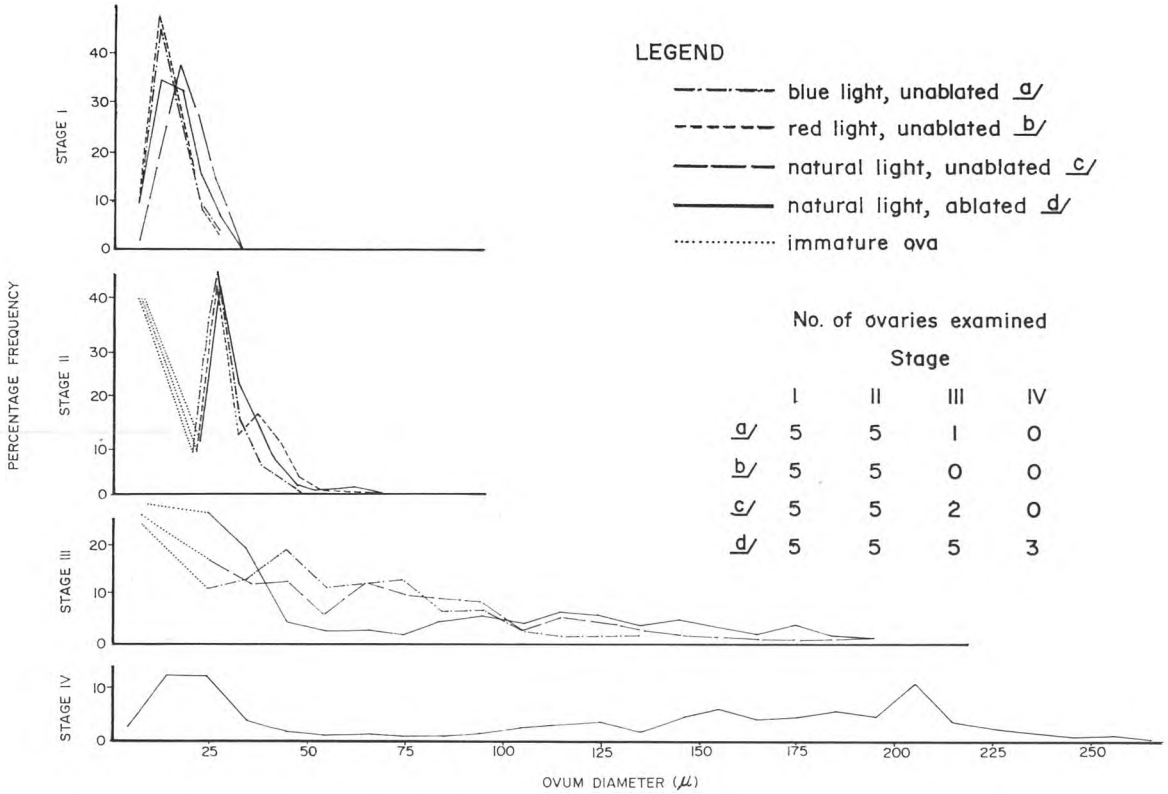


Fig. 4. Ovum diameter frequency at various stages of maturation in P. monodon under different treatments.

Spawning P. monodon caught in action.

3. Larval Rearing. Frozen *Brachionus* and frozen brine shrimp with live algal feeds were found effective feeds for prawn larvae. An average survival rate of 41 percent from nauplius to postlarva was obtained in 2-ton conical bottom wooden larval rearing tanks. Frozen *Tetraselmis* was a good feed for *Brachionus*. A feeding level of 400,000 to 600,000 cells *Tetraselmis* per ml could increase *Brachionus* density to more than four times the maximum density attainable if fed with live *Chlorella*.

In an experiment with *P. merguiensis* testing different feeding levels of *Chaetoceros*, highest survival rate was 77 percent at a feeding level of 100,000 to 150,000 cells per ml. Feeding level influenced the rate of larval development starting from the zoea stage. (Fig. 5)

Average survival rate for *P. monodon* fed with live algal feeds along with frozen rotifers and brine shrimp was 41 percent. This was considered better than prior experiments in the Barangay Hatchery using live feeds which gave average survival rates of 30-40 percent covering an equivalent culture period from nauplius to postlarvae.

The ability to rear *P. monodon* in the hatchery using frozen rotifers and brine shrimp could simplify operations in the hatchery as it would no longer be necessary to synchronize the mass production of live *Brachionus* and the hatching of brine shrimp at specific larval stages of *P. monodon*. It would then be possible to mass produce rotifers and hatch brine shrimp even during the period when there were no larvae in the hatchery and to freeze them for later use.

4. Nutrition and Feed Development. To determine the best postlarval feed, postlarvae weighing an average of 15.61 mg were fed with brown mussel meat and artificial diets containing casein, shrimp meal, squid meal and *Spirulina* as protein sources at a rate of 20 percent of their biomass per day for a period of 10 days. Results showed that squid meal was the most superior in terms of weight gain (Fig. 6), feed conversion efficiency and protein efficiency ratio. Fresh brown mussel meat was comparable to shrimp meal regarding protein efficiency ratio values and survival rates.

To compare the effects of different feeding regimes on survival, fecundity and hatching rate, *P. monodon* broodstock with females unilaterally ablated were given four different feeding regimes combining fresh feeds and pelleted diet. Females fed a combination of fresh brown mussel and pellets produced the greatest number of eggs as well as nauplii. Although females fed a pure fresh diet had an approximately equal number of eggs, hatching rate was lowest among all treatments. Females on a pure pellet diet produced the lowest number of eggs and nauplii.

On the effect of various lipid sources (beef tallow, fish oil, soybean oil, corn oil, coconut oil and pork lard), results indicated that beef tallow had the best growth rates. Based on feed conversion values and survival rates, fish oil was better utilized than beef tallow. Those fed with pork lard, coconut oil and corn oil did not show satisfactory growth.

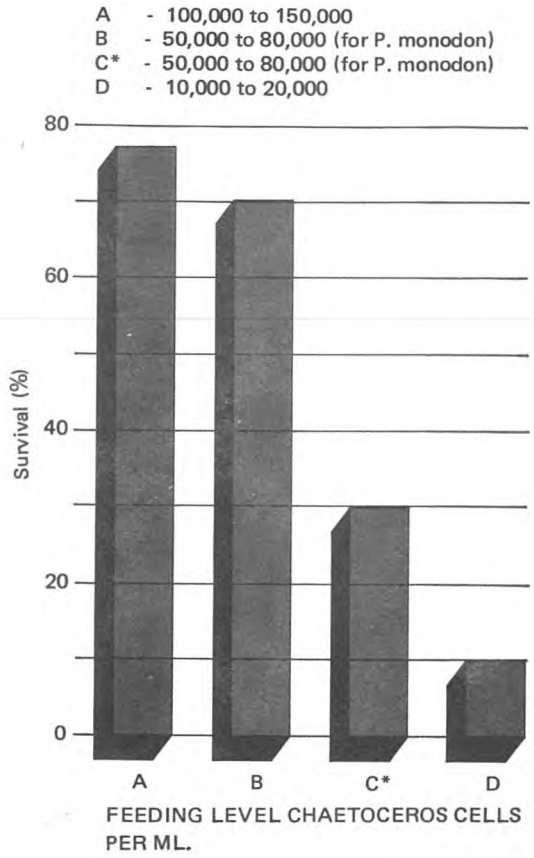


Fig. 5 Survival Rate of P. Merguiensis Fed Chaetoceros from Nauplius to Postlarva.

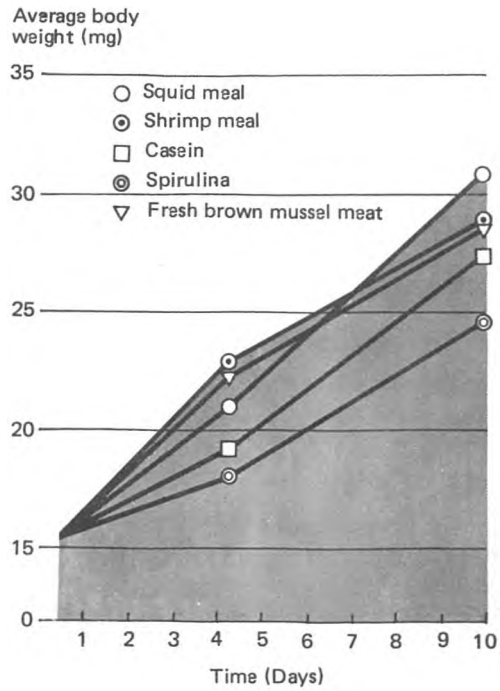


Fig. 6. Growth Rate of P. Monodon Postlarvae Fed Fresh Brown Mussel Meat and Diet Containing Various Protein Sources.

P. monodon juveniles weighing 1-2 g were fed on diets containing "ipil-ipil" *Leucaena leucocephala* leaves, for a period of eight weeks in a fiberglass aquaria provided with continuous aeration and a flowthrough system, diets made up of fish meal, shrimp head meal in different treatments of ipil-ipil leaves. Those fed with commercial leaves had an average gain of 12 percent in weight and 31.5 percent body length over all other groups. Survival rate was highest (87.5 percent) for those fed the diet containing soaked leaves of the local variety. Those fed local unsoaked leaves also had zero survival. Soaking the local variety of leaves for 42 hours in freshwater was an effective means of reducing the toxic lysine derivative (mimosine) present in ipil-ipil leaves which caused the poor survival among those fed the unsoaked leaves. The juveniles fed a control diet lacking ipil-ipil leaves did not gain significantly in comparison to diets with ipil-ipil leaves.

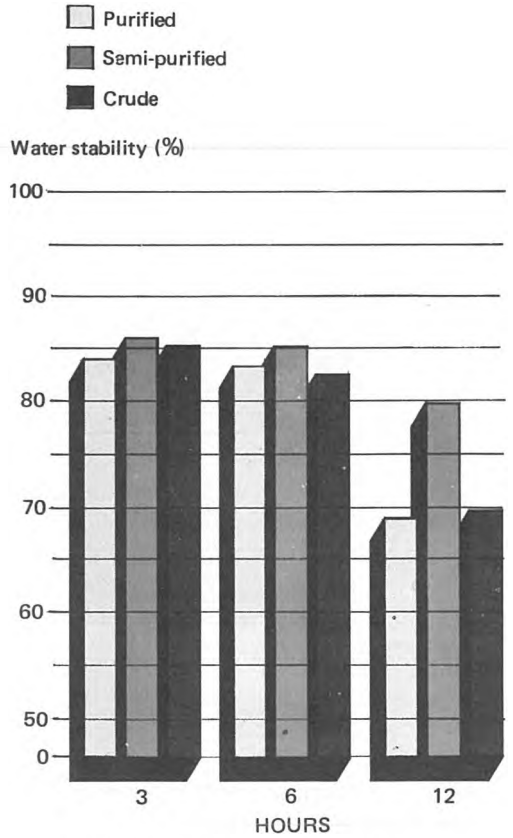


Fig. 7 Water Stability of Shrimp Diets Containing Various Sources of Sago Palm Starch.

