AQUACULTURE DEPARTMENT

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

TIGBAUAN, ILOILO, PHILIPPINES

1975 ANNUAL REPORT

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The main station at Tigbauan, Iloilo is conveniently located near the sea.

1975 IN REVIEW

Research Activities

As we look back to 1975, we face our third year with greater confidence. Out of a languid barrio we have indelibly carved an aquaculture research complex on a scale that has never before been attempted. Aquaculture requires bold steps if it is to catch up with the great strides already achieved on land by agriculture. We cannot forever depend primarily on hunting for our aquatic resources.

We began with the prawns — a luxury species here and abroad and consequently, a potential dollar-earning cash crop. We are now studying the milkfish — the most widely-cultured and the most important brackishwater fish in Southeast Asia. We have also started a research on mussels — potentially the most productive protein-producer. Thus we move along parallel tracks towards our twin target: food and foreign exchange from aquatic resources.

We are on the verge of eliminating the major constraint in our prawn fry production — the lack of spawners. With the completion of the life cycle of the prawn and the rematuration of spent spawners in captivity on an experimental scale, we can now develop a captive brood stock on a mass scale.

Our hatchery is still saddled with problems. With our multidisciplinary team working on various aspects of prawn fry survival, we hope to improve our production to achieve a consistently high harvest rate.

We have launched a major effort to fully domesticate the milkfish. Our milkfish laboratory complex in Pandan, Antique could be ranked as one of the largest single set-up devoted to the study of one particular species of fish.

The social aspect of aquaculture is given no less attention. In a joint project with PCARR, we have launched an exhaustive survey of the socio-economics of aquaculture to cover the whole Philippines and all phases of aquaculture as it touches the people — the ultimate beneficiary of all our efforts.

In all our undertakings the thrust is towards production and the approach is multidisciplinary team effort. Expatriate scientists from Japan, Canada, New Zealand work side by side with Filipino scientists, learning from each other, and sharing a common vision.

Training and Extension

Technology is shared as it is acquired on a continuous basis with our training and extension program. Extension workers from BFAR, fishpond operators and technicians attend sessions consisting of lectures and actual demonstrations by our researchers. Private fishpond operators are involved in production research with fry supplied by our hatchery. We are expanding our training program to include participants from other member countries.

Project Site Development

The inauguration of the main facilities at Tigbauan consisting of a production hatchery, laboratories, dormitory and cafeteria in April 1975 was followed soon after with the construction of support facilities. Scheduled for completion by mid-1976 is an administration building, apartment building, library and training complex and several staff houses. We are also developing our water, sewer, and power system.

In Leganes, pond development is in progress. A field research laboratory building, a utility building, and duplex living quarters are being constructed.

The milkfish research station at Pandan, Antique consisting of laboratories, a dormitory, two guest houses and a series of canvas tanks was completed in less than two months in November 1975.

Temporary laboratory and physical facilities were set up at Igang for the gonadal maturation of prawns. We also finalized plans for a freshwater station at Tapao Point, Binangonan, Rizal within Laguna de Bay.

Laboratories and Library

Our research capability was boosted with the arrival of sophisticated instruments from the Japanese government such as an amino acid analyzer, an atomic absorption spectrophotometer and a gas chromatograph; and by the acquisition of important journals and books in fisheries, marine science and allied fields.

Staff Recruitment and Development

Major appointments in the research staff made during the year covered the following areas of specialization: oceanography, microbiology, ecology, nutrition, microtechnique, sanitary engineering and mathematics. Key administrative positions were also filled up.

As part of our continuing program to upgrade our personnel, we sent ten of our research staff abroad for advanced training or graduate degrees in such fields as fisheries statistics, chemical oceanography, hatchery operations and Macrobrachium culture. We also organized a supervisory training for executive leadership, a trainors' training seminar, and a seminar on scientific writing as part of an in-service training program.

Linkages

To strengthen our ties with national agencies concerned with fisheries development, we participated in various conferences such as the First PCARR Fisheries Congress, the 11th Annual Convention of the Fishpond Association of the Philippines and the Consortium's Meeting of the Inland Fisheries Program.

In July, 1975, we organized the National Bangos Symposium in cooperation with BFAR, PCARR and UPCF. The symposium was attended by 200 participants from various government, private and international institutions involved in fisheries.

We sent delegates to the 13th Pacific Science Congress at Vancouver, Canada in August 1975. After the congress our representatives proceeded to the United States and Europe to conduct exploratory negotiations for external support to the Department.

Funding

In 1975 total funds received as outright grants amounted to $5.6 million, an increase of 80% over the previous year. Of this, 70% came from the Philippine government. The rest came from the governments of Japan, Australia, New Zealand, Singapore, Thailand and the IDRC of Canada. By year's end we have an accumulated fund balance amounting to $3.1 million and total assets of $5.9 million.

Secondary gate at Leganes fishpond.

Participants to National Bangos Symposium prepare to work on problems on harvesting, handling, marketing and transporting.

The jumbo tiger prawn, Penaeus monodon.

DOMESTICATION OF *Penaeus monodon*

Development of *Penaeus monodon* Brood Stock

In Southeast Asia, particularly the Philippines, the sugpo, P. *monodon*, is considered one of the penaeid species most suitable for commercial culture. Relatively eurythermal and euryhaline, it grows to a size larger than any other penaeid species. *P. monodon* fry used for stocking in ponds are traditionally collected along estuarine coasts using hand nets. Limited and unpredictable fry supply constitutes a major constraint to expansion and development of the sugpo industry.

The full-scale cultivation of *P. monodon* can be realized if a continuous supply of fry, which is largely dependent on the availability of spawners, is assured. In the islands of Panay and Negros, spawners are normally gathered from fish traps and otter trawls and purchased at ₱5.00 each. Aside from being expensive, collection from the natural habitat is adversely affected by bad weather conditions and other uncontrollable factors. The main problem of our Tigbauan hatchery is how to secure an adequate supply of spawners.

In December 1975, after 2 1/2 years of study, we at the SEAFDEC Aquaculture Department succeeded in inducing *P. monodon* to mature and producing the first generation of postlarval fry following standard hatchery procedures. This major achievement is the first recorded completion of the life cycle of *P. monodon* in captivity.

Shortly thereafter, we also succeeded in inducing ovarian rematuration of spent spawners from the hatchery. Our success in inducing gonadal maturation and rematuration will eventually solve two major problems in prawn culture: 1) the high cost of obtaining gravid females in natural fishing grounds; 2) dependence on seasonal periodicity of gonadal maturation of wild female stock.

Completion of Life Cycle of *P. monodon* in Captivity

Inducing Maturation

The success in completing the life cycles of other commercially important penaeids using eyestalk ablation techniques in various parts of the world provided the stimulus for this study. Ovarian maturation does not usually occur when these prawns are kept in captivity. In contrast, testicular development proceeds normally even without ablation.

Crustacean eyestalks are known to contain the storage and distribution centers of the gonad and molt-inhibiting hormones. Published works to date have shown that eyestalk removal is likely to produce either precocious molting or precocious gonad development depending on the relative interactions of other ambient environmental factors and the age of experimental animal. More recent commercial applications of the technique have shown that the removal of only one eyestalk, rather than both, is sufficient to initiate gonadal development while reducing mortality and impairment of normal behavioral responses for feeding and mating. Moreover, suppression of gonadal responses to light and photoperiod is minimized.

All previous attempts to complete the life cycle of *P. monodon* as far as we know, have failed, resulting in the subsequent spawning of unfertilized or non-viable eggs.

Source of Experimental Animals

In our study, we used *P. monodon* 25-day post larvae (P_{25}) produced in the hatchery of the Mindanao State University Institute of Fisheries Research and Development (MSU-IFRD) at Naawan, Misamis Oriental. We transported these to the ponds at Leganes where they were stocked and reared for five months. Immediately thereafter, 1500 specimens with average weight of 16.4 g were transported to our experimental prawn maturation pens at Igang for further observation under fully marine conditions.

Initially, we utilized only 3 of the 12 compartments. We stocked a group of 500 5-month old shrimps in each of the 3 compartments. In 10 months we rotated the 3 groups on adjacent pens except on two successive occasions when we did bimonthly transfers because of extensive algal fouling.

When the shrimps reached the age of 15 months, 600 were selected for the experiment commencing April 1975. They were classified into three groups, each consisting of 100 females and 100 males. Females in two of the groups were subjected to bilateral ablation and unilateral ablation, respectively. The third group of animals served as control. Males were left unablated as spermatogenesis has been previously observed to continue even when animals were held in captivity. We separated the three groups from each other since earlier trials in which they were mixed resulted in the mortality of bilaterally ablated animals. We believe this was due to cannibalism by normal unablated shrimps. Rotation between pens continued as before.

Feeding

The amount of feed we used for each group was placed at about 10% of total body weight of standing stock. The feeding schedule was set once daily in the afternoon. The pattern of feeding by kinds of feed depended on the availability of materials used. The feeds used in the order of their availability include: (1) Mussels, *Modiolus metcalfei;* (2) Alamang, *Ascetes* sp.; (3) Toad, *Bufo marinus;* and (4) Trash fish. The trash fish consisted of immature species of fish represented by the following families: *Leiognathidae, Mullidae, Synodontidae,* etc.

In this study, we made no attempt to compare the acceptability or suitability of each kind of feed used. All of them were apparently consumed by the prawn.

Maturation Pens

The pens were constructed inside Humaraon, a tidal cove of about 2 hectares (Fig. 1). The cove is naturally protected on all sides by extensively weathered coralline rock hills and opens to the outlying waters through two channels stretching 84 m and 82 m, respectively. The depth of water in the mud-bottomed pen area is 4 m at chart datum. The dominant hillside vegetation is ipil-ipil (*Leucae-*

Fig. 1. The prawn maturation pens at SEAFDEC Sea-Farming Station in Igang Bay, Nueva Valencia, Guimaras Island.

na glauca and *Cassia* sp.) and there are considerable stands of the mangrove *Rhizophora mangele* along the shoreline.

The pen system at Igang consists of 12 compartments, each with a surface area of 250 sq m tightly fenced with bamboo slats (Fig. 2). We suspended a double netting bag with 1.5 cm mesh size (stretched) within each pen and buried 20 cm below the muddy substratum. At the center of each compartment we set dried twigs of *Rhizophora* and *Avicennia* for shade and protection from predation and cannibalism.

Environmental Conditions

We collected hydrological data (air and water temperature, total alkalinity, salinity and dissolved oxygen) from within the enclosure (Fig. 3). Secchi disc readings taken at 1000 hours once a week in October 1974 ranged from 4.0 m to 2.5 m with an average of 3.4 m.

Resident planktonic biota within the pens as determined by biweekly tows included an abundance of *Nitzschia sigma, Melosira nummuloides, Navicula* sp. and *Cocconeis splendica.* The dominant filamentous algae were *Oscillatoria* and *Cladophora.* Zooplankton consisted of copepods and ciliates.

Sampling Routine

We sampled 30 animals from each compartment monthly for 8 months for two reasons: 1) to determine the stage of ovarian development defined according to the five maturation stages used by other workers and confirmed to be applicable to *P. monodon;* and 2) to determine increase in body weight, total length and carapace length. All monthly samples were returned to the pens except for some specimen used for spawning experiments or sacrificed for histological studies. Results of the ablation experiment are detailed in Table 1.

Spawning

We carried out the spawning of the 7 stage III and IV females and the hatching of their eggs in 1 m^3 fiberglass tanks filled with sea water. One gravid female was placed in each tank containing two air stones to ensure adequate agitation and aeration for newly spawned eggs. In the morning following spawning, spent females together with detritus were removed from the tanks while the released eggs were examined and counted.

Larval Rearing

The newly hatched nauplii were fed after two days, when all residual yolk had disappeared. Some 40,000 zoea larvae were retained in each of the tanks and fed with cultured *Skeletonema costatum* twice daily at a concentration of approximately 20,000 cells per ml. Mysis stages were given a supplementary diet of bread yeast at the rate of 2 gm per day and rotifers at 30 cells per ml. A further food supplement of minced tuna meat was fed daily to the postlarvae between the first and 15th day at a daily rate of 10% of their estimated total body weight. During the rearing of postlarvae, the tank bottom was occasionally stirred and 20% of the water was replaced each day. All larvae except the progeny of spawner No. 7 (Table 2) were reared outdoors because we thought indoor night temperatures (20 - 25°C) to be much lower for satisfactory feeding and larval growth than the ideal (27°C).

Comparison with Wild Spawner

Hatching rates of 74% and 87% obtained from Stage IV spawners and an average of 42% from Stage III animals as well as the number of eggs laid compare favorably with that of gravid females captured from the sea. Larval survival rate was relatively low in most cases but these mortalities can be attributed almost entirely to specific problems occurring in the hatchery, e. g., infection, dwindling and insufficient larval food supply, etc. The larvae themselves showed no abnormalities under microscopic examination, suggesting complete viability of progeny produced by spawners induced to mature by ablation of one eyestalk.

Fig. 2. Structural detail of the prawn maturation pens.

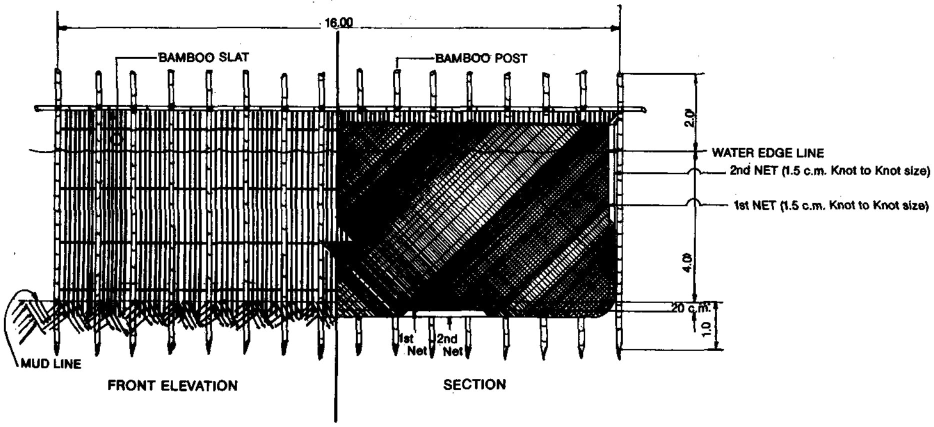
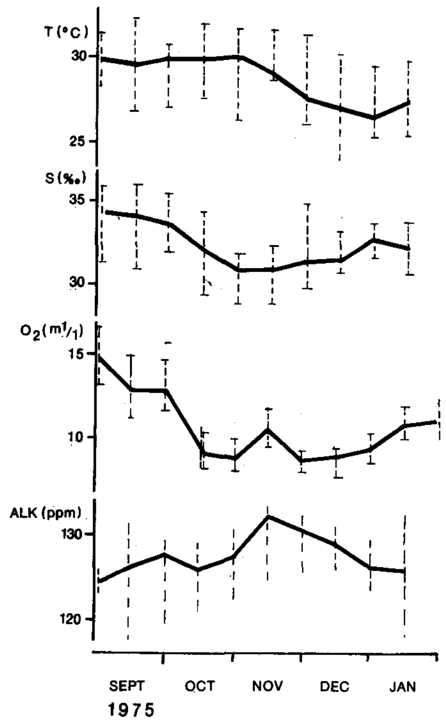


Fig. 3. Hydrological data taken from Igang Bay, Guimaras Island.



The completion of the life cycle of *P. monodon* in captivity is likely to have considerable economic implications for Southeast Asia particularly the Philippines. We plan to continue this experiment and broaden its scope to include mass propagation of spawners under more closely controlled conditions to ensure adequate and continuous supply of fry for the industry. Improved ablation techniques known to reduce mortality and studies to determine the most suitable age during which to ablate pond stock are underway. We have intensified our work on the nutritional requirements during ovarian maturation as well as spermatogenesis. If successful, this project will greatly enhance efforts to intensify mass production of *P. monodon fry* on a massive scale all year round.

Rematuration of Spent Females in Captivity

Available Data on Penaeid Spawning

The number of times an individual prawn could breed during its lifetime is hard to document in nature. But it is generally accepted that although a few crustacean species breed only once, in most species breeding follows a cyclic pattern.

In some cases the number of times an individual penaeid could spawn during its lifetime can be inferred from the size range of spawners caught

Table 1. Survival and maturation of 15-month old hatchery produced *Penaeus monodon* reared in pens at Igang, Guimaras Island.

	Unablated		One Eye Ablated		Two Eyes Ablated	
Date	Stock	Stage-No.	Stock	Stage-No.	Stock	Stage-No.
4-25-75	100	None	100	None	100	None
6-5-75	83	II-1	67	II-3	46	III-1
				III-1		
7-2-75	-	-	61	III-2	40	III-3
8-14-75	68	II-1	55	None	27	II-3
9-17-75	64	II-1	47	II-2	20	III-2
		III-1				
10-16-75	56	II-1	38	II-1	4	None
		IV-1				
11-8-75	49	II-1	38	None	0	-
12-21-75	46	II-3	36	IV-3	-	-
		IV-1				
12-29-75	40	II-3	32	III-3	-	-
1-16-76	39	II-1	27	II-8	-	-
				III-4		

in nature as in *Parapenaeopsis stylifera*. Some penaeids, e.g., *P. setiferus*, are multiple spawners during a single season, with only a few probably surviving to spawn during a second season.

Ovarian rematuration of *P. indicus* in captivity has been accomplished at the MSU-IFRD Hatchery in Naawan, Misamis Oriental.

There is no available record on the number of times *P. monodon* could spawn during its lifetime. However, our preliminary histological examinations of Stages III and IV ovaries of wild spawners indicated the occurrence of previous spawning. The simultaneous presence in the maturing ovary of atretic follicles and a large number of developing oogonia and oocytes are clear indications of previous and forthcoming spawning, respectively. (Fig. 4). This encouraged us to continue our experiment.

Recycling Spent Spawners

Stages III and IV spawners, sorted out from nearby fish traps in Batan, Aklan and Himamaylan, Negros Occidental including those from commercial trawlers plying the area, were transported to our Tigbauan hatchery and allowed to spawn. A total of 189 spent spawners accumulated from August to November 1975 were transported in four batches to our culture pen at Igang. Similarly, a total of 194 males 15 to 25 months old taken from our Leganes ponds was transported in six batches and kept in the same culture pen (Table 3).

The culture pen we used in this study consisted of a rectangular nylon net measuring 15.6 m^2 and 7 m deep with 1.5 cm mesh (stretched). This is attached to a 15.6 m^2 bamboo skeletal framework suspended by 10 air-filled 210-liter oil drums (Fig. 5). The net is held firmly by 3 pieces of # 12 metal anchor, aside from a 15-kg sand bag attached to each of the four bottom corners.

The whole stock was examined three times in a four-month period (October to February) by lifting the whole net primarily to observe any progress in ovarian rematuration, and secondarily to determine the effects of the ablation treatments on survival rates (Table 4).

Three treatments on eyestalk ablation were made on a total of 189 spent spawners. The treatments consisted of (a) control, without ablation; (b) unilateral ablation; and (c) bilateral ablation. Of the 189 spawners used, 40 were ablated unilaterally, 40 bilaterally, and the remaining stock of 109 served as control.

Results

Table 5 shows the results of our observation on the ovarian rematuration of spent *P. monodon* spawners. In the second examination we conducted four months later, 12 of the 91 surviving

Table 2. Spawning record of unilaterally-ablated female *P monodon* reared in captivity.

Spawner No.	Stage of Maturity	Carapace Length (mm)	Body Weight (g)	Count (10^3) Eggs	Nauplii (N)	Zoea (Z)	Mysis (M)	Post-Larva (P)	Remarks
1	IV	65	113	355.0	263.0	248.0	0	0	Complete spawning; died at Z_3.
2	IV	58	90	95.0	77.0	30.0	0	0	Complete spawning; died at Z_3.
3	III	54	110	80.0	32.0	18.5	17.0	6.5	Partial spawning; M_1 infested by nematodes.
4	III	54	108	130.0	76.0	20.0	5.5	0.9	Complete spawning after two days in tank infested by nematodes at M_1.
5	III	69	160	110.0	48.0	15.5	5.0	0.8	Completely spawned after two days; M_1 infested by nematodes.
6	III	54	120	375.0	0	0	0	0	Eggs unfertilized.
7	III	50	100	270.0	170.0	108.0	36.0	(Still being reared)	Mass mortality in two outdoor fiberglass tanks; remaining mysis healthy.

