ANNUAL REPORT 1977

AQUACULTURE DEPARTMENT

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

TIGBAUAN, ILOILO, PHILIPPINES

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SUMMARY OF ACHIEVEMENTS

CY 1977 marked for the Aquaculture Department a highly successful year in its research, training and extension activities. For the year under review, two research achievements stood out among others, namely: 1) the artificial fertilization and hatching of milkfish eggs, and 2) the first production of the crab stages of ***Scylla serrata*** or "alimango" under controlled conditions.

The first achievement signified the elimination of the need to capture fry from their natural habitat and, at the same time, insured a steady, all-year round supply of fish seed for stocking purposes. The second achievement launched the research on crab species to wider, unexplored areas critical to the successful seafarming of the said species.

Like research, training and extension activities of the Department intensified. The International and Local Training Programs were implemented with the involvement of more participants. The Graduate Training Program extended more scholarship and grants to deserving recipients.

Furthermore, training and extension received fresh impetus with the organization of the Asian Institute of Aquaculture (AIA) as a new unit of the Department. Envisioned to provide the mechanism to effect regional cooperation in manpower training and transfer of technology, the AIA which went into the final stages of organization development by the end of CY 1977, was the innovative response of the Department towards resolving the manpower shortage in the field of aquaculture in the region. It is hoped that with the AIA, the Department's role as a prime manpower center for aquaculture not only in the region but throughout Asia would be institutionalized.

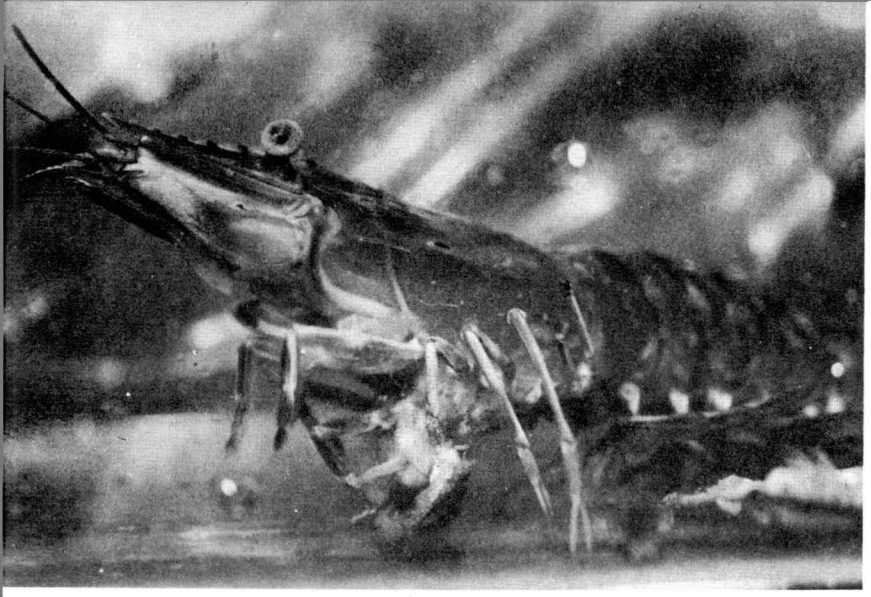
Special projects strengthened the bid of the Department to demonstrate the viability of aquaculture as a self-sufficient activity and to bring development into the remote, economically depressed regions of the country. The Barangay Prawn Hatchery System Project has been implemented with encouraging results thus establishing the opportunity for low-income fishpond operators to make use of a hatchery system made up of low-cost materials and inputs.

In infrastructure development, CY 1977 proved to be an equally active year as facilities, buildings and laboratories, continued to be constructed in all the different project sites of the Department. The Nutrition and Feeds Laboratory Building in the Tigbauan Main Station, due for completion by December 1978, is expected to boost up the research capability of the Department in the areas of nutrition and fish reproductive physiology. The Freshwater Fisheries Station in Binangonan, Rizal has likewise undertaken buildings/facilities construction in preparation for full operationalization next year. The arrival of procured research equipment further facilitated the progress of various researches in the laboratories of the Department.

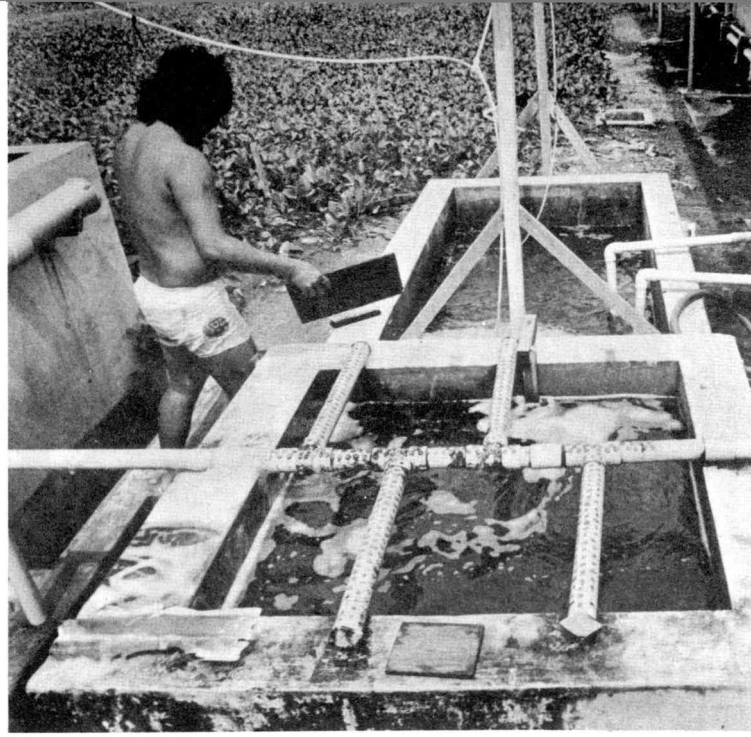
Linkages with international and national cooperating agencies firmed up the institutional capability of the Department to generate financial,technical and other modes of assistance/cooperation/support and also widened the network involvement of the Department for greater or increased information and communications dissemination in aquaculture.

The various programs, projects and activities of the Aquaculture Department for CY 1977 therefore enhanced the growth and development of the Department towards its avowed objective of harnessing the aquaculture potential of the region and eventually solve the perennial food shortage and malnutrition problems of the region's million inhabitants.

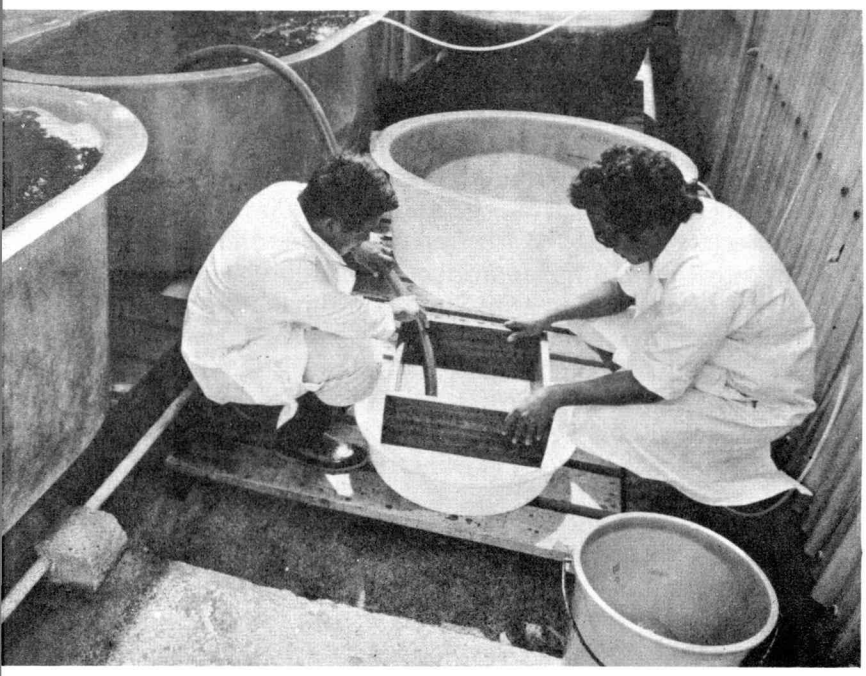
It is for these reasons that the Department enthusiastically and optimistically enters the last two years of the Second Development Decade (1970-79) for a fuller implementation and a wider scope of programs and projects at the advent of the Third Development Decade (1980-89) towards 2000 A.D. and beyond.



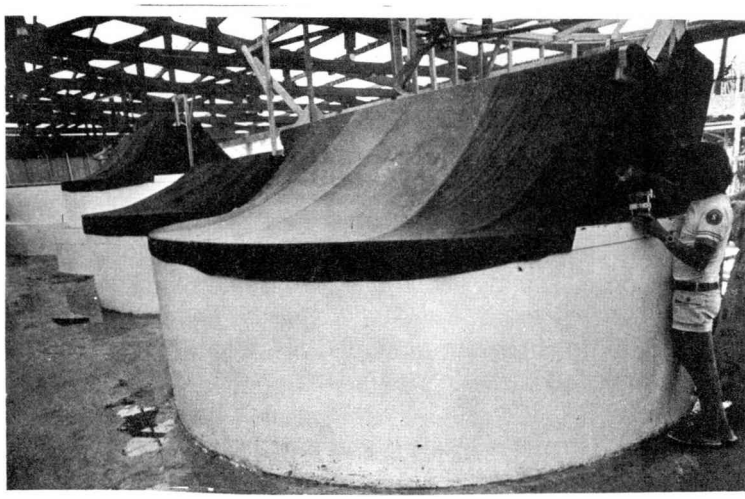
Gravid female of Penaeus monodon



Diatom Chaetoceros calcitrans in sand filter for feeding to prawn larvae

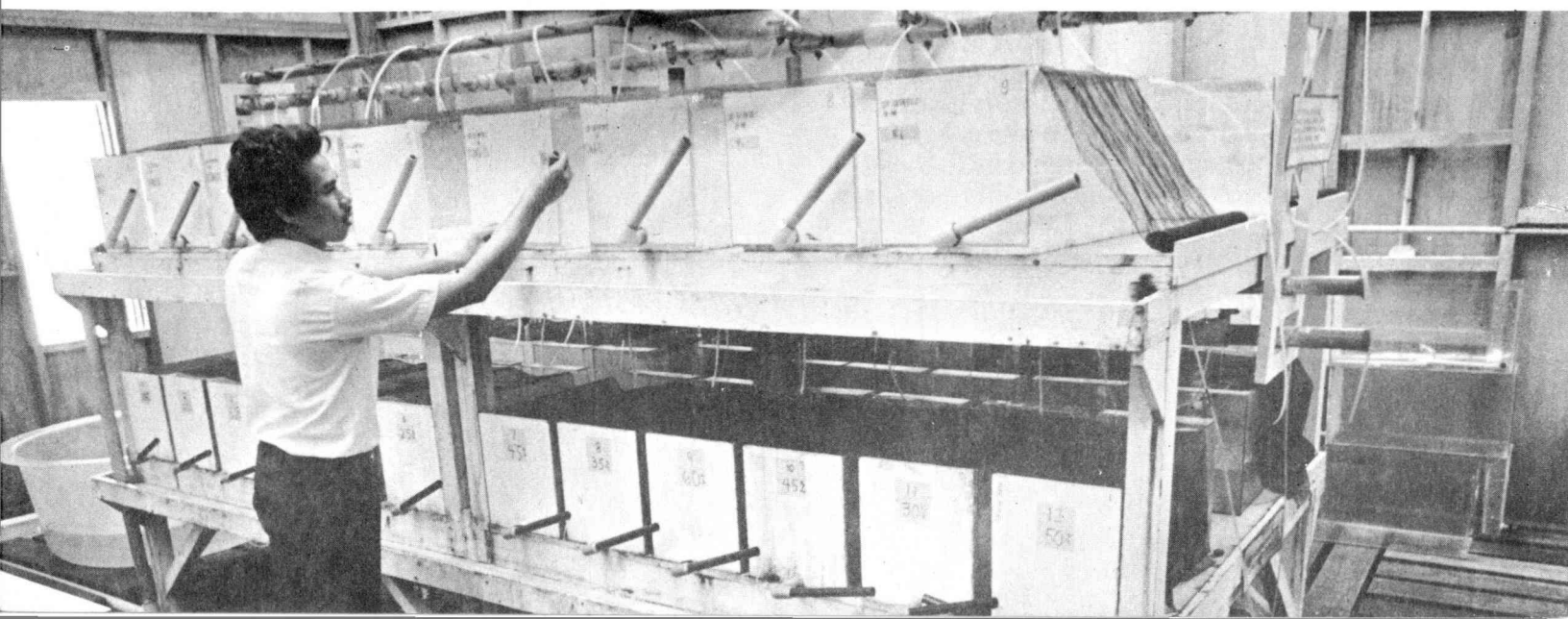


Washing Penaeus monodon eggs to remove spawning debris



Feeding Penaeus monodon broodstock in ferroconcrete maturation tanks

Studies on salinity preference of Penaeus monodon fry



RESEARCH

Prawn Program

1. Ecology and Life History of Penaeid Shrimps. As rich fishing areas, Batan Bay (Aklan Province) and the Tigbauan-Guimbal coast (Iloilo Province) were found to abound in 14 penaeid species. The most dominant were ***Penaeus merguiensis***, ***Metapenaeopsis palmensis*** and ***Metapenaeus ensis.***

The different life stages of the ***P. monodon*** species were identified. Measurements of size, body weight and other biological characteristics were likewise recorded.

2. Food and Feeding Habits of Adult Penaeids The objective of the research was to determine the percentage composition and frequency of occurrence of various food items present in the gut of adult prawns. Some specimens had empty foreguts while others had full or half-filled foreguts. Those with empty foreguts had a rapid clearance rate with 50 per cent of the food eaten having moved through the foregut an hour after ingestion. Their midguts, however, revealed remains of shells of small crustaceans, polychaete setae, gastropod shells, fish scales and ophiuroid ossicles.

3. Physico-Chemical Parameters at Early Development Stages. The different physico-chemical factors affecting survival and growth of ***P. monodon*** larvae were studied. These included the effects of chemicals, temperature, salinity and oxygen consumption.

It was found out that the zoea larval stage was most sensitive to nitrite and ammonia. Later stages were more tolerant. Temperature did not significantly affect all larval stages but growth accelerated at temperatures between 28°C and 34°C. Also, molting from mysis to postlarva became two days faster in aquaria at temperatures between 29°C and 34°C. P_5 to P_9 postlarvae were less tolerant to salinity changes than postlarvae from P_{10} and later stages. Growth, however, was faster at lower salinities. At a temperature range of 20°C-30°C, oxygen consumption depended on both weight of postlarvae and temperature.

4. Pond Cultivation. Research on improved methods of prawn culture in brackishwater ponds identified various critical aspects important in pond cultivation of prawns.

A comparative soil study showed that the growth rate of prawns was similar in either clay loam or sandy soil. But clay loam proved more of a disadvantage as hydrogen sulfide gas was evolved causing depletion of dissolved oxygen; prawns turned blackish lowering their commercial value; and conditions favored the spread of diseases.

The combination of seawater and river water was found superior for culture ponds. Although ***P. monodon*** could be cultured in either fresh or marine waters, growth rate appeared to be faster in ponds with salinities lower than seawater. The most suitable salinity range was established at 15-25 ppt.

The recommended intensive culture using natural and supplemental feeds was found easiest to manage in 1-5 ha ponds with the nursery pond constituting 3-5 per cent of the rearing pond area. A practical design of ponds included two gates for each pond (one connected to a water supply, another to a drain canal), a pond constructed on the same tidal level as the mean low water level, and a water depth of 1.5 m spread over 50-70 per cent of the pond bottom and 30-50 cm deep over the remaining portion.

Intensive pond preparation activities yielded various guidelines as to draining and drying of both nursery and rearing ponds as well as the application of fertilizers. Thus, it was found most appropriate to start pond preparation 3-5 weeks before stocking.

Ponds were drained and dried until the soil turned whitish indicating a moisture content of 20-25 per cent. Drying assured that there would be no predators in the area while fertilization created favorable conditions for the production of zoo- and phytoplankton. Chicken manure was applied at the rate of 200-500 kg/ha. Urea was added to the manure at a weight ratio of 1:10. Care, however, had to be taken not to overfertilize. Ammonium sulfate and superphosphate for example, were found to produce water acidity if recommended rates were exceeded.

Studies also determined the stocking rates in prawn ponds. For wild fry (at P_{15} to P_{20}), it was 20-30 pcs/m^2. For hatchery fry (at P_{10}), it was from 30-50 pcs/m^2. Nursery and rearing ponds had similar stocking methods but the stocking rate of the latter was 2-3 pcs/m^2. Stocking was preferable early in the morning or in the evening.

Various studies came up with guidelines such as sheltering fry from winds by sticking tree twigs, nipa leaves, etc. into the pond mud; determining a feeding schedule and a water change schedule; water management, transport and harvest methods, among others. Feeding rate was determined at 15-20 per cent of total body weight. Addition of water in the nursery pond was scheduled at nightime and gradually at the rate of 10 per cent of the total volume per day. Optimal water quality indices were fixed as follows: water temperature, 25°C-35°C; pH, 7.0-8.5; DO, over 4 ppm; and NH_3 and H_2S, almost nil.