Pellet diet stability tests were also conducted. Three isonitrogenous and isocaloric practical-type diets using purified, semi-purified and crude starch from sago palm *Metroxylon sago* Rottb., as binders, were pelleted through a 2-mm diameter die in a Hobart meat grinder. These diets were steamed for five minutes at 85°-90°C and oven dried to a moisture content of approximately 10 percent. The pellets were evaluated for water stability after 3.6 and 12 hours in seawater at 32 ppt salinity and 28°C temperature. Approximately equal amounts of the three diets remained intact after three and six hours. After 12 hours immersion , the pelleted diets decreased significantly in water stability. However, the diet containing semi-purified sago starch had the highest water stability (79.1 percent). Values for pellets with binder using purified and crude sago starch were nearly the same (Fig. 7). The use of pure sago incurred an additional cost of P4.15 per kg diet while semi-purified and crude sago starch as binders obtained P0.17 and P0.18 cost increments respectively per kg diet. Semi-purified sago starch was therefore deemed preferable to crude sago starch.

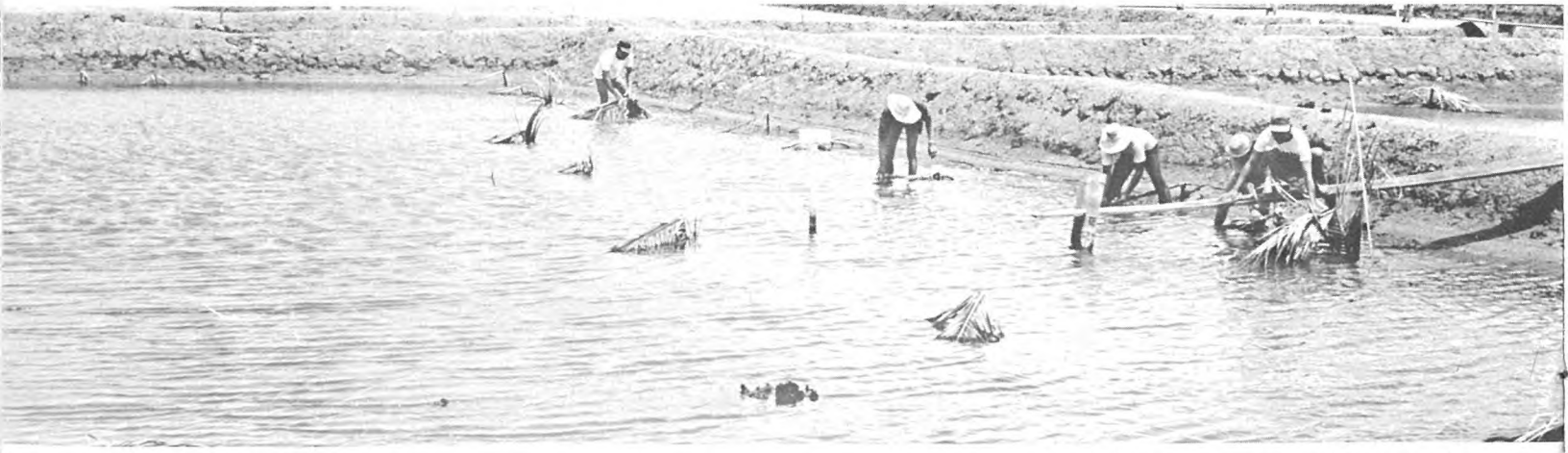
Prawn nursery tanks at Leganes station.

Pellets prepared with fish water obtained by boiling the fins, bones and skin of guitar fish or sharp-nosed shark plus agar bars or crude agar made from sun-dried *Gracilaria confervoides* were tested to determine their stability in water. The most stable pellets after six hours were those prepared with fish water or plain water and crude agar. However, after 24 hours immersion, pellets prepared with fish water and agar bars proved most stable (65.1 percent) while those prepared with fish water and crude agar were the least stable (43.7 percent).

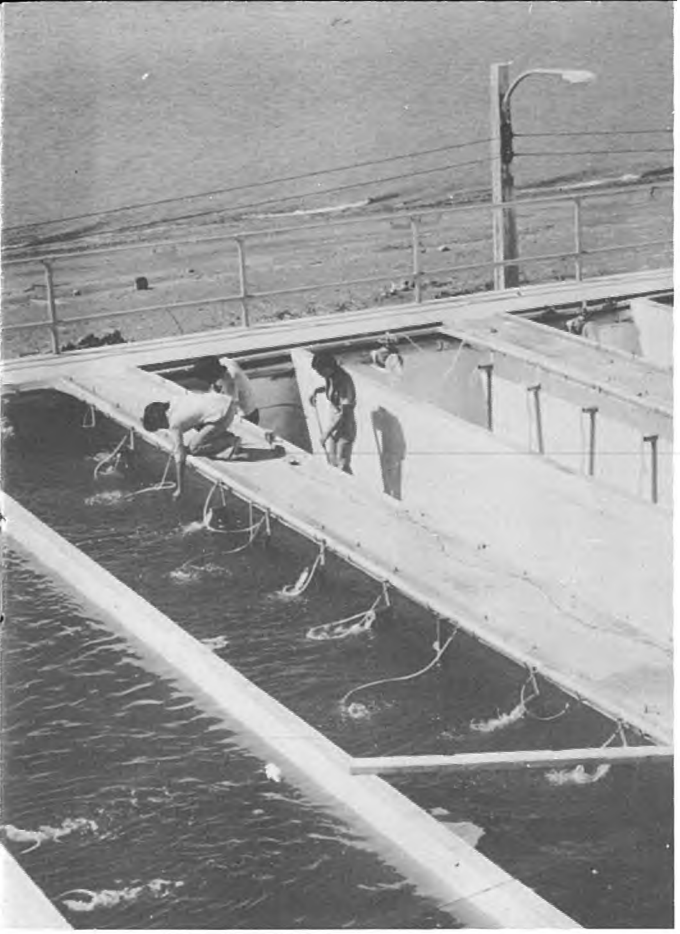
To find a suitable attractant for purified diets, five juvenile *P. monodon* weighing about 0.2 g were reared on purified diets. The basal diet contained 53 percent casein; cornstarch, 34 percent; corn oil, 5 percent; cholesterol, 1 percent; Vitamin mineral mix, 2 percent; and alpha cell, 5 percent. Plain water, shrimp, mussel, squid or trash fish extract at 125 ml were used to gelatinize the cornstarch.

Approximately 10 percent of total biomass was fed morning and afternoon. Prawns were readily attracted to pellets made with shrimp and mussel extract. Pellets prepared with fish and squid extract were not as acceptable and the least attractive pellets were those prepared with plain water. Prawns fed with the mussel attractant gained the most weight (219 percent) over a 62 day period while those fed pellets made with fish extract gained the least. Highest survival rate was observed in the group given the shrimp attractant followed by mussel. If growth and survival rates are used as criteria for measuring the attractability of the diet, mussel would be considered the best attractant followed by shrimp.

Installation of coconut fronds in earthen ponds as vertical substrate for prawn fry.



Leveling of newly constructed prawn pond.



Algal tanks for mass culture of phytoplankton.

5. Natural Feeds. Algal preservation studies consisted of four inter-related phases: harvesting, preservation, viability tests on frozen algae, and larval feeding with preserved algae. Test organisms included two diatoms, *Chaetoceros calcitrans* and *Skeletonema costatum*, and two flagellates, *Tetraselmis chui* and *Isochrysis galbana*.

A simple yet effective method in harvesting of algae from cultures through adjustments of pH of the culture media was developed. The procedure simulated auto flocculation and effected rapid and nearly complete recovery of algal cells. This was effected simply by raising the culture pH with 1 N sodium hydroxide to a level that cause floc formation, followed by setting of algal floc and finally neutralization of harvested algae back to its initial pH. Techniques of freezing and sun-drying were investigated as possible methods of preserving algae. Viability tests and feeding trials were done on frozen samples while sun-dried algae was used solely for larval feeding experiments. Viability tests showed that freezing with added agents as chemical flocculants and protectants was effective. Sun-dried algae showed satisfactory results as larval food. Both frozen and sun-dried algae can therefore be used to supplement fresh algae.

Growth of diatoms *Chaetoceros* and *Skeletonema* at temperature ranges 21°-25°C continuously, illuminated by 40-watt daylight flourescent bulbs at a light intensity of 27,000 lux at salinity levels of 8, 12, 16, 20, 24 and 32 ppt, showed a wide range of tolerarance to salinity from 8-32 ppt. The optimum salinity requirement however was registered at 16 ppt. Population peak growth was generally obtained in 46 hours of culture period at all salinity levels. On the other hand, growth of *Skeletonema* at salinity levels below 12 ppt was much lower than higher salinity levels.

On the mass rearing of *Artemia* from nauplii to adult, very fine rice bran measuring less than 60 microns in diameter was found to be a suitable feed. Rice bran concentration, as feed for *Artemia* should be maintained at 25-35 cm turbidity for good survival.

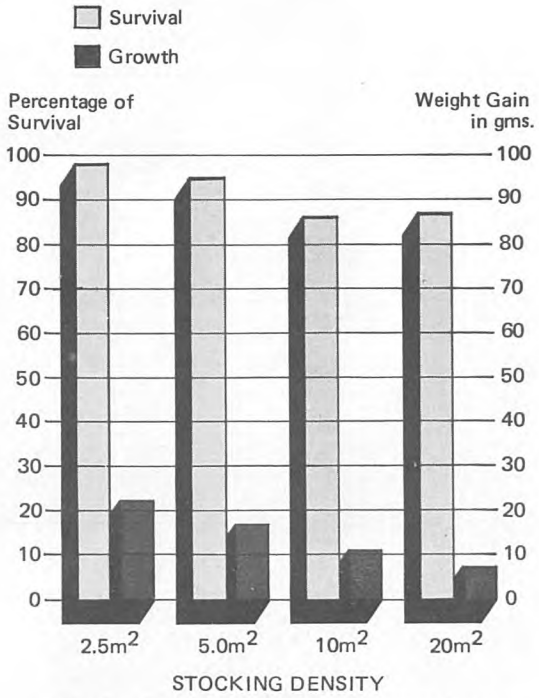


Fig. 8 Growth and Survival of P. monodon at Varying Stocking Densities.