Numerals suffixing N, Z, M, P indicate days surviving in each stage.

females we recovered showed Stage II ovaries. Further observation revealed that 1) all 12 were unilaterally ablated; 2) none of the control showed signs of ovarian development; and 3) all the bilaterally ablated animals perished. Out of 63 surviving control animals, 53 were further ablated unilaterally because of encouraging results observed on the use of this treatment.

We made our third spawner inventory 11 days later and 54 females were recovered. Again, no ovarian development was observed in the four remaining females under the control. Fourteen unilaterally ablated females exhibited ovarian development from Stages II to IV (Table 5). Out of this number, four females developed to Stages III and IV which were kept alive in a 60-liter plastic pail and transported by boat to our Tigbauan hatchery. Unfortunately, two of the females spawned while in transit. The other two spawned completely at our hatchery and produced a total of 600,000 nauplii. Since then they have undergone normal embryonic development.

Conclusion

Our experiment on ovarian rematuration is still going on and our periodic examination of the stock of spent spawners is being carried out more often. It is possible that rematuration and respawning of other prawns could have taken place unnoticed considering that it took only 11 days to transform some of the Stage II females to Stage IV.

These two experiments indicate the significance of unilateral ablation in inducing maturation and rematuration of *P. monodon* in captivity. It also shows the rapid, phenomenal ovarian development from Stage II to Stage IV. In only 11 days, some females of Stage II have developed into Stages III and IV. The experiment further indicates that unilaterally ablated animals compare well with normal ones with regard to survival rate.

Fig. 4. Photomicrograph of a 10µ - section of a Stage III ovary taken from a wild spawner showing 1) atretic follicle; 2) oogonia; 3) oocyte.

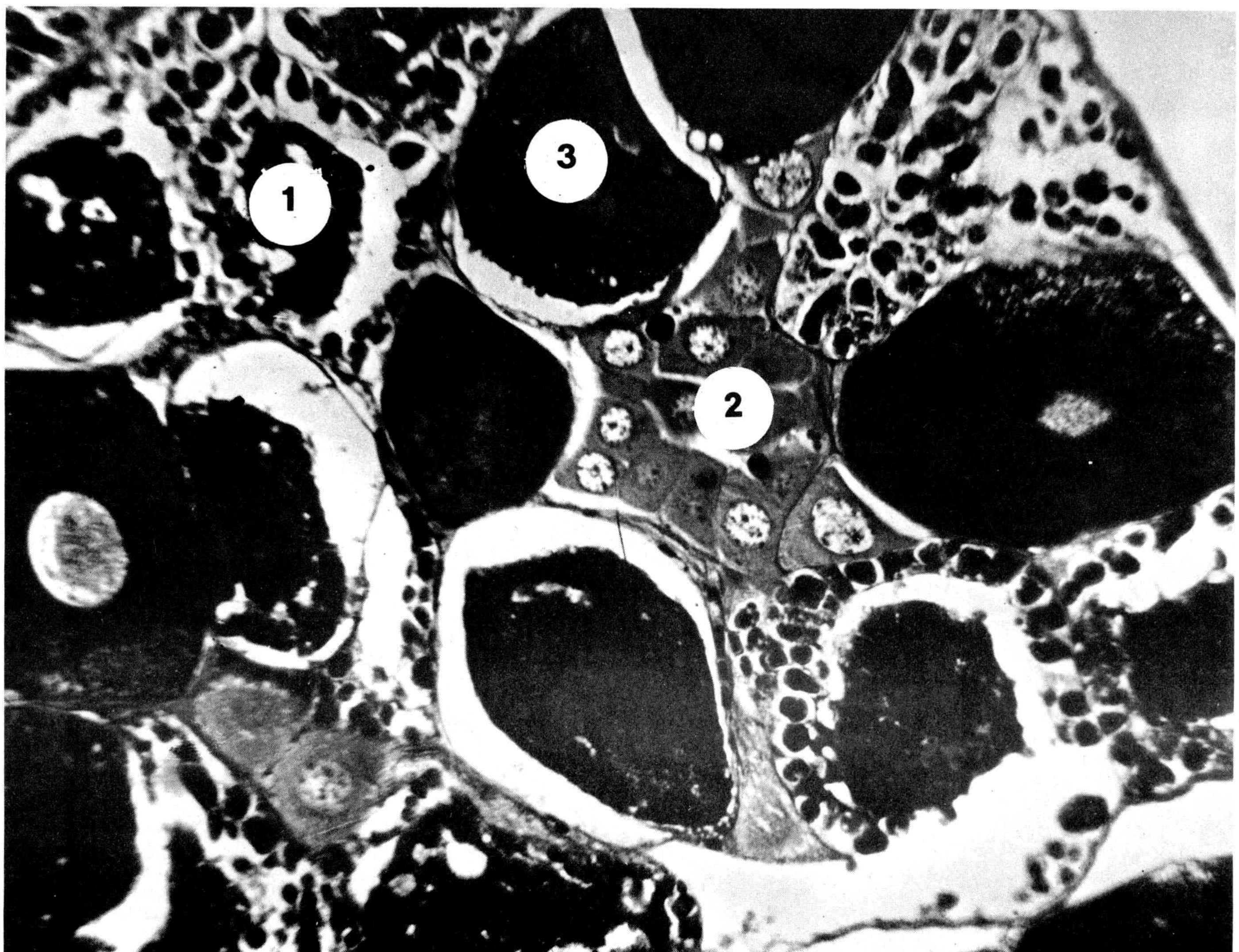


Table 3. Stocking data of *P. monodon* in the maturation pens.

Batch No.	Date Transported	Males	Number Spent Females	Total
1	August 30, 1975	0	1	1
2	September 15, 1975	34	32	66
3	September 16, 1975	45	97	142
4	November 4, 1975	0	59	59
5	January 5, 1976	85	0	85
6	January 31, 1976	30	0	30
	Total Number	194	189	383

Table 4. The survival rates of spent *P. monodon* after eyestalk ablation.

Date of Spawner Inventory	Control			Unilateral Ablation			Bilateral Ablation		Total No. Recovered
	No. added	No.	% Survival	No. added	No.	% Survival	No.	% Survival	
10/26/75	—	34	—	—	40	—	40	—	114
11/4/75	59*	93	—	—	40	—	40	—	173
2/18/76	—	63	68	—	28	70	0	0	
	-53**	10		53**	81				91
2/29/76	—	4	4	—	50	62	—	—	54

*Additional spent spawners stocked

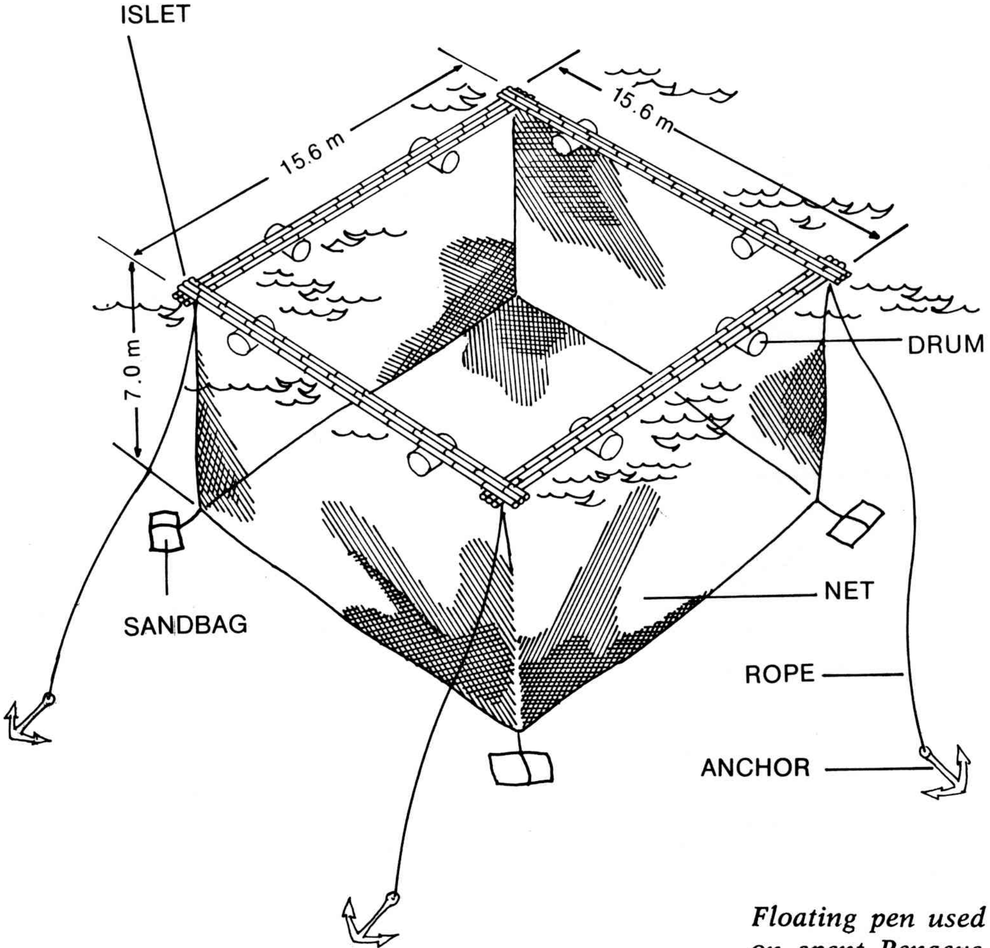
**Under the control, the number of female animals was reduced from 63 to 10 due to encouraging result of gonadal re-maturation development with one eye ablation treatment; 53 animals were ablated unilaterally thereby increasing the number of surviving animals to 81.

Table 5. Survival and ovarian rematuration of spent *P. monodon* spawners after ablation of one eyestalk, Igang Bay, Guimaras Island.

Date	Total No.	Maturity Stage				Control (Unablated) [a]
		II	III	IV	V	
Oct. 26, 1975	114 [b]	0	0	0	40	34
Nov. 4, 1975	91	12	0	0	16.	63 [c]
Feb. 18, 1976	54	10	3	1	36	4 [d]

a. None showed signs of rematuration. b. 40 animals had both eyestalks ablated, all perished. c. 59 more were added on Nov. 4, 1975. d. 53 were ablated unilaterally due to encouraging results shown by experimental animals, the rest died.

Fig. 5 Floating pen of the rematuration of spent spawners *(P. monodon)*



Floating pen used for rematuration experiments on spent Penaeus monodon spawners.

STUDIES ON THE PRAWN

Catching the Wild Spawner

Spawner Survey

The bulk of *P. monodon* spawners used in the hatchery was initially collected only from commercial trawlers by our collectors based in Himamaylan, Negros Occidental and Roxas City in Capiz. The spawners are available from trawlers any time of the year in limited numbers and become more abundant from late April to early June. Prawns normally constitute no more than 5% or 6% by weight of a typical trawler's catch. Of this there might be one or two gravid *P. monodon* and often, none at all.

We found *P. monodon* to be very scarce among the exploratory and commercial catches. Their wild population in the Panay Gulf seems to be unreliable as a source of spawners for the hatchery at the desired quantity. During exploratory trawling on board R/V SEAFDEC II, it took us an average of 1 1/2 hours covering 5 miles to catch one female *P. monodon* and almost 7 hours (about 25 mile-drag) to catch one spawner. *P. monodon* was most frequently captured in offshore areas within 10 to 30 m of water. There is considerable justification for believing that their largest populations are found where there is a large expanse of relatively shallow inshore areas with flat muddy bottom, such as off Himamaylan, Negros Occidental and off Pilar Bay and Sapian Bay on the northern coast of Panay Island.

Recently, we found the bamboo fish corrals (baklad) in Batan Bay and its vicinities to be an excellent source of gravid *P. monodon*. A short survey revealed that while assorted prawn species constitute only an average of 4% by weight of a trawler's catch, they constitute 24.8% of a fish corral's catch. Furthermore, the prawn catch of the baklad is made up of 60% *P. monodon*, 22% *P. indicus*, and 18% other penaeid species.

The gravid females are caught only during the Southwest monsoon from May to August; this suggests a periodic spawning migration to the open sea after growing and maturing in the estuarine area. The sizes of the spawners caught range widely (Table 6), implying either multiple spawning during the lifetime of a female prawn or differential ages at maturity.

Table 6. Size-ranges of mature female prawns from Batan Bay, Panay Island.

	P. monodon	P. semisulcatus	M. ensis
Carapace length (mm)	57-76	31-54	27-40
Body length (mm)	195-248	137-176	120-134
Body weight (gm)	120-220	18-41	18-41

The Batan Bay-Banga Bay system appears to be the most productive area for penaeids including *P. monodon*, (Fig. 6). The presence of large expanses of shallow inshore waters with rich marginal vegetations is very much favorable as a nursery ground for the penaeid juveniles.

The topography of the Bay entrance is also a very important feature. Its narrow width of 1,450 m concentrates the prawn going out offshore and its depth of 9-13 m extending 4 km offshore and 6 km into the entrance of inner Banga Bay very much favors the commencement of gonadal maturation.

We believe it is highly advisable to introduce a gill net fishery in the Batan Bay system to collect as many spawners as possible. At present, the main fishing gears to catch sugpo spawners in the area are the fish corrals and filter nets, all of which are effective only during spring tides. On the other hand it will be inadvisable to use the gill net during spring tides since it is likely to be fouled up by debris. Thus the gill net can be alternated with the fish corrals and filter nets to capture spawners under all tidal conditions.

Even if the catch of wild spawners is stepped up, it will still be inadequate to supply the hatchery. It is necessary to improve and expand the rearing facilities at Igang Station to mass produce *P. monodon* spawners. Igang Bay is very well sheltered. The occurrence of oceanic water close to shore as indicated by the presence of *euphasiids* makes the place very suitable for gonadal maturation.

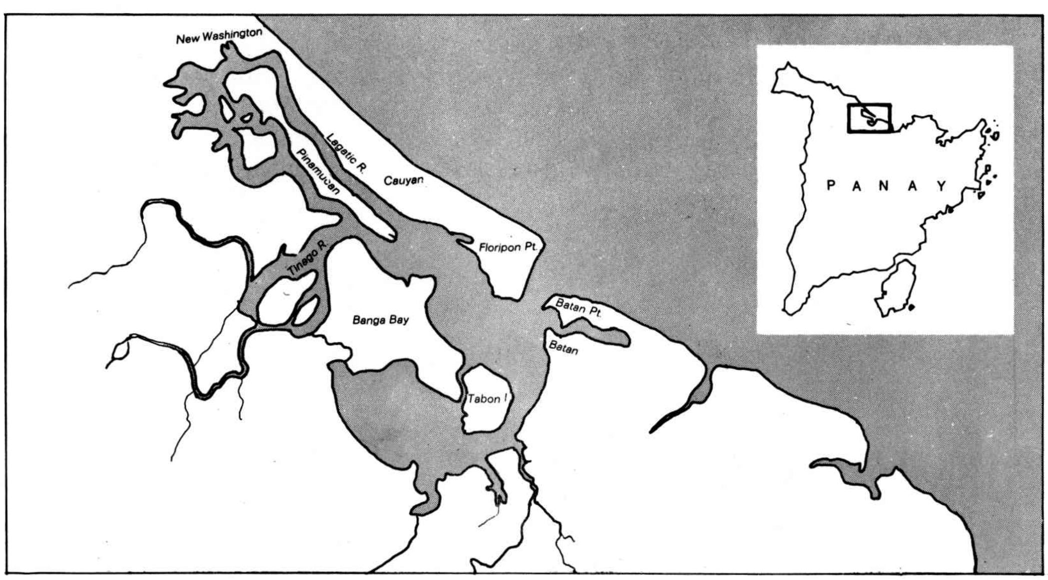
Spawner Collection and Transport

The transport of spawners from the collection points to the Tigbauan hatchery is now a routinary procedure. Gravid females are sorted immediately after the catch is hauled in. Gonadal stage is determined by viewing the animal against a strong light with the dorsal side towards the observer. The ovary appears as a dark mass with the shape varying according to the stage of maturity (Fig. 7). We do not include weak or injured spawners because they usually spawn in transit, produce very few viable eggs, or do not spawn at all.

Two procedures are used in transporting the spawners to the Tigbauan hatchery. For overland transport, a 300-liter PVC tank with a portable aerator is used. This method is used for transporting spawners from Roxas City, 155 km away from Tigbauan, as well as for spawners collected from Batan Bay and vicinities. We have successfully transported as many as 50 spawners at one time.

Spawners from the Himamaylan station in Negros Occidental are shipped via inter-island vessels from Bacolod City inside plastic bags with approximately 10 liters of seawater chilled to 9°C, inflated with medical oxygen and sealed with rubber bands. The plastic bags which can contain as many as three spawners are packed inside styrofoam boxes with ice packs to maintain low temperature. Clipping the rostrum to prevent puncturing the plastic bag and the telson to keep move-

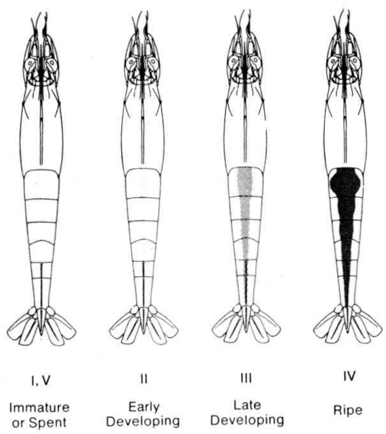
Fig. 6. The Batan Bay - Banga Bay system, in Aklan, Panay Island.



ment to a minimum used to be the standard operating procedures. This has since been replaced with the less stressful method of restraining the animal in a cocoon of nylon mosquito netting material. Transport time from the collection points to the Tigbauan hatchery is never more than five hours.

Upon reaching the hatchery, the chilled bag of spawners is allowed to equilibrate with the ambient temperature in the hatchery by floating it in the spawning tank. Only then are the spawners released.

Fig. 7. The appearance of the ovarian mass at the different stages of maturity of *P. monodon*



Mass Seed Production

The Hatchery

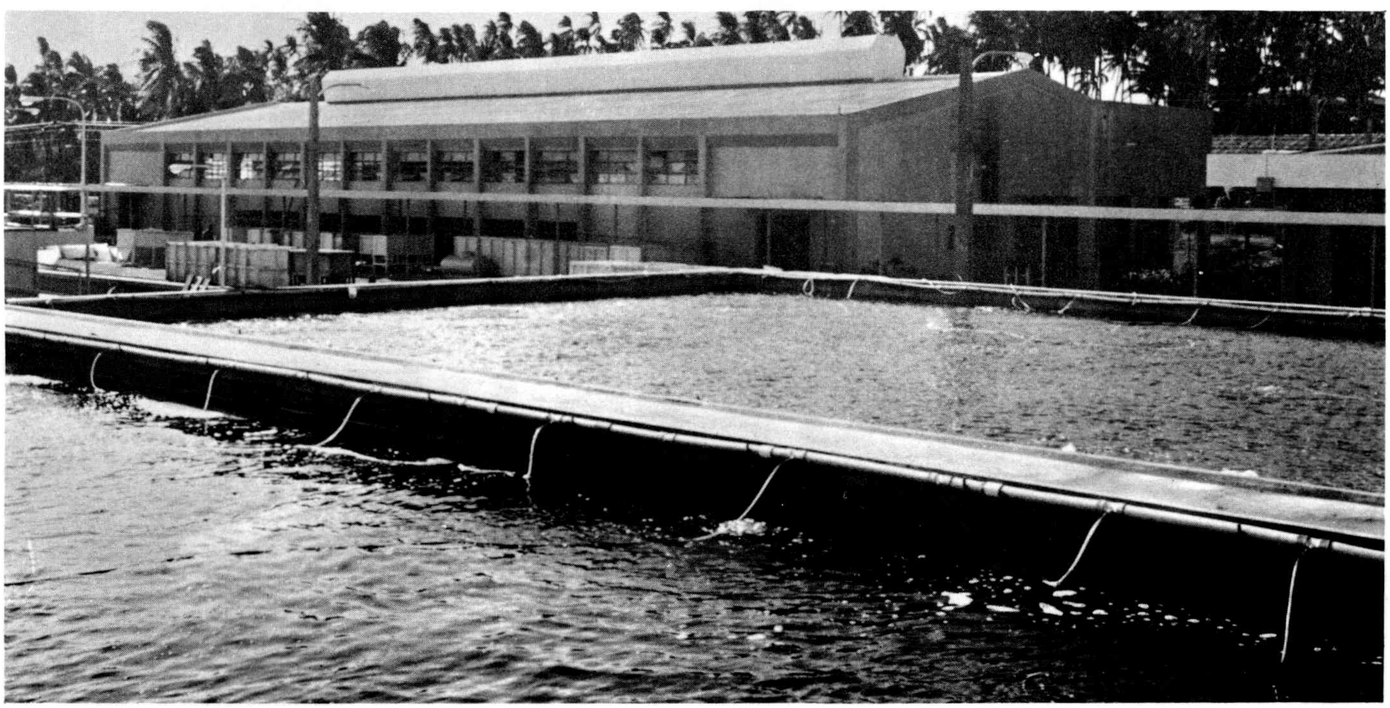
The hatchery consists of six 50-ton and six 120-ton concrete tanks inside a coralex-roofed building as well as four open-air 200-ton tanks. All the tanks are equipped with aeration pipes, fresh and sea water system, and a harvesting pit.