5. Artificial propagation. The unilateral eyestalk ablation technique, a feat achieved first in 1975, led to several accomplishments in the induced spawning of *P. monodon*. Thus, stocks in concrete tanks were ablated producing 61 spawners from 196 females. The attempt demonstrated the feasibility of mass producing sugpo spawners in land-based tanks by eyestalk ablation. Contributing to the mass scale production of spawners was the completion of the eight maturation pens in Batan Bay. Annual spawner production for 1977 was 3,603 spawners, a 300 per cent increase over the 1976 figure of 1,360 spawners.

The ablation technique likewise succeeded in spawning 4-month old *P. monodon* females. In the latter experiment, of the the total 349 females, 35 (10 per cent) had a second spawning and 5 (1.4 per cent) had a third spawning.

Related studies involved series of experiments on the transport of spawners, eggs and nauplii and tagging

Table 1 Observations on the effects of some chemicals on the spawning efficiency of *P. monodon* gravid females.

Chemical	Dose ppm	Spawning efficiency (%) 1st	2nd	3rd	Number of eggs 1st	2nd	3rd	Hatching rate (%) 1st	2nd	3rd
Control	-	25	50	0	34,200	17,000	0	47	100	0
Furanace	3	16	33	75	2,337,000	439,588	348,480	98	60	43
Formalin	50	30	42	75	3,974,200	313,077	216,000	93	89	0
Ca hypochlorite	5	75	75	0	82,270	65,000	0	42	78	0
Malachite green	0.5	0	0	50	0	0	217,200	0	0	28
Potassium permanganate	50	0	75	50	0	50,000	218,100	0	28	64
Treflan	10	0	0	50	0	0	274,000	0	0	23

prawns around the stalk of the unablated eye for identification purposes.

6. Barangay Sugpo Hatchery. Further refinements of scaling down hatchery technology within reach of the small-scale entrepreneurs continued and the basic requirements of the barangay hatchery system were determined. This included a seawater supply with a salinity range from 28-32 ppt, an air supply system provided by a compressor or blower, 2-ton larval rearing tanks made of marine plywood shaped into a cylinder with octagonal cross-section and a conical bottom, 1-ton wooden tanks (at 60 cm deep) for use as algal rearing tanks, 1-ton cubic wooden tanks to serve as culture containers for ***Brachionus*** (a natural feed for larvae, and a roofed structure to house the tanks.

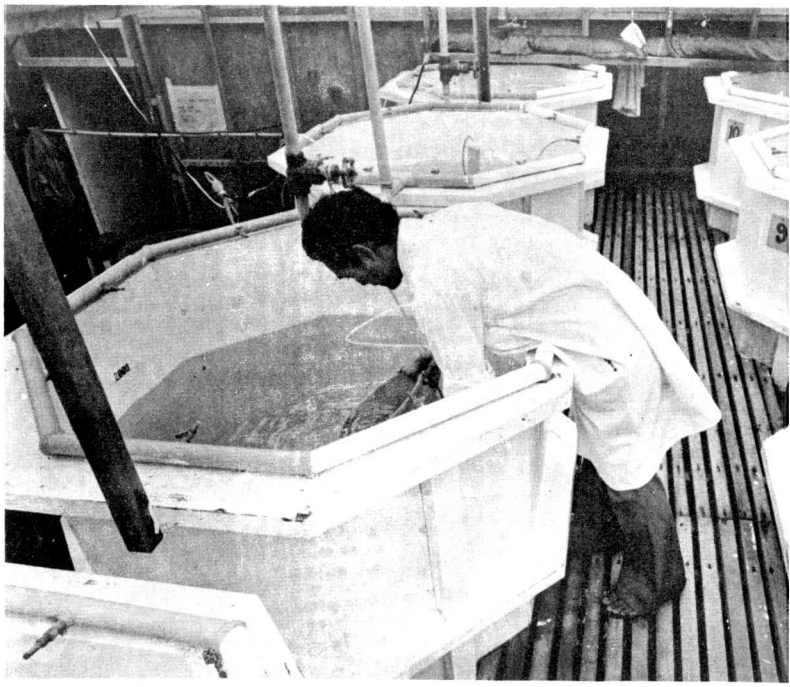
A necessary feature of the barangay hatchery was the culture of such natural feeds as the diatom ***Chaetoceros calcitrans,*** the ***Chlorella*** and the ***Brachionus.*** Already, precise procedures in culturing them had been delineated including steps to follow during the spawning of ***P. monodon*** spawners, hatching, rearing in larval culture tanks, harvesting and transport.

7. Natural Feeds. The search for natural feeds for prawn larvae led to studies in the brine shrimp, ***Artemia salina,*** and the diatom ***Chaetoceros.*** A technique was developed to decapsulate ***Artemia*** cysts as these, if ingested, caused harmful effects in the guts of fishes and crustaceans.

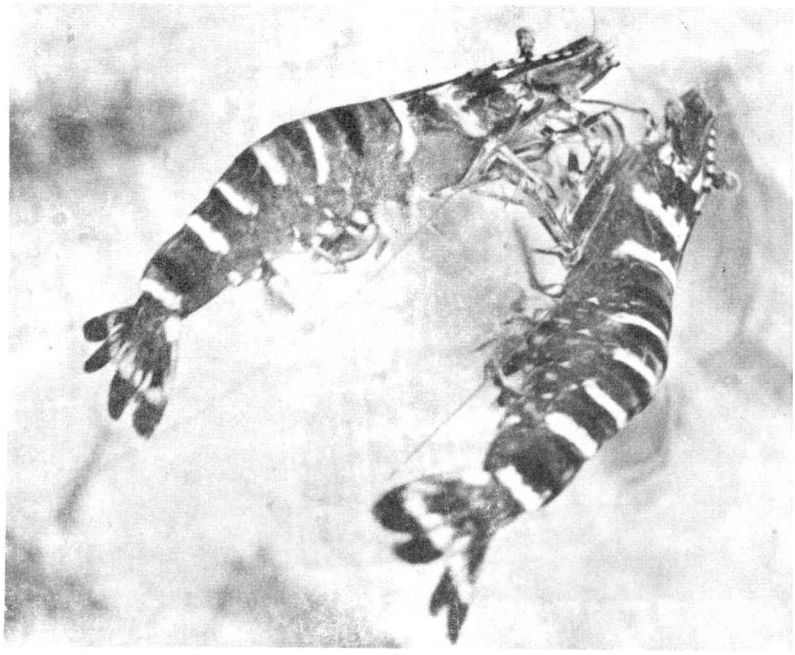
Decapsulated cysts fed to Mysis (M_3) of penaeids were comparable to freshly hatched brine shrimp nauplii as food. A method of mass-rearing ***Artemia*** from nauplii to adults bore positive results. A feed formula using **Spirulina,** yeast, shrimp head meal and fish meal was highly acceptable to ***Artemia***. Equally acceptable were ***Ipomea batatas*** and ***Ipomea pes-caprae*** individually mixed with rice bran. Studies were also conducted on how certain environmental parameters affected cyst or nauplii production. Water turbulence, for example, prevented riding and copulation of male and female brine shrimps. More offsprings were produced at a salinity of 50 ppt than in ordinary seawater of 30-34 ppt salinity. Also, in addition, ferrous ammonium sulfate and disodium EDTA at a salinity of 50 ppt increased offspring production by 34 per cent and cyst production by 89 per cent. A method of harvesting ***Artemia*** cysts was developed by increasing salinity to 150 ppt.

Experiments on ***Chaetoceros*** included effects of light intensity on their growth responses, storing procedure, and a comparative study of two media for stock cultures. It was concluded that cultures of ***Chaetoceros*** exposed to 26,000 lux and 23,000 lux

Transfer of Penaeus monodon nauplii to 2-ton barangay hatchery tank



Penaeus monodon broodstock during feeding time



reached peak growths a day earlier than those exposed to lower light intensities. However, cultures exposed to 12,000 lux gave the most yield in terms of cell densities. Storing involved freezing the culture with the addition of coagulants like alum and lime. The more suitable medium for maintaining stock cultures of ***Chaetoceros*** was the modified Guillard and Thyther medium.

8. Nutrition and Feed Development. The study of artificial feeds was an intense research activity for 1977. One study tested the binding capacity of the materials used as binders in shrimp pellets. These materials included sago palm starch, corn starch, gelatin, agar and bread flour. Agar seemed to be the best binder but sago palm starch, corn starch, and bread flour were preferred. This was because more water was needed to dissolve agar than to make a stiff dough, making the process of extrusion into pellets technically difficult. Prior experiments also indicated that postlarvae did not readily accept pellets made with agar.

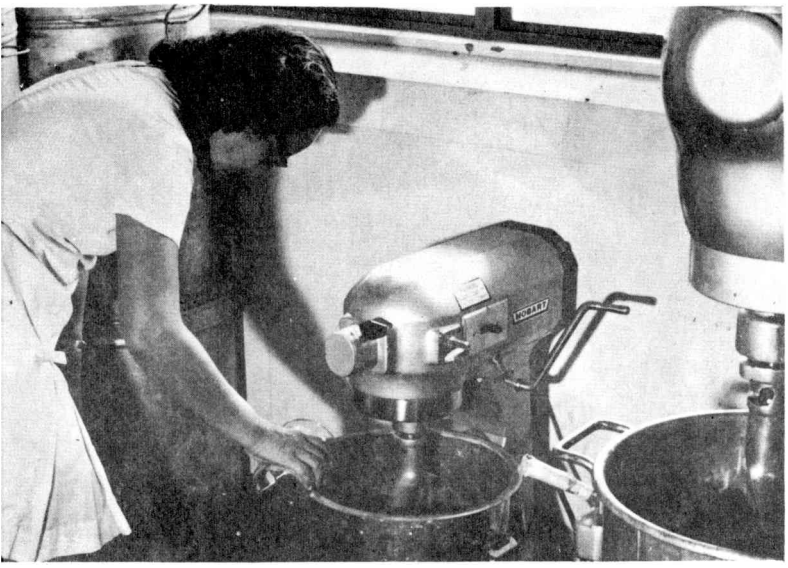
Another study tested three feed combinations for their acceptability and water stability. Prawns fed with the feed FP-2s-77 gained the most in weight and length but had the lowest survival. Both 1s and 2s pellets disintegrated in water easily. Attractibility tests showed that prawns were most readily attracted to the 1s and 2s pellets although this may have been due to their rapid disintegration.

Effects of varying levels of protein indicated that *P. monodon* post larvae fed with a 30 per cent protein diet at an early stage, had a significantly high growth rate. Older postlarvae seemed to require a higher protein diet of 40 per cent for a higher growth and survival rate.

Protein sources, such as fish meal, shrimp head meal, and ***Leucaena leucocephala*** ("agho" or "ipil-ipil"), were used in the formulation of feeds. Results of scientific investigations indicated that shrimp head meal, used in combination with fish meal, provided better growth to postlarvae than when either was used alone. A ratio of 1:1 was found to be the best combination. The use of ipil-ipil seeds or a combination of leaves and seeds with fish meal appeared to give better growth responses than when only leaves were used.

At larval stage, there was still no substitute for natural feeds as one study found out. Those fed natural food had higher survival rates than those fed artificial feeds combined with natural food. Particle size and settling characteristic may have caused artificial feeds to be unavailable to the larvae.

Fish diet preparation



Monitoring Physico-chemical parameters of waters around Panay Island

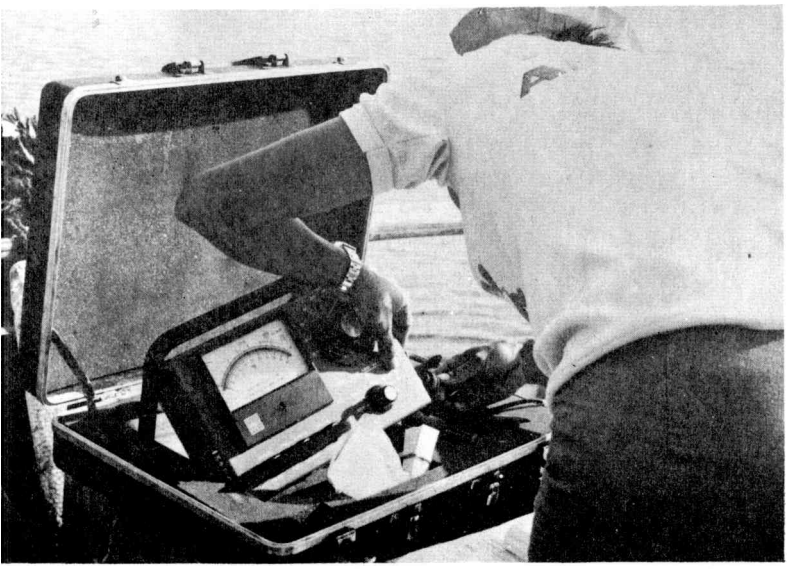


Table 2 Growth and survival of *P. monodon* fed different types of formulated pellet feeds.

Diet	Initial weight (gm)	Final weight (gm)	Weight gain (gm)	(%)	Initial length (mm)	Final length (mm)	Length gain (mm)	(%)	Survival rate (%)
FP-1s-77	0.14	0.48	0.34	242	28.1	40.0	11.9	42	80
FP-2s-77	0.27	0.86	0.59	218	32.8	49.6	16.8	51	37
Ralston Purina shrimp pellet	0.21	0.41	0.20	95	30.6	38.4	7.8	25	73

9. Pathology. Research identified a suctorean *Ephelota gemmipara*, in tank-spawned and reared *P. monodon* larvae. Infection ranged from 2-26 per cent of the population attaching on broad and immobile parts of body segments, carapace, uropods in both zoea and mysis stages. *Ephelota* weakened the host through the sucking and piercing action of its tentacles followed by the extraction of liquids from the cytoplasm.

The bacteria known to cause diseases in penaeids had been found mostly Gram-negative. A study using tryptone glucose yeast extract agar was tested to see if recovery of Gram-negative bacteria could be increased. Results established tryptone glucose yeast extract agar as the medium in the recovery, culture, and maintenance of Gram-negative bacterial pathogens.

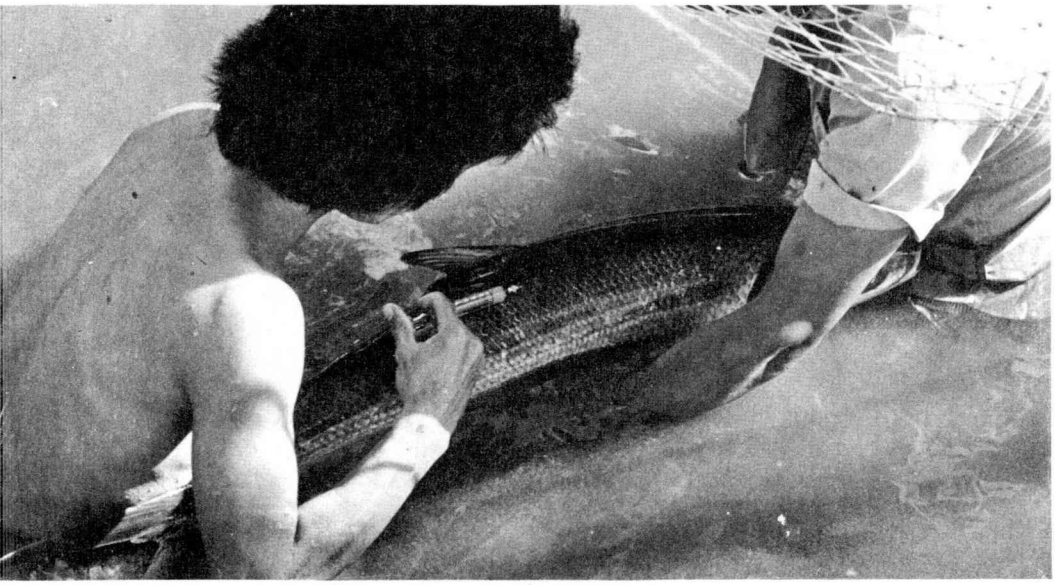
Studies likewise delved into effects of chemical treatment on *P. monodon*. As to effects on hatching, it was found out that furanace and formalin did not affect the hatching rate of *P. monodon* eggs. Malachite green and treflan inhibited hatching at doses of 1 ppm and 10-50 ppm respectively. Hatching rate was also reduced in those exposed to 5 ppm of calcium hypochlorite. Potassium permanganate inhibited a large number of treated eggs. Larvae exposed to furanace, formalin, malachite green and treflan had the highest survival but when these were infected with the fungus *Lagenidium* sp., only those hatched from eggs treated with treflan (at 1 ppm) yielded survivors at the postlarval stage.

Malachite green and cupric sulfate were also studied as to their acute toxicity levels on zoeal, mysis, and postlarval stages. Malachite green toxicity was directly proportional to chemical concentration in all tested larvae. Increasing exposure period increased mortality in zoea and mysis. Doses of 0.6135μg/L for zoea, 6.9505μg/L for mysis and 3.99μg/L for postlarvae were recommended. Copper sulfate registered behavioral and physiological effects. The larvae lost their balance and were lethargic, producing few swimming movements and confining themselves at the bottom of the aquaria. Moribund larvae had faster but weaker heartbeats than healthier larvae. Delayed molting of Z_1 to Z_2 was also noted.

On the other hand, furanace was studied as to its effect on the population growth on *Chaetoceros* and *Brachionus*. But there were no significant differences observed in mean densities and percentage survival.