6. Pond Production. Growth and survival rates of *P. monodon* juveniles cultured for three and a half month period in 200-sq m earthen ponds with flowthrough system giving a 10-20 percent daily water exchange were stocked with fry at a rate of 2.5, 5.0, 10 and 20 per sq m. Dry pelletized feeds were given daily at 10 percent body weight during the first two weeks then reduced by one percent every succeeding two weeks up to five percent two weeks before harvest. Results showed that stocking density had an inverse response in terms of growth and survival rate (Fig. 8). In terms of prawn biomass, the higher the density, the greater the production.

An experiment to determine the optimum stocking density per unit area on traditional methods without supplemental feed was conducted. During the experimental period of six months, environmental conditions were maintained with water temperature at 26.8° to 33.5°C, salinity ranging from 22-23 ppt, and pH

range 4.0-8.8. Juveniles with average body weight of 0.5 g stocked in eight 500-m ponds at stocking densities of 0.5, 1.0, and 3.0 sq m each, showed the best growth performance and production. The average body weight at harvest was 22.0 g and production of 112.6 kg per ha for the 0.5 g per sq m stocking density.

To test the hardiness of postlarvae, gradual acclimation to freshwater was conducted for one-day and three-day periods. Among the different ages of postlarvae tested, P_{35} postlarvae gave high survival rates of 98.99 percent while higher mortality rates were obtained for P_{20} and P_{90}. A three-day acclimation period was optimum for all ages of postlarvae. Shorter duration of acclimation produced survival values of as low as 20 percent. This was true for P_{20} and P_{90}, but not for P_{35} which showed high survival regardless of acclimation period.

The Jalaud River has considerable long-term significance at the Leganes Station since it provides the only reliable source of freshwater to control increasing salinities during the February to June dry season. This source has already been tapped by our engineers and construction teams.

7. Physico-Chemical Properties of the Jalaud River. A 24-hour monitoring programme was carried out during the highest tide of each month from June to November. During rainy days, turbidity was above 220 ppm; during sunny days, turbidity did not exceed 100 ppm.

8. Pathology. Two methods of spawner disinfection to control fungal infections in larvae were evaluated for effectivity. In the first method, spawners immersed in 5 ppm Treflan R for 30 minutes spawned; in the second spawners washed for an hour, then immersed in 5 ppm Treflan for another hour, and washed for a few minutes, spawned. Results of six trial runs showed the second method superior to the first.

A total of 44 hatchery runs of *P. monodon* larvae were monitored for diseases and associated micro-organisms. Common diseases and causes of mortality observed were: *Lagenidium callinectes, Sirolpidium, Chitinoclastic bacteria, Epistylis* and *Vorticella.* Others observed but which did not cause substantial mortality were: *Acineda, Licmophora abbreviata, Nitzchia closterium* and *Zoothamnium.*

Sensitivity of *Lagenidium sp* to 34 antimyotic compounds were tested. Fungitoxic effects were evaluated from observations made on the development of vesicles, zoospores and mycelia growth. Three classifications of mycostatic reactions were noted. Mycostatic dose A of both isolates were found to be at 1 mg/L with clotrimazole, crystal violet, econazole nitrate, malachite green, Treflan and Trifluralin; at the level of 1-5 mg/L with benzalkonium chloride, deconil, detergent, fuchsin and furanace and, at 10-50 mg/L with benlate, formalin, griseofulvin, phenol and potassium permanganate. Both isolates however exhibited variable

Prawn pellets preparation.

mycostatic levels with copper sulfate, 2, 4D, hydrogen peroxide methylene blue, piraricin, resiguard and tolnafate. Mycocidal levels were likewise determined in nutrient agar. Amphotericin, iodine, nystatin, triacetin, boric acid, fungitox and PVP-iodine proved to be poor antifungal agents. Furthermore, mycelial growth seemed readily inhibited by antifungal agents, compared to sporogenesis.

Zoea, mysis and postlarvae of *P. monodon* were exposed to varying concentrations of Treflan-R. Results showed that zoea can tolerate up to 0.1 ppm dose for 96 hours while mysis and postlarvae can withstand chemical exposure at 1 ppm.

Also, bacterial isolates were made from *P. monodon* larvae, postlarvae, juveniles and adults with concomitant occurrence of mortalities in rearing tanks. Identification of these isolates showed that *vibrio* had been persistently associated with shrimp kills.

P. monodon feeding on experimental pellets.

SEAFARMING PROGRAM

The mussel and oyster research projects have continued with progress at Himamaylan and Banate substations of SEAFDEC with emphasis on production and spat collection for colonizing new areas using new and successful culture techniques. These techniques are also being used on a demonstration basis for training and extension activities of the Department.

Mussel

At present there are six rafts in Himamaylan, supporting a total of 400 ropes, each 1 meter in length. At 15 kg per meter of rope, the ropes have a potential production of 6 tons of mussel. Partial harvests of 2,100 kg have already been made.

Histological analysis and environmental monitoring were continued to provide a guide for future farming activities such as the proper time to lay growing ropes so as to catch the main spatting time. A ten point system of gonadal stage classification has been worked out. This consists of a resting or zero stage, four development stages, a pre-spawning or ripe stage and four post spawning stages. For farming purposes, it would be adequate to lump the four developmental stages into just one stage - i.e. one spawning stage followed by one post spawning stage to arrive at a four stage classification (Fig. 9). The inactive stage in non-reproductive phase and therefore sex differentiation is not possible at this time.

Mussel settlement on polypropylene rope with coconut husks.

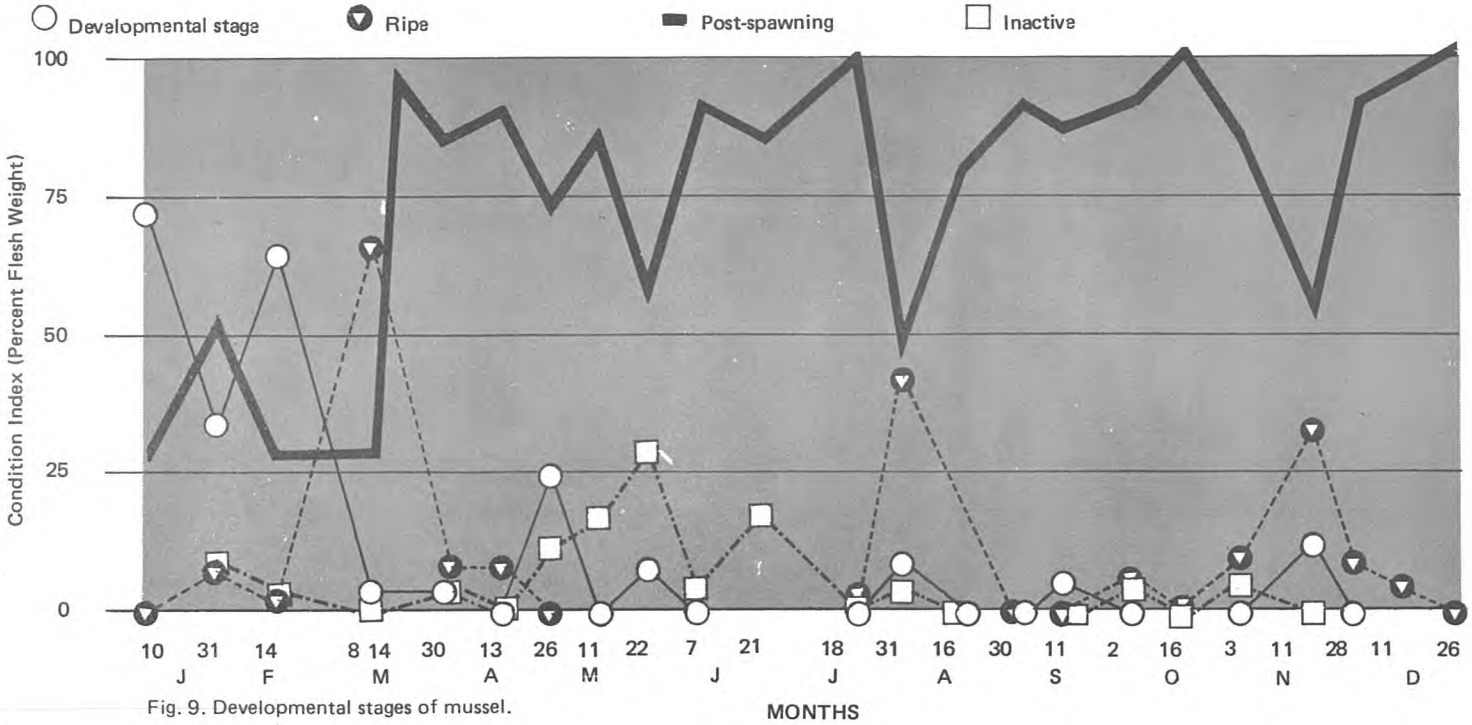


Fig. 9. Developmental stages of mussel.

Oyster shell clutch laden with oyster spats.

Basic biological studies such as condition index by wet weight and by dry weight (Fig. 10) and spat monitoring of mussel were done. It was found that the best time to harvest mussel are in the months of January, May and July thru September.

An investigation of the comparative suitability of different spat collecting surfaces using oyster shells and coconut shells showed that oyster shells, on the average, collects 3.72 times more spats than the coconut shell of comparable sizes.

Our observations at Banate showed further that there are two types of oysters: denticulated and non-denticulated later differentiated as belonging to genus Saccostrea and crassostrea respectively. On both coconut and oyster shells the Crassostrea spat always predominates ranging from 1:6 to 18:2 in oyster shells and from 2:6 to 36:1 on coconut shells (Fig. 11)

The oyster pilot farm in Banate (area 180 m^2) produced about 2.5 metric tons of oysters for the entire year of 1978.

Placuna

Placuna are found off the Guimbal area on the southern coast of Panay with major concentrations at farther off the municipality of Oton, occurring mostly from 7-12 meter depth on soft muddy bottoms. During the 1978 season, there were two major landing areas located farther off Oton for the *Placuna* harvested.