When in full production the hatchery is capable of producing as much as 100 million fry a year. From May to September, 1975 we produced only 2.2 million fry (Table 7). Low production is due to several factors, e.g. lack of spawners, diseases, water quality and feeding. The activities in the Tigbauan laboratories are concentrated along these lines.

Conditioning of New Tanks

The 50 and 120-ton tanks were completed late January 1975. On February 6, 1975 conditioning operations to detoxify the concrete tanks were started. Ingredients used in the manufacture of cement are known to give off toxic materials which is a recurrent problem in the use of newly constructed tanks. Aging the tanks is time-consuming. Our biologists, chemists and hatchery technicians attempted to hasten the conditioning process to immediately use the hatchery complex. The tanks were all scrubbed with a brush and continuously flushed with seawater to remove all extraneous debris that might have stuck to the concrete walls and floor, after which they were air-dried. Actual conditioning involved the introduction of live organisms to the tank.

The hatchery building. Foreground are outdoor tanks used for the mass culture of Chlorella and Brachionus.



Mixed species of snails numbering 128,000 collected from the SEAFDEC ponds in Leganes were used. More than 80% of the snails were identified as *Cerithidea cingulata* (Gmelin). Milkfish, tilapia, penaeid prawns were also used in different combinations with the snails.

The role of the organisms in the conditioning process cannot be properly evaluated; however, their role as an index of toxicity cannot be discounted. The great number of test animals that died in the course of the experiment is a strong indication that certain deleterious factors were at work.

Hatchery Operations

In April 1975, with the tanks conditioned, the hatchery started experiments on the mass seed production of three species of prawns, namely, *Penaeus monodon*, *P. semisulcatus* and *Metapenaeus ensis*. Spawners in our hatchery are obtained from trawlers operating within the Panay and Negros Occidental waters and from fish corrals in Batan Bay, Aklan.

Table 7. Hatchery production record, May to December, 1975.

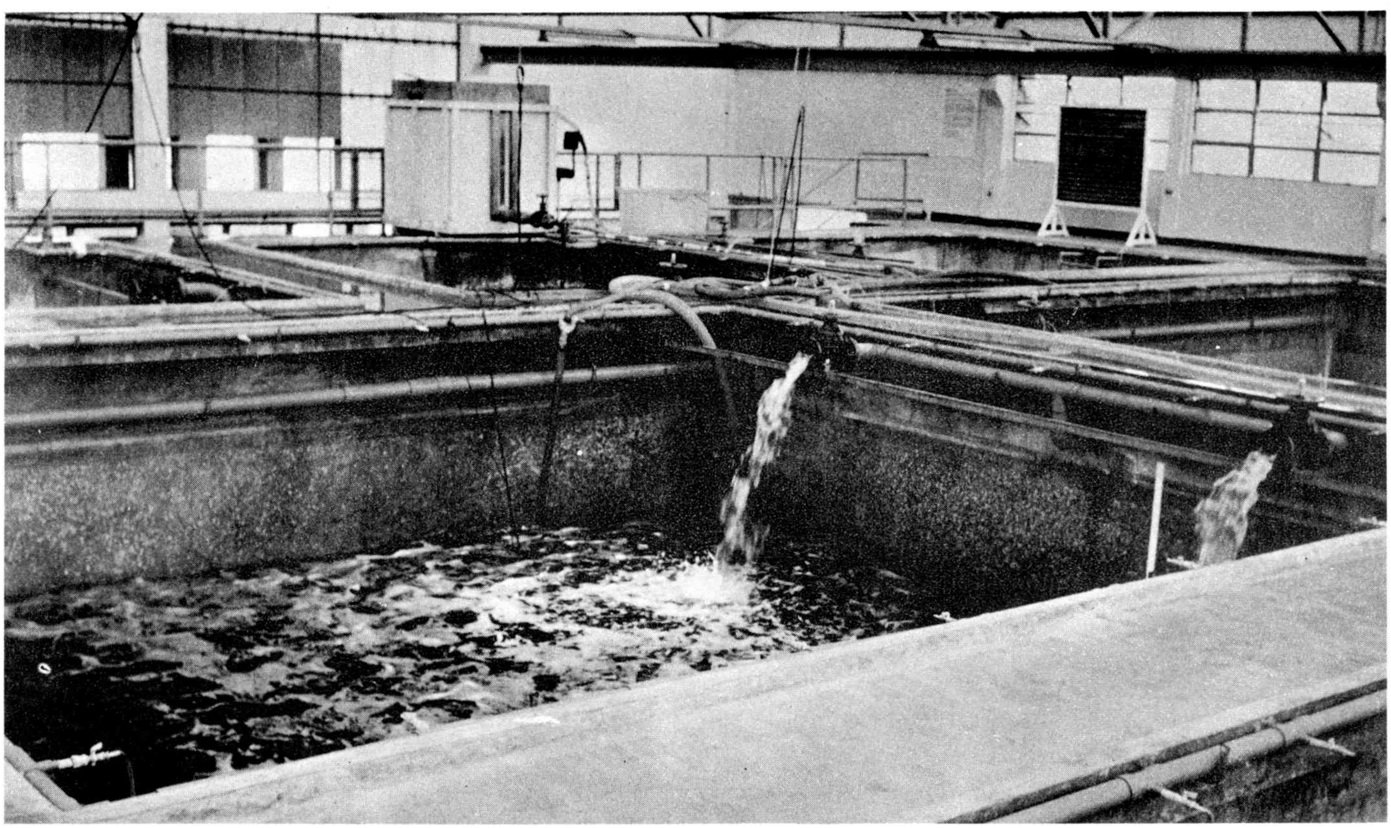
Month	No. Fry Harvested	No. Spawners Used	No. Fry per Spawner
May	262,800	307	856
June	446,500	173	2,581
July	403,700	61	6,618
August	80,000	136	588
September	194,000	133	1,459
October	388,000	223	1,740
November	375,000	118	3,178
December	75,000	65	1,154
Total	2,225,000	1,216	1,830

The techniques we use in our hatchery are basically an adaptation of Japanese techniques to Philippine conditions. However, while the Japanese require 30 to 90 spawners for every 80 to 200 cu m of water, we use only 2 to 6 spawners for every 50 - 200 cu m of water. And while the Japanese usually stock the spawner directly in the large larval rearing tanks, we make the spawners spawn in fiber-reinforced plastic (FRP) tanks of 1.5 tons capacity at the rate of 5 to 10 spawners per tank, with the nauplii subsequently transferred to the rearing tanks. This facilitates the manipulation of nauplii density in the rearing tank. A *P. monodon* spawner produces an average of 213,000 nauplii; *M. ensis*, 124,000 and *P. semisulcatus*, 50,000.

The spawning and rearing of the larvae are carried out at temperature of 28°C — 29°C, salinity of 31.3 to 34.21 ppt, and pH of 8.0 - 8.5. Continuous aeration assures a dissolved oxygen level of 6.2 to 6.6 ml/liter.

Spawning occurs at night. The spent spawners are removed from the spawning tanks the following morning. Pinkish fatty substances adhering to the sides of the tank are removed before

The indoor hatchery tanks with capacity of 120 tons each.



they decompose and pollute the water. Spawning is considered complete when all the eggs in the anterior to the posterior lobes of the ovary have been extruded, and partial when there are some eggs left in any of the anterior, median or posterior lobes.

Preparation of Rearing Tanks

The rearing tanks are thoroughly scrubbed and rinsed with sea water then dried for at least two days before they are used. This rids the tanks of harmful organisms and prevents possible pollution from decaying organisms that may have been left during the previous operations. Seawater is pumped directly from the sea and filtered into the tanks through a vinylon cloth bag of 80 mesh per cm^2. This kind of filter removes coarse particles and prevents the entry of predators admitting only the minute phytoplankton (e.g. *Nitzschia* and *Chaetoceros)* and zooplankton (e.g. rotifers and copepod nauplii) which are needed as food by the prawn larvae and postlarvae.

After the eggs are hatched in the FRP tanks, water is introduced into the rearing tanks to a depth of 2 m and aerated.

Filling the rearing tanks at this particular time assures a bloom of diatoms by the time the nauplii have metamorphosed into zoea, thus providing them with food.

Egg Stage

Newly released eggs are irregular in shape and remain suspended in water until they absorb enough water to assume a spherical shape. Then they settle at the bottom of the tank around 20 minutes after they are extruded. Cell division soon follows and the eggs are hatched into nauplii within 8 to 16 hours.

Nauplius Stage

The nauplii are capable of swimming by paddling their three pairs of appendages (Fig. 8). The nauplius molts six times throughout the duration of its stage and is nourished by its own yolk. Usually it attains a survival rate of 80% — 100%.

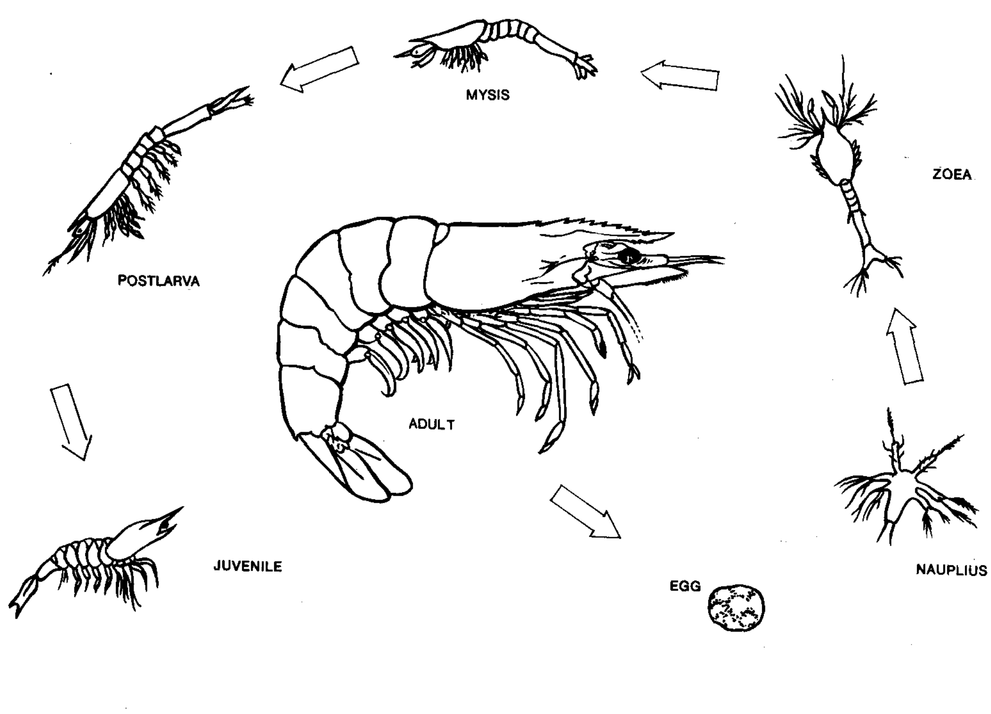
The nauplii are counted before they are transferred to the rearing tanks to regulate stocking at a density of 6,000 fry per m^3. The number of larvae is estimated by ocular counting of five random samples in a 1-liter beaker, after which the average is computed and multiplied by the volume of water in the tank.

The depth of the water in the rearing tank is maintained at 200 cm to inhibit excessive bloom of the diatoms and also to prevent toxic decomposition of products to reach critical concentration. The nauplius changes into the zoea stage in 32 to 53 hours, depending on the species being cultured and the water temperature (Table 8).

Table 8. Time period for each larval stage of three penaeids reared in the SEAFDEC hatchery.

Stage	Duration (Hours)		
	P. monodon	P. semisulcatus	M. ensis
Egg	14-16	12-14	8-10
Nauplius	48-53	42-48	32-36
Zoea	96-120	120-144	72-96
Mysis	96-120	96-120	96-120
Postlarvae	(can be harvested anytime after 9 days)		

Fig. 8. The larval stages of *P. monodon*



Zoea Stage

The body of the zoea is considerably elongated and possesses a carapace which initially covers about one-half of the body length, but gradually tends to reduce proportionally as the larvae grow.

Starter diatoms and inorganic fertilizers are not applied to the rearing tanks since the newly introduced water contains numerous diatoms and sufficient nutrients for the maintenance of phytoplankton population consisting of *Rhizoselenia, Nitzschia, Chaetoceros, Thalassiosira, Thalassiothrix* and *Navicula.* Total diatom density varies from 2,000-100,000 cells per ml with predominance of *Chaetoceros* and *Rhizosolenia.* Excessive diatom bloom and collapse of the diatom population can result in high mortality. Methylene blue and Malachite green at concentrations of 0.02 ppm have been effectively used to control excessive diatom population growth to 5,000 cells per ml.

Baker's yeast is introduced as a food supplement when the larvae reach the zoea stage up to the 4th postlarval stage.

After 3 moltings, within 3-6 days, the zoea metamorphose into the mysis stage.

Mysis Stage

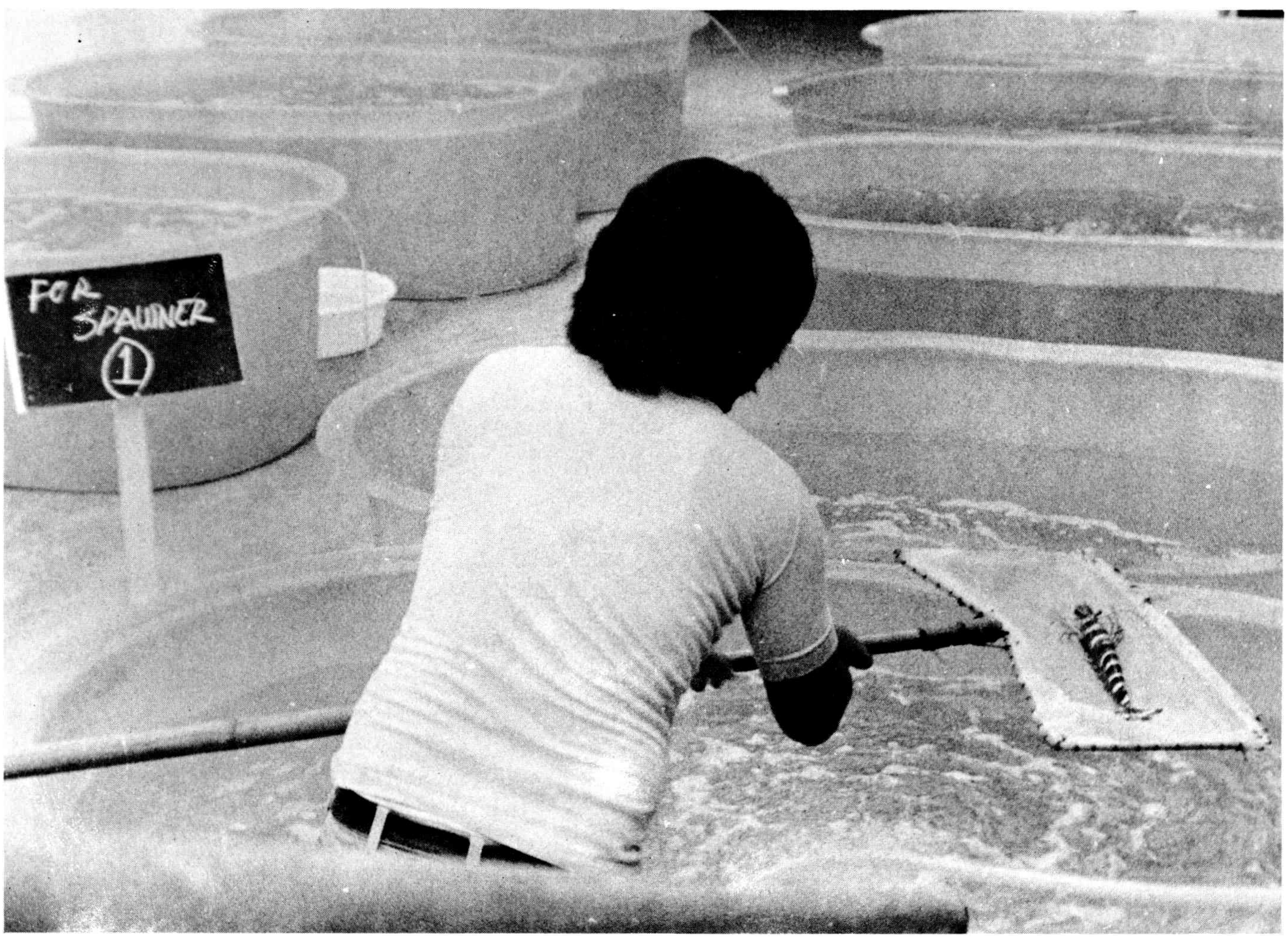
The larvae in the mysis stage of *P. monodon* and *P. semisulcatus* appear like tiny shrimps with their heads always pointing towards the source of light. The mysis of *M. ensis,* on the other hand, is oriented in a horizontal position. The mysis of all three species swim with a downward or upward motion by means of their periopods and may dart backward by flexing the abdomen. During this stage the rudiments of the pleopod appear.

Artemia salina nauplii, rotifers, and copepods are added to their diet at this stage until the fourth postlarval stage (P_4). One fifth of the total volume of the water is changed every day from the mysis stage to prevent deterioration of the water quality. It is here that mass mortality occurs especially if the number of larvae per tank exceeds 6,000 per m^3 (Table 9).

Postlarval Stage

The postlarvae have functional pleopods which are now used for active swimming; they also possess developed chelipeds for grasping food organizms particularly zooplankton. They remain planktonic

Series of 1.5-ton FRP tanks used for spawning prawns.



during the first 4-5 days, after which they settle to to the bottom or crawl on the sides of the hatchery tank.

Brine shrimp nauplii make up most of their food up to P_4 after which they are fed minced mussel meat 4 times per day. The rations are adjusted according to the amount of unconsumed food and the corresponding growth of the post-larvae.

Results of the experiments on the rearing of the three penaeid species are summarized in Table 10.

Harvest, Pre-treatment and Transport of Fry

Penaeid fry may be harvested as early as P_9. It involves draining of the rearing tanks by siphoning the water until the depth comes to 1/2 m or less. The siphon is fitted with a screen box to prevent the fry from being sucked during the draining process. Lowering the water level reduces the pressure of the water coming out from the tank as the valve of the drain pipe is opened, thus minimizing mechanical injury on the fry.

Two methods are used in collecting the fry. One employs a cylindrical vinylon net with one end fitted to the drain pipe and the other free end held by one worker. The drain pipe is opened to trap the fry inside the vinylon net. Another method employs an inverted net with an opening fitted to an elbow which is oriented upwards to prevent the fry from being washed to one side. They are then transferred to small wooden tanks by buckets or scoop nets. The temperature of the water in the wooden holding tank is held at 5°C lower than the ambient temperature from 30 min to one hour, after which the temperature is further lowered to 18°-20°C before they are packed in 50 cm x 96 cm polyethylene bags.