Field Laboratory, Pandan, Antique

Transporting of adult milkfish (sabalo)



Hormone injection of the adult milkfish (sabalo)

Gonad examination from the adult milkfish (sabalo)

Ecological studies of water around Panay Island

Milkfish Program

1. Artificial Fertilization and Hatching of Milkfish Eggs. The most outstanding achievement for 1977 was the artificial fertilization and hatching of adult milkfish eggs or sabalo eggs through induced spawning with the use of hormone injection. The initial experiment was done in Pandan Station (Antique Province) through the scientific efforts of Dr. William E. Vanstone working under the SEAFDEC-IDRC Milkfish Program. A hormone solution consisting of 4 ml. saline solution with 60 mg acetone-dried Pacific salmon pituitaries and 4,000 I.U. human chorionic gonadotropin was used. The result demonstrated the possibility of induced breeding of milkfish by the injection of the hormone solution paving the way therefore to the eventual mass-production of milkfish fry and the elimination of capture fisheries.

2. Studies on Batbatan Island. Meteorological and hydrographic studies were conducted on the eastern coast of Batbatan Island (off Antique coast), an island confirmed as a spawning ground for milkfish. The objectives of the studies were to find out and monitor the environmental events affecting the spawning grounds, spawning activity, time of spawning, and how eggs and larvae were carried to the shore. The sandsplit at the eastern tip of the island was found subjected to change by wind directions. In the first week of November, when a small southward tail was formed making a semi-cove, sabalos or sexually mature milkfish were sighted.

3. Drift Card Experiments. Research area was the Cuyo East Pass (the body of water between the west coast of Panay and the Cuyo group of islands). The aim was to determine the role surface currents play in transporting milkfish eggs and larvae from spawning ground to shore waters.

Drift cards, sealed and containing spaces for the finder to fill in as to time and place of recovery, were sent afloat. Partial results indicated that the time duration for egg and larvae to be transported ashore took about three and a half months.

4. Embryonic Development. The eggs and newly hatched larvae of milkfish induced to spawn had the same embryonic development as that of other pelagic fish eggs. Newly fertilized eggs had an average diameter of 1.16 mm and a very narrow perivitelline space containing several cortical granules which disappeared within a few minutes. The yolk was slightly yellow, devoid of oil globules and were finely granulated. Hatching occurred between 35-36 hours after fertilization at 32 ppt salinity and temperature range of 28.4°C. Newly hatched larvae measured 3.5 mm in length. The yolk was relatively large and tapered posteriorly. The head projected in front of the yolk.

5. Environmental Parameters. Salinity preference, regardless of the salinity in which all fry studies were acclimatized, was 32 ppt. This preference did not change with age. As to light intensity, fry were attracted to light from 20-, 50-, and 100-watt bulbs. Prolonged exposure to light, however, caused gradual withdrawal from the light source. The study of fry reaction to different light intensities was also conducted to improve fry collection techniques even in offshore areas and mangrove swamps. On minimum dissolved oxygen tolerance, results showed that the bigger fishes were affected much earlier by a decrease in dissolved oxygen than did smaller fishes. Median lethal concentration (TL/50) was 0.425 ± 0.025 ppm as against 0.12 ± 0.04 ppm respectively. This suggested that in brackishwater ponds, when the oxygen level dropped to about 1.4 ppm, and unless aeration was done, several fishes would get killed while a further decrease to 0.03 ppm could produce a total kill of specimens about 4 g with the marketable-size fishes and bigger ones dying first.

6. External Sex Characteristics of Spawners. No visible differences were found in male and female milkfish spawners. The anal region, however, exhibited anatomical differences. Externally, the anus of the male had two openings, namely, the anterior anus and the posterior or urogenital opening at the tip of the urogenital papilla. In the female, there were three openings. The most anterior opening was the anus followed by the genital pore. The third opening was the urinary pore which was posterior to the genital pore.

It was also easy to distinguish between the sexes since in the ripe male fish, milt oozed out of the urogenital pore when the abdomen was pressed. Gravid females had distended abdomens. Males were found to have smaller sizes than females.

7. Effects of Formalin Preservation on Fry. After preservation in formalin, fry immediately shrank in length and decreased in weight. Fry in freshwater-formalin solutions shrank less than fry in seawater-formalin solutions. It was recommended that fry be preserved in formalin for a week before length measurement and three weeks before body weight measurement.

8. Sperm Preservation. Sabalo sperms mixed with an extender and kept in a refrigerator at an average temperature of 14.8°C showed motility after four days of storage. Those kept in a freezer did not show motility upon thawing.

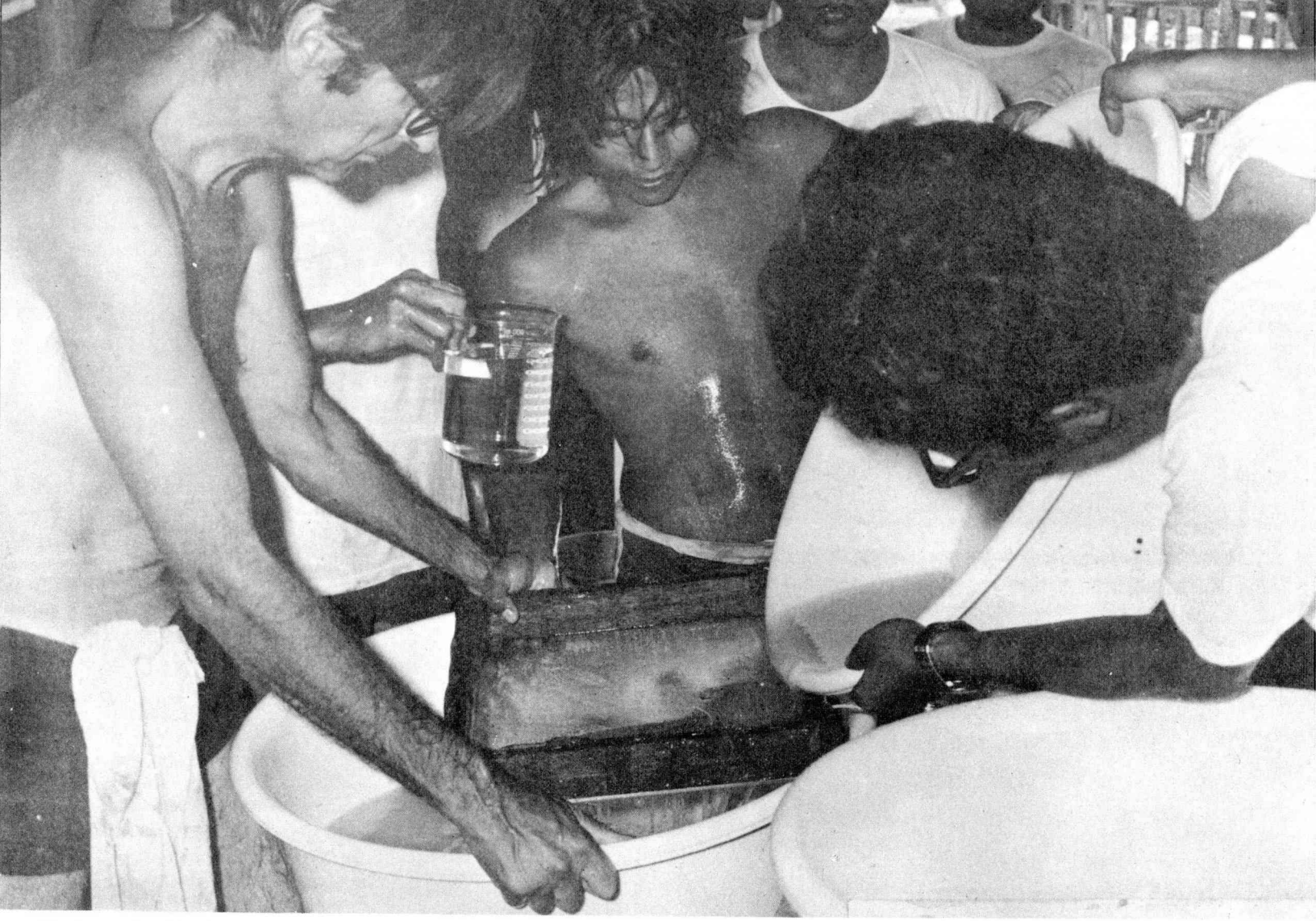
9. Pathology. One unidentified species of copepod belonging to the genus ***Caligus*** of the family ***Caligidae*** was found to infest the adult milkfish broodstock kept in canvas tanks. Research discovered the parasites already infested the milkfish in the open sea and were brought into the tanks attached on the body surface especially on fins of adult milkfish. Within the tanks, the parasites reproduced and reinfested their hosts.

Tests were made using Neguvon at a concentration of 0.25 ppm. This concentration, maintained for 12-24 hours in the sabalo-containing tanks in a closed water system with aeration, was effective in controlling ***Caligus.***

Table 3 Embryonic development of milkfish.

Time from fertilization			
Hours	Minutes	Stage	Remarks
1	10	2-cell	
1	15-20	4-cell	
1	30-35	8-cell	
1	40-50	16-cell	
2	10-15	32-cell	
2	30	64-cell	
3	30	many cell	
5	10	Blastula	
to			Blastulation in progress
9	25		
9	30	Gastrula	
to			Gastrulation in progress
12	10		
12	50	Neurula	Appearance of neural grove
13	50		Beginning of optic vesicle differentiation
14	27		Start of notochord formation
15	30		Beginning of somite segmentation
18	30		Embryo 1/2 of egg circumference
22	50		Embryo 3/4 of egg circumference, heart beating, tail free from yolk and occasional body movement
24	10		Frequent body movement
30	0		Tip of tail reached the head
34	0		Tip of tail past the head
35	0	Hatching	
to			
36	0		Hatching in progress

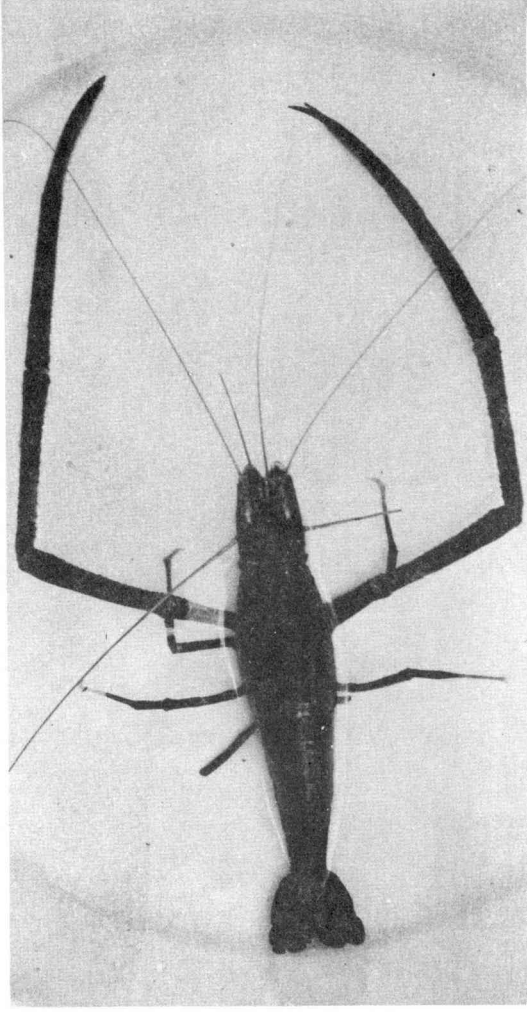
salinity, 31 ppt
temperature, 28.4-29.2°C



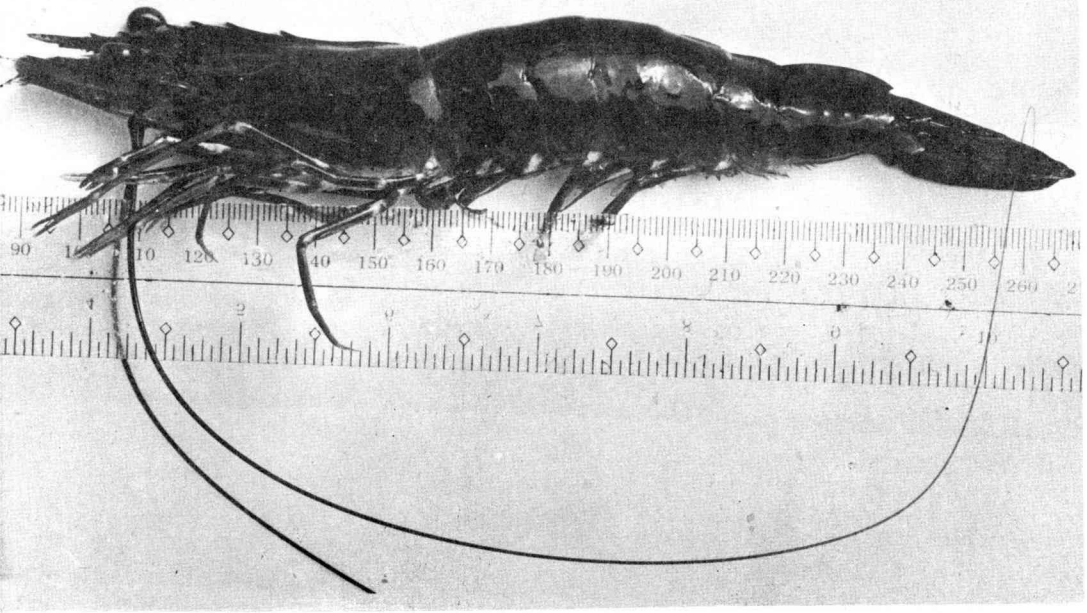
Sieving of fertilized eggs

Extracting the pituitary gland from adult milkfish (sabalo)

Milkfish production from fishpens in Laguna de Bay



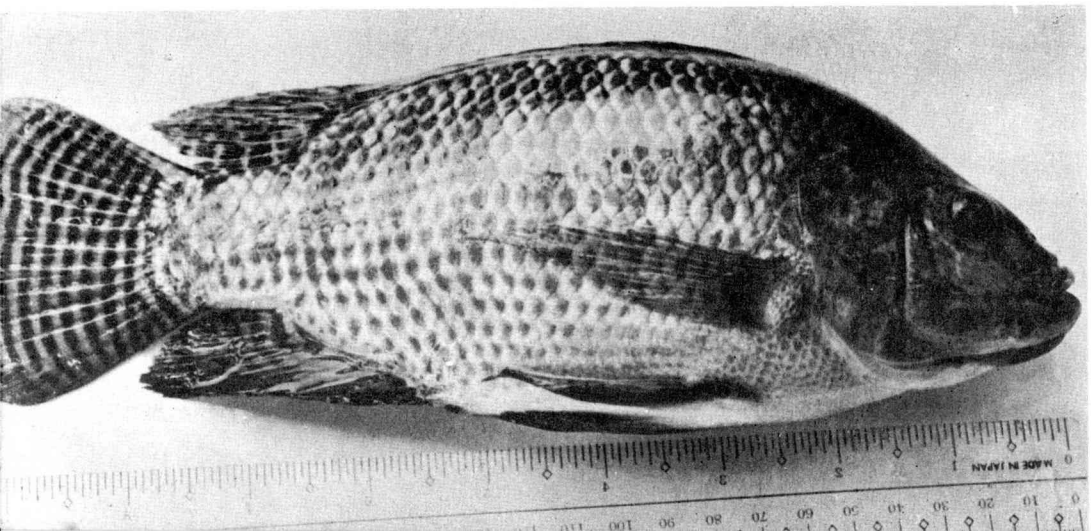
Macrobrachium sp.



Marketable-sized P. monodon farmed in Laguna de Bay

Culture of algae for milkfish fry production

Adult Tilapia sp.



Freshwater Program

1. Physico-Chemical Parameters of Laguna de Bay. Based on a one-year monitoring activity (Oct. 1976-Oct. 1977), the various environmental parameters influencing fish production in the lake have defined the lake as still favorable for freshwater culture of desired species. For example, the lake temperature range of 28.5°C-32.3°C was found favorable to 23 fish species in the lake; pH value range of 7.6-9.3 was suitable to phytoplankton production; the dissolved oxygen values from 6.1-9.4 $\mu g/LO_2$ were high enough to counterbalance small amounts of toxic pollutants that may enter the lake; mineral salts for the growth of fish and planktons were substantial; salinity range of 0.14-1.35 ppt was not harmful to freshwater species; nutrients were high enough to support dense populations of fishes with total inorganic content (nitrate, nitrite, ammonia) ranging from 309-1,081 $\mu g/L$ and a phosphate content of 60-223 $\mu g/L$. The lake also had almost no concentration of sulfides.

Average depth was 2.78 m. But the lake became turbid at certain times of the year decreasing algal production as sunlight did not penetrate deeper into the lake bottom. May to December was the period suitable for both algal production and milkfish culture.

2. Fishes and Benthic Fauna. The most common fish species were ***Arius Manilensis, Therepon plumbeus, Ophiocephalus striatus*** and ***Glossogobius giurus.*** Benthic organisms included mostly mollusks of the genera ***Stenomelania, Corbicula, Idopoma*** and ***Melaniodes.*** The most abundant were ***Stenomelania.***

3. Phytoplankton Species. Dominant phytoplanktons were the blue-green algae, followed by the diatoms, green algae, and ***Euglenophyta.*** The most common blue-green algae were ***Chlorella, Pediastrum*** and ***Scenedesmus.*** Among the diatoms were ***Melosira, Cyclotella, Navicula, Nitzchia*** and ***Fragilaria.***

Overlapping blooms of ***Microcystis, Gleoetheca*** and ***Anabaena*** occurred in June and July and the first two weeks of August, causing the dark blue-green color of the lake water. ***Microcystis*** growth seemed to be independent of the fluctuations of light transparency, temperature and salinity. Peaks of growth coincided with the high inorganic nitrogen and phosphate content of the lake.