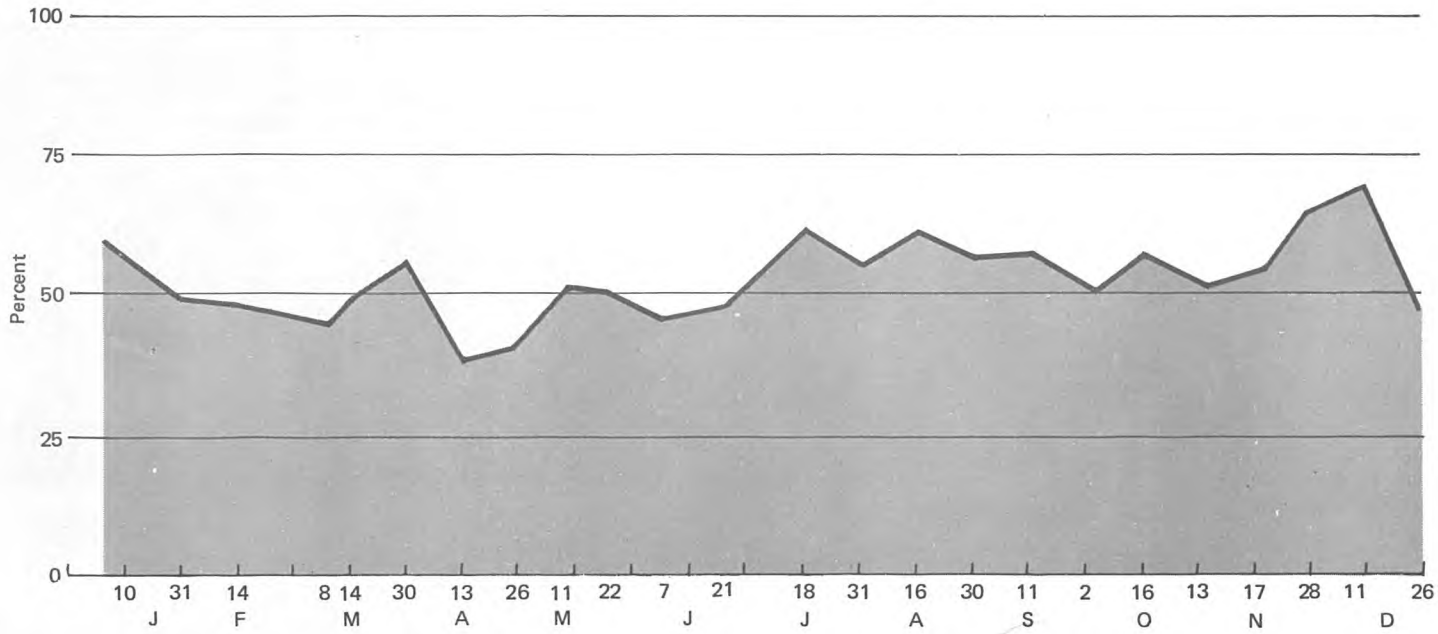


Fig. 10. Condition index of mussel.

The distribution and abundance of *Placuna* within the Iloilo strait were studied using the catch statistics obtained from the biggest landing area at Cabanbanan. Records indicated that this area accounted for at least 50 percent of the total landings. Data showed that between 15 March and 29 April 1978, 30,903 boxes of 18.5 million *Placuna* were landed at Cabanbanan (Fig. 11).

Length frequency studies conducted from January to May 1978 showed that the average growth of *Placuna* is 8.8 mm per month (Fig. 12). and preliminary histological studies showed that many *Placuna* shells are harvested before they spawn.

Crab Studies

Some preliminary but valuable information concerning the breeding and growth of the crab was obtained as follows:

- Courting behaviour and mating occurred in all salinities between 20 ppt and 30 ppt with actual mating recorded at highest salinities between 20 ppt and 26 ppt. (Fig.13)

- Gonadal condition indices were analyzed visually and histologically for both males and females.

One case of spawning was observed in 30 ppt but the eggs were not hatched. Salinities of 20 ppt appear to produce higher molting frequencies and greater body weight gains per molt than in the case at salinities 26 ppt or higher (Fig. 14).

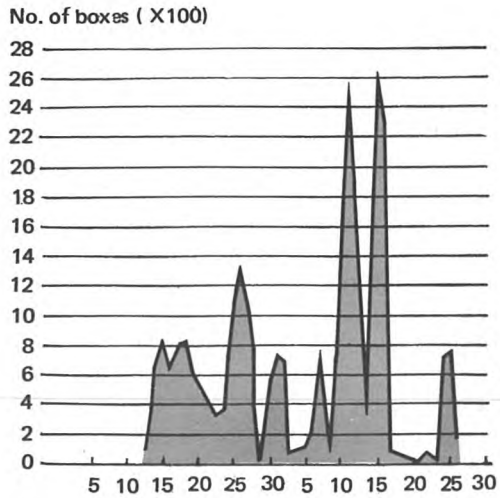


Fig. 11. Placuna Yield for the Period March 15, April 29, 1978 (Oton).

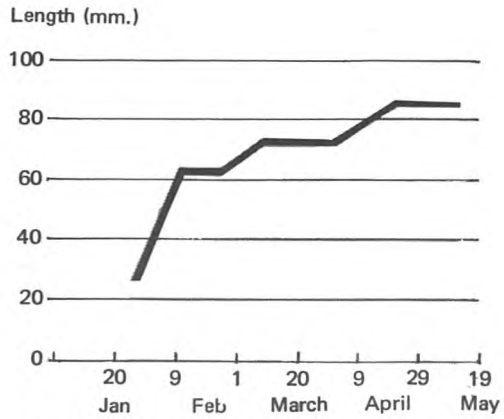


Fig. 12. Modal growth of Placuna from 26 January to 8 May 1978.

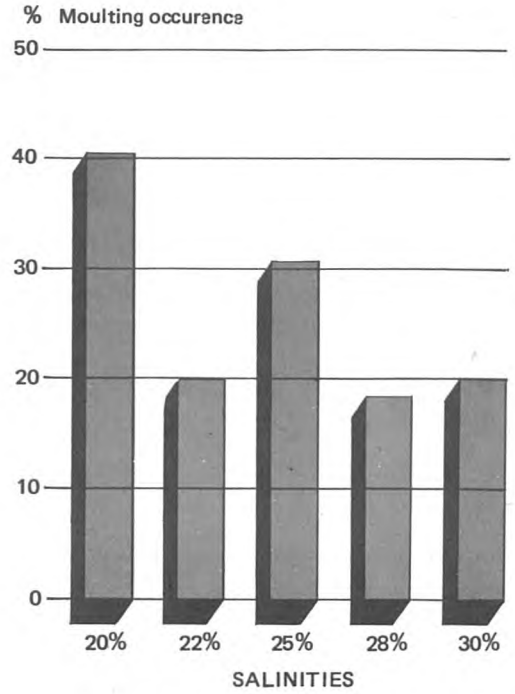
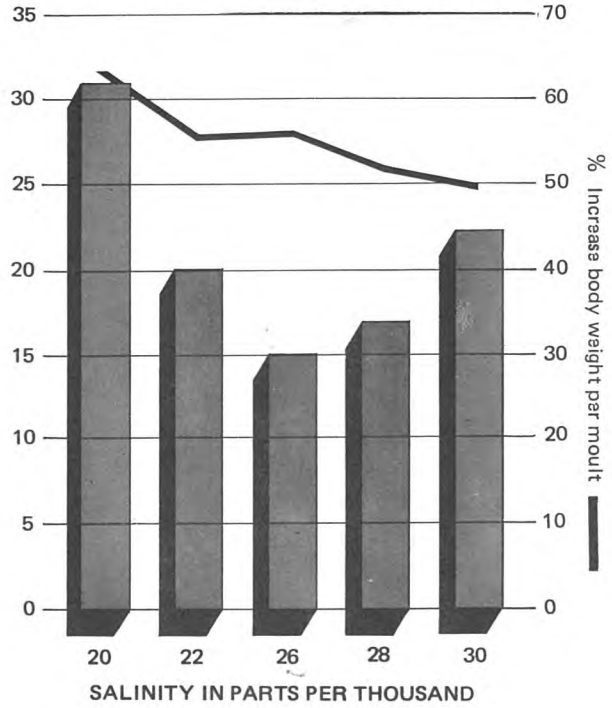
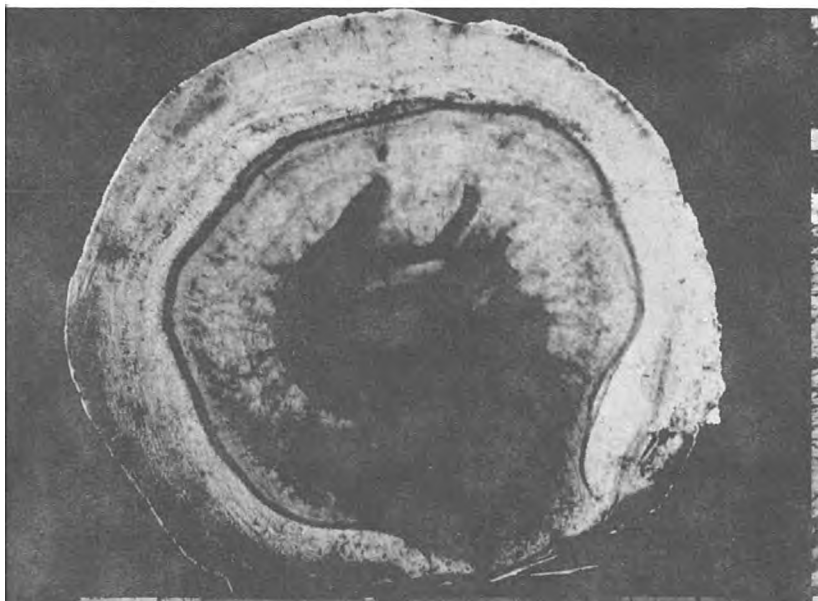


Fig. 13. Percent Mating Occurences in the Scylla Serrata Broodstock Held at Different Salinities for the Period from July to November 1978 (n 12 pairs).

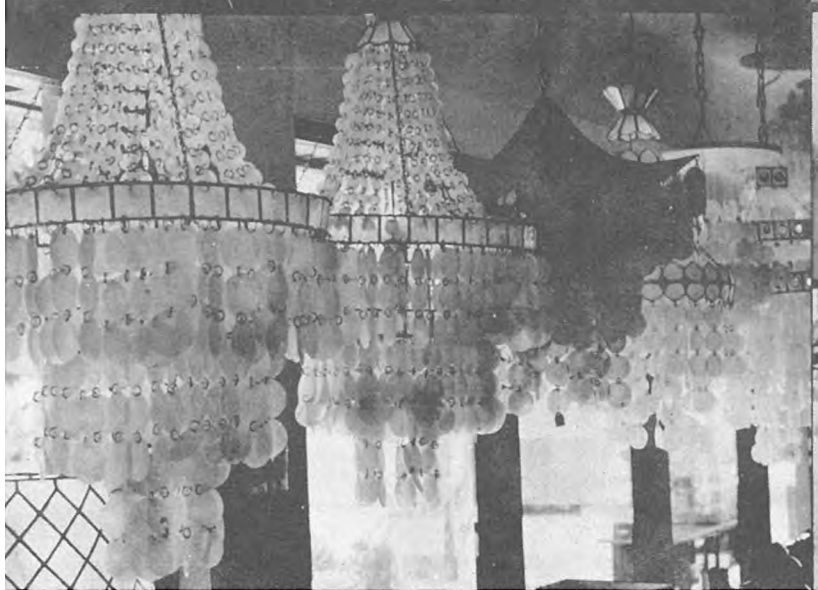
Fig. 14. Relationship Between Moulting Occurences, Body Weight Increments and Salinity for Scylla Serrata in Laboratory Aquaria. (n 24 crabs held for 7 months in each of two runs March-May and June-Sept., 1978).