Fry density is estimated by visually comparing the density of an unknown population with that of a standard consisting of head-counted individuals. Identical containers are used for the standard and the unknown sample, and the volume of water in the sample is adjusted to be as close to the standard as possible. If transport time is within 8 hours, as much as 40,000 P_{10}-P_{15} frv are packed in one plastic bag with 16 liters of chilled seawater. Survival rates are between 70%-100% upon arrival at the destination.

Table 9. Survival of *P. monodon* larvae in the SEAFDEC hatchery at two density levels.

Date	Stage	Larval Count (1000/M^3)	% Survival from N_1
A. High Initial Density			
4-7-75	N_1	4,000	100
8	N_2	4,000	100
9	Z_1	4,000	100
10	Z_2	4,000	100
11	Z_3	4,000	100
12	Z_4	4,000	100
13	Z_5	3,600	90
14	M_1	3,100	77.5
15	M^2	2,000	50
16	M_3	764	19.1
17	M_4	540	13.5
18	M_5	360	9
19	P_1	270	6.75
20	P_2	270	6.75
21	P_3	–	–
Harvested			
5-9-75	P_{21}	30	0.75
B. Low Initial Density			
6-10-75	N_1	450	
11	N^2	450	100
12	Z_1	405	90
13	Z_2	405	90
14	Z_3	405	90
15	Z_4M_1	400	88.89
16	M_2	400	88.89
17	M_3	337	74.89
18	M_4	247	54.89
19	M_5P_1	247	54.89
20	P_2	138	30.67
21	P_3	136	30.22
Harvested			
7-2-75	P_{14}	120	26.67

Table 10. Survival of the larvae of three penaeid species spawned in the SEAFDEC hatchery.

Stage	Density (Thousands/M^3)		
	P. monodon	P. semisulcatus	M. ensis
Nauplius	8585	183	2,080
Zoea	585	183	2,990
Mysis	305	110	2,023
Postlarvae harvested	220	14	4
Stage	P_9	P_{23}	P_{32}
% Survival N_1 – P_{21}	2.6	7.7	0.2

Experiments in fry transport have been conducted to determine the best stocking density for long-distance transport. As shown in Table 11, survival can be as high as 97% in 48 hours if the fry density is 2,500. Fry from our hatchery have been sent out to Fiji and Kuwait with minimal losses.

The plastic bags containing the fry are inflated with clinical oxygen and sealed with rubber bands. These bags together with an ice-pack are placed inside styrofoam boxes to maintain water temperature at 19°-20°C during transport. Arrangement inside the styrofoam boxes is such that direct contact of the ice-pack with the fry bag is avoided as this might lower the water temperature beyond the fry's limit of tolerance. The fry cannot tolerate temperature below 15°C.

Upon reaching their destination, the fry are again acclimatized to the temperature and salinity of the nursery or rearing ponds before being released to minimize stress and mortality.

Identification of Penaeid Larvae

Hatchery produced sugpo fry still constitutes only a very small portion of the total supply of fry. Prawn culturists are still heavily dependent on natural supply which is often mixed with other shrimp species. At the fry stage, the extraneous species can easily be mistaken for *P. monodon*.

Identification of live fry in the field is an important prerequisite for their farming in brackishwater impoundments and may be accomplished with the naked eyes by referring to their color patterns. For this reason we have prepared a key to the species of penaeid fry based on color pattern.

We have also prepared a key to the stages of penaeid zoea and the species of *Penaeus* juveniles based on structures (Fig. 9). The keys were based upon plankton collections within the Panay and Negros waters.

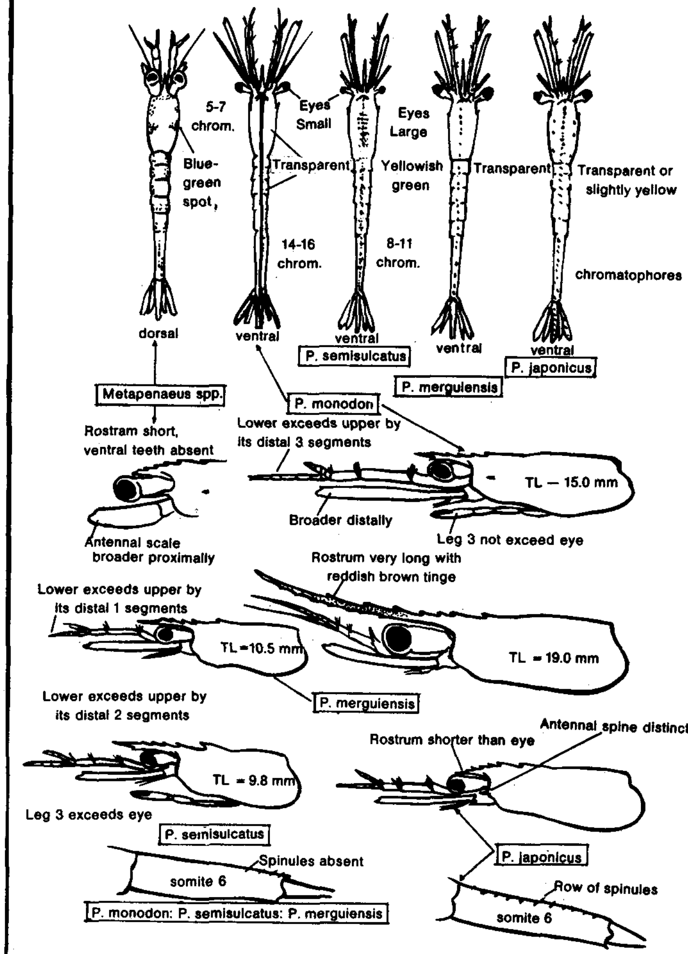
Table 11. Survival of *P. monodon* post-larvae at different density levels inside polyethylene bags regularly used for fry transport. The water temperature inside the bags were maintained at 19°C -20°C by using pre-chilled sea-water and ice packs.

Expt. No.	Larval Stage	Packing Temp. °C	Duration (hour)	Fry Density Per Bag	Percentage Survival
1 — a	P_{12}	20° C	24	2,500	100
1 — b	P_{12}	20° C	24	2,500	100
2 — a	P_{12}	20° C	36	2,500	97
2 — b	P_{12}	20° C	36	2,500	97
3 — a	P_{12}	20° C	48	2,500	97
3 — b	P_{12}	20° C	48	2,500	97
4 — a*	P_{15}	20° C	63	2,000	50
4 — b*	P_{15}	20° C	63	5,000	40
5 — a**	P_{18}	19° C	26	2,500	98
5 — b**	P_{18}	19° C	26	2,000	98
5 — c**	P_{18}	19° C	26	2,500	98
5 — d**	P_{18}	19° C	26	2,500	98
5 — ee**	P_{18}	19° C	26	2,500	98

*Sent to Fuji Island

**Sent to Kuwait

Fig. 9. The juveniles of various penaeid species.



Water Quality

Studies on Physical Parameters

Maintenance of high survival rates is necessary in mass seed production and is dependent on such factors as quality of water in culture tanks. It is important that optimal water conditions be established under controlled laboratory conditions so that measures may be taken to maintain such conditions within the established range. We conducted studies on the effect of salinity, temperature, pH, nitrite and ammonia on the growth and survival of *P. monodon* larvae.

Temperature and Salinity

Results indicate that without prior acclimatization postlarvae from P_{10} to P_{13} can tolerate a wide range of salinity (5 to 39 ppt).

Table 12 shows the effect of salinity on the survival and growth of postlarval *P. monodon* at ambient temperature, pre-acclimatized at 32 ppt salinity. Although growth is faster at lower salinities, survival rates are more or less constant at all examined salinity levels, indicating that postlarvae can withstand a wide salinity range. We also noted that growth rates varied among individual postlarva regardless of salinity.

Growth was essentially the same regardless of temperature. With the limited number of postlarvae weighed at the end of the experiments (5 to 10 individuals), differences in weight are not significant.

Ammonia, Nitrite and pH

Results of experiments with different pH levels ranging from 5.8 to 9.2 suggest that postlarvae can tolerate pH levels between 7.0 and 8.6 although the actual range may be wider.

Table 12. The survival and growth of *P. monodon* postlarvae at different salinity levels at ambient temperatures.

Salinity Range ppt	ph Range	Nitrite range, ppm	Average Wt./fry* mg.	Average % Survival
A. P11;Initial wt. 2.0 mg; Temp.; 25.5 — 29° C				
9 — 12	8.00 — 8.27	0.24 — 6.44	6.58	71
16 — 21	8.17 — 8.41	0.76 — 9.12	3.98	60
26 — 30	8.15 — 8.45	0.80 — 8.43	2.44	51
33 — 39	8.31 — 8.53	0.82 — 12.25	2.87	51
B. P13; Initial wt.; 2.09 mg;Temp.; 24.8 — 25° C				
10 — 14	7.99 — 8.39	0 — 4 60	4 55	18
27 — 32	8.35 — 8.55	0. — 2.25	3.68	25

* Average weight for A measured 10 days after start of experiment; B,12 days.

Figure 10 shows a typical result of the effect of nitrite on the survival of *P. monodon* postlarvae. The tolerance level of postlarvae at the early postlarval stage starting from P_3 is between 50 and 80 ppm $NaNO_2$. Postlarvae from P_{10} and above were found to be more tolerant to nitrite, with the tolerance level at about 100 ppm. Growth rates appear to be similar at all examined nitrite levels.

It may be noted that no other parameters were measured except survival and growth rates. We do not know whether there is any permanent effect by nitrite at high but tolerable concentrations (50-100 ppm.). All we know is that in higher animals nitrite is carcinogenic at much lower concentrations.

Results suggest that postlarvae can withstand ammonia concentrations up to about 50 ppm (Fig. 11). Although there are differences in the response of postlarvae used in the two runs, it is clear that 100 ppm gives significantly higher mortality rates. Growth rates were essentially similar at all ammonia levels examined as determined from the average weights of the postlarvae.

Fig. 10. The survival of *P. monodon* post-larvae at different nitrite concentrations.

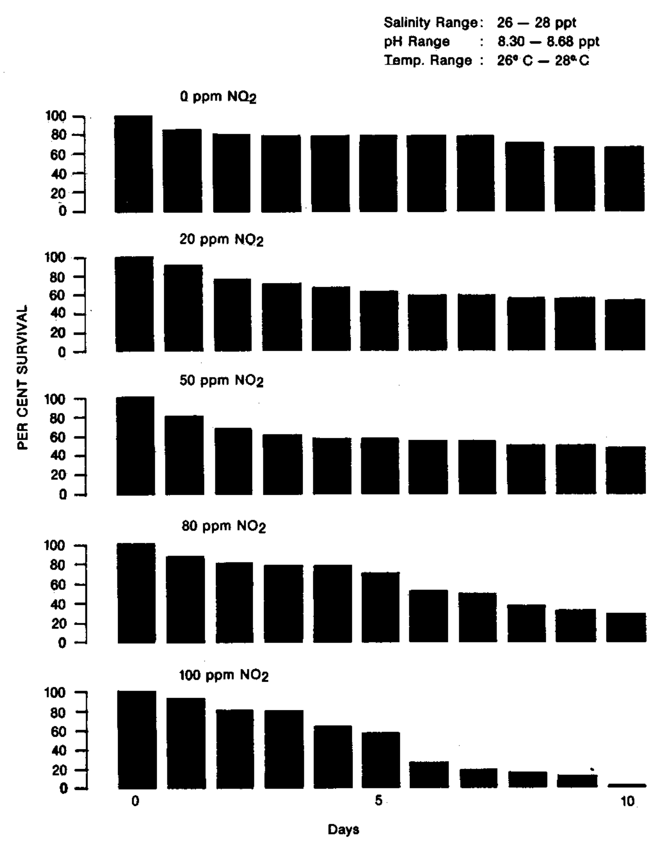
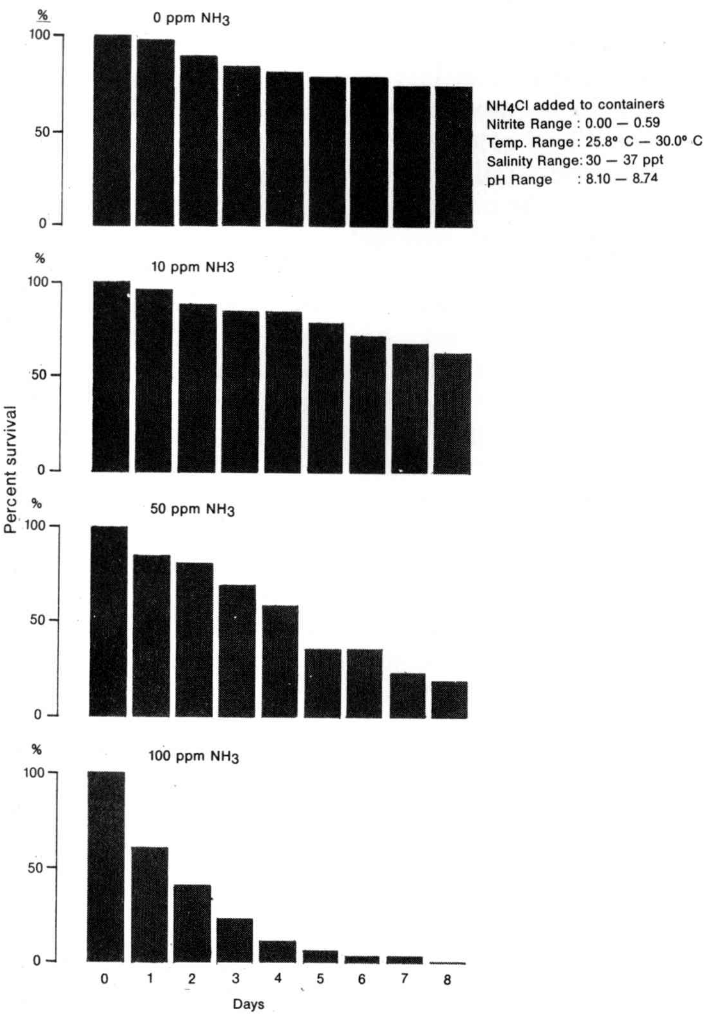


Fig. 11. The Survival of *P. monodon* post-larvae at different concentrations of ammonia



Nutrition and Feed Development

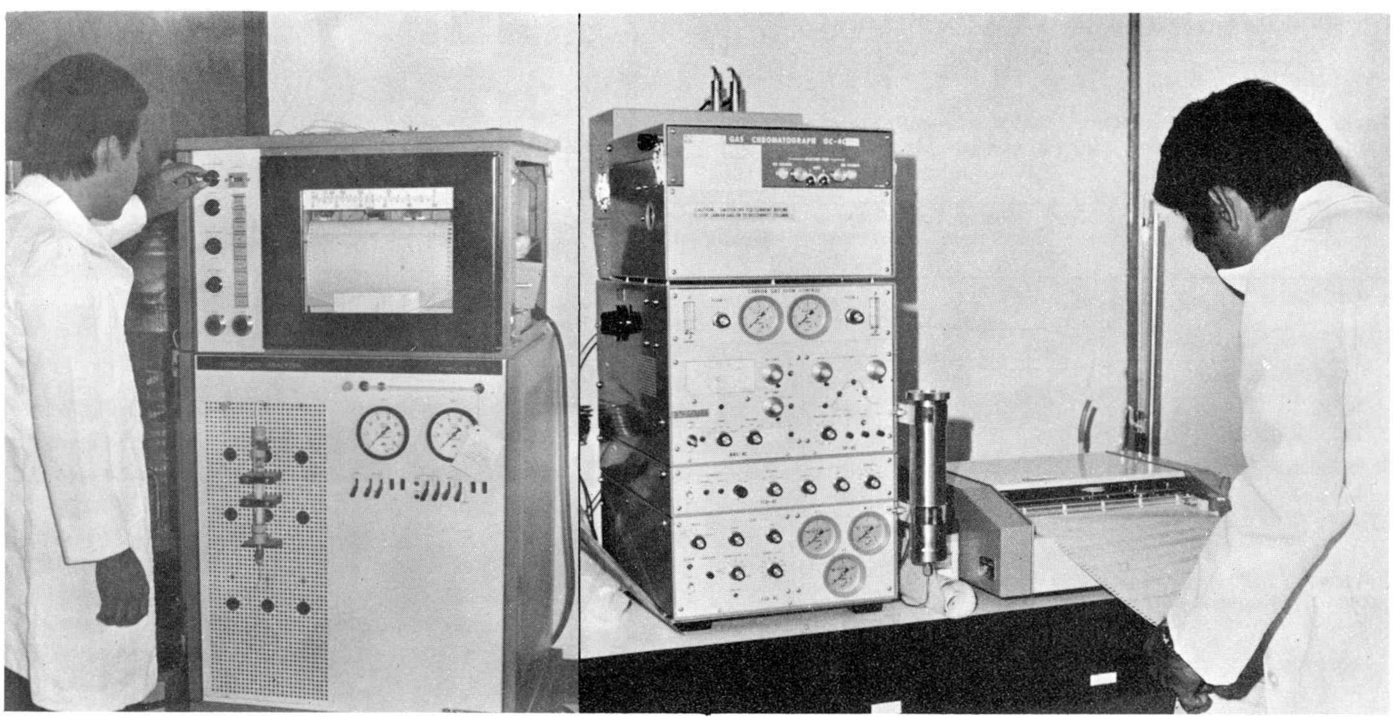
The Search for Ideal Feed

Studies on nutrition and feed development are necessary in the intensive culture of fish species. Such studies aim at solving some feeding problems of *P. monodon* both in the hatchery and in the fishpond.

There are two distinct areas in our studies: feed for larvae and feed for juveniles and adults. Experiments conducted in the Tigbauan station are mainly on larvae while studies made in the Leganes ponds, on juveniles and adults. Our studies on the culture of such natural feeds as diatoms, brine shrimp and water flea were carried out simultaneously with our studies on other unconventional sources of protein. We tried to look for locally available materials which may be suitable for feed, e.g., defatted coconut meat, rice bran, shrimp heads, ipil-ipil seeds, alamang, soybeans.

Studies to increase growth and survival rates of larvae with the use of cheap, locally available feeds were carried out in small aquaria or in 0.5 and 1.0 ton fiberglass tanks. Studies on prawn nutrition requirements may take years but feed development has to continue and should be improved as nutritional requirements are gradually being determined.

Newly-arrived amino-acid analyzer and gas chromatograph will be used for nutrition studies, feed development and other biochemical studies.



Mussels

We studied the effects of feeding mussels and the time of feeding on growth and survival rates of *P. monodon* postlarvae (P_5) for a period of 6 months. In preparing unwashed mussel feed, whole mussels were rinsed and drained. A 1:1 ratio of mussel and water was placed in a Waring blender and ground at low speed for five minutes. We followed a similar procedure for washed mussels except that the whole mussels were ground in a meat grinder and rewashed before comminution in a Waring blender. Aliquot portions were weighed in small plastic bags and kept frozen until just prior to feeding. Some 100 P_5 larvae were reared in 12" x 8" x 6" glass aquaria with 7 liters of seawater.

We used two replicates in experiment 1 and three for experiments 2 and 3. Initial and final lengths and weights of 20 random samples were recorded including daily counts of larvae that jump out of the water.

In experiment 1 (Fig. 12) we found that unwashed mussel feed gives higher survival rates (18% and 30%) than washed mussel (0 and 18%). In fact the average weight gain generally went up as we increased the amount of feed although the average length gain was about the same for both treatments.

In experiments 2 and 3 the survival rates were higher among those given 2.4 g. Given the same amount of feeds, growth and survival rates were relatively higher among those fed in the afternoon. Differences in growth and survival rates in the two experiments may have been due to differences in initial length and weight of the larvae used. Larvae in experiment 2 were 10.8 mm long and weighed 1.1 mg while those in experiments 2 and 3 were 5.5 mm and 6.6 mm, respectively. Initial weights of the larvae in experiments 1 and 3 were 0.38 mg and 0.16 mg. respectively. We might surmise that the weight and length at the beginning of the experiment did affect the final results.