4. Freshwater Culture of Milkfish. Three methods of acclimation were tested for fry: 1) the gradual and continuous; 2) the gradual by partial removal of brackishwater; and 3) direct stocking in lake water. The first two methods gave high percent survival of 88 and 83.6 respectively while the third resulted in 59.3 percent survival. The feasibility of acclimation eliminated the need to grow fry in brackishwater. This also reduced production cost of fishpen operators as fry would only cost P0.08 and fingerlings at P0.25 each.

Floating cages for rearing of cultivable fish species

5. Freshwater Culture of *Macrobrachium.* The complete larval stages of the giant freshwater prawn or lobster, ***Macrobrachium rosenbergii*** ("ulang" in Pilipino), had been identified. There were a total of eight larval stages.

Macrobrachium was found mating readily in captivity. Females rematured without the need for males. But the eggs produced were infertile. Ecological factors favoring the spawning of ***Macrobrachium*** included salinity values at 0.466-0.861 ppt; concentration from 3.43-7.5 ppm; alkalinity at 34.3-66.5 ppm; and total hardness from 45.5-62.0 ppm. A direct relationship existed between fecundity and body weight. Average fecundity of 52 spawners collected from the wild was 21,465.

The formulated diet used for larval rearing consisted of eggyolk, liver, carrot, potato, tomato, bacon and starch. Larvae reached the 7th stage with 37 per cent survival. High mortality occurred between the 6th and 7th stages. Maintenance of water level was a critical factor in larval rearing. The nitrite level seemed to be the most variable factor.

6. Lake Farming of *P. monodon*. Gradual acclimation in aquaria and marine plywood tanks through the slow dripping of freshwater over a 1-day, 3-day, and 4-day period resulted in a 98 percent survival. Acclimated ***P. monodon*** was then grown in floating hapas in the lake. Growth rate increased by as much as 200 percent more than that in brackishwater.

Supplementary feeding with boiled clams ***Corbicula Manilensis*** ("tulya"), trashfish and shrimps ("yapyap") or "gango") were efficiently consumed. Since all acceptable supplemental feeds were available in the lake itself, prawn farming in the lake was expected to prove more economically feasible than in brackishwater ponds.

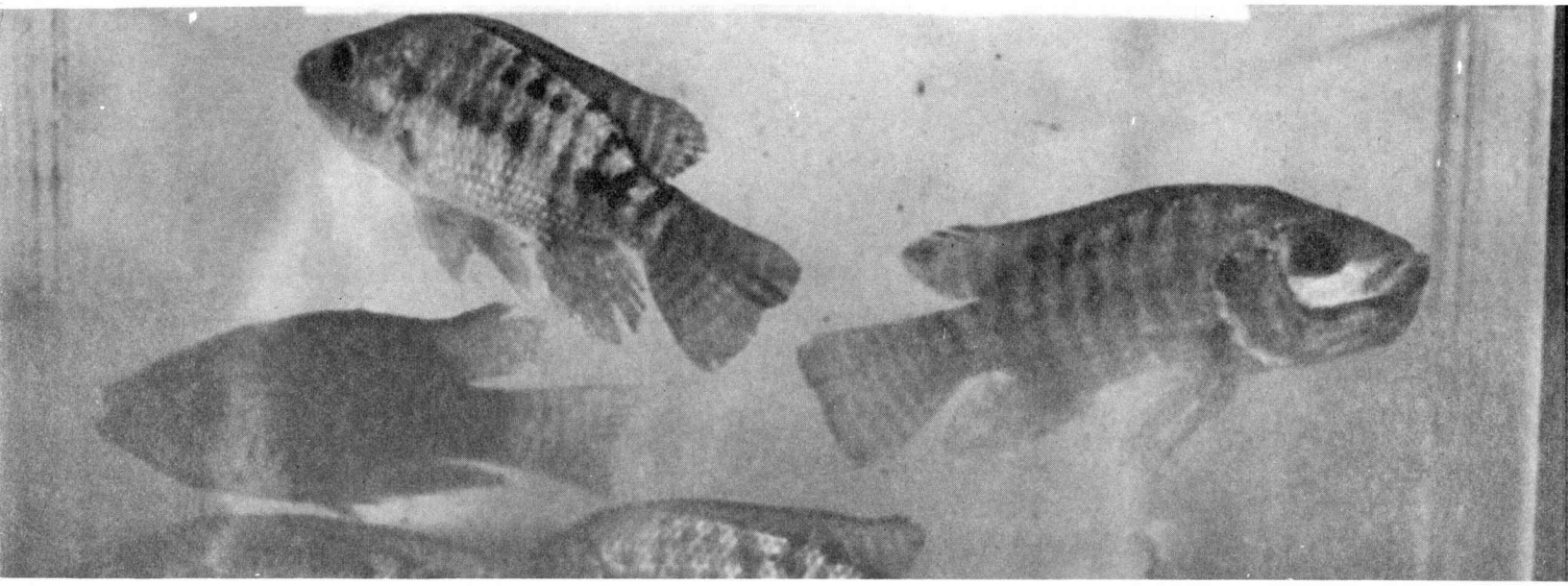
7. Natural Feeds. Research focused on the isolation, identification and mass-production of zooplankton such as rotifers (e.g., ***Brachionus***) and microcrustaceans (e.g., ***Moina macrocopa, Alona,*** and ***Cyclops***). ***Chlorella*** and dried ***Mallotus ricinoides*** ("kilap") branches served as culture feeds. The results clearly indicated feasible mass production of zooplanktons as high population growth was obtained. ***Moina, Cyclops*** and ***Alona*** had better population counts in unaerated set-ups. ***Moina*** was particularly recommended as substitute for ***Artemia*** which is not locally available. ***Moina*** was found acceptable to larvae in later stages of development of ***Macrobrachium.***

Mallotus is a weed whose stems, leaves and branches were utilized as substrate materials for large-scale production. ***Chlorella ellipsoidea*** produced "green water" for larvae of ***Macrobrachium. Chlorella*** also made possible the highest percentage survival of larvae and the lowest nitrite content of the water. Gut examination of ***Macrobrachium*** larvae revealed ***Chlorella*** was assimilated. The optimum feeding rate with a supplemental feed consisting of clams ***(Corbicula)*** was 10 percent of the body weight.

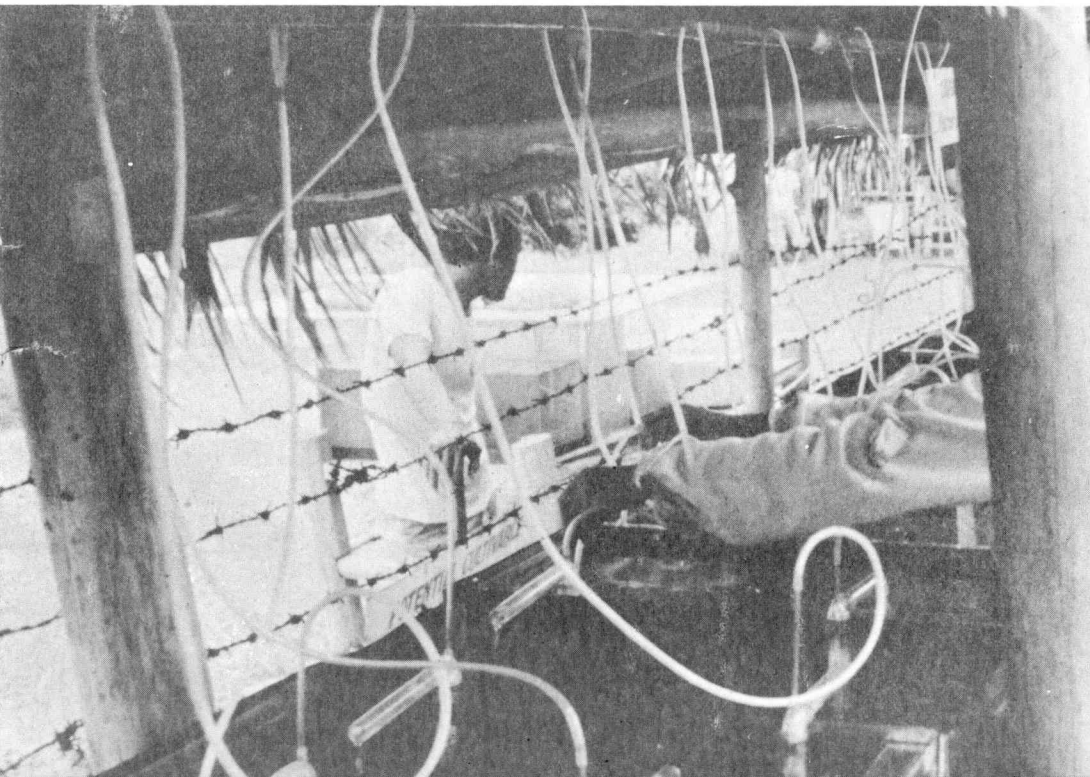
Lake farming of Penaeus monodon in Laguna de Bay

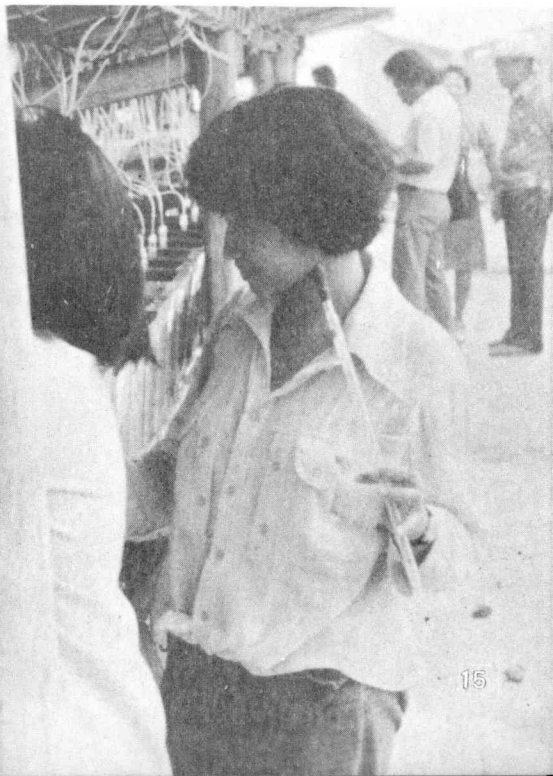
Tilapia nilotica 100 fingerlings

Tilapia nilotica 200 fingerlings



Larval rearing of Macrobrachium





SEAFDEC Experimental Mussel Farm, Himamaylan, Negros Occidental

Transfer of oyster and mussel spats

Seafarming Program

1. Mussel Farming Industry Survey. The survey was undertaken in view of the need to collect data from existing mussel farming areas; to discover new mussel populations in the face of reclamation in natural settlement areas; and to transfer seed mussels into areas found suitable for culture in the survey. Natural settlements of the green mussel, ***Mytilus smaragdinus*** appeared restricted to estuarine areas in Manila Bay, the northern shores of Panay Island, the Iloilo Strait, the western shores of Negros Island, and western Samar Island. Although mussels had been reported from other areas, these were found to be the brown mussel, ***Modiolus metcalfei.*** The brown mussel was found more widespread than ***M. smaragdinus.***

2. Biology Studies of *M. smaragdinus.* Based on the mussel population at an experimental farm in Sapian Bay (Capiz Province), it appeared that there were mussels in spawning condition throughout the year. Induction of spawning was seldom necessary as the ripe mussels spawned spontaneously upon re-immersion. Larval development from the egg to adult stages were studied including the desired environment in each stage.

Other biological areas were likewise explored. It was found that in its natural environment, the settlement of mussels occurred throughout the year. Highest settlement was observed in March. Migratory behavior or the tendency of mussels to detach themselves from culture ropes and wander awhile before reattaching was related to size. The smaller the mussels, the faster they moved and the wider the range.

Observations on growth revealed that after seven months, mean size was about 80 mm, exceeding the required marketable size of 50-60 mm. It appeared that a mean growth rate was easily achieved in Sapian Bay due to the fact that the mussels there were from a naturally undisturbed settlement. Growth experiments with transplanted mussels gave less comparable growth sizes.

A related experiment was on predation. Mussels transferred to Leganes fishponds were crushed and consumed by the mudcrab, ***Scylla serrata.***

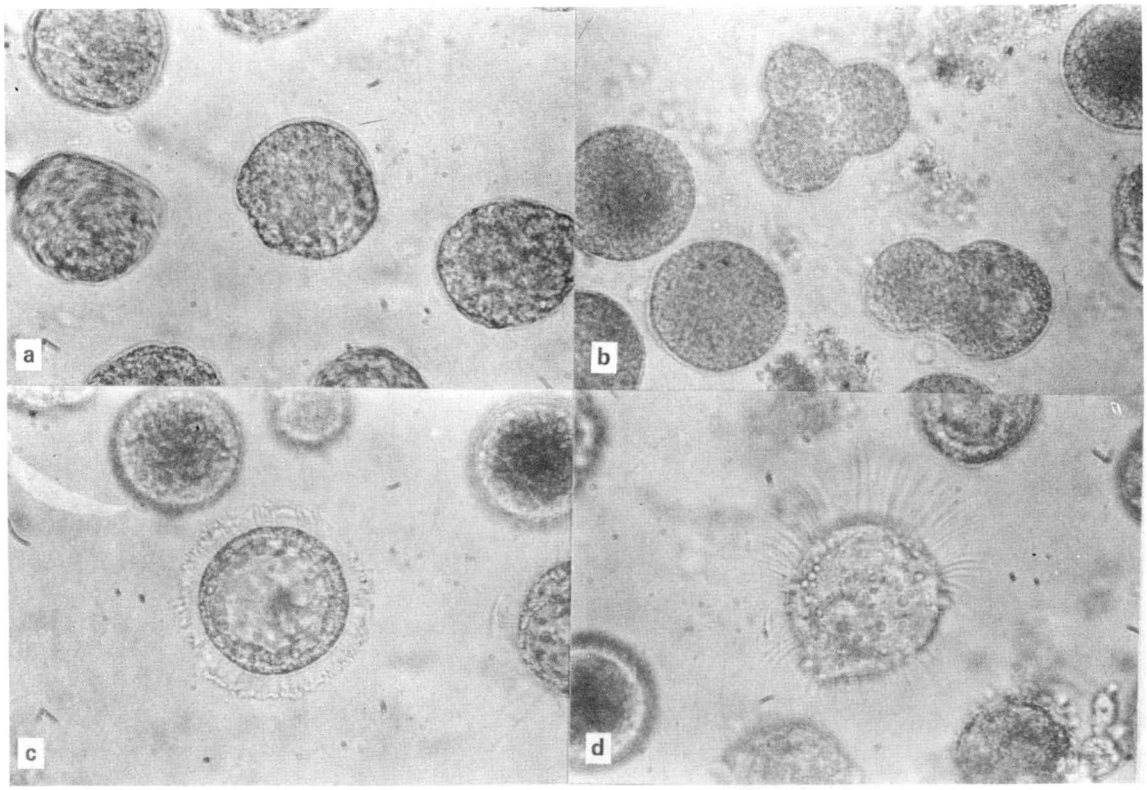


Fig. 1 Developmental stages of *M. smaragdinus*: a) 2 and 3-celled stage, b) free swimming blastula and c) early trichophore larva, d) pediveliger larva.

Transfer of green mussel ***Mytilus smaragdinus*** *spats*

3. Mussel Farming Techniques. Materials and methods known to be successful in other countries were investigated and compared with local methods of mussel culture. Work centered on spat collection, seed mussel transfer and mussel farm construction.

The materials tested were: 1) coir rope, 2) black polypropylene film rope, 3) black polypropylene film, 4) blue polypropylene fiber rope, 5) coconut husk, and 6) bamboo. Observations were made on the ability of each material to attract and retain mussel larvae, repel fouling organisms, and withstand immersion in seawater. Bamboo was not found a good material as it became subject to attack by teredinids. It also deteriorated rapidly upon immersion. The rest of the materials were considered good mussel collectors with the black polypropylene film as the most attractive to mussel larvae although it tended to attract other competitors.

Experiments found out that in the transplanting of collected seed mussels to areas suitable for growing, problems on mortality and reattachment of seed mussels into the new substrate emerged. Survival was improved, however, if the mussels were rinsed in seawater regularly. The use of coir twine or black film which could be transferred intact with its catch and wound onto growing ropes or bamboo sticks appeared feasible and easy. Juvenile mussels, tended to be very mobile when disturbed. Further research work could yield additional information on this area.

The suitability of sinamay as binder for retaining transplanted mussels was tested. As a good binder rots at the shortest time possible after the transplanted mussels have attached to the growing ropes, it was found that sinamay rotted faster than synthetic fibers allowing newly transplanted mussels to reattach firmly to the growing ropes and also giving them more freedom to eat. Sinamay, however, had its disadvantages. The sinamay strip accumulated suspended particles or silt making the entry of food difficult and feeding activity reduced. The fibrous nature of the sinamay made possible the abundance of foulers like the filamentous algae and mussel spat.

4. Mussel Farm Construction. Two types of mussel farms had been constructed. The first was a shallow water farm, the other a deep water farm.

The shallow water farm required low capital investment and was suitable for the fish-trap operator turned mussel farmer. The pilot farm was constructed in Himamaylan (Negros Occidental Province) covering an area of about ¼ ha of which a quarter was devoted to seed production and the rest for growing mussels to marketable sizes. The modified suspension method was adopted.