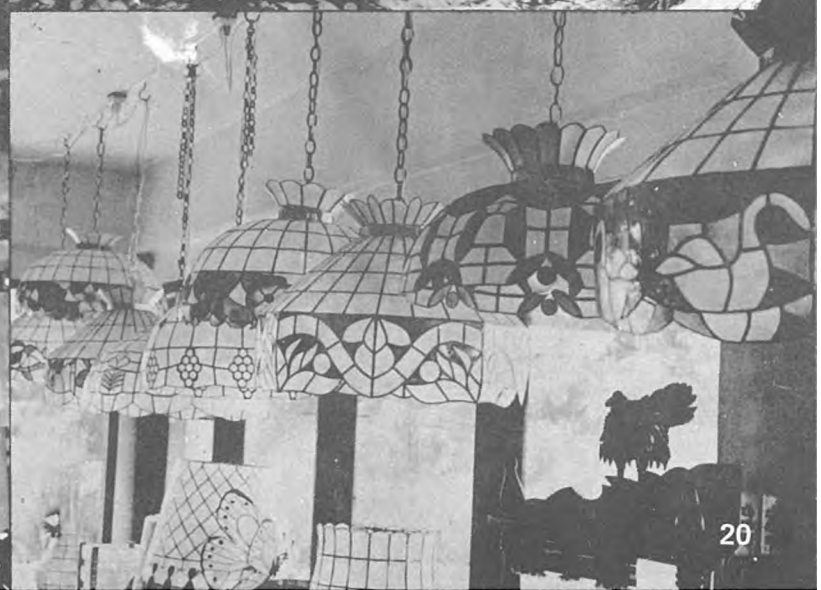


Live Placuna



The famous Capiz lamps made from placuna shells.





FRESHWATER PROGRAM

1. Milkfish Culture. Milkfish fry were subjected to two methods of acclimation: (a) gradual and continuous acclimation by adding freshwater and (b) gradual acclimation by removal of brackishwater. Of the two methods of acclimation, the highest percent survival of 88 percent was obtained in the first by the gradual lowering of salinity from 12 ppt to freshwater using continuous dripping of fresh water. The second method was not effective in reducing stress of the fry and had a survival rate of 83.6 percent. Direct stocking in freshwater in hapas reduced the survival rate to 59.3 percent. However, direct and immediate transfer in the lake gave the fastest growth after one week because of the availability of natural feeds in the water.

To determine the effect of substrate and stocking density on growth, milkfish fingerlings were stocked in cages with mud substrate and in floating ones for two months. Stocking density was 2, 6 and 10 fingerlings per sq m. Results showed that body weight and length increased when stocking density was decreased from 10 to two per sq m. Slightly faster growth rates were obtained with fingerlings reared in cages with substrate (about 4 percent).

The effects of stocking density and water depth on the growth of milkfish fingerlings stocked at 2, 6 and 10 per sq m and depths of one and two meters were assessed. Growth and development performances of milkfish were observed to respond inversely with stocking density, i.e., weight and length increased when stocking density was reduced from 10 to two per sq m. Fish stocked at 10 per sq m produced the lowest increment. It was concluded that an inverse relationship between growth rate and stocking density existed.

2. Tilapia Production. Research focused on the continuous supply of high quality fry. Breeding studies were undertaken to produce hybrids that could show better production performance.

Hatchery and wet lab buildings at Freshwater Station, Binangonan, Rizal.

To develop pureline broodstock of *T. nilotica* and *T. mossambica* and to determine the growth dynamics of various crossbreds, inbreds and hybrids of tilapia, crosses were made between *T. nilotica* and *T. mossambica.* The tilapia species used in crossbreeding were *T. nilotica* from Laguna de Bay designated as A, from CLSU as B and *T. mossambica* from Malabon as C.

Increase in body length, width and weight of four F_1 crosses were maximum from April to June. After this period, growth and body development were observed to increase at a slow rate until the sixth month. Among the crosses, A x C showed the fastest growth rate from the third to the fifth culture month. This was closely followed by B x C but its growth rate did not follow a definite pattern from third to the sixth month.

In general, results indicated that the F_1 crosses of *T. nilotica* and *T. mossambica* were as big as the *T. nilotica* but not smaller than the progenies. All the F_1 progenies A x C and B x C were as big as the male parent but not smaller than the *T. mossambica* female parent. In most cases, the B x C crosses were not significantly better than C x C.

Studies were also conducted to optimize the production of *T. nilotica* in cages in the lake. Major factors affecting production such as stocking density and sex were thoroughly investigated.

T. nilotica fingerlings were stocked in cages in the lake at densities of 50, 100 and 150 per sq m. Fish stocked at 50 per sq m produced the highest mean length and weight, followed by those stocked at 100 and 150 per sq. m. (Fig. 15).

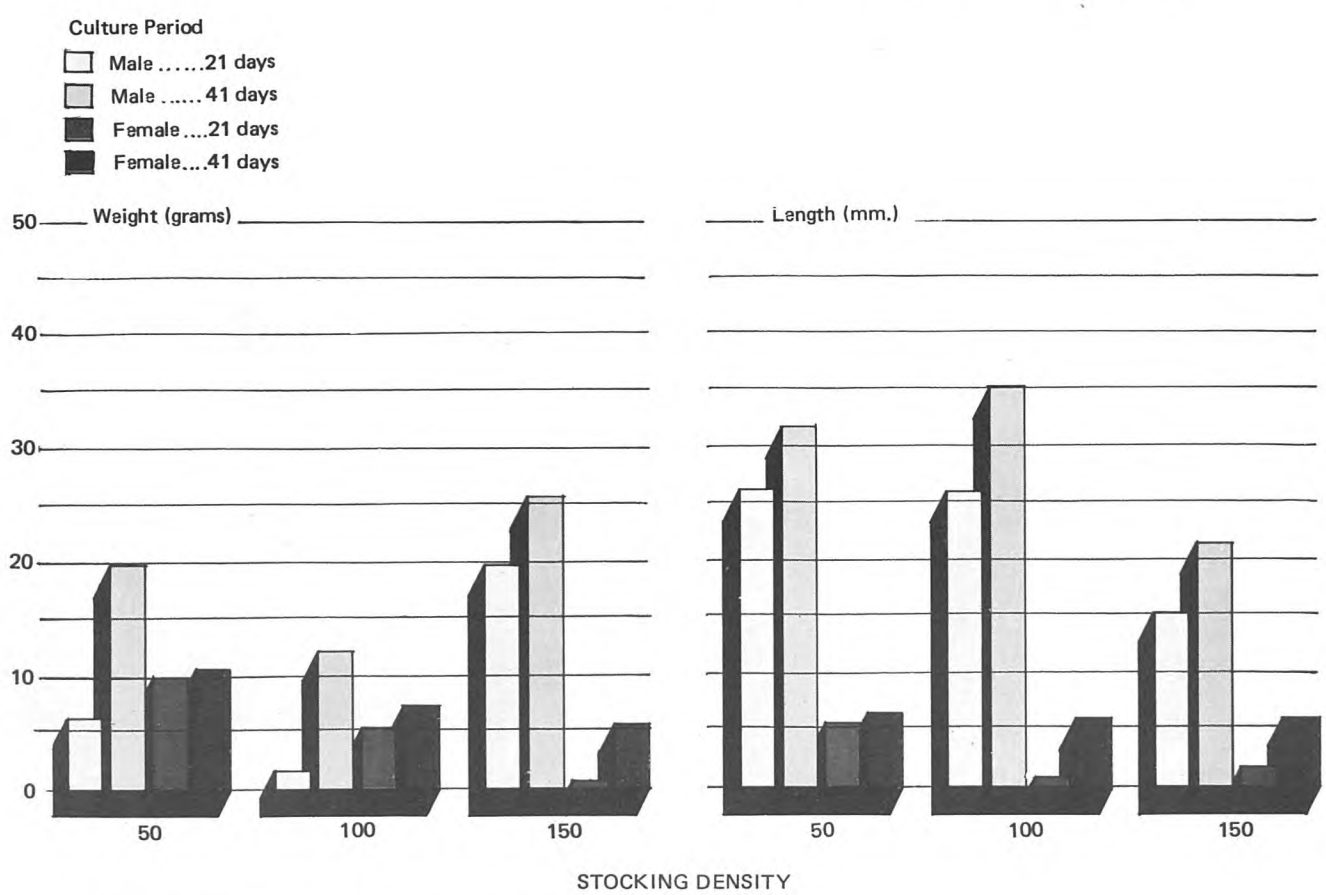


Fig. 15. Growth Increments of Monosexed Male and Female T. nilotica Cultured at Three Stocking Densities in Cages and Two Culture Periods.

To compare, the growth rates of monosexed male *T. nilotica* at different stocking densities were faster than females. Among the males, it was observed that those stocked in cages at a density of 150 per cu m had the highest weight increment after 41 days. Result also suggested that all male tilapia could be reared at stocking densities as high as 150 per cu m.

3. Prawn and Shrimp Farming. Transport and handling experiments were conducted to obtain maximum survival of hatchery-produced and wild fry of *P. monodon* as well as spawners of *Macrobrachium sp.* The existing transport practices, although practical and economical, need further improvement and refinement when applied on a large scale basis.

To determine the effects of different containers, temperature control and anesthetics on survival during transport, *Macrobrachium sp.* were transported in styrofoam boxes, plastic bags in buri baskets, and in plastic pails. Significantly higher survival rates were obtained for specimens transported using styrofoam boxes with battery operated aerators as compared to those in oxygenated plastic bags in buri baskets and plastic pails. Of the two types of anesthetics tested, chloroform and sulfuric ether, did not show any significant difference. However, specimens transported with anesthetics showed highly significant survival rates over those transported without anesthetics. Temperatures below 20°C also reduced abortion among gravid females and produced good survival rates during transport.

To determine the effect of increasing stocking density of prawn, postlarvae (P_{10}, P_{15}) were subjected to varying periods of acclimation (3, 4 and 5-days) and different stocking densities 20, 10 and 5 per sq cm. Algae cake was given as feed at 15 percent body weight per day. Results showed that survival was not affected by higher stocking densities during the acclimation period. The high percent survival of postlarvae stocked at 20 per sq cm was also not affected by the duration of acclimation. However, a slight increase in mortality was noted in 10 per sq cm stocking density in 3 and 4-day acclimation periods. The same trend was observed at a stocking density of 5 percent. Extending the 5-day acclimation period resulted in 99 to 100 percent survival in all treatments (Fig. 16).