Larvae which were fed 3.2 g did not grow better than those fed 2.4 g. This made us believe that 3.2 g was in excess of the needs of the fry.

Finally, cannibalism was observed among the starved groups and those fed 0.8 g. The starved fry were pinkish and weak while those given higher amounts of unwashed mussels were brownish-black and active. Our observation needs to be confirmed in succeeding experiments because present results are very tentative and preliminary.

Egg Yolk in Feed

Egg yolk is a complete protein and contains cholesterol which some penaeids need. It is available in the community and is relatively cheaper than bread yeast and brine shrimps so we tried it as feed for zoea, mysis and first postlarval stage (P_1). Results of our preliminary runs showed that 0.05 ml to 0.1 ml of egg yolk (1 part egg yolk to 6 parts water) given thrice per day could support growth up to the first postlarval stage when given to zoea or mysis.

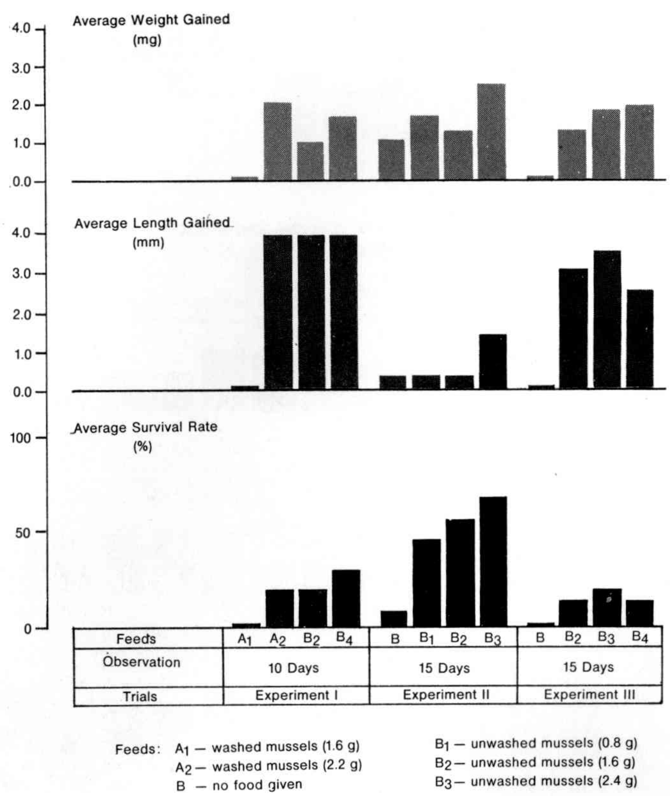
In one trial where egg yolk or egg yolk plus agar was given from the mysis to P_1 the survival rate was 86-90%. Results were very erratic and unduplicated and we feel more trials have to be carried out.

Miscellaneous Feeds

Various feeds were given to the *P. monodon* larvae using a stocking rate of 50 P_5 larvae per aquarium (9.5 liters). Our preliminary results showed 42% survival rate after 15 days of feeding rice bran and fish meal or a combination of both, while those fed with corn and ipil-ipil died after five days.

The feasibility of using food refuse from the cafeteria as feed for the larvae was done in 400-liter fiberglass tanks in the Wet Laboratory. Larvae from spawners caught from Himamaylan, Negros Occidental were kept and reared in the tanks and fed with fermented food refuse. We used a proportion of two kg food refuse per 60-liter of seawater under heavy aeration. The sediments at 1 g/liter of water was given twice when

Fig. 12. Survival and growth of P. *monodon* larvae using washed and unwashed minced mussels.



the larvae were at the last nauplius stage. Water in the tank was not changed during the rearing experiments. Water temperature ranged from 25.1 to 27.4°C and salinity from 26.5 to 28.4 ppt.

It appears that the fermented food refuse was as good as the cultured diatoms as feed (Fig. 13). . Survival rate at zoea 3 was 41.4% and 42.4% for cultured diatoms. We took the average count by drawing five random samples in a 300 ml beaker and by counting the number in each sample. Whether the microflora in the feed was partly responsible for the survival rate, we still do not know.

We conducted another experiment using food refuse in combination with cultured diatoms and bread yeast. The combination of vegetable refuse, diatoms and bread yeast gave the highest survival rate of 74% from the nauplius to P_3; followed by bread yeast and vegetable refuse 28.1%; and vegetable refuse plus diatoms 6.2% (Fig. 14). The diatoms were mainly *Skeletonema* sp. (dominant species), *Chaetoceros* sp. and *Nitzschia* spp. with a density of about 1,000 to 25,000 cells/ml. A discrepancy in the estimated number of larvae could be due to sampling errors and the results of this experiment need verification in subsequent trials.

Fig. 13. Survival of *P. monodon* post-larvae under two types of feed: diatoms and vegetable refuse.

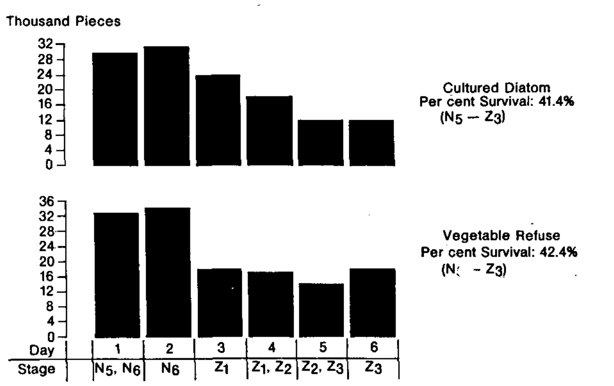
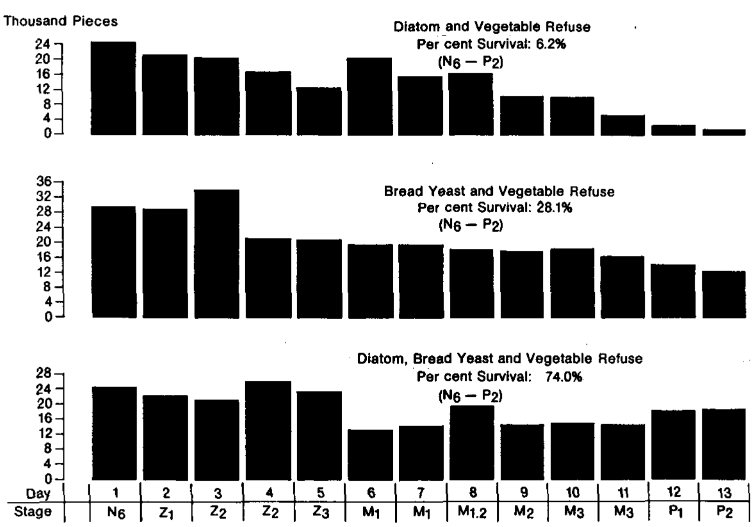


Fig 14. Survival of *P. monodon* Postlarvae under different feed combination.



Diatoms

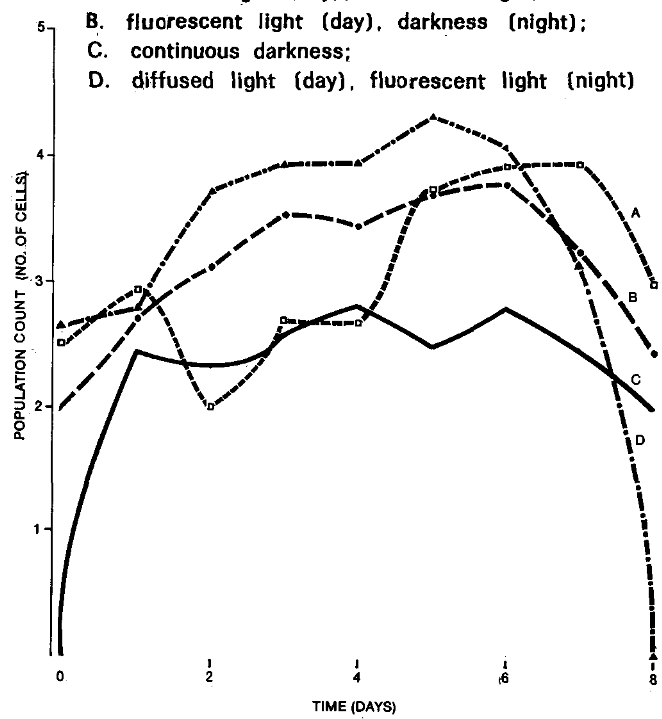
Successful mass culture of diatoms was obtained using 80-90% seawater fertilized with inorganic fertilizers ($NaNO_3$, 2 ppm; $FeCl_3$, 0.2 ppm; K_2HPO_4, 0.2 ppm, $NaSiO_3$, 1-0 ppm, Clewat 32, 1.0 ppm) and provided with aeration. Bloom of *Chaetoceros* sp. was obtained after two to three days at density of 100,000 to 200,000 cells per ml.

We drained one culture tank (Tank A) completely and transferred into it 30% of the starter diatom from another tank (Tank B) before adding 80-90% seawater and fertilizer. For Tank B 20% of the culture was retained and 80-90% seawater and fertilizer were again added. The following day Tank B was drained completely repeating basically the same procedure. With this method we were able to maintain diatom bloom for 20 to 30 days.

We were able to propagate the pure culture of *Nitzschia closterium* and *Skeletonema costatum* through the repeated subculture method of isolation and propagation. These species were cultured in erlenmeyer flasks, containing Allen-Nelson media set under fluorescent light with 6000 lux. After several days, if the species became dominant, contents were transferred to several flasks and the procedure was repeated. The species was then propagated in 1-ton tank using the procedure previously described for *Chaetoceros*. *N. closterium* has been mass produced continuously for 40 days while 90% *S. costatum* has been mass produced for one month by controlling light and through chemical fertilization.

Fig. 15. Population dynamics of *Skeletonema* under different light regimes.

A. diffused light (day), darkness (night);
B. fluorescent light (day), darkness (night);
C. continuous darkness;
D. diffused light (day), fluorescent light (night)



Skeletonema

While no particular problem was encountered in the blooming of *Skeletonema* during the dry season, we believe there would be problems during the rainy season due to the light required for *Skeletonema* cell division. In our preliminary study on its culture indoors, we found that continuous light (diffused light at daytime; flourescent light at night) was most suitable. The "lag" phase runs for three days, followed by the "maximum stationary" phase which may be maintained for two days, before the onset of a very rapid decline on the 7th day. Figure 15 illustrates the growth of *Skeletonema* in four different regimes of light.

A high nitrate modified Pringsheim's solution with complete micronutrients was tested indoors to see if the "asymptotic" population can be stabilized and maintained longer than two days as observed. The effect of the addition of the latter fertilizer is shown in Figure 16. This, however, is accomplished at the expense of the final length of the chain (Fig. 17).

Brine Shrimp

To initiate the mass production of brine shrimp *Artemia salina* under local conditions we conducted studies on its life cycle and feeding habit. Brine shrimp nauplii were reared in 24-liter plastic basins with a population of 5,000 nauplii per basin. Three types of feeds were used: *Chlorella*, diatoms, and microorganisms present in seawater. When mating adults appeared in each basin they were collected and subjected to a salinity stress of 53 ppt.

We observed that nauplii fed with *Chlorella* developed and matured faster than those in the other two treatments. Life cycle was completed from 2 to 3 weeks at salinity between 32 and 36 ppt and temperature range of 27°C to 32°C.

Adults started to lay eggs four days after a salinity stress of 53 ppt. Egg and nauplii production was highest two weeks after the salinity stress was given, gradually decreasing as the female became acclimated (Fig. 18). The zero entry on the 30th day was due to another salinity stress of 90 ppt. Contrary to our expectations, more nauplii than eggs were produced after the second salinity stress due probably to the continuous aeration and daily supply of *Chlorella* which increased the amount of dissolved oxygen in the water medium.

Different salinity levels were tested. Brine shrimp nauplii hatched from commercial eggs (Long Life Aquaria Products, St. Thomas, Ontario,

Fig. 16. Maintenance and stabilization of *Skeletonema* population at high level using different levels of Pringsheim's solution under a 12-hour diffused light condition

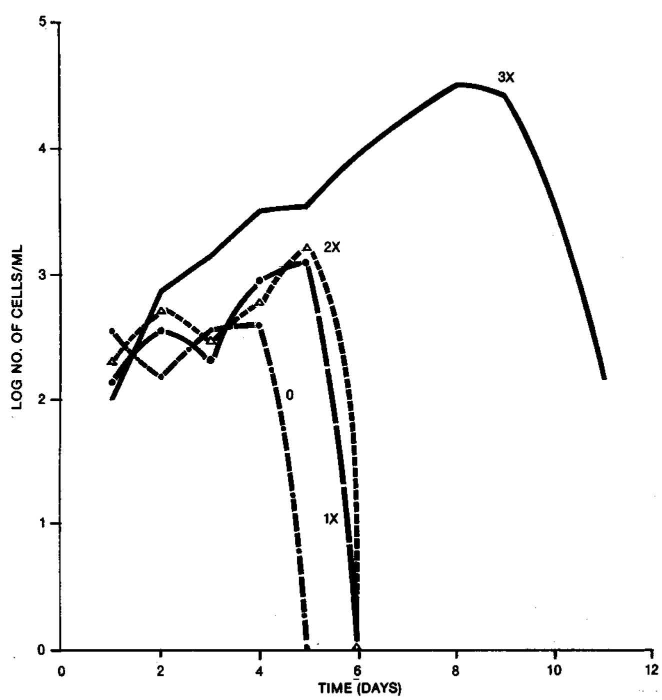


Fig. 17. Shortening of *Skeletonema* chains at high population levels.

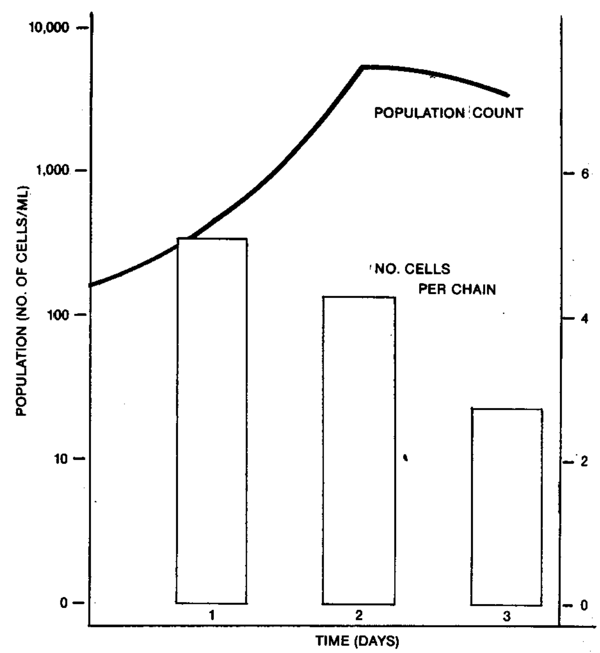


Fig. 18. Egg and nauplii production of brine shrimps. Figures are based upon total population estimate of culture using a 24 liter diameter plastic basin.

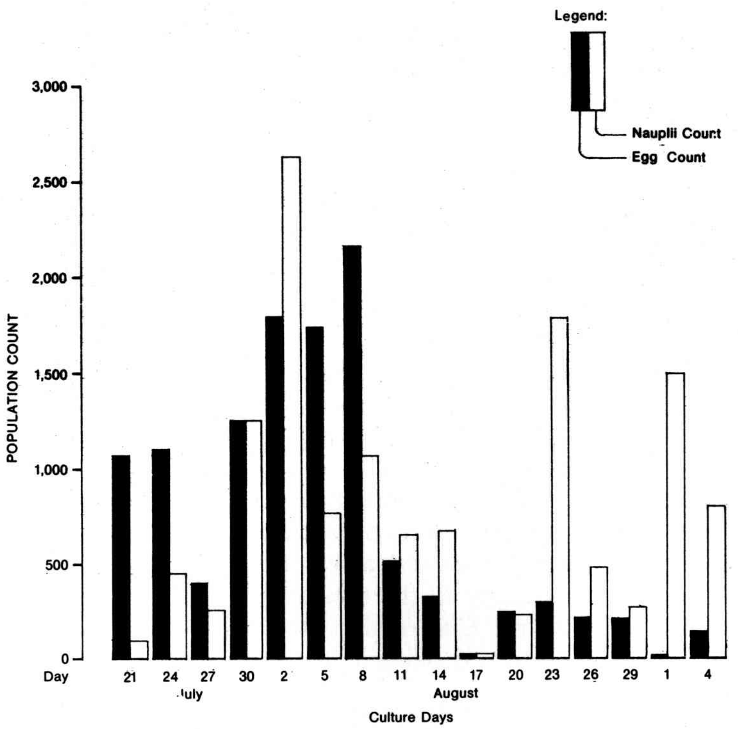
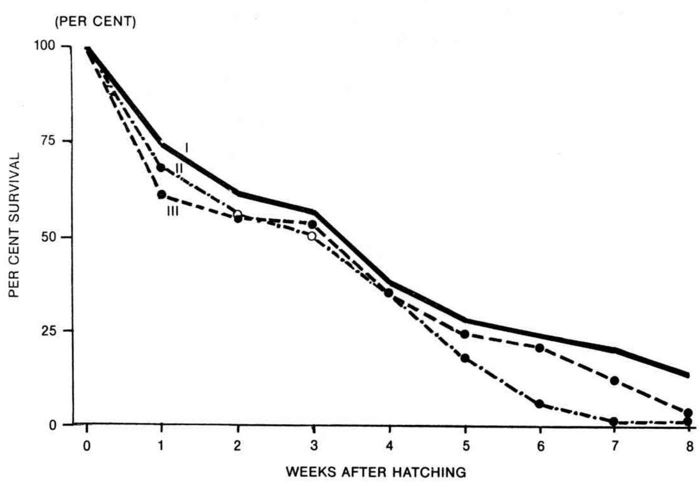


Fig. 19. Survival of brine shrimps reared at different salinity levels.



TREATMENT	SALINITY (%) INITIAL	FINAL	AVE. NAUPLII PRODUCED
I	32.29	41.00	167.67
II	53.00	65.48	84.33
III	76.16	85.56	37.00

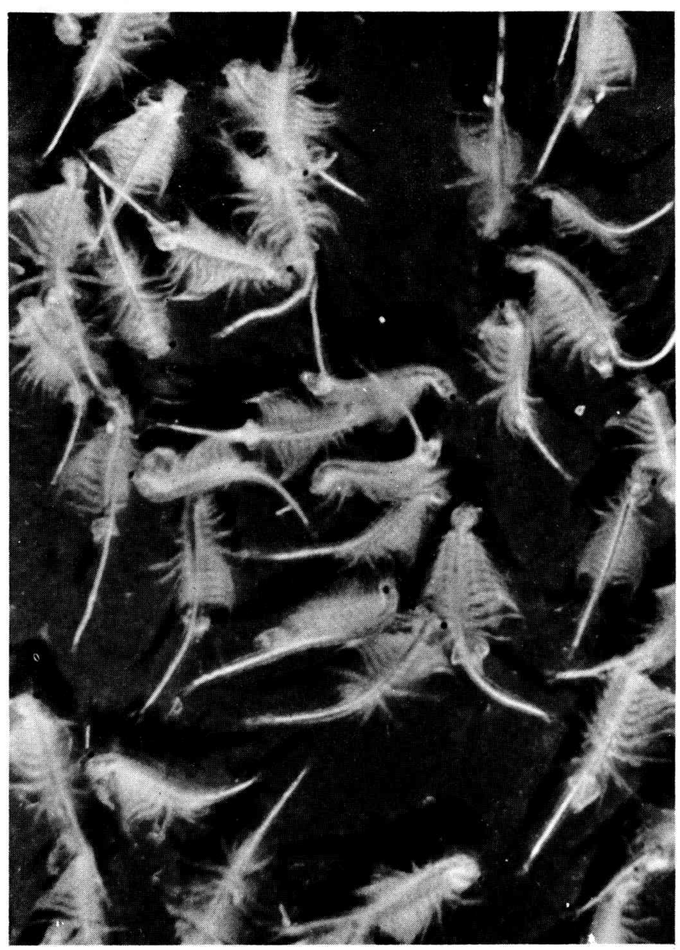
Canada) were reared in 3-liter round plastic containers at salinity levels of 32, 53 and 76 ppt. Each treatment was replicated thrice using a stocking density of 100 nauplii per 2,500 ml and *Chlorella* as feed.