The deep water farm was capital intensive requiring a substantial investment but capable of generating returns in excess of 100 per cent of total investment. Site for the farm was the Tigbauan Main Station. Spherical, plastic bouys donated by the New Zealand Government together with locally-made plastic bouys form the flotation structures to suspend the mussel ropes.

5. Crab Studies. Two crab species, the mudcrab or mangrove crab ***Scylla serrata*** ("alimango") and the stone crab ***Charybdis hellerii*** ("kasag"), were the foci of crab research. Efforts yielded the first production of the crab stages of the two species. Complete larval development studies identified five zoea stages and one megalopa.

The biology of ***S. serrata*** was also studied. It was observed that molting was faster in higher salinites (30-34 ppt); pre-copulatory molt was necessary prior to actual mating; fertilization was internal wherein the paired gonapodia of the male entered the paired genital openings of the female for the disposition of sperms; and that the rate of gonadal development of freshly copulated females was fastest at salinities of 26 ppt followed by 22 ppt.

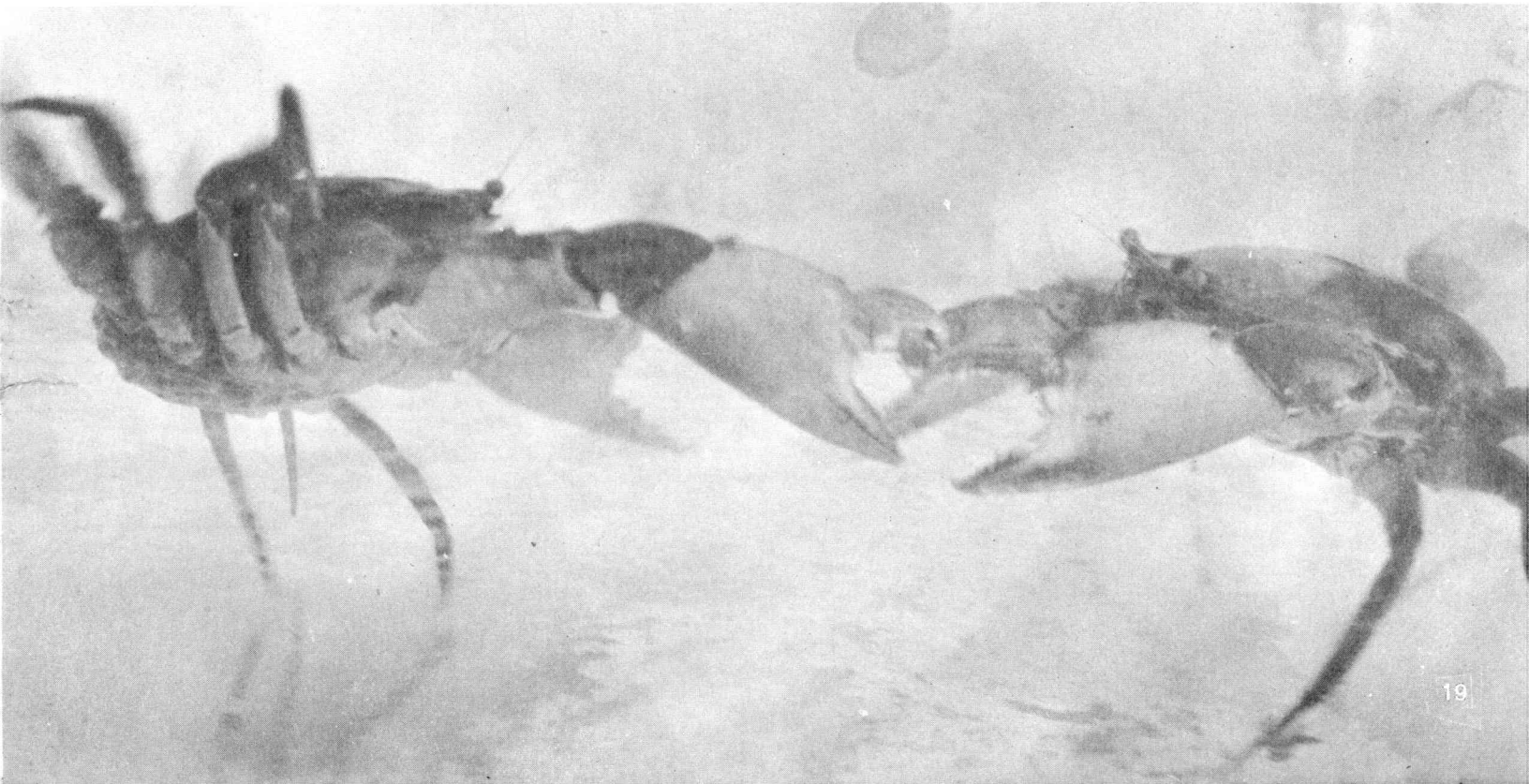
Stocking density tests revealed larval survival to be highest at the rate of 30 larvae in 500 mL from Z_1-Z_2 stages. Temperature varied from 26°C-20°C. Salinity ranged from 30-32 ppt. With 30 larvae in 500 mL, there was 50-60 per cent survival during the fourth day of rearing.

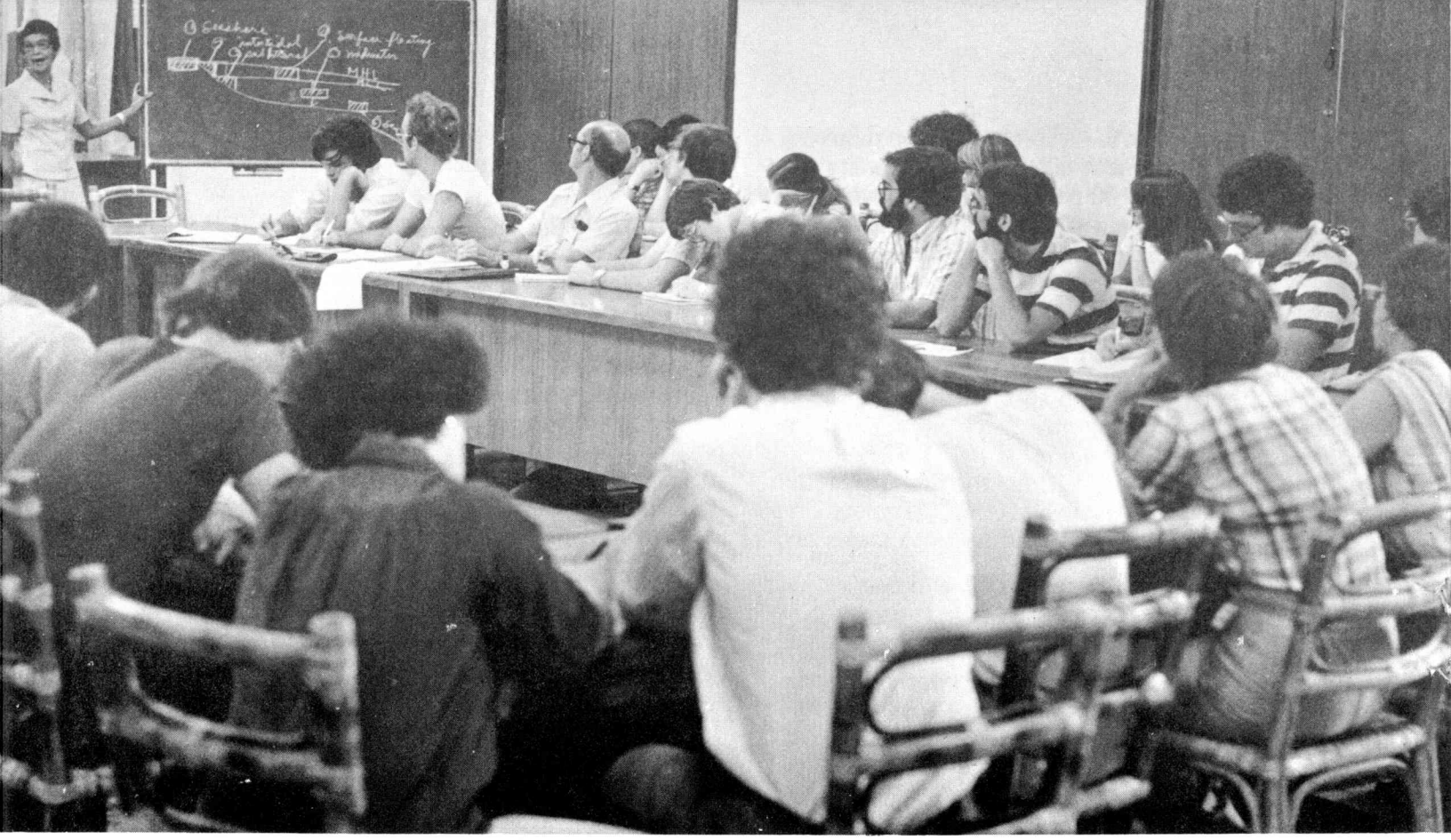
In ***C. hellerii,*** survival was relatively high during Z_1 but went down during the final zoea stage. Feeding was mostly with ***Artemia*** nauplii most of which outgrew the larvae, a situation which may have caused heavy mortality during the final zoea stage. Larvae also showed cannibalism. Sometimes megalopae were seen eating zoea larvae. Mortality decreased from crab stage onward.

Feed development studies discovered that the best feed combination was ***Artemia+Chaetoceros*** or ***Artemia + Brachionus*** and ***Chaetoceros*** or ***Chlorella.*** The rate of feeding used was fixed as follows: ***Artemia*** (5-10 eggs/mL); ***Chaetoceros*** (100,000-500,000 cells/mL); ***Brachionous*** (3-7 individuals/mL); and ***Chlorella*** (100,000-500,000 cells/mL).

To develop a land-based broodstock of the crab species, a refuge system was installed consisting of three compartmented concrete hollow blocks arranged to allow crabs to take shelter and protection. Stocking rates had been determined depending on whether the stock was homogeneous or heterogeneous. It was observed that with the refuge systems, sexual maturity was attained earlier, at 62mm carapace breadth, and growth increment of crabs was 80-100 per cent higher compared to one where refuge was not provided.

Mudcrab Scylla serrata spawners





Special training for US Peace Corps Volunteers at Tigbauan Main Station

Off-campus practicum students undertaking research studies on aquaculture

TRAINING AND EXTENSION

Training The past year saw the conduct of numerous training and extension activities. The regular training programs included the following:

A. International Training Program. Intended to bridge the gap in aquaculture manpower development in Southeast Asia and to fulfill the training commitment to member-countries, the Aquaculture Department continued with increased vigor the conduct of four training programs, namely:

- AQUACULTURE RESEARCH METHODOLOGY (a five-month training program which started October 24, 1977 with 14 participants);
- AQUACULTURE MANAGEMENT (another five-month program which was also launched on October 24, 1977 with 15 participants);
- AQUACULTURE ENGINEERING (a one-month program which was conducted from November 2-December 2, 1977 with nine participants); and
- SMALL-SCALE PRAWN HATCHERY MANAGEMENT (a two-month program conducted from October 12-December 12, 1977 with three participants).

The participants came from different countries not only in the region but also from other developing countries in Asia.

B. Local Training Program. Target participants under this program were the pond owners or cooperators as well as their technicians and caretakers. For 1977, the following training programs were held:

- SUGPO CULTURE (in three separate sessions with 57 participants comprising of pond owners/operators and their technicians who were willing to set aside at least one to two hectares of their ponds for research purposes);
- BARANGAY SUGPO HATCHERY MANAGEMENT (a two-month session with 10 participant pond-owners)
- POND ENGINEERING; and
- MUSSEL AND OYSTER FARMING (in four separate sessions with a total of 74 participants).

C. Graduate Study Program. Already in its second year of implementation, the Aquaculture Department-University of the Philippines study program granted scholarships to 20 more recipients who enrolled in June 1977 in UP Diliman. This raised the number of total recipients availing of the opportunity to pursue an M.S. degree in Fisheries major in Aquaculture to 40 in all. The new grantees came from various governmental institutions in the Philippines, Indonesia and Thailand.

The latter part of 1977 brought a new dimension to the Graduate Study Program. The move to create an Asian Institute of Aquaculture (AIA) within the Aquaculture Department had effected a possible redefinition of its scope of activities in preparation for its integration under the AIA mechanism when the latter would be fully implemented next year.

D. Other Training Programs. Besides these regular training programs, the Aquaculture Department conducted special training for graduating students from various regional schools of fisheries in the Philippines who were sent on work experience for their off-campus practicum course. For 1977, the Aquaculture Department's Training and Extension Division coordinated such training of 39 graduating students. The students stayed for an average period of four weeks. Within this period they were exposed to research and production activities in the Tigbauan Main Station and other suitable project stations of the Department.

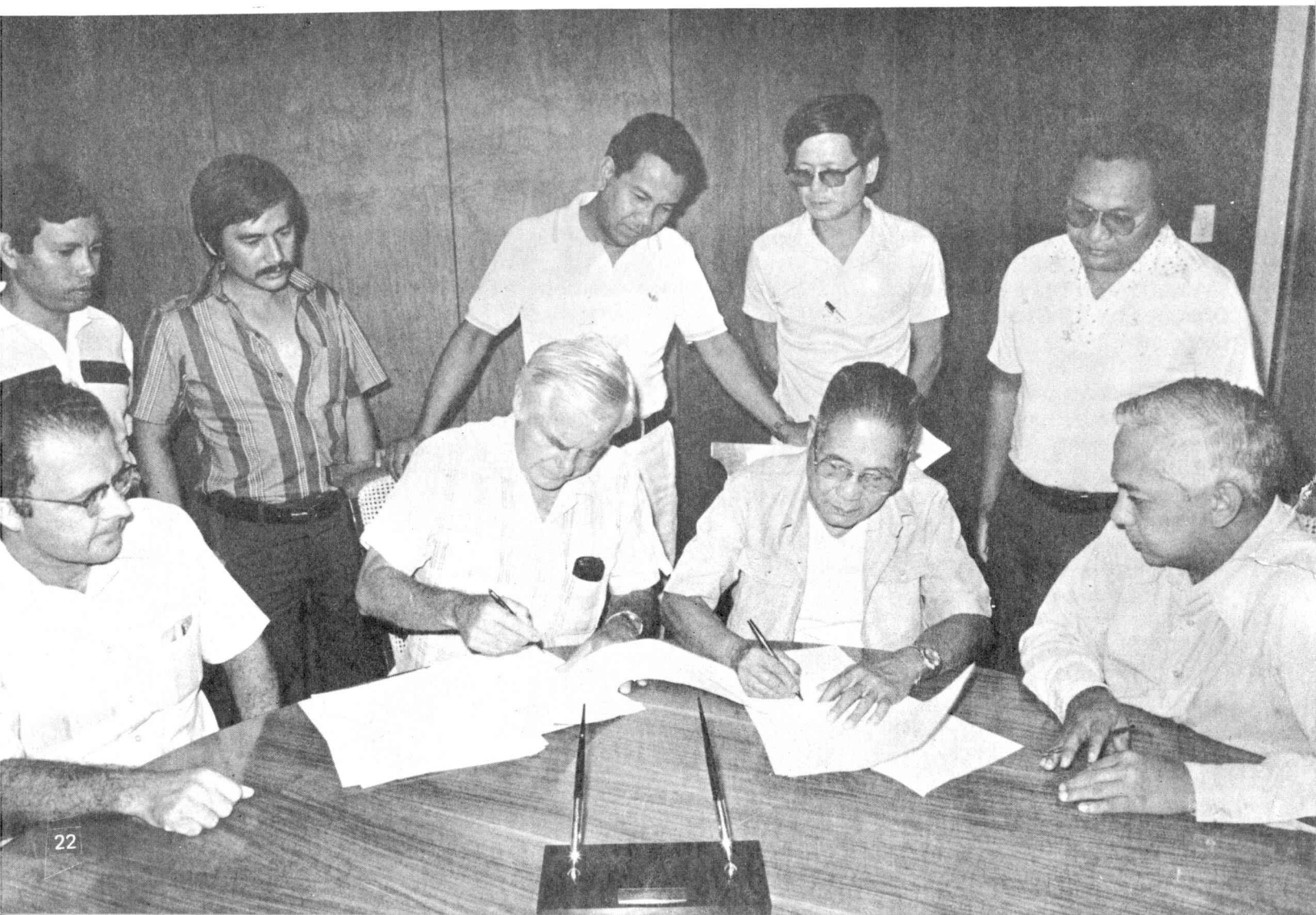
Extension

The past year was equally a busy year in terms of the number of extension activities done. Various seminar-workshops, conferences and meetings were hosted by the Aquaculture Department or coordinated with other national/international institutions or agencies, namely:

- INTERNATIONAL WORKSHOP ON MANAGEMENT (held from May 25-June 2, 1977 with 51 participants in cooperation with the East-West Food Institute of Hawaii)
- SEMINAR-WORKSHOP ON BANGUS AND PRAWN CULTURE (in coordination with the Western Visayas Federation of Fish Producers, Inc. and held from May 19-21, 1977 with 200 fishfarmers attending)
- SECOND BIENNIAL MEETING OF THE AGRICULTURAL ECONOMICS SOCIETY OF SOUTHEAST ASIA (November 3-6, 1977 with 85 delegates to discuss problems and potentials of freshwater and brackishwater aquaculture as they relate to economics)
- COASTAL ZONE RESOURCE USE AND MANAGEMENT (CZM) ORGANIZING COMMITTEE MEETING (November 7-8, 1977 co-sponsored by the Agricultural Development Council)
- REGIONAL WORKSHOP ON AQUACULTURE ENGINEERING (November 27-December 3, 1977 with 28 participants
- INTERNATIONAL SEMINAR ON FISHERIES RESEARCH MANAGEMENT (December 11-17, 1977 with 28 participants to confer and recommend steps to improve research management capability in support of fisheries).