The effect of supplemental feeds at varying feeding rates on growth and survival of *P. monodon* reared in the lake was studied. Acclimated postlarvae (P_{20} - P_{30}) were stocked at 20 per sq m in cages and given three types of supplemental feeds: Feed 1- Algae cake; Feed 2 - trash shrimps and clams; Feed 3 - algae cake and trash shrimps. Feeding rates varied at 5, 10 and 15 percent of the body weight.

Results showed that trash shrimps and algae cake at 15 percent body weight gave better growth (42.3 gm and 150.2 mm) compared with clams plus trash fish and algae cake. Highest survival rate of 90 percent was also attained in treatments given clams and trash fish.

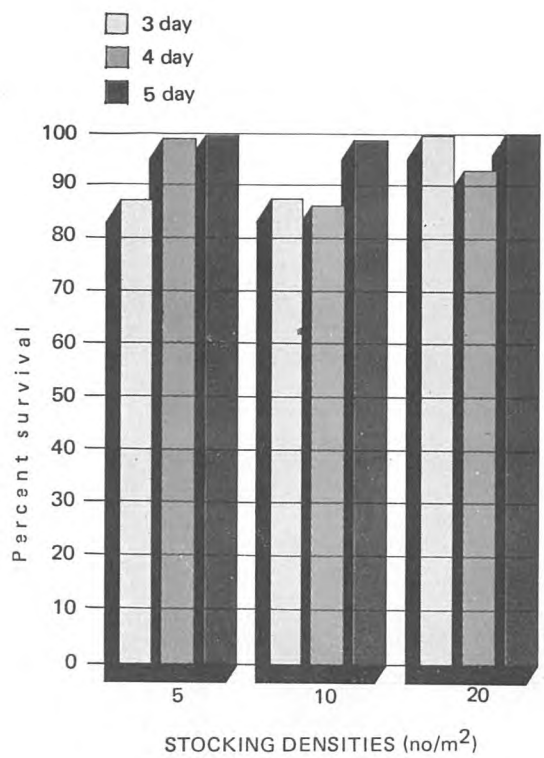


Fig. 16. Percent Survival of P. monodon Postlarvae at Different Stocking Densities and Acclimation Period

Prawn fry from Iloilo prepared for acclimation to freshwater in Binangonan.

P. monodon reared in freshwater are lighter in color.

Asian Institute of Aquaculture

Events leading to the establishment of the AIA came to a head at the start of 1978. Conceived as a mechanism to ensure the availability of high level manpower for aquaculture and allied fields, to provide an efficient techno-transfer process, and to promote regional cooperation to accelerate aquaculture development, the AIA became operational on May 23, 1978 with the appointment of Dr. Joseph Madamba as its first Director.

For the period under review, the AIA undertook the following activities:

1. Technology Verification and Packaging. The plans of work and activities included in the verification of local and borrowed technologies are in-country testing schemes, post-doctoral and post-masteral fellowship programs. Commodities included for verification and field-testing studies were milkfish, mullets, tilapia, carps, catfish, fresh and brackishwater prawns and shrimps, mussels and oysters.

2. Training. Activities included the coordination with the University of the Philippines in expansion of their formal graduate study program; the conduct of non-formal courses both on the international and national level, the latter in collaboration with BFAR; and the sponsorship of special training programs.

For the UP-SEAFDEC Collaborative Graduate Aquaculture Program, a new batch of 15 scholars enrolled in UP to pursue M.S. Aquaculture and other related fields. A total of 52 students were enrolled under the program: 37 were in their final year while 15 joined the program in June 1978.

The International Training Program had 29 participants on two short-term courses, namely, Aquaculture Research Methodology and Aquaculture Management. The first had 14 participants while the second 15. Trainees came from member-countries of the SEAFDEC and other Third World countries in the region. The National Training Program, on the other hand was held both on-station and *in situ* and trained 522 participants. These were made up of interested private pond owners, BFAR extension workers, technicians, fisheries school teachers, bank appraisers and graduating fisheries students.

The National Training Program included: Sugpo Culture, Mussel and Oyster Culture, Fishpond Engineering, Barangay Sugpo Hatchery Operations, and Pond Culture Management. The last was conducted *in-situ* under a Memorandum of Agreement between BFAR and the AIA to bring manpower development programs right at the ponds to remote fishfarmers. Through a Mobile Training and Extension Team, the *in-situ* training program was implemented in the following regional sites: 1) Zamboanga City for Region IX (October 25-28; 74 participants); 2) Tacloban

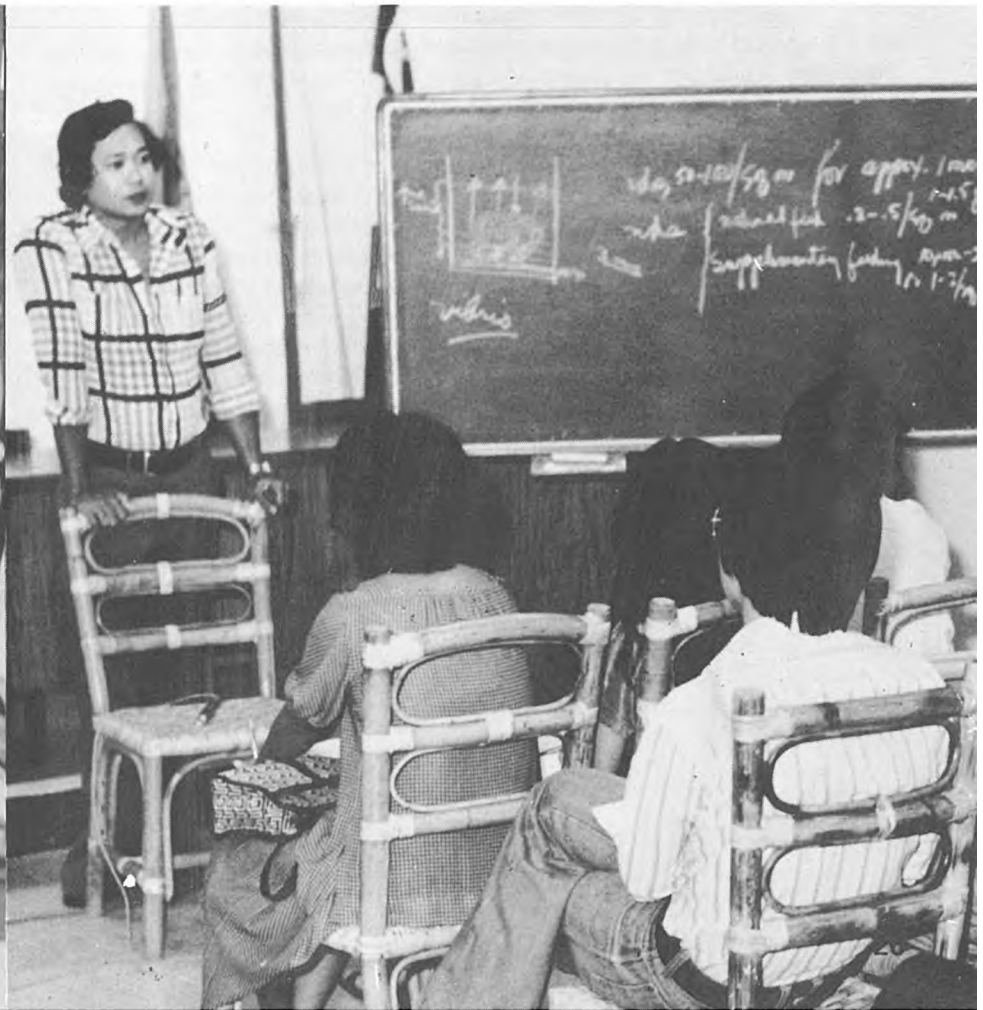
Training on small-scale hatchery management

City for Region XIII (November 6-10; 55 participants); 3) Bais City, Negros Oriental (November 9-13; 52 participants); 4) Calape, Bohol (November 12-16; 60 participants) and Sorsogon for Region V (November 17-21; 40 participants)' The training at Bais City; Calape, Bohol and Cebu City was for Region VII participants.

Special training was undertaken for various national or international agencies and organizations upon request. For CY 1978, there were a total of 134 special trainees which included 56 Peace Corps Volunteers; 73 graduating students and a fisheries faculty member from Camarines Sur, three Indonesians and a trainee from Holland. The training for the PCV's was designed to orient PCV's assigned with BFAR on Philippine fisheries and aquaculture.The graduating students underwent special training as part of their off-campus practicum while the lone fisheries faculty trainee from Pasacao (Camarines Sur) School of Fisheries requested training on different aspects of aquaculture. The four foreigners were sent by their respective organizations, namely, the German Foundation for International Development and the FAO-UNDP.

3. Communications/Publications. Designed to gather, process and disseminate popular, semi-technical and technical information on aquaculture; to provide a mechanism for the return flow of information, the AIA set into motion a series of publications, printing, audio-visual and other media services for the period under review.

Foreign students and trainees.



Three regular publications were launched, namely: ASIAN AQUACULTURE, AQUA DEP'T NEWS, and FISH FARM NEWS. The ASIAN AQUACULTURE, a monthly newsletter of the Department, was started July 1978. As of December 1978, it counted a circulation of 4,000 individuals and agencies in 83 countries involved in aquaculture research development. The newsletter contained news on current activities, policies, plans, programs and accomplishments in aquaculture in Asia. Also included were research reports and development programs from the various countries of Asia and other parts of the world. The AQUA DEP'T NEWS, a fortnightly internal news sheet of the Department started its first issue on September 1978. Replacing the former *Aquaculture Department Newsletter* issued monthly by the Office of the Director of Research, AQUA DEP'T NEWS supplied information on current Department activities and policies concerning research, training, personnel and administrative matters, socials, sports, etc. to all the Department's personnel all over the country. FISH FARM NEWS, also a fortnightly mimeographed news service but designed primarily for radio broadcast, began October 1, 1978. It contained some ten news articles mostly about fishfarming and some tips on crops and livestock farming, resource conservation, new ideas and inventions to help fish producers to improve their performance. As of December 1978, FISH FARM NEWS counted 200 radio stations all over the Philippines, 65 community newspapers, seven magazines, all fisheries schools, all metropolitan dailies and some 200 individual subscribers, among its clients.

Other publications were brochures on the AIA, the training courses, workshop proceedings, a manual and other technical information documents. For its part, the Audio-Visual Services had produced two slide-tape sets: one on the rationale behind the AIA, its objectives, organization, and current and future thrusts; the other on the technology developed to make prawn farming feasible for small fishfarmers.