We noticed no significant difference (5% level) in the survival of brine shrimp reared at various salinity levels although more nauplii were produced at 32 ppt (treatment 1). Results of this experiment indicate that brine shrimps can be reared successfully at salinity levels between 32 and 53 ppt (Fig. 19).

Water Flea

The water flea, *Moina macrocopa* was cultured with brood of advanced embryos for several days in three plastic tanks (two 300-liter capacity and one 700-liter capacity) under ordinary laboratory temperatures. We used wine-colored culture media of one kg of cow dung in 45 liters of water, 750 g of rice straw in 45 liters of water, and a combination of equal amounts of both. We found aeration to be necessary in the cultivation of *M. macrocopa*. Examination of the medium showed the presence of bacteria, algae, protozoa and other microorganisms.

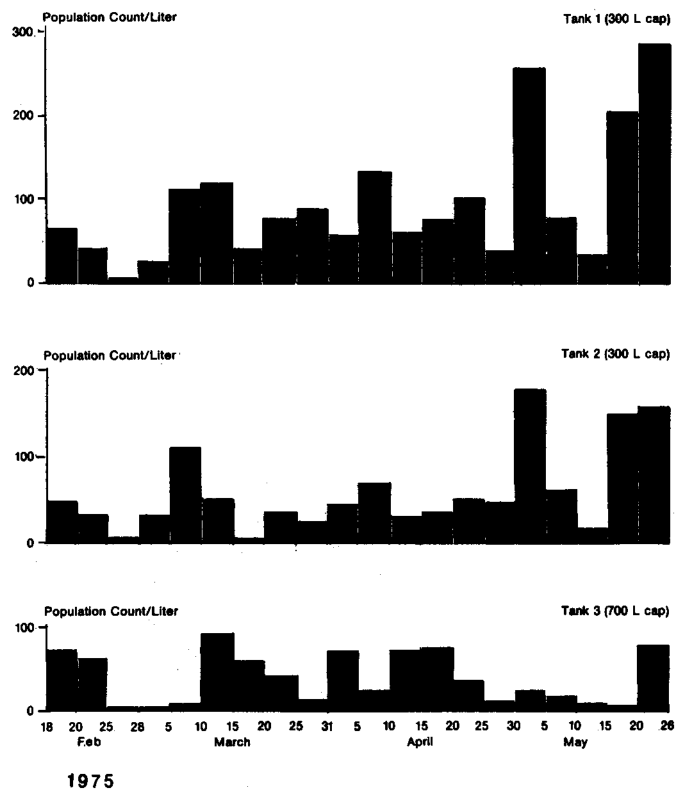
The brine shrimp, Artemia salina.



Results showed a positive correlation between aeration and water flea populations. The non-aerated medium developed scum as the water flea population increased and as the medium aged. Stock culture of *M. macrocopa* was maintained for 4 to 6 generations in 36 days. The reproductive response of water fleas kept in a mixture of hay infusion and cow dung was satisfactory. Such mixture produced and increased the number of viable young. The population density of water fleas reached peak proportion on the third to sixth day diminishing after each peak (Fig. 20). We noted no tendency for the clone of water fleas to adjust and improve when the medium became old although there could be some toxic or inhibiting factors present in the medium.

Population density was difficult to maintain because of the inherent, spontaneous physiological changes peculiar to water fleas and other related cladocerans. Probably other external stress suppressed the population growth of *M. macrocopa.* The population density of 168 adult Moina per liter of medium is very satisfactory from the viewpoint of production.

Fig. 20. Population growth of *Moina macrocopa.*



We found high egg counts in sediments of the culture media. The eggs hatched when these sediments were dried in the sun and subsequently watered. Such response is a protective mechanism in the life cycle of *M. macrocopa* for in nature they are periodically exposed to the rigors of the environment.

There are problems attendant to establishing and maintaining cultures of water fleas in the laboratory. We found the culture media contaminated with rotifers, tentatively identified as *Brachionus rubens,* and *Cyclops spp.* which crowd out the water fleas. Under favorable conditions, rotifers may cover the entire body of water fleas including their appendages which apparently interfere with the movement of the latter.

Effects of Feeds and Feeding Rates

We carried out replicated trials on the effects of feeds and feeding rates on the growth and survival rates of the different larval stages of *P. monodon* using 0.5 and 1.0-ton FRP tanks. In all trials a randomized complete block design with two replicates was used at a stocking density of 10 larvae per liter of seawater.

Four treatments were applied from Z_1-M_2 stage: A) mixed diatoms, 1-5 x 10^3 cells per ml; B) mixed diatoms, 6-10 x 10^3 cells per ml; C) mixed diatoms plus bread yeast, 1-3 x 10^3 cells per ml plus 1 g per ton; and D) mixed diatoms plus *Brachionus,* 1-5 x 10^3 cells per ml plus 2-4 individuals per larva. Mixed diatoms predominantly *Chaetoceros* sp. fed at the rate of 1-5 x 10^3 cells per ml, gave the highest survival rate of 50.11% (Table 13). Mixed diatoms plus bread yeast or *Brachionus* gave slightly lower survival rate of 45.14% and 44.92%, respectively. However, supplementary feeding with bread yeast or *Brachionus* gave healthier and bigger larvae than those fed with mixed diatoms alone. Differences among trials were not significant at the 5% level.

Table 13. Survival of ***P. monodon*** **larvae using different rates of mixed diatom and supplementary feeds. A. Mixed diatoms, 1-5 x 1000 cells/ml; B. Mixed diatoms, 6 - 10 x 1000 cells/ml; C. Mixed diatoms, 1 - 3 x 1000 cells/ml and Baker's yeast, 1 gm/ton water; D. Mixed diatoms, 1 - 5 x 1000 cells/ml and** ***Brachionus*****, 2 - 4 individual per larva.**

Treatment	Mean Survival Rate (%)			Total	Mean
	Trial 1	Trial 2	Trial 3		
A	22.35	68.80	59.17	150.32	50.11
B	24.83	73.51	50.69	149.03	49.68
C	25.13	50.41	59.88	135.42	45.14
D	37.47	25.00	72.28	134.77	44.92

For Mysis$_3$ to Postlarva$_4$ (M_3 - P_4) we varied the rates of feeding with brine shrimp nauplii from 5 to 50 per larva per day. The result we obtained shows that survival rate generally goes up with increased feeding rate. Mean survival rate ranged from 33.2% (5 nauplii per larva), Table 14. There was no significant difference in survival rate among treatments.

We studied the survival of *P. monodon* postlarvae from P_5 to P_{15} using minced clam meat at the rate of 20%; 40%; 60% and 80% biomass feeding rate. Some 100 postlarvae P_5 were used per treatment at a stocking density of 10 P_5 per liter of seawater.

Growth measured in terms of length and weight increased generally with increased feeding levels (Table 15). Survival rates obtained in this study were very erratic. The number of surviving larvae differed between replications per treatment and more so between treatment. No conclusions could be drawn until further studies have been conducted.

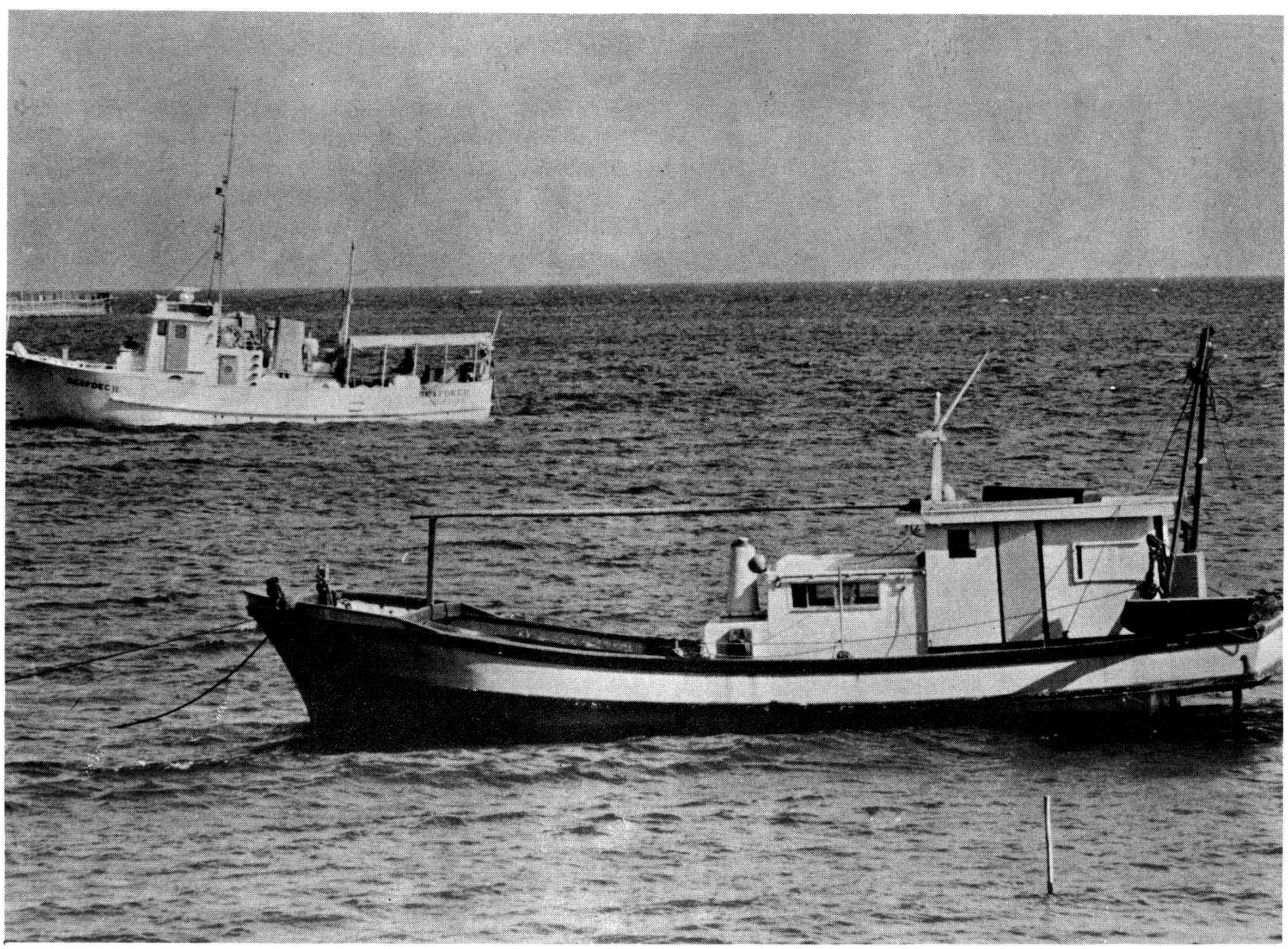
Table 14. Survival of *P. monodon* larvae under a diet of brine shrimp nauplii.

Treatment	Mean Survival Rate (%)			Total	Mean
	Trial 1	Trial 2	Trial 3		
A	22.35	68.80	59.17	150.32	50.11
B	24.83	73.51	50.69	149.03	49.68
C	25.13	50.41	59.88	135.42	45.14
D	37.47	25.00	72.28	134.77	44.92

Table 15. Survival of *P. monodon* postlarvae at different feeding rates of minced mussel meat. Feeding levels were set as percentage of estimated biomass of postlarvae.

Feeding Level	Length (mm)	Weight (mgm)	Survival Rate %
A (20%)	2.98	1.13	20.97
B (40%)	3.25	2.04	15.42
C (60%)	3.55	1.92	15.06
D (80%)	4.07	4.67	4.40

The 20-ton SEAFDEC II and the 4-ton SEAFDEC I used for prawn spawner collection and ecological studies on prawns and milkfish.



Diseases

Formulation of Media

One major aspect we are studying in the large-tank culture of prawns is changes in the bacterial flora of the hatchery tank seawater. We need baseline studies on the natural bacterial flora and identification of pathogenic microorganisms that may cause mass mortality in the culture tanks. However, before any baseline studies could be carried out we had to study various recovery media.

We tested different recovery media for the different aspects of microbiological work particularly isolation. Of the three salt-free media tried, we observed Bachmann's Agar (BA) to be better than the standard Tryptone Glucose Yeast Extract (TYGE) and Nutrient Agar (NA), Fig. 21. An added advantage of this medium is its ability to recover a wider range of bacterial genera.

There are other aspects of the work that need media thus seawater agar and salt-fortified TGYE were also tested. The former was observed to recover 1.66 x 10^3 c/ml, which is less than the recovery of both TGYE and NA. Table 16 assesses the performance of NA fortified with 3 levels of salt.

While it appears that 3.0% of salt more effectively isolates a greater number, the population suffers from very low variability (few species). Likewise the colonies were very small and mostly microaerophilic (submerged in agar).

Three different media designed to recover sulfide-producing organisms from seawater have also been tested. Kligler Iron Agar (KIA) showed higher recovery than did Sulfide Idole Motility Agar (SIM) and Triple Sugar Iron Agar (SI).

The Natural Bacterial Flora of the Hatchery

In our study of the spectrum of the bacterial population in natural hatchery water as recovered in Bachmann's agar, we observed the following:

a) On the basis of 56 isolates identified on December 1-31, 1975, 13 (23.2%) are Gram-positive and 33 (59%) Gram-negative.

b) 27 of these Gram-negative isolates and 9 of the positive isolates are identified to the genus. The general bacterial composition of seawater is shown in Table 17.

Meanwhile, several isolates are being determined. The target number is 300 colonies, a job we believe would be finished by the end of the year.

Prediction of Mass Mortality in Hatchery Tanks

A technique which would enable us to predict the onset of diseases in hatchery tanks will have to be perfected. This makes use of daily examination of 50 individuals in a population from the zoea stage to postlarvae 6. The patterns in the appearance and disappearance of various ectocommensals at the moment are giving us leads in the prediction of mass mortality.

With these assumptions we were able to foresee the development of a nematode-caused and a fungus-triggered mortality.

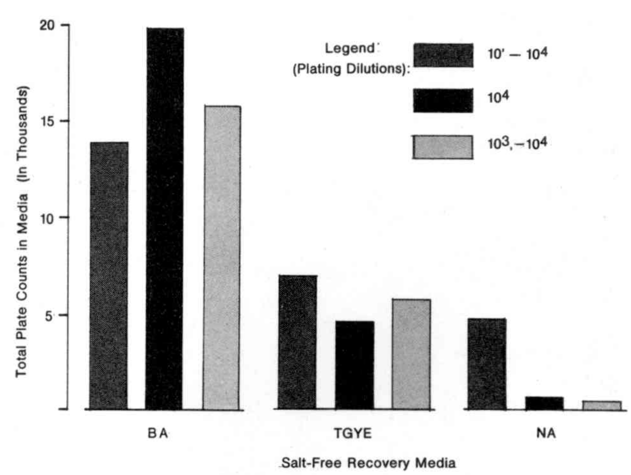
Table 16. Recovery of bacteria in NA fortified with three concentrations of salt.

Salt Concentration	Total Plate Count	Variability of Isolates
2.0%	2.275 x 10^3	varied
2.5%	6.25 x 10^2	Less varied
3.0%	4.775 x 10^3	Not varied; colonies very small

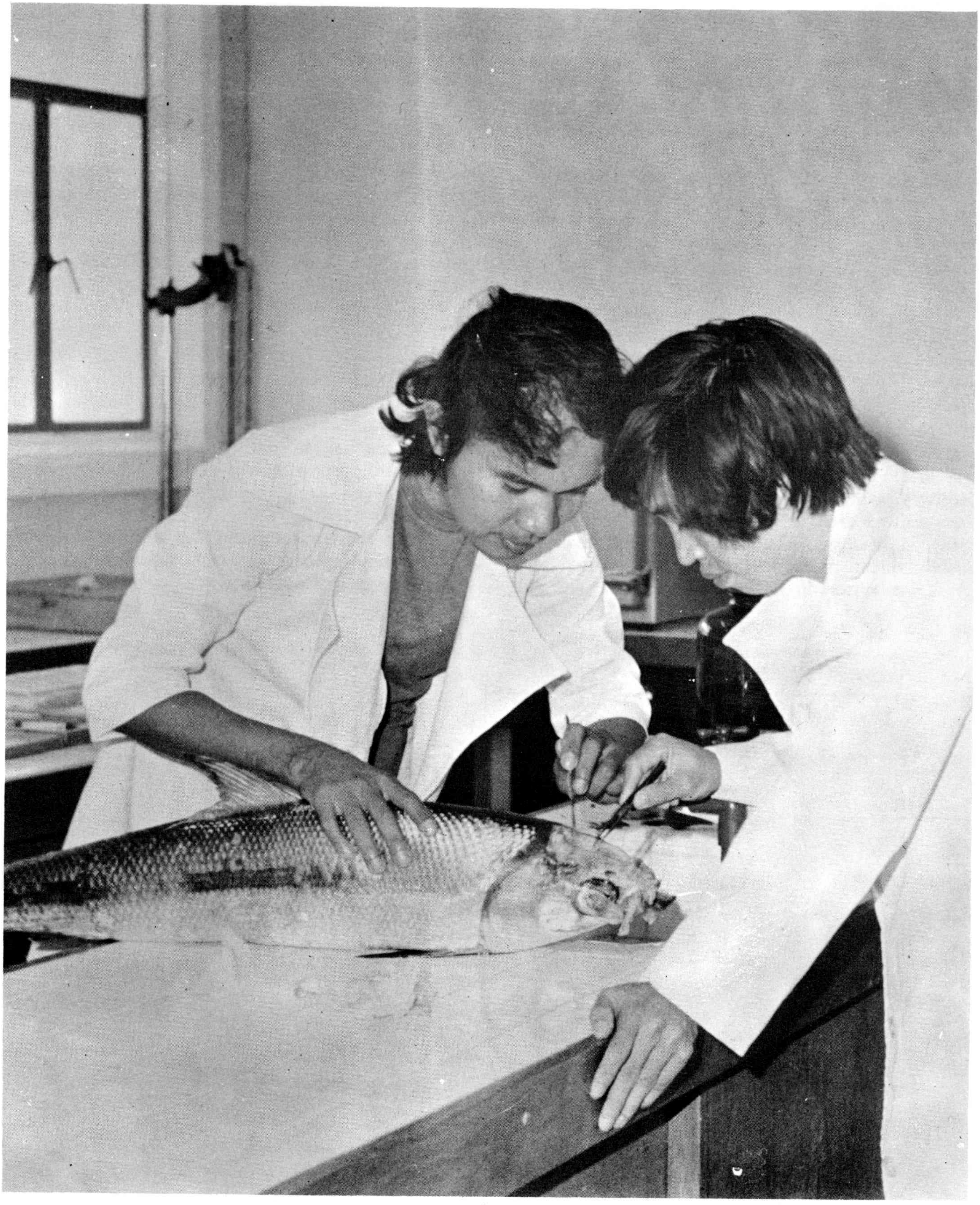
Table 17. Bacterial composition of seawater from the hatchery tanks.

A. Gram-positive isolates	No. of Isolates	Percentage
Micrococcus	6	10.8
Corynebacterium	1	1.8
Peptococcus	1	1.8
Bacillus	1	1.8
B. Gram-negative isolates		
Acinetobacter	11	19.8
Flavobacterium	1	1.8
Moraxella	7	12.6
Photobacterium	1	1.8
Plesiomonas	3	5.4
Pseudomonas	4	7.2

Fig. 21. Stability of three different media in the recovery of bacteria.



Biologists look for sabalo pituitary gland.



MILKFISH RESEARCH

Taming the Sabalo

Bangos, *Chanos chanos*, the most important brackishwater fish in Southeast Asia, today poses a major challenge to aquaculture research. While cultivation techniques are advanced enough to be capable of producing 2,000 kg/hectare/year, and while the industry is extensively developed in the Philippines, Indonesia and Taiwan, there is one severe constraint to its further expansion — the scarcity of fry.