As an integral part of Training and Extension, the Library, in an effort to cope with the increasing needs for books, materials and other references for trainees, participants and students, augmented library collection with an aggregate total of 3,844 titles in 7,345 volumes. The collection was acquired either through donations or by outright purchases.

Dr. R. Neal and Dr. R. Power of the USAID and Dean D. K. Villaluz and Dr. J. C. Madamba of SEAFDEC are shown signing the Memorandum of Agreement for fishries development



SPECIAL PROJECTS

Technology Transfer Package

1. Barangay Sugpo Hatchery System. The objective of this project was to introduce a hatchery system that entailed minimal costs to low-income fishfarmers. The hatchery innovation consisted of five major components utilizing seawater and air supply. The feasibility was not only expressed in economic advantages but in other benefits as well. For instance, the system only demanded minimal training in the operation and physical facilities did not require much space.

Because of its low operational costs, there was a high possibility that more rural people would accept the innovation. When properly transferred to fishing communities, the system would definitely alleviate the plight of low-income families.

It was planned that the system could best operate within the context of the Barangay Cooperative framework. Plans were being carried out to enlist government support and provide the project with financial inputs for the spinoff. Other plans recommended growth centers for the Barangay Sugpo Hatchery System packages to be selected on regional basis and in coordination with the National Economic and Development Authority (NEDA) and the Bureau of Fisheries and Aquatic Resources (BFAR).

In the meantime, groups of fishfarmers in the province of Iloilo have adopted the system in their respective ponds with very encouraging results. For its part, the Aquaculture Department intensified its research efforts on further standardizing the system.

2. Regional Prawn Aquaculture Program. The Aquaculture Department proposed an inter-agency Regional Prawn Aquaculture Program the objectives of which are:

- To locate, establish and operate shrimp or prawn hatcheries at strategic locations of the country
- To locate, develop and operate collection and maturation stations for prawn spawners at each of these locations to regularly supply the hatcheries
- To identify existing and potential pond or pen systems for the commercial culture of shrimps and prawns
- To identify existing and potential processing and packaging centers of shrimps and prawns for export
- To train managers and technicians to manage and operate the foregoing program.

The proposed regional prawn centers would be established in strategic parts of the Philippines, namely: Aparri (Cagayan), Damortis (La Union), Cavite City (Cavite), Lucena City (Quezon), Naga City (Camarines Sur), Batan (Aklan), Himamaylan (Negros Occidental), Tacloban City (Leyte), Zamboanga City, Naawan (Misamis Oriental), Davao City, and San Jose (Mindoro Occidental).

In each of these centers, the project components to be included would be: hatchery, processing plant, fishpond and pen cooperators and training and extension.

The hatchery would include spawner collection and maturation pens, feed production tanks and water acidity monitoring laboratory. The processing plant would include the processing and freezing of shrimps for export. The fishpond/pen cooperators would include the private sector in each region. The training of managers and technicians would be undertaken by the Aquaculture Department while the extension of culture technology to a greater number of operators would be entrusted to BFAR.

Integrated Fisheries Community Development Program (IFCDP)

To demonstrate the feasibility of aquaculture as a viable socio-economic activity geared towards solving the food production problems in rural areas, the Department proposed the IFCDP in cooperation with the Canadian International Development Agency (CIDA), BFAR, and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

The objectives of the IFCDP included:
- To increase the productivity of fishfarmers in pilot centers and consequently raise income levels
- To hasten and institutionalize the adoption of fishery technology developed in the laboratories of the Aquaculture Department and
- To establish pilot centers for the effective transfer of fisheries technology.

Components of the proposed program would be Applied Research, Training, and Information. The first phase would call for the establishment of Fisheries Community Development Centers (FCDCs) to serve as pilot centers. Relevant researches using ponds of fishfarmers and involving the farmers themselves would be conducted. Projected sites of the FCDCs would consist of Iloilo, Capiz, Leyte-Samar, Camarines Sur, Mindoro Oriental, Pangasinan, Cagayan Valley and Zamboanga.

The second phase would call for a series of meetings with the staff of the sponsoring agencies including the private sector to identify the needs and problems of the industry, compile benchmark information, and design a training program. The third phase, closely related to training, would be the information activity component. Specialized courses on fisheries would be evolved for fishfarmers, technicians and interested parties. Seminars and workshops on various aspects of aquaculture would also be organized to serve as forums of discussion on problems related to the industry.

Aquaculture Technology Resources Management Program

As an expansion of the pilot nature of the IFCDP, the Aquaculture Department launched this program to evolve national delivery systems in the transfer of technology from the laboratory to the end-users. Under joint sponsorship with the Development Academy of the Philippines (DAP), the objectives of this program were:
- To introduce systematic, new and improved fish production, processing and marketing technology
- To provide opportunities for verifying and dissemination of vital technological, economic, educational, political, and social innovations
- To utilize the above-mentioned channels for the collection of information relevant to the advances in the industry as inputs for the development of improved and new technology
- To develop and mobilize the rural sectors and to engage the participation of the private sector to fully develop the industry and
- To provide a link between the rural and the private sector on one hand, and the government institution on the other hand, so that the latter would become more responsive to the needs and potentials of the industry.

The program model, after its full development in the Philippines, would be presented by the Aquaculture Department for possible adoption by other SEAFDEC member-governments.

Asian Institute of Aquaculture (AIA)

To solve the problem of manpower development in aquaculture industry in the region, the Aquaculture Department organized the Conference on the Establishment of the Asian Institute of Aquaculture held in Manila and the Tigbauan Main Station on October 6-8, 1977. In the conference, where 28 researchers, scientists, and educators from different universities and research institutions in Southeast Asia participated, the Aquaculture Department formally proposed the establishment of the AIA.

The draft proposal was later refined and submitted to the SEAFDEC Council at its Tenth Meeting in Metro Manila on December 5-10, 1977. The Tenth Council Meeting approved the program of activities and the budgetary requirements of the Aquaculture Department for 1978, including that of its Training and Extension Division of which the AIA was incorporated.

The objectives for establishing the AIA were as follows:

General:

- To ensure the availability of high-level manpower for the conduct of researches in aquaculture and upgrade the present state of aquaculture technology and elevate it to the level of such agricultural activities as rice, corn, poultry, etc.
- To provide opportunities for local and international researchers in aquaculture to conduct researches in the AIA and thus create favorable conditions for research

- To promote regional and international cooperation among scientists, technologists, fish farmers, as well as institutions engaged in aquaculture development
- To provide opportunities for verifying and packaging aquaculture technology and disseminating the same to interested countries and institutions.

Specific:

- To actively participate in formal degree programs in cooperation with other universities in the region, leading to M.S. and Ph.D. degrees on reproductive physiology and fish nutrition, the most exigent discipline in the field of aquaculture, according to experts
- To conduct non-degree training programs on various aspects of aquaculture technology
- To administer research grants, award scholarships and faculty exchange programs
- To plan, organize and implement consultant and advisory services in aquaculture education and training; and
- To organize meetings, workshops and seminars.

The idea behind the AIA was the need to institutionalize the education and training of fishery and aquaculture manpower resources in Southeast Asia—and, hopefully, in other developing countries of Asia. There are already various universities and research organizations in some countries offering fisheries courses and related disciplines but none has assumed a regional character or scope.

Establishing the AIA would tap the ready resources of these universities and research agencies and thus solve in concert or mutual coordination the myriad problems of aquaculture development. This cooperation would not only strengthen efforts in producing desired high-quality graduates on both the M.S. and Ph.D. levels but would also successfully integrate and interchange faculty, researchers, students, and course areas in the field of aquaculture.

Furthermore, the AIA was envisioned to serve as a forum through which the best minds in fisheries would come together to deliberate and draw up solutions, strategies, plans and policies for hastening aquacultre development. In this way, the drafting of inter-agency or inter-country plans; the undertaking of problem-oriented research projects; the laying out of policies to service Asian universities and other institutions, among others, would be facilitated and sooner implemented.

In general, the AIA was conceived as a mechanism to bring about cooperation among educational and research institutions in the region to improve the state of manpower of aquaculture research and development.

The AIA Plan would absorb the entire Training and Extension Division of the Aquaculture Department. Its expanded nature would necessitate the integration of several other projects like the regular Graduate Study Program sponsored jointly with UP and the Research Fellowship Program.

Research Fellowship Program

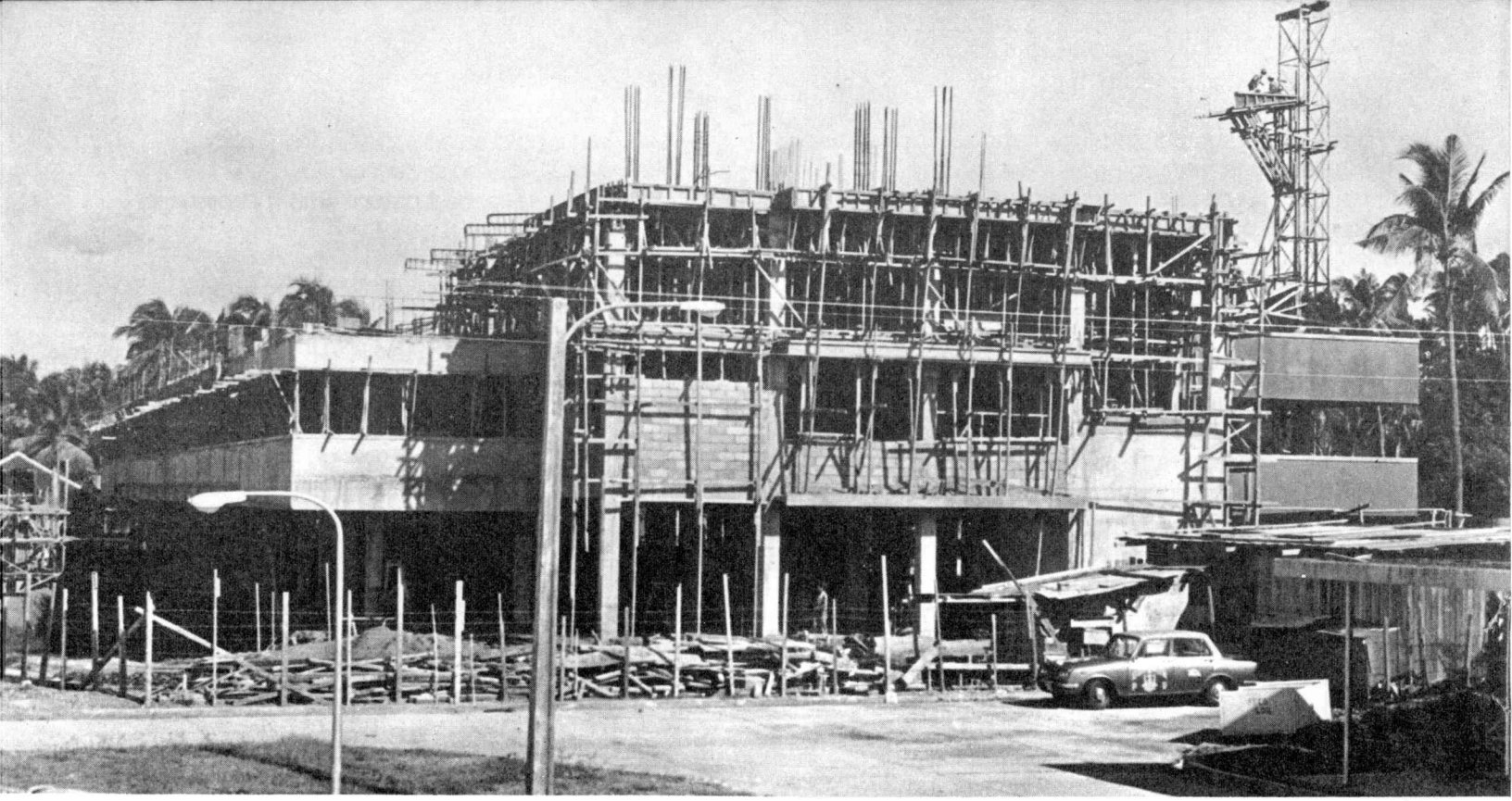
This program offers Senior Fellowship grants, Research Associate grants, and Masteral Research Internship grants. Privileges include stipend/ allowance, a round trip air fare, research expenses, and insurance. The aim is to make full use of existing limited scientific manpower for aquaculture research.

Senior Fellowship grants are open to outstanding researchers and scientists in fisheries research from Asia, who may want to engage in scientific studies related to the varied program matrix of the Aquaculture Department. Invitations have been extended to researchers who may presently be connected with other research organizations, universities, or private enterprises but who may find the opportunity to spend a few months with the Aquaculture Department to share their expertise in aquaculture research. Depending upon their approved project proposals, fellowship grants are granted for periods of four months to a year, with possible extension depending upon the progress of the project.

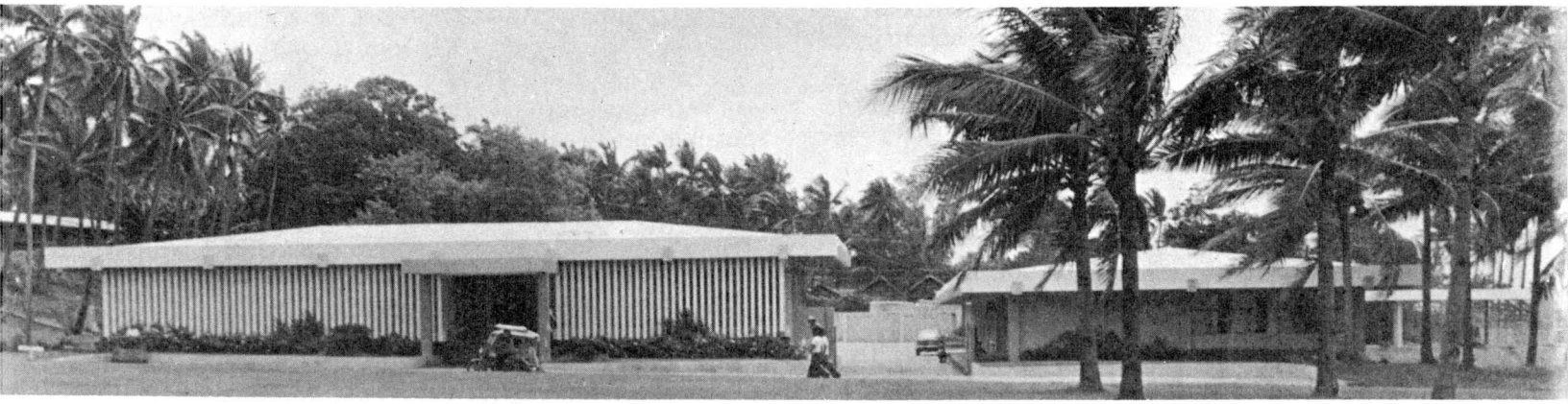
Research Associates grants are open to young but highly promising technical men in aquaculture, in the early stages of their career, and who may want to pursue relevant research projects with the Aquaculture Department. Their researches will be of a semi-supervised nature with assistance provided by the researchers of the Department. A minimum qualification of a B.S. degree in fisheries or related disciplines, but preferably a Master's degree is required.

The Masteral Research Internship grants are for graduate students from Southeast Asia who have completed their academic requirements leading to the Master's degree in fisheries or related disciplines from recognized institutions, and who may want to conduct their thesis research at the Aquaculture Department.

Already, two foreign students from the University of Hawaii working on their thesis research had been extended grants under the Research Fellowship Program. By 1978, this program would be integrated with the AIA.



Nutrition and Physiology Research Laboratory, Tigbauan Main Station



Training and Extension Building, Tigbauan Main Station

Hatchery System, Freshwater Fisheries Station, Tapao Point, Binangonan, Rizal

INFRASTRUCRURU DEVELOPMENT

The intensification and expansion of the programs of the Aquaculture Department demanded the construction of infrastructure facilities in its various project stations.

In Tigbauan, the three-storey Nutrition and Feeds Laboratory Building was being constructed to meet the new research thrusts on nutrition and reproductive physiology. Other research structures and facilities completed in 1977 included the Wet Lab Extension covering a total floor area of 800 sq m and wherein the barangay hatchery and broodstock maturation tanks of the prawn program are housed; 10 units of algal tanks; a roots blower house for the three units of 45 KW roots blowers providing aeration requirements of research projects; and four units of canvas tanks.

Support structure and facilities included the construction of the two units of high concrete jetties at the seaside portion in order to prevent erosion; expansion of the dining hall; completion of the gasoline station equipped with 16,000-liter reservoir; and installation of the water system. The last activity was still on-going; in the meantime,two freshwater shallow wells had been dug to provide the water needs of the station.

In Leganes, the permanent facilities constructed in 1977 were the Administration Building (which houses the administrative offices and research laboratories); a utility building; a six-door apartment and duplex-type residential houses; and a powerhouse with a 150-KVA generator. Other infrastructure construction comprised of 12 units of 1,000 sq m bangus experimental ponds for feed development studies; 24 units of 1,000 sq m nursery ponds to stock P_5-P_{25} sugpo; four units of 1 ha rearing ponds to stock P_{35} to marketable size sugpo; and freshwater gate and pumping facilities to tap freshwater from the nearby Jalaud River.