4. Library and Documentation. As of December 1978, the Library had 586 titles which came as purchases while 718 titles came as gifts and exchanges. The book collection stood at 3,600 titles in 5,000 volumes of which 4,000 were purchases and 1,000 as gifts and exchanges. A total of 200 journal titles were regularly received, 114 of which were regular subscriptions and the rest from gifts and exchanges. Around 400 bound periodical volumes were available in the Library for the year under review. The 175 microfiche titles were received from the US Agency for International Development. It was expected that requests for more titles on extension work, fishes, aquaculture, technology transfer, and research management would be received shortly. Vertical file materials totalled about 4,600 in reprints and photocopies a good number of which came from personal collections of two foreign scientists on assignment at the Department.

The Library catalogued and classified about 4,500 titles of materials: 3,600 book titles, 650 vertical file materials, 175 microfiches, and around 30 publications. As to book selection and ordering, there were some 300 new titles ordered. On the other hand, gifts and exchanges with about 300 aquaculture and fisheries research and teaching institutions were opened. Of these, some 70 percent signified their respective interest by sending their reprints and publications. About 80 serial titles were already regularly received as exchanges.

Growing library of the Department

A *Catalog of the Library*, a 288-page mimeographed and classified listing of the holdings of the Library, was issued. Addenda to the Catalog was expected to come out early next year.

Microphotographic services began with the installation of three JICA-donated equipment: microfilm camera, microfilm printer and a microfilm/microfiche reader/printer. In this case, microfilming of the Department publications had been complete. Permission to microfilm publications from PCARR and the Central Inland Fisheries Research Institute (CIFRI) of India had been received and work on these publications had been programmed. Permission from the UP Inland Fisheries Project, the FAO, the Indo-Pacific Fisheries Council, the South China Sea Fisheries Development and Coordinating Programme, among others have also been sought.

Readers Services had been planned through the Selective Dissemination of Information (SDI), Scientific Literature Service (SLS), Current Awareness, and Photocopying Service. These services would be offered to all research staff of the Department as soon as their software and hardware requirements would be inputted.

Documentation work by the AIA through acquisition of materials about Asian aquaculture and related fields had been launched. For this, linkages between aquaculture libraries and organizations had been proposed and a workshop on the need to effect a mechanism for cooperative acquisitions had been scheduled.

5. Special Projects. The AIA continued to coordinate with external agencies with whom SEAFDEC signed bilateral agreements to undertake projects essential for aquaculture development. These projects included: SEAFDEC-PCARR Socio-Economic Research Project, UP-SEAFDEC Graduate Aquaculture Study Program, SEAFDEC-UPLB Freshwater Aquaculture Research Project, and the BFAR-SEAFDEC Training and Extension Project

Data bank for research outputs.

6. Aquaculture Planning. For CY 1978, the AIA conducted planning workshops on aquaculture development strategies: 1) National Workshop on Aquaculture Development Strategies (August 2-4, 1978), and 2) Regional Workshop on Aquaculture Development Strategies for Asia (August 6-13, 1978). The first was an in-country workshop in the Philippines to identify problem areas for research which focused on three major areas, namely, manpower, research and extension,data base, and credit and financing. About 90 participants composed of planners, researchers, educators, technologists, extensionists, bankers and fish farmers in the Philippines attended. The outputof the first workshop was the country paper submitted for discussion in the second workshop.

In the second workshop, 68 development experts made up of aquaculture planners, educators, credit specialists, economists, scientists andpractitioners from nine Asian countries (Bangladesh, India, Indonesia, Nepal, Philippines, Singapore, Sri Lanka, Thailand) including Japan and representatives of 10 regional/international agencies and institutions assessed the status of aquaculture in eight Asian countries and formulated an Asian Plan of Action for Aquaculture and Small Fishfarmer Development.

During the year, the AIA likewise formulated a dozen action-oriented project proposals to elicit funding support from international donors. The proposals have already been submitted to appropriate external institutions.

- Aquaculture Technology Backstopping for Developing Projects in Selected Countries of Asia, Africa and the Middle East.

- A Proposal to Strengthen Aquaculture Research and Development Infrastructure in Developing Countries of Asia;

- Regional Collaborative Project in Aquaculture for ASEAN Countries;

- Program for Integrated Fisheries Area Development;

- International Aquaculture Information System;

- The Asian Institute of Aquaculture Library;

- Aquaculture Manpower Development for Asia;

- Establishment of Six Regional Prawn Production Centers in the Philippines;

- Aquaculture Development Planning Workshops, Special Topics, Seminars and Short-Term Training Programs for the Development of Aquaculture in Asia;

- Aquaculture Case Studies Development;

- Aquaculture Manpower Development for Latin America; and

- Establishment of Pilot Regional Oyster Production Centers

Regional Workshop on Aquaculture Development Strategies.

Infrastructure Development

The Department operated six major stations in CY 1978, namely: Tigbauan Main Station; Leganes Station and Pond System; Pandan Milkfish Research Station; Igang Seafarming Station; Binangonan Freshwater Fisheries Station and Zamboanga Station in Southern Mindanao. The Department also maintains substations in the following areas: Batan, Aklan for prawn spawner collection, maturation and culture pens; Hamtik, Antique for milkfish fry studies; Batbatan, off Panay Island for sabalo spawning and ecology studies; Himamaylan, Negros for mussel and oyster research; Naujan, Mindoro Oriental for sabalo collection; and Liaison Offices in Iloilo City and Metro Manila.

Tigbauan Main Station

The fourth phase of the Tigbauan Main Station construction program has almost been completed except the Nutrition and Physiology Research Laboratory which was 50 percent complete as of December 1978. When finished, the facility would permit research into the major technical problems of fisheries nutrition and reproductive physiology. The water supply system was 90 percent finished while the Social Hall and Dining Hall was in a similar stage of completion.

Administration building.

Leganes Station and Pond System

The major construction at Leganes for CY 1978 included milkfish experimental ponds; administration-laboratory buildings; utility buildings and housing facilities, all of which were completed in July 1978.

Igang Seafarming Station

The Igang Seafarming Station was adopted for the culture of other marine fish and shellfishes. Some basic equipment for the culture system of larvae and juvenile rearing, as well as floating cages for broodstock development was installed.

Binangonan Freshwater Fisheries Station

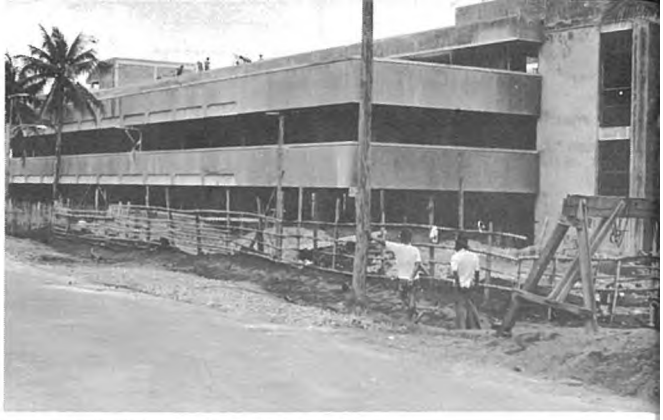
Aside from the Phycology and Chemistry laboratories, a multi-purpose building to serve as a wet laboratory was constructed. In it is to be housed a modest Conference/Audio-Visual Room, a library, a Physical Plant Office, Radio Room, and a clinic. A ₱1.54 million hatchery building at Tapao Point was nearing completion. With a floor area of 900 sq m, the building is expected to house two tanks each with four compartments of 3-ton capacity, two smaller tanks for spawning, and two rows of hatching trays. The modest beginning of Ecology, Biology, Phycology, Nutrition and Micro-technique Laboratories would be temporarily housed in this large hatchery building. Other facilities included tanks, aquaria, aeration system, floating cages and fishpens installed to augment the existing ones which were being used in the culture of various freshwater species. Four units of duplex cottages for research personnel and visiting researchers were also being constructed.

Himamaylan Station

The mussel farm was transferred from the original site to some 200 m along the same river. The necessity of transferring the substation site to one near the farm site was to give way to the Bacolod-Kabankalan Superhighway.

Equipment

Several crates of laboratory equipment were received in March 1978. The major bulk of the shipment was part of the donation of the Japanese Government through the Japan International Cooperation Agency (JICA). Other equipment consisted of VWR equipment bought from the United States which included: nitrogen distilling and digesting apparatuses, rotary evaporator, analyzers, balances, vacuum drying oven and magnetic stirrer. The New Zealand Government continues its support for the mussel research project with several consignments of essential equipment.



Nutrition building under construction.

Pandan substation.

Leganes pumphouse.

Igang substation

Administration and Personnel Development

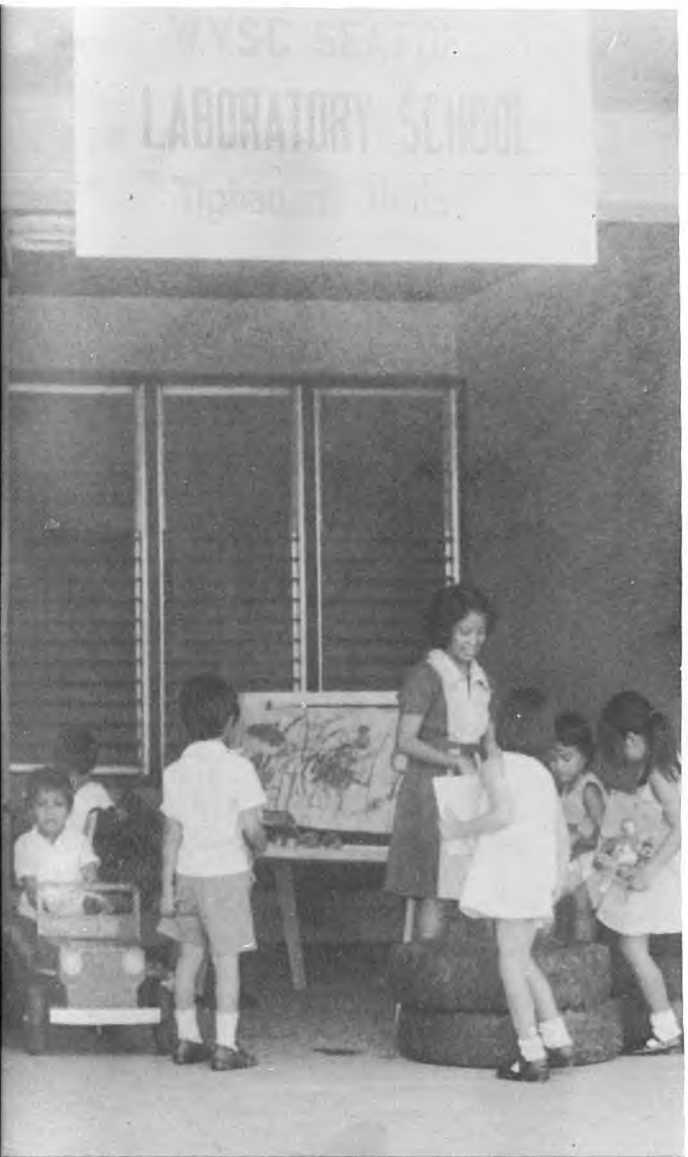
The stage of institutional growth attained by the Department in CY 1978 reached a stable level such that it became necessary to revise its management and organizational policies. The objective was to insure steady policy and information or feed forward-feedback systems for better efficiency and results.