In 1974 the fry requirement of the Philippines was estimated at 1.2 billion but the supply was as low as 500 million. This shortage was due to the fishpond operators' dependence on natural supply of bangos fry. Bangos is not yet fully domesticated and attempts to spawn them in captivity have been unsuccessful. The sabalo, as the bangos spawner is known in the Philippines, remains elusive.

With the assistance of the International Development Research Centre (IDRC) of Canada, we are directing a major effort towards the domestication of the sabalo to develop the technology to mass produce the bangos fry. A laboratory complex and supporting buildings have been completed in Barrio Mag-aba, Pandan, Antique (Fig. 22) on the northwest coast of Panay Island at a total cost of US $80,000.

Prior to the approval of the Cdn. $826,000 grant from IDRC, we had already started a series of preliminary studies on the bangos spawner and fry. A Sabalo Biological Studies Team was stationed at Pandan, Antique from May 13 to June 25, 1975.

The Sabalo Team was involved in developing techniques for catching, handling, transporting and domesticating adult bangos; determining the different stages of gonadal development; morphometric measurements and stomach contents; determining the spawning area; distribution of eggs, larvae and fry of milkfish; and monitoring the ecological conditions of the area under investigation.

Pandan Site

Our selection of the Pandan site was prompted by 1) the reported abundance of sabalo in Pandan Bay (Fig. 23); 2) the reported availability of freshwater in the area; and 3) the existence of an otoshi-ami (a fixed net with a 30-m deep bag in 30 m of water 500 m offshore), which was operated jointly by the Bureau of Fisheries and Aquatic Resources (BFAR) and a private operator. Along with the otoshi-ami, several fish corrals could adequately supply live sabalo for our experiments.

From May 13 to June 25, 1975 a total of 106 sabalo was captured in the otoshi-ami. Considerable data were collected on the morphometry of fry and adults and on the stages of gonadal development and stomach contents of adult bangos. At the same time, we gained some experience in the handling and transport of adults. We obtained very little information on the spawning site and the distribution of the eggs and larvae and our attempts to transport the adults were not successful.

Studies on the Sabalo

Stomach Content Analysis

Analyzing the contents of the formalin-preserved stomachs from 106 sabalo, we found many groups of phytoplankton and zooplankton and remnants of benthic algal forms (Table 18). Results show that adult *Chanos* are generally plankton feeders with no specific preference for feeding at any water level. They are also capable of feeding on benthic forms.

Age Determination

We analyzed scale samples from the 106 sabalo by applying the technique used successfully on domesticated grass carps in China. The method consists of counting the number of sets of discontinuous lines (Fig. 24) on each of five representative scales taken from four areas: on the first three rows above the lateral line immediately posterior to the insertion of the dorsal fin; three rows below the lateral line immediately posterior to the insertion of the ventral fins; directly above the pelvic fin; and around the anus.

Only 81 specimens were successfully analyzed. The discontinuous lines were faint and hardly discernible on some of the specimens. The scales examined contained three to five sets of discontinuous lines and each set was assumed to represent a period of one year.

For purposes of comparison and as a way of checking our interpretation of the sabalo scale data, we analyzed scales from pond-reared bangos whose ages are known. Discontinuous lines were absent on the scales obtained from 6 to 8-month old bangos. Scales from two 2-year old specimens obtained from the BFAR fishpond in Naujan, Mindoro Oriental contained two sets of discontinuous lines.

Maturity and Fecundity

We did not find any ripe female among the 106 sabalo caught during the season; most were spent and the rest of the females were still developing (Table 19). Some of the spent females had a

Fig. 22. The principal sites for milkfish research. Hamtic is an important fry ground while the milkfish spawners are caught at Pandan.

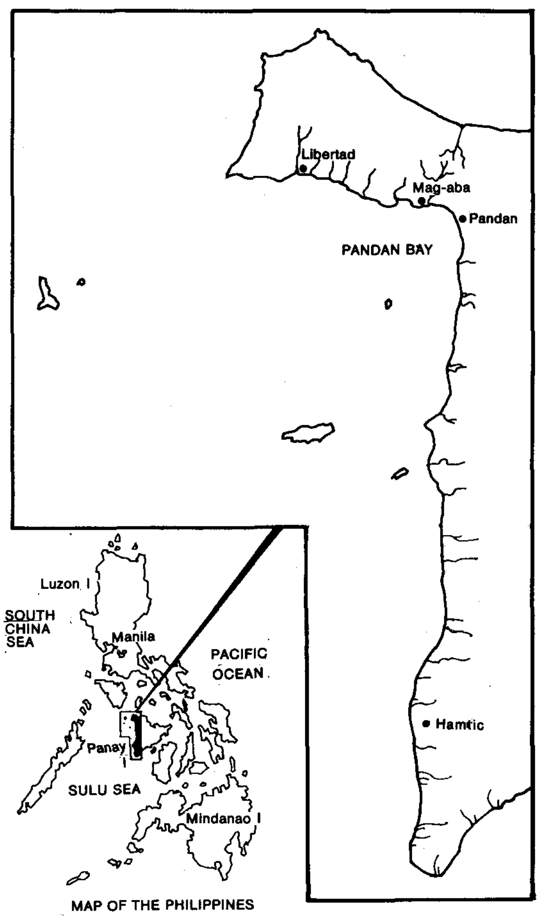
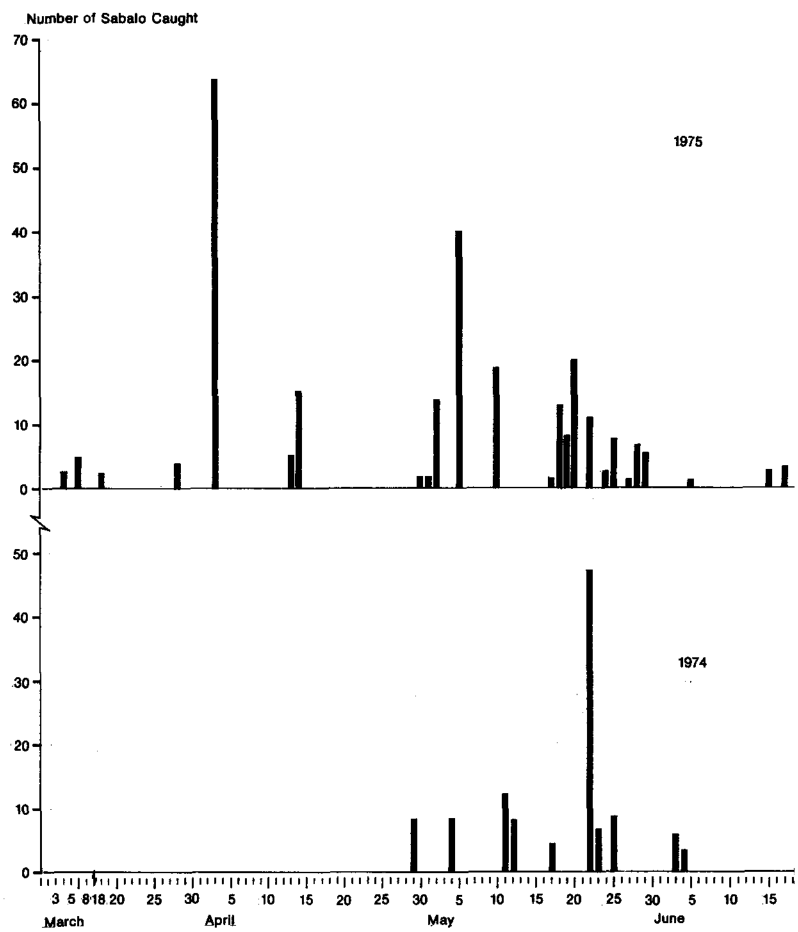


Fig. 23. Sabalo catch record of the otoshi-ami, 1974-75



few loose degenerate eggs left in the ovary. Several had mature testes (Table 20).

Fecundity studies were conducted on two mature females collected durng a preliminary survey prior to the formation of the Sabalo Team. We found the two fish to have a fecundity of 3.72 and 3.97 million eggs, respectively.

Bangos Fry Survey

From May 21 to June 25, 1975 we captured 522 bangos fry along the shore using a 2 m deep drag seine, and 1,500 from the otoshi-ami, Fig. 25. The fry caught from the shore ranged in length from 11 to 14.3 mm while those from the otoshi-ami, 5.8 to 14.6 mm.

The catch data suggest that the number of fry caught by the otoshi-ami was greater 1 to 2 days prior to the new and full moon, and 2 to 3 days after the new and full moon along the shore.

The finding on shore fry fishery agrees with the observations of fry collector and fishery officers in Southern Luzon and in Antique Province. It differs, however, with the observations in other countries that the greatest abundance of fry occurs 1 or 2 days before and up to 3 days after the new and full moon.

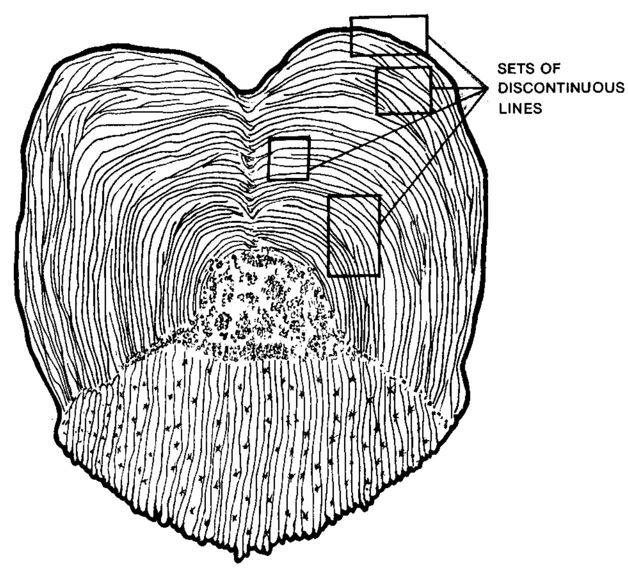
We conducted a more extensive fry survey in Hamtic, Antique, one of the major bangos fry fishing centers in the Philippines. In 1975, the production amounted to 12 million fry valued at ₱960,000, providing employment to some 700 fishermen. The concession fee collected was P303,000.

In May 1975, we established four observation stations (Fig. 26) in Hamtic Bay. We used a standard fry net made of coarse abaca cloth 3 m x 125 m. Fry are caught by two fishermen dragging the net for one hour in waist-deep water along the shore. From our monthly data, it appears that bangos fry are regularly caught from May to December, with a minor peak from May to July and a major peak

Table 18. Dietary itams of adult Chanos chanos (Forskal) from Pandan Bay, Antique based upon the examination of the esophagus and stomach content of 96 specimens.

FOOD ITEMS	NUMBER OF SPECIMEN CONTAINING EACH ITEM	PERCENTAGE OF SPECIMEN CONTAINING EACH ITEM
DIATOMS	56	58.3
Nitzchia, Thalassiothrix Fragillaria, Rhizosolenia, Coscinodiscus, Ceratium Navicula, Chaetoceros, Eucampia, Ditylum Melosira. Biddulphia		
ZOOPLANKTON	90	93.75
Copepods	83	86.5
Egg case	3	3.1
Crustacean Egg	6	6.1
Crustacean nauplii	2	2.1
Crustacean Zoea	4	4.2
Crustacean Juvenile	1	1.04
Crustacean shell	2	2.1
Crustacean appendages	2	2.1
Fish egg	14	14.6
Fish larvae	5	5.2
Vorticella	1	1.04
Sarcodina	1	1.04
Foraminiferan	1	1.04
Ciliophoran	2	2.1
Cladoceran	1	1.04
Echinoderm larva	1	1.04
ALGAE	71	73.96
Chlorophyte	39	40.6
Cyanophyte	37	38.5
Rhodophyte	28	29
DETRITUS	65	67.71
DEBRIS	5	5.2
PIECES OF SAND	1	1.04

Fig. 24. Diagram of a typical dorsal scale from a Sabalo with an estimated age of four years.



from October to December (Fig. 27). In contrast, the major peak in most parts of the Philippines occurs in April to June.

We observed that the catch of bangos fry is greatly affected by the tides and inshore winds, the peaks coinciding with the new and full moon. Spring tides bring the fry closer to the estuarine coastal areas for feeding and since they generally inhabit the surface layers, they drift inshore — making them available to fishermen.

Other physico-chemical factors do not appear to affect the abundance of fry. Salinity in the area ranges from 30 to 34 ppt and temperature, 28°C. to 31°C. We noted that freshwater flow attracts more fry as indicated in the catch of Stations II and III which are located close to the mouth of freshwater rivers. At this stage, we cannot determine whether the fry are responding to low salinity or reacting negatively to the flow of water, as is commonly known.

We also took length measurements of the fry during the peak months. Mean length of the monthly runs did not vary considerably: 14.48 + 0.70 mm in October, 14.21 + 0.82 mm in November, and 14.21 + 0.82 in December (Fig. 28).

We are continuing our survey in order to determine whether or not the result we obtained during the study period is the norm for Hamtic Bay.

Seed Bank

The shortage of bangos fry and fingerlings throughout the country at certain seasons of the year is aggravated by floods and typhoons. A seed bank for bangos would help guarantee a more continuous supply and more stabilized prices throughout the year. The traditional method of stocking bangos fry in small earthen-diked shallow ponds is

Milkfish ecological survey team on board SEAFDEC II.

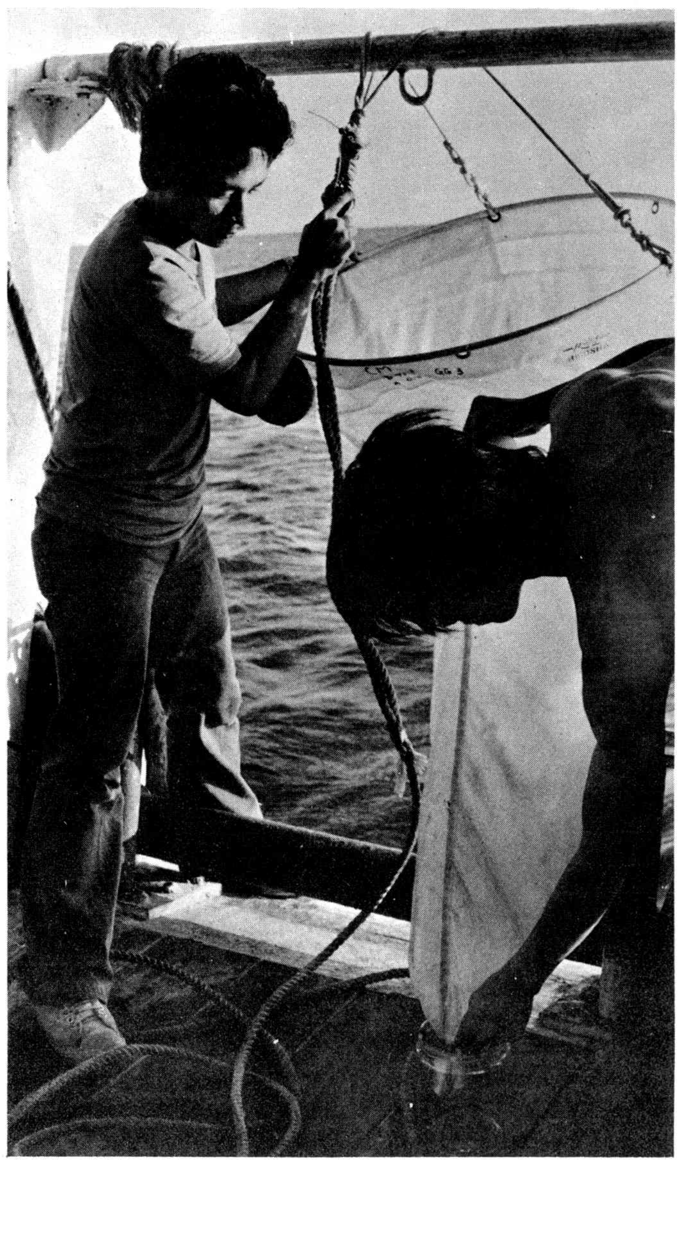


Table 19. Gonad condition of 36 female Sabalo (Chanos chanos) caught in Pandan, Antique, May 10 to June 16, 1975*

	STAGE MATURITY			
	DEVELOPING EARLY	DEVELOPING LATE	MATURE	SPENT
NO.	7	2	0	24
Mean Fork Length (cm)	76	78	—	79
Mean Body Weight (gm)	5850	6885	—	6,194
Mean Ovary Weight (gm)	111	600	—	82
Mean Gonado-somatic Index	1.90	8.71	—	1.32

*The gonad condition of three specimens could not be determined as to whether they were developing or spent.

Table 20. Gonad condition of 70 male sabalo, *Chanos chanos*, caught in Pandan, Antique, May 10 — June 16, 1975.

	SEXUAL MATURITY		
	Developing	Mature	Spent
NO.	0	43	27
Mean Fork Length (cm)	—	75	75
Mean Body Weight (gm)	—	5,922	5,320
Mean Testis Weight (gm)	—	222	51
Mean Gonado-somatic Index	—	3.75	0.95

subject to natural calamities, so we tried using 200-ton concrete tanks with aerators and studied the stocking density and survival rate of the fry under tank conditions. We also tried using suspension net, 1-ton marine plywood tanks, and shallow plastic basins for stocking the fry. We came up with low survival rates (1.5%.)

The major problem we encountered was the occurrence of predatory species with the bangos fry. It was difficult to distinguish the predatory species from the bangos fry. At the stage that they are collected they are all transparent and of the same size, making sorting on a mass scale virtually impossible. The extent of occurrence of the predator species as well as their identity was not known until much later when they were more fully developed. The predators were identified to be composed of the following species: *Elops hawaiiensis, Megalops cyprinoides, Glossogobius giurius* and *Therapon jarbua.* They were observed to have grown faster than the bangos fry and examination of their stomach content revealed the presence of bangos fry.

Fig. 25. A comparison of fry occurrence and abundance between the otoshi-ami and shore fry fishery at Pandan, Antique in May, 1975.

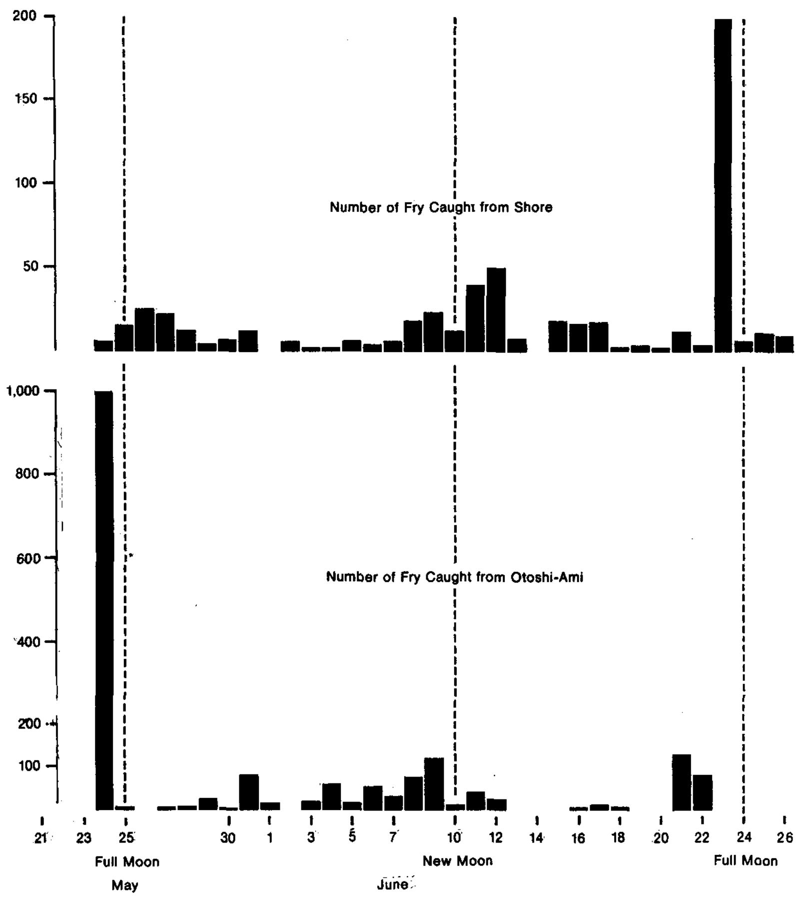


Fig. 26. The observation stations for studies on the bangos fry at Hamtic, Antique.