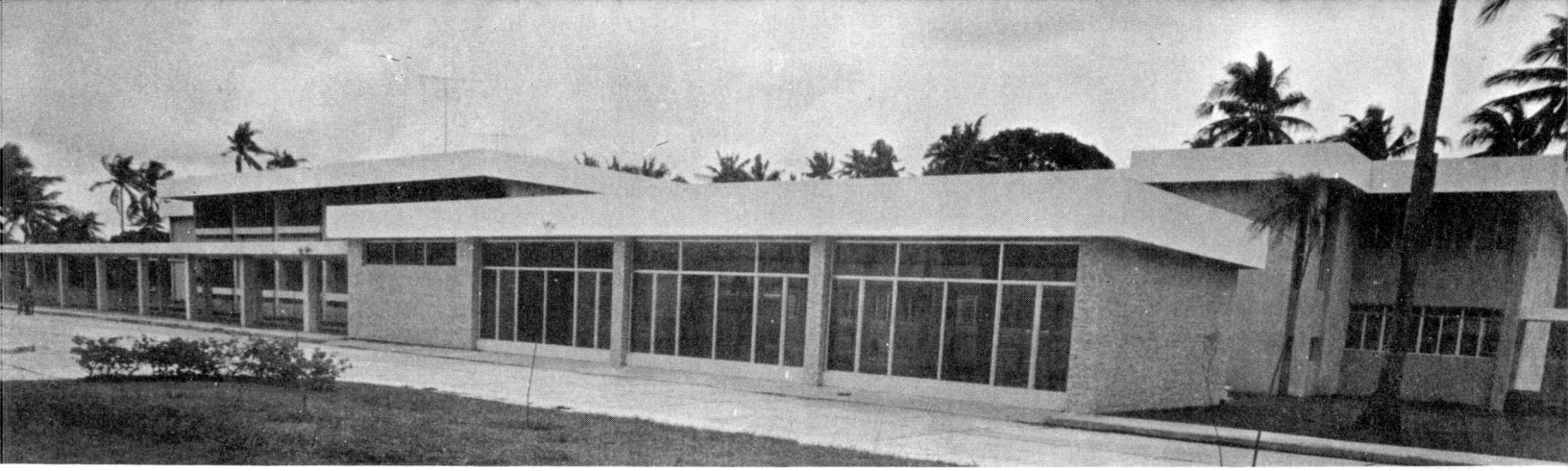
In the Binangonan Freshwater Fisheries Station, construction of the hatchery building with a floor area of 900 sq m was undergoing and was scheduled for completion in 1978. In accordance with the five-year freshwater research plan, other infrastructures would be constructed in the station.

The Seafarming station in Igang started construction of a proposed biochem laboratory building; wet and field laboratories; a training center; a dormitory and dining hall; two guest houses; six staff houses; generator and pump house including rootes blower house; two water tanks; an open pond for nursery, cove enclosures; drainage and sewage system; among others.

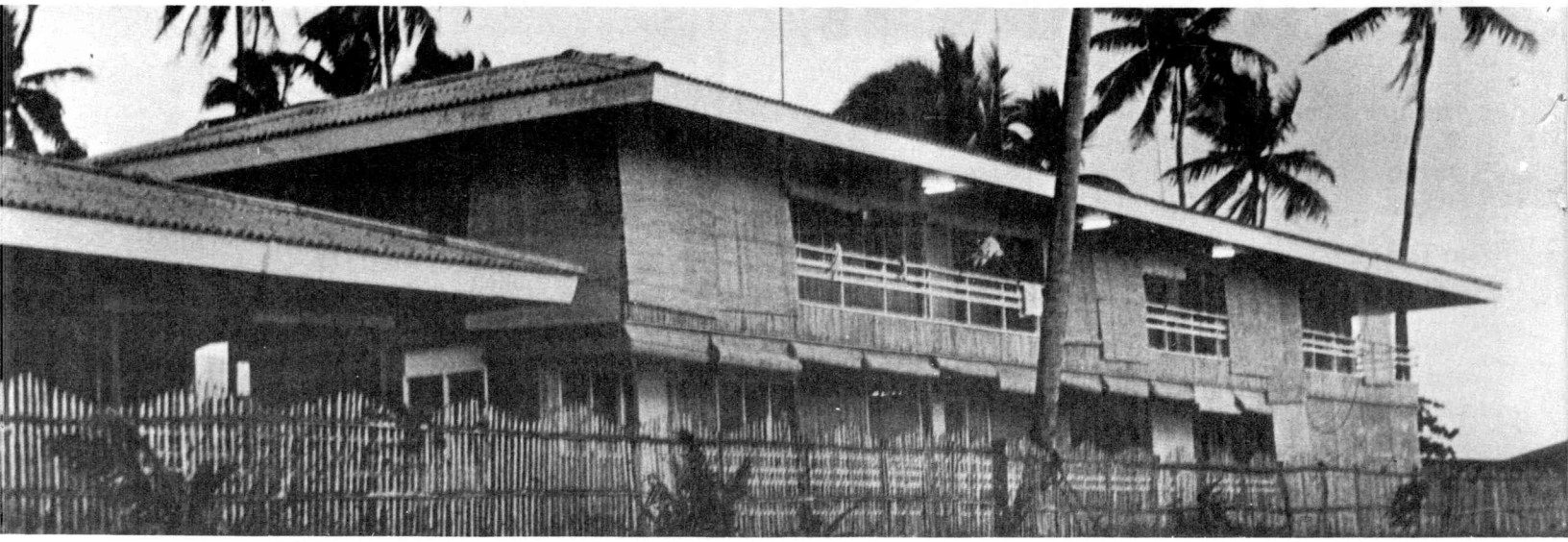
Pandan Station acquired more units of canvas tanks for sabalo experiments. Expansion included research and supportive facilities, other canvas-holding tanks, and a lagoon where the sabalo were stocked and copepods were cultured.

Batan station on its part completed its eight maturation pens. Meanwhile, the Aquaculture Department launched its Lake Naujan Sabalo Hatchery Project in Mindoro Oriental which occupied a total area of 6.8 has. Infrastructure and facilities included six nursery ponds, six experimental rearing ponds, and one office-laboratory building, three concrete hatchery tanks, one portable generator and one service jeep.

The Zamboanga Outreach Station was established this year to serve as a demonstration site for the farming of finfishes and shellfishes. The particular site to be developed would be the Atoll Lagoon in Sta. Cruz Pequeno Island.



Apartments for trainees, Tigbauan Main Station



Dormitory for research staff, Pandan Milkfish Research Station

Leganes Station and Experimental Pond System

ORGANIZATIONAL DEVELOPMENT

Flexibility and adjustibility characterized the organizational development of the Aquaculture Department. For 1977 the top leadership demonstrated its capability to chart new and innovative directions and channel limited manpower resources into productive inputs.

Thus, for 1977, the following organizational developments took place:

- In August 1977, a Director was appointed to head the Research Division. Among his responsibilities were to plan, develop, implement and evaluate all research activities; and to properly coordinate with the Development and Administrative Services Division to make certain that adequate supportive services would be provided in the conduct of research activities.
- A Research Council was organized in November 1977. This Council, composed of the Chief of the Department as Chairman, the Deputy Chief as Co-Chairman, the Executive Director as Vice-Chairman, and the Director for Research as the Executive Secretary, determines the internal research priorities of the Aquaculture Department.
- In its Tenth Meeting in Manila on December 5-9, 1977, the SEAFDEC Council Directors appointed Dr. Noboru Hoshino as Deputy Chief of the Aquaculture Department. Dr. Hoshino has worked with the Aquaculture Department since 1974 as a fisheries expert. He is the second Deputy Chief, the first one being Mr. Tatsuo Kawachi who served from October 1975-September 1977. As Deputy Chief, Dr. Hoshino assists the Chief in the management of the Department and acts in his behalf during the Chief's absence.
- From October to December 1977, the move to establish an Asian Institute of Aquaculture gained momentum. By 1978, changes in the organization of the Aquaculture Department would be effected with the absorption of the Training and Extension Division together with other programs into the AIA framework.

Reflecting the overall performance of the Aquaculture Department for 1977 were the staff and rank-and-file highly qualified men and women possessed of skills and capabilities within their lines of specialization. As of December 1977, there was an aggregate manpower strength of 650 recruited from various institutions of learning throughout the country. Of these, 350 were in the Research Division; 209 in the Development and Administrative Services Division; 37 in the External Affairs Division; 30 in the Training and Extension Division; and 25 in the Business Affairs Division.

Together, they constituted the human inputs of the organization of the Aquaculture Department. To develop and improve the effectivity of its human resources, the Aquaculture Department continued its Staff Development Program. For 1977, nine foreign and 39 local scholarships were therefore awarded; 18 went on short-term training or observation study grants; and a number of its experts participated in workshops, seminars and conferences. The 39 local scholarships were either made available through joint sponsorship with the Department of Natural Resources (DNR), BFAR, and the Philippine Council for Agriculture and Resources Research (PCARR) or through the regular staff development scholarship grant. The short-term training and observation tours afforded its recipients opportunities to keep abreast with the latest in trends and techniques in their own specialization.

Contributing to the efficiency of its employees were the various regular employment/personnel benefits and incentives given, an integral feature of the policy of the Aquaculture Department to offer the best possible work environment for its employees.

Signing the Memorandum of Agreement between UP Los Baños and SEAFDEC Aquaculture Department

Chinese delegates being briefed on prawn research project

INSTITUTIONAL LINKAGES

In 1977, the Aquaculture Department established new linkages with various national and international agencies/organizations in the effort to enlist the assistance and support of institutional resources in the region and other parts of the world;

International

SEAFDEC-ICAR. The Aquaculture Department and the Indian Council for Agricultural Research signed a Memorandum o Agreement to promote and accelerate the progress of research and training the the scientific cultivation of aquaculture and fisheries, including the possibility of integrating agricultural techniques and products in the development of coastal as well as inland fishing rural populations. A follow-up meeting took place in New Delhi from November 8-17, 1977 to finalize the annual work plan of the program.

SEAFDEC-CIDA. The Canadian International Development Agency was still evaluating the Aquaculture Department's proposal on the Integrated Fisheries Development Program. A CIDA project team would be sent in January 1978 to gather more data on this project.

SEAFDEC-TAC/CGIAR. The Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), a consortium of the world's largest development institutions, with IDRC initial support, planned to send a Study Team to determine and assess the Aquaculture Department's research capabilities and needs for possible support. This signified eventual recognition of the Department's stature as an international aquaculture organization. Dr. Q. F. Miravite, Executive Director; and Mrs. Z. Balangue, Executive Officer, went to London in October to finalize arrangements in creating the international committee to start the work evaluation.

SEAFDEC-ODM. The Ministry of Overseas Development of the United Kingdom expressed its willingness to finance the services of British expatriate scientists for two years to assist the Aquaculture Department in the shrimp and prawn culture research at the Leganes station of the Aquaculture Department. Projects related to this ODM support would include:

- pond preparation studies
- water quality control studies and its effects on pond management procedures
- feed preferences of species

The ODM will also provide scholarship grants in the UK for the Department's research staff.

SEAFDEC-DANIDA. The Danish International Development Agency would be sending two experts to assist in the development of the Freshwater Aquaculture Station in Binangonan, Rizal and also provide short-term training grants for two of Aquaculture Department's research staff. DANIDA would also help in the establishment of a workshop for the fabrication of laboratory equipment.

SEAFDEC-ADC. The Agricultural Development Council and the Department have effected tie-ups on the conduct of research on mangroves and swamps. In November 1977, the ADC and the Aquaculture Department jointly sponsored the Conference among the members of the Agricultural Economics Society of Southeast Asia.

National

SEAFDEC-DAP. The tie-up was effected through the Aquaculture Technology Resources Management Program (See ***Special Projects***).

SEAFDEC-UPLB Freshwater Aquatic Resources Development Program: The Aquaculture Department and the University of the Philippines at Los Baños would be conducting joint projects for the development of freshwater aquatic resources and enhance the viability and productivity of freshwater in the country initially focusing on Laguna de Bay. Both institutions would pool their manpower resources and facilities to conduct research, training courses, and socio-economic studies in freshwater aquatic resources development.

The construction of a lake ecosystem model in Laguna de Bay would be part of its program.

SEAFDEC-LLDA: The Aquaculture Department and the Laguna Lake Development Authority negotiated possible tie-ups on:

- water quality management and lake ecosystem studies
- fishpen productivity in Laguna de Bay
- large-scale farming of species

The objective was to conserve, develop and optimize the utilization of the lake's resources, particularly fishery resources.

SEAFDEC-SEARCA-BFAR Integrated Fisheries Community Development Program (See ***Special Projects).***

Analytical Laboratory, Freshwater Fisheries Station, Tapao Point, Binangonan, Rizal

FUNDING SUPPORT

Through various sources of funding, the Aquaculture Department was able to sustain its existing programs and projects and evolve new ones.

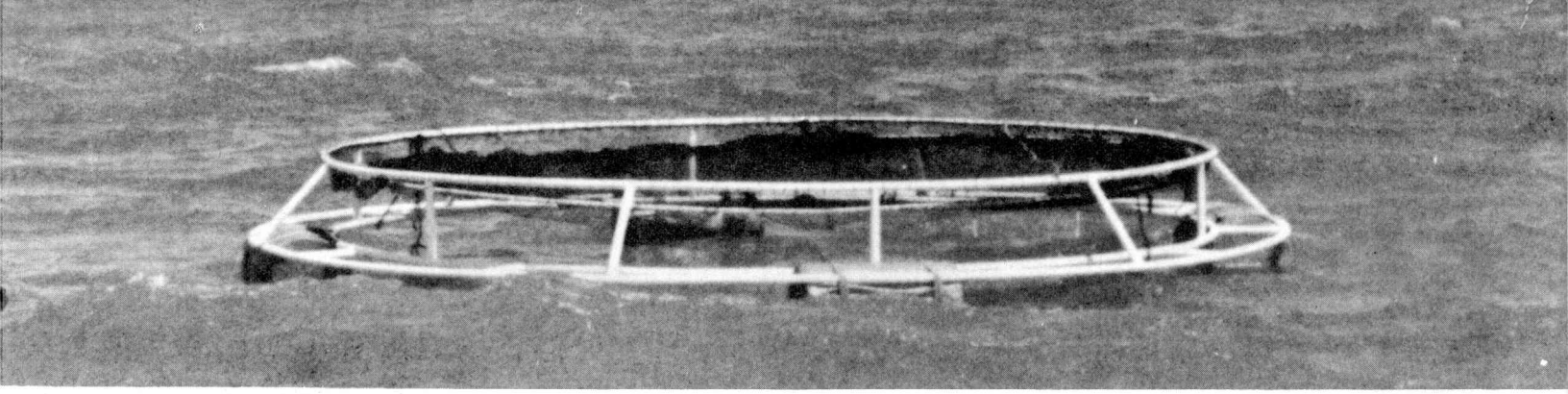
The Philippine Government contributed the biggest share. For CY 1977, it contributed a total of ₱55M. Of this total, ₱49M came from BFAR and the balance of P6M was shared by the DNR. Of total funds received, ₱30M was earmarked for Operating Expenses while ₱25M was allocated to finance Capital Expenditures such as laboratory buildings, hatcheries, equipment and other ongoing projects of the Aquaculture Department. BFAR contributed ₱24M and DNR was committed to release ₱6M for the Operating Expenses allocation. Total outlay for Capital Expenditures came solely from BFAR. As against the total of ₱31.5M Philippine Government contribution in 1976, the 1977 contribution represented an increase of 75 percent over the 1976 figure.

From the Japanese Government, the Aquaculture Department received laboratory and other equipment amounting to approximately ₱3.5M coming from a 1976 Grant as well as the unexpended Grant balance from 1975. Equipment from Japan for its 1977 Grant amounting to about ₱2.0M had already been ordered and expected to be received by the end of the year. Also funded by the Japanese Government were the services of eight Japanese experts including the Deputy Chief. The sum of ₱0.35M representing Japanese contribution for 1977 had been received to fund the training programs of the Aquaculture Department. A request for short-term training grants for SEAFDEC staff members for training in Japan was approved and the trainees had undergone the program. The amount of ₱3.0M representing part of the proceeds of the fifth Japanese rice donation to the Philippines was likewise approved.

The International Development Research Centre (IDRC) released its second year allocation to the Aquaculture Department in the amount of Cdn$205,000 for the support of the milkfish research project thereby increasing its funding support to $465,000. Another Cdn$110,000 representing a portion of the third year grant was expected to be remitted by IDRC in December as part of an original Cdn$826,000 grant allocated to the project for a three-year period.

The New Zealand Government advised the Aquaculture Department that it had approved a grant of $150,000 for the support of the Aquaculture Department's Mussel research and Oyster project, as well as related studies on low-cost seafarming.