The Department thus effected a decentralized system of allocating the management functions of policy-making, planning and program implementation. The Chief and his Deputy formulate policies, set priorities, authorize the establishment of research stations, and approve the annual budget with the assistance of the Executive Committee, in turn composed of senior officials of the Department including the Executive Director. The key functions of the Executive Director are exercised with the aid of the technical management advisory groups such as the Office of Planning and Evaluation, the Development and Management Staff, and various standing committees. The Director of Research head the Research Division under which are the four integrated research programs of the Department each headed by Program Leaders. Research proposals are screened through the Technical Evaluation Committee (TEC) composed of a subject matter evaluation leader (appointed on ad hoc basis) acting as chairman and a group of technical consultants drawn from Department staff members.

To maximize research outputs, supportive services had been organized like the Statistical Computer Service Unit; Centralized Analytical Laboratory; Data Bank; Documentation and Publication Unit; Microtechnique Service Group; and Central Wet Laboratory.

The AIA, like the Research Division, operates likewise on a decentralized system. The AIA Director shares his functions with his Deputy Directors. To maximize output, the AIA is divided into six component units: Technology Verification and Packaging, Training, Communications and Publications, Library and Documentation Services, Special Projects and Aquaculture Planning.

The laboratory school for the children of the staff.



Personnel

As of December 31, 1978, the Department had a total of 747 personnel and staff. Of these, 214 are with research, 46 with the AIA, 146 with the Station Operations Group, 43 with the Development and External Affairs Group. 203 with Administrative Services, 28 with Auxiliary Services Group. 18 with Management Group, and 49 others from uncategorized units. According to station assignments, 491 are with Tigbauan Main Station; 55 with Leganes Station and Pond System; 41 with the Pandan Milkfish Research Station; 17 with Igang Seafarming Station; 69 with Binangonan Freshwater Fisheries Station; 6 with the Zamboanga Station; 6 with Batan Station; 4 with Himamaylan Substation; 52 with Makati Liaison Office; and 5 with Iloilo Liaison Office.

Among the key appointments in the Administration during the year were the following:

Dr. Noboru.Hoshino - Deputy Chief of the Department
Dr. Joseph Madamba - Director of the AIA
Dr. Thomas G. Flores - Deputy Director, AIA (Outreach)
Dr. Hiralal Chaudhuri - Deputy Director, AIA (Training and Technology Verification)
Mr. Alejandro V. Lim, Jr. - Financial Officer
Mr. Ben de los Reyes - Internal Auditor
Mr. Pedro Bueno - Communications Officer of AIA

In another development, the Japan International Cooperation Agency (JICA) continued sending experts on various aquaculture research areas. Three experts were appointed to replace those whose terms of services with the Department had expired as follows:

Mr. Hideo Mochizuki
Mr. Shiro Hara
Mr. Shigehisa Yamasaki

During the year, Japanese experts were assigned for periods ranging from one to four months, namely:

Dr. Akio Kanasawa
Mr. Haruo Nakajima
Mr. Isamu Yamaji

Staff Development

To have an efficient roster of qualified staff and personnel, the Department undertook a staff development program which offers local study grants, foreign study grants, short-term observation and study tours, and in-service training for further improvement in the researcher's respective line of specialization.

Local Study Grants. In cooperation with the Philippine Council for Agriculture and Resources Research (PCARR), BFAR and the Ministry of Natural Resources (MNR), deserving employees were granted for CY 1978 scholarships to enable them to pursue graduate studies in local universities, specifically in the University of the Philippines. Fifteen of those granted in 1976 and 14 of those awarded in 1977 were extended their grants while 18 new scholarships were granted for school year 1978-79.

The Department also awarded special local study grants to three staff members for 1978.

Foreign Study Grants. The Department, in cooperation with international agencies, renewed the foreign study grants of nine staff members and granted two new grants. The Department gave likewise a special foreign study grant to one staff member and non-degree grants to four research staff members.

Foreign Seminars/Study Tours. To expose further its research and technical staff to existing technology in aquaculture in other countries, the Department sent 100 personnel and staff in CY 1978 to participate in such seminars/study tours/conferences.

Local Seminars-Workshops. For the specialization of other administrative personnel in their respective areas, the Department sent 53 employees to attend seminars and conferences either held in Iloilo City or Metro Manila.

Foreign Visitors. For CY 1978, some 100 foreign visitors made up of scientists, experts and dignitaries or government representatives visited the SEAFDEC Main Station at Tigbauan to tour and survey research facilities of the Department or to explore possibilities of institutional linkage.

Scuba-diving lessons for researchers

Institutional Linkages

In CY 1978, existing tie-ups with various academic, research and development institutions all over the world were strengthened while new ones were initiated. The tie-ups further signified the Department's readiness to undertake cooperative ventures with counterparts for the advancement of aquaculture and related fields.

International

SEAFDEC-OI. The Aquaculture Department and the Oceanic Institute (OI) signed a Memorandum of Agreement last October 7, 1978 calling for joint activities in research and development particularly on milkfish, transfer of technology, and exchange of information. A cooperative program emphasizing artificial propagation, induced breeding, and larval rearing of milkfish was formulated for implementation next year. The OI is a non-profit marine science center founded and based in Hawaii in 1960.

SEAFDEC-ODM. A Memorandum of Agreement between the Ministry of Overseas Development (ODM) of the United Kingdom was prepared with the aim of implementing the proposed project in prawn pond culture at the Leganes Brackishwater Demonstration Station. The proposed project seeks to study the monoculture of *P. monodon* from juvenile to marketable size with particular reference to such factors as water quality, feed preferences, and to study the physico-chemical problems in and associated with flow-through ponds.

SEAFDEC-DANIDA. With the Danish International Development Agency (DANIDA), SEAFDEC was awarded two training grants: one for a 12-month study on the "Dynamics and Production of Zooplanktons in Esrom Lake" starting June 1, 1978, the other for a three-month training on water engineering system, operation and repairs of laboratory equipment.

SEAFDEC-ICAR. In accordance with the Memorandum of Agreement between ICAR and SEAFDEC signed in Manila on July 23, 1977, a collaborative research work plan for 1978-79 was prepared for eventual implementation by both parties. SEAFDEC scientists will train in India on the following: soil and water chemistry, freshwater fish culture, induced breeding of carps and catfish, fish endocrinology, control of aquatic weeds and algal blooms, prawn culture and special topics. ICAR scientists will train in the Philippines on the following: brackishwater fish culture, nutrition and feeds of fish and prawns, fish culture in pens, induced breeding of milkfish. The first batch of four Indian scientists started their three-month training program on prawn breeding and culture last November 27, 1978.

Signing of the Memorandum of Agreement with Oceanic

The Government of Israel. The Israel Government, through its Embassy in Manila, awarded two fellowship grants to the research staff of the Department for them to join the International Course on Fish Culture in Dor, Israel from July 5 to October 25, 1978.

OTHERS. Linkages were likewise opened with other institutions for the accelerated development of aquaculture. These included exchange of information, expertise and research materials with: the Aquaculture Coordinating Project of the Centre Nacional Pour L'Exploitation Des Oceans (AQUACOP-CNEXO), the Tungkang Marine Laboratory in Taiwan, the Agricultural and Fisheries Department in Hongkong, and the National Inland Fisheries Institute (NIFI) at the Kasetsart University in Bangkok.

National

SEAFDEC-PCARR Socio-Economic Research Project. The SEAFDEC Aquaculture Department and the Philippine Council for Agriculture and Resources Research entered into an agreement in January 1975 to exchange scientists and technologists, scientific literature, information and methodology; to make use of experimental fields and facilities of the PCARR national network for field testing of SEAFDEC research technologies; to establish mutual relations between the scientific and technical divisions of the organizations of both parties; and to grant fellowships to selected scientists and researchers.

The Executive Director Confers with the Dean of the UP College of Fisheries

SEAFDEC-MMSU Project. The Department and the Mariano Marcos State University in Ilocos Norte launched a project to undertake milkfish seedbank establishment in strategic areas of the four Ilocos provinces. The objectives included the provision of a continuous supply of milkfish fry in the region and to generate rural income for the people. The implementation of the project would involve the organization of seedbank cooperatives among fry gatherers in Ilocos. Representatives from both parties had already finalized arrangements for the operationalization of the project.

UP-SEAFDEC Graduate Aquaculture Study Program. In May 1976, a Memo of Agreement was signed between the University of the Philippines and SEAFDEC committing their resources and facilities to support a graduate study program leading to M.S. in Fisheries, major in Aquaculture. In 1978, the graduate study program had enrolled a total of 52 scholars in UP. Thirty-seven were already in their final year while 15 joined the program in June 1978. Out of the 37 who were in their final year, 21 were undertaking their thesis research.

SEAFDEC-UPLB Freshwater Aquaculture Research Project. The Project which began in mid-1977 continued conducting research activities in the lake. Planned for construction is a lake ecosystem model for an ideal fishing village community, Pipindan, an adjacent village in the neighborhood of the Freshwater Fisheries Station in Tapao, Binangonan, Rizal. For CY 1978, an action group composed of four members from both organizations had been formed to formulate appropriate training and extension programs involving the transfer of freshwater aquaculture technology.

BFAR-SEAFDEC Training and Extension Project. In October 1978, another Memo of Agreement was signed between BFAR and SEAFDEC. Both agreed to create a Mobile Training and Extension Team to conduct training programs *in situ* in different regions of the country; set up strategic demonstration projects in various parts of the country; and contribute to the national effort of increasing food production. For the year, the *in situ* training on Pond Culture and Management was undertaken in the following regions: Region IX (Zamboanga City); Region VIII (Tacloban City); Region VII (Cebu City; Calape, Bohol; and Bais City in Negros Oriental); and Region V (Sorsogon, Sorsogon).

BFAR-SEARCA-DAP-SEAFDEC Aquaculture Resources Management Project. Formerly two separate projects: one involving the Bureau of Fisheries and Aquatic Resources, the Southeast Asian Regional Center for Graduate Study and Research in Agriculture, and SEAFDEC, the other between the Development Academy of the Philippines and SEAFDEC. The project had been merged into one to maximize resources. In November 1978, a Memo of Agreement was signed among the four organizations. Planned for operation in early 1979, the Project would undertake an aquaculture resources management program covering the whole Panay Island for the macro level and Barotac Nuevo, Iloilo (milkfish production); Pontevedra, Capiz (prawns); Sapian, Capiz (mussels; and Batan, Aklan (aquaculture commodity mix) for the micro level.