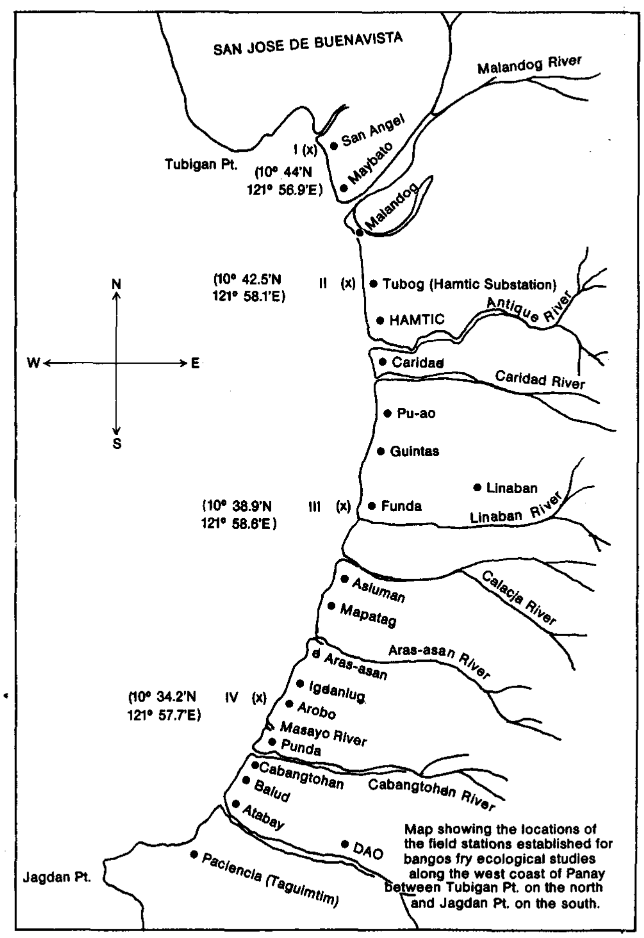


Fig. 27. The catch of bangos fry in Hamtic, Antique, May-December, 1975

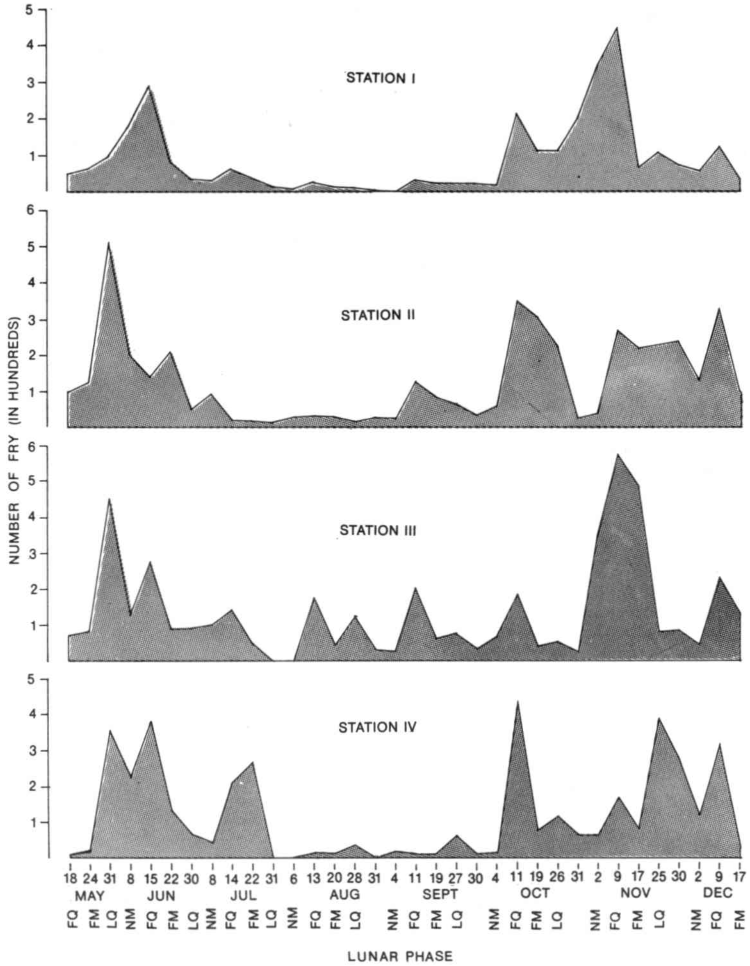
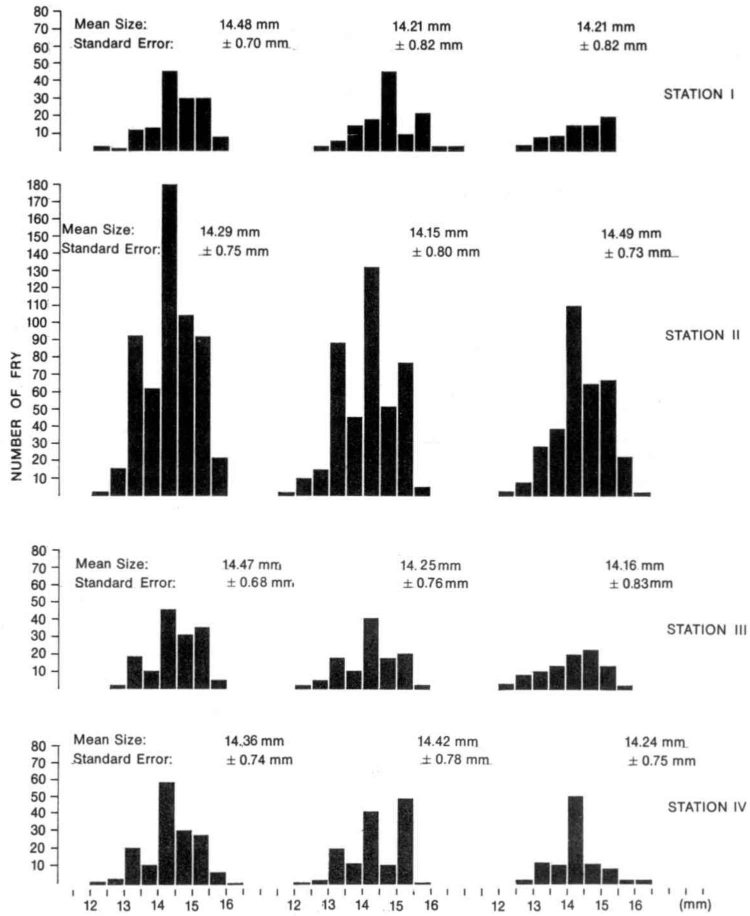
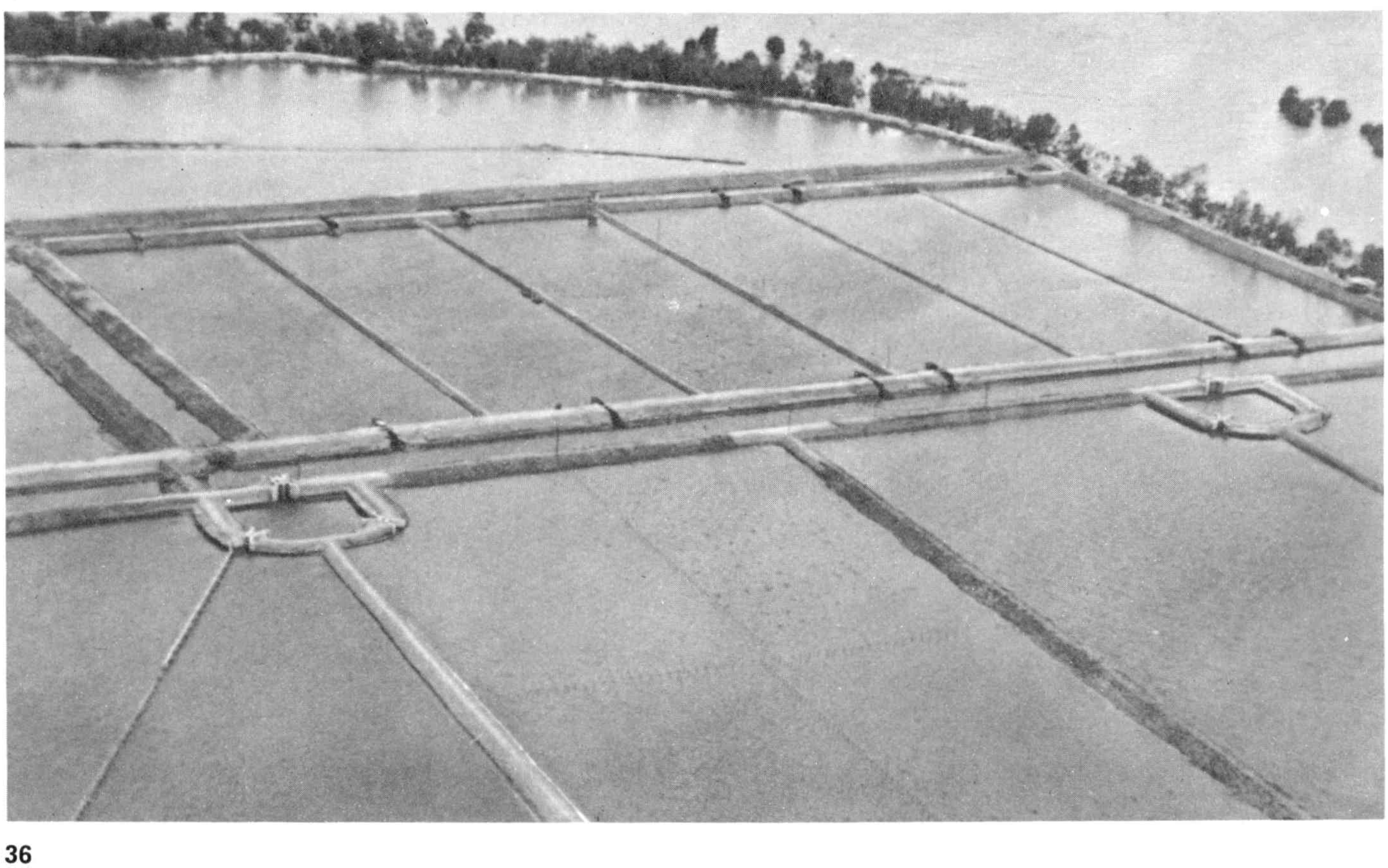


Fig. 28. Length-frequency of bangos fry caught in Hamtic, Antique during the peak season in October to December, 1975



Portion of the Leganes fishpond.



POND CULTIVATION

Pond Facilities

Construction and development of ponds is still going on in our 96-hectare fishpond area in Leganes, Iloilo. At present all the ponds need further excavation to be considered fully developed. The average pond bottom is 1.5 m above the zero-level; ideally, the elevation should be no more than 1.0 m above zero level. Compounded by the lack of freshwater flow into the fishpond area, the high elevation causes salinity as high as 60 ppt during the dry months from February to May. During other months salinity seldom exceeds 34 ppt. We are now drawing plans to tap the nearby Jalaud River to enable us to control pond salinity.

Transplanting the Sugpo Fry

For purposes of harvest, Tigbauan hatchery operations need feedback on survival rates of fry of different postlarval stage stocked in the Leganes ponds. We took four different postlarval stages and reared them up to 6.7 weeks in nylon suspension nets set up so as to simulate the pond condition. The suspension net method was used because it solves the problem of difficult recovery of the mud-burrowing sugpo - - the net is simply lifted from the water and the experimental animals are harvested.

Results show higher survival rates for P_{15} and P_{18} with no significant difference between the two.

Experiments to determine optimum stocking density for *P. monodon* show that low stocking density results in higher average body weight: 3.38 g at 1 fry/m^2 vs. 1.76 at 4 fry/m^2 after 15 weeks. Fry stocked in compartments along the gate side of the pond showed higher growth rate than replicates on the side away from the gate. The experiments are still in progress.

Rearing Experiments

We are comparing the effectivity of constructing diagonal canals and zigzag canals on the pond bottoms on improving prawn survival (Fig. 29). Initial results are encouraging. Survival in the pond compartments with zigzag canals was 51% as against 19% in the compartments with diagonal canals. More observations shall be undertaken.

Traditionally, prawns are only secondary products in fishponds; milkfish is the principal crop. The high economic value of prawns has given rise to the idea of monoculture of prawns. Our preliminary observations indicate that there is no significant difference in the survival of *P. monodon* when reared by itself or together with milkfish. There is a minimal overlap in the feeding habits of the prawn and the milkfish. At the early stages, both animals feed on lablab and plankton. The prawn becomes predominantly carnivorous during its later stages.

Feeding the prawns is a major problem in prawn farming because they are carnivorous; moreover, economic feasibility and biological requirement are often incompatible. In the search for the ideal supplementary feeds we are testing salted mussels, trash fish, chicken entrails and commercial pelletized fish feed.

Studies on Organic Pesticides

Predator control is another major problem in the pond cultivation of *P. monodon*, *C. chanos* and other species particularly during their vulnerable stage. Chemical pesticides are often resorted to with its resultant build-up in food chains. In order to find safe pesticides that are naturally degradable into nontoxic forms, we tested the effect of toxic local plants on common pond pests as well as on *P. monodon* and *C. chanos*. Three plants were used — casla tuba *(Croton tiglium)* fruit, lagtang *(Anamirta cocculus)* fruit, and bugani bark. The dried and pulverized extract was added at the rate of 1 g per 3 liters of pond water in aquaria containing the previously acclimatized tests animals.

All fish species show varying degrees of susceptibility to the plant poisons in contrast to *P. monodon*, a crustacean which remained alive even after three days. On the average *C. chanos* was observed to succumb after the shortest time of exposure, followed by *Poecilia* (Fig. 30).

Research plans for next year include bioassays using tobacco dust and root of the derris, a local plant which is one of the sources of rotenone, a widely used piscicide.

Maturation Experiment

P. monodon is not known to attain sexual maturity when confined in ponds. We attempted to induce precocious maturation in captivity by extirpating both cyestalks of 3,000 *P. monodon* juveniles averaging 5 g in weight. Mortality was massive among the experimental animals with only 4.5% survival as against 49% in the control group. Growth rate of the survivors, however, was phenomenal. The ablated animals increased by 56.7 g in 120 days, the unablated by only 15.4 g during the same period. There was no evidence of sexual maturity in any of the test animals. Further experiments will be conducted using older animals.

Research with the Private Sector

The involvement of private fishpond operators under an ongoing Cooperators' Program handled by our Training and Extension Unit has expanded our research capability in pond cultivation. Analysis of the data from the First Cooperators' Program shows a correlation index of 0.72 between salinity and average body weight of prawns at harvest (Fig. 31). The correlation index obtained is significant at the 5% level. There is no evidence

Fig. 29 Sketch of pond compartments with diagonal and zigzag canals.

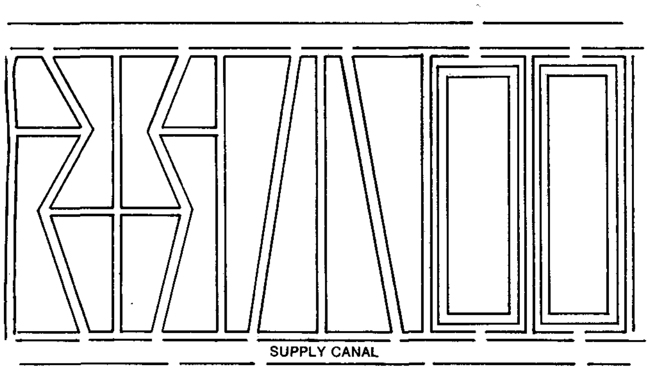
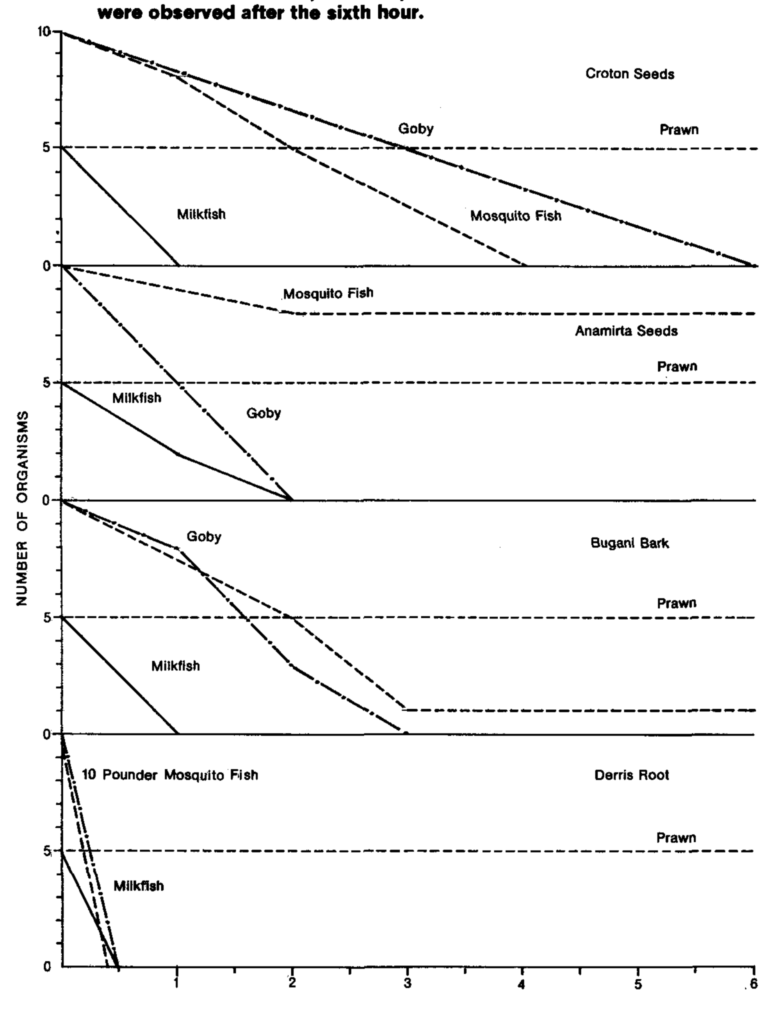


Fig. 30. The effect of certain organic pesticides on milkfish, prawns and some fishpond pests. Observations were continued for 72 hours, however, no further deaths were observed after the sixth hour.



that survival was affected by salinity. There was no control over pond design, size, pond management practices, fertilizers and other variables.

We are still awaiting the full results from the Second Cooperators' Program to see whether the first observation will be duplicated. Laboratory experiments also indicate faster growth at lower salinity. (See section on Water Quality.)

The cooperators were involved in an experiment on the use of suspension nets as an intermediate step prior to the release of sugpo fry into the ponds.

The practice of acclimatizing bangos fry in a suspension net (traditionally known as bitinan) for a number of days prior to pond stocking has been reported to improve survival rates. The rationale is to provide a predator-free environment to the still vulnerable fry and to release them after they have gained enough strength to escape predation. Previously this method has never been tried on sugpo.

An experimental group used the suspension net for one month while a control group stocked fry directly. Overall survival during harvest for directly stocked prawns was 24.0% and 7.3% for those initially stocked in suspension nets. Recovery from the suspension net after one month averaged 25% (Table 21).

Mortality could be traced to the relatively limited volume of water inside the net compared to the whole pond in direct stocking. Decreased volume leads to competition for food, space, oxygen and other resources. As individual fry succumbs to the stress, cannibalism takes place. On the other hand, bangos is not normally a cannibalistic species. This may explain the success of the use of suspension nets in acclimatizing bangos fry prior to stocking, and its failure on sugpo. Moreover, the length of time for this particular experiment (one month) may have been too long.

At this stage we recommend direct pond stocking of sugpo fry for better recovery provided the standard requisites for pond preparation of drying, dike repair, pesticide application, etc., are undertaken to