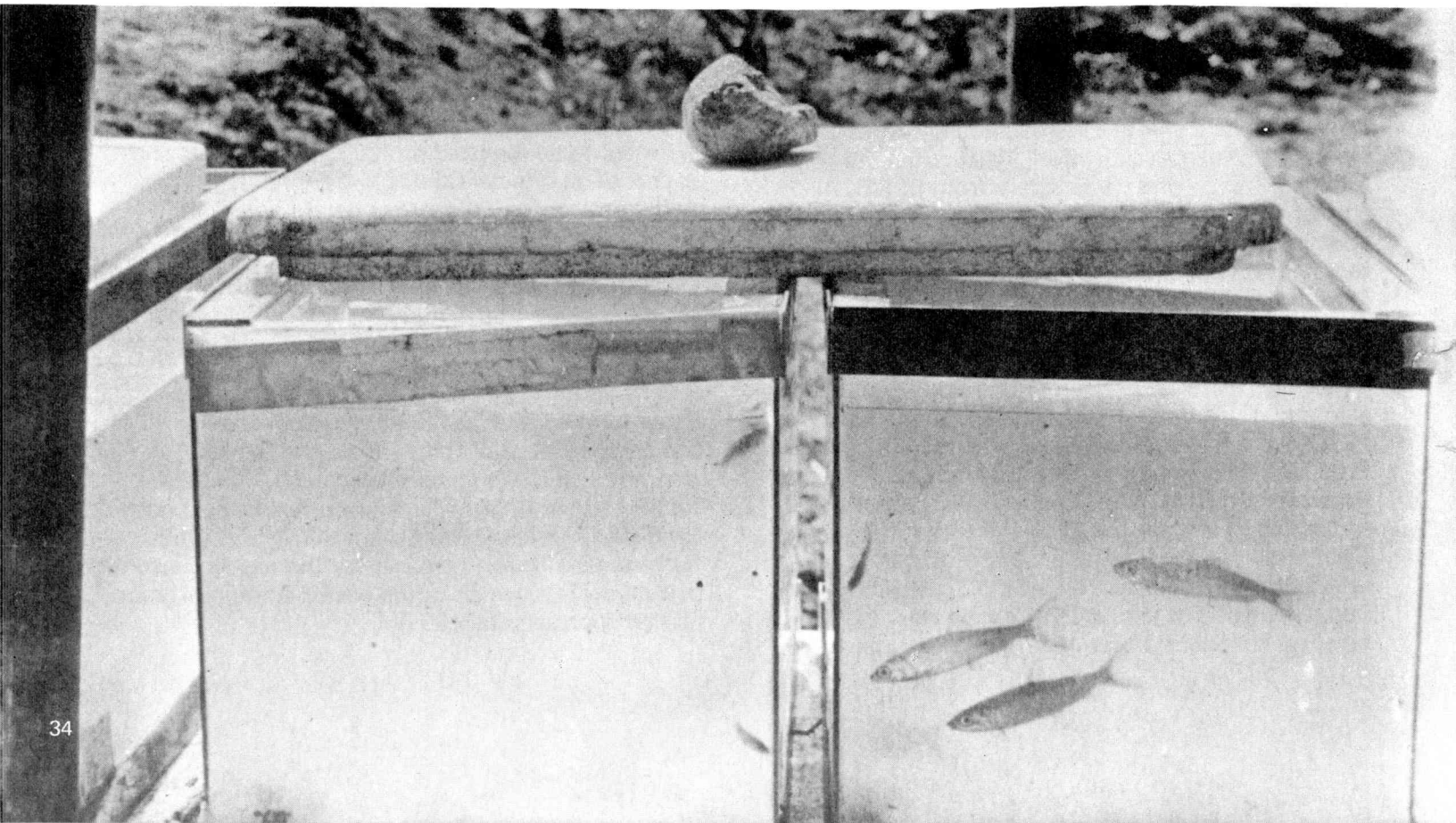
Other funding sources hoped to materialize for 1977 and early 1978 would come from the Danish International Development Agency (DANIDA) for support to the Freshwater Aquaculture Project and from the Overseas Development Ministry (ODM) for services of foreign experts for the Leganes prawn culture project, which would have a combined grant cost of approximately $0.5M.



Floating cage for sabalo and other finfish broodstock

Preparation of ponds prior to stocking

Test for tolerance of milkfish and prawns to pesticides including tobacco dust and derris



PROSPECTS

Thus, with the achievements of CY 1977, the Aquaculture Department faces the succeeding year, 1978, with increased optimism and confidence.

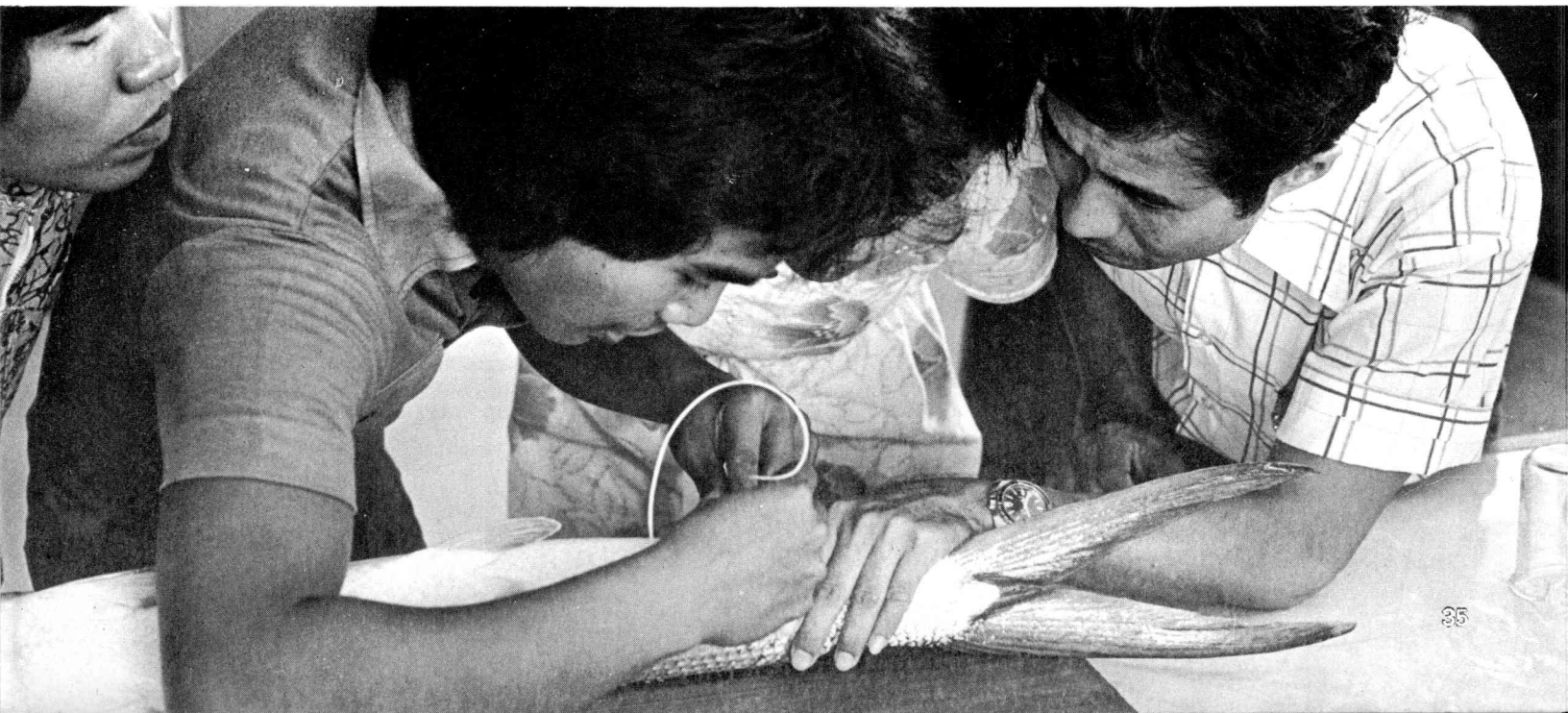
Certainly, the store of research knowledge it has accumulated puts the Aquaculture Department in the forefront of science and sustains itself as the leading institution for aquaculture not only in Southeast Asia but in all the world. Research efforts continue making advances despite the limitations of material and human resources.

For one, there is yet no adequate technical expertise to accelerate research in aquaculture. In time, however, these limitations will be handled with the assistance and cooperation of research and development agencies.

Among the factors contributing to the growth of the institution are the creation of the Asian Institute of Aquaculture and the nearby completion of the Nutrition and Feeds Laboratory Building. The operationalization of the AIA in mid-1978 make the Aquaculture Department a body with a truly regional character. The Nutrition and Feeds Laboratory on its part would accelerate research in the Aquaculture Department.

And as research studies, training programs, extension activities, and special projects intensify, the Aquaculture Department indeed braces up for 1978 and the year beyond ready for deep involvement in the national and global struggle to solve the food problem in Southeast Asia and the world.

Sexing the adult milkfish (sabalo)



TECHNICAL EXPERTISE ASSISTANCE

1. DR. NORMAN WILIMOVSKY - Assisted the Department in preparing the framework and other requirements for the International Fisheries Research Management Workshop in Baguio City, December 11-17, 1977. Wilimovsky is Professor, Institute of Animal Resource Ecology, University of British Columbia

2. DR. ARTHUR VESPRY, MS. MARGOT SCHENK and MS. BARBARA BIRD - Consultants in the development of the Department's library and information systems. Vespry is Information Scientist, IDRC, Singapore; Schenk is Librarian, Fisheries and Environment Maritime Regional Library, Department of Fisheries and Environment, Nova Scotia, Canada ; and Bird is Information Specialist, Hamilton Library, University of Hawaii.

3. DR. KATSUZO KURONUMA - Evaluated the programs and progress of the Department for expanded funding support from the Japanese Government.

4. DR. PATRICK SORGELOOS and MR. ETIENNE BOSSUYT - Consultants on brine shrimp (*Artemia salina*) research from the University of Ghent, Laboratory for Biological Research of Environmental Pollution, Belgium.

5. DR. JUICHI KATOH - Consultant on Fishpond Engineering Studies and Professor of the Laboratory of Environmental Hydraulic Engineering , Tokyo University of Fisheries. He was the main resource person during the recently completed Fishpond Engineering Training Program conducted in Tigbauan, Iloilo from October 30 to November 24, 1977.

6. DR. TETSUSHI SENTA - Conducted ecological studies around Panay. Senta is Professor, Faculty of Fisheries, Nagasaki University.

7. DR. W. S. HOAR - Evaluated the research programs of the Department particularly on prawn and milkfish culture. Hoar is Professor of Zoology, University of British Columbia.

Feeding the Penaeus monodon broodstock inside the wet laboratory

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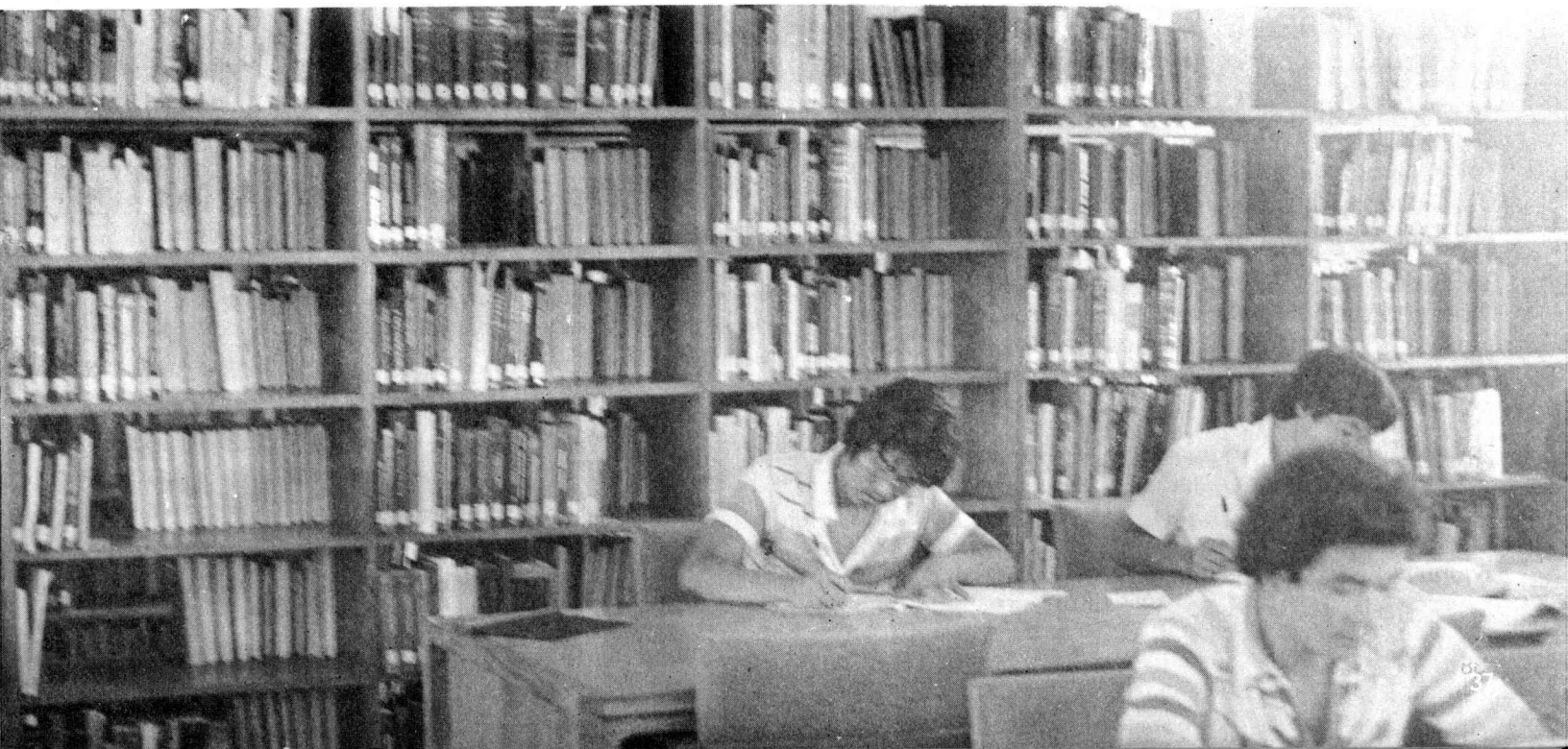
Library at the Main Station services researchers and graduate students



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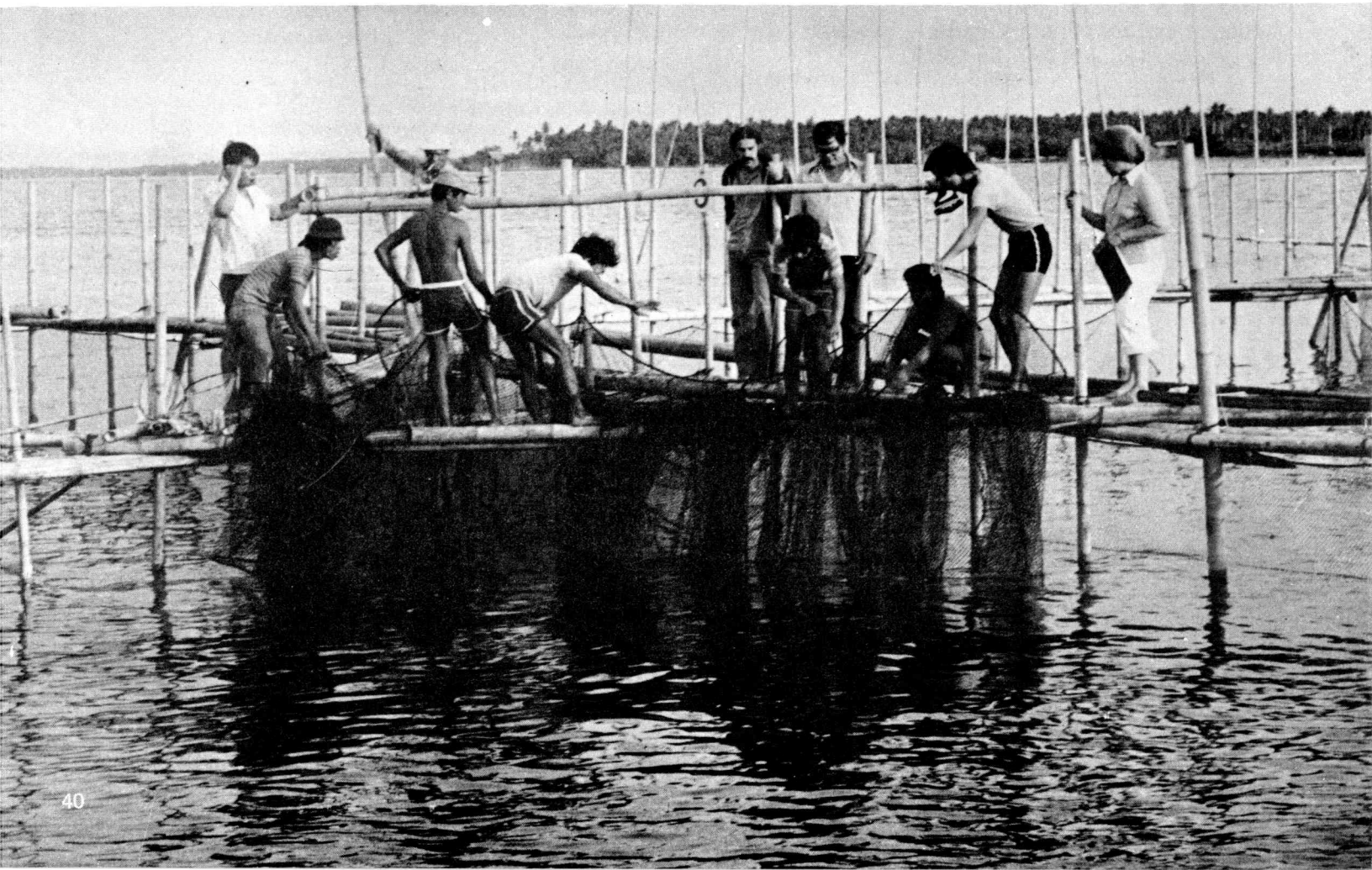
Sampling Penaeus monodon spawners in maturation pens, Batan, Aklan



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AQUACULTURE DEPARTMENT

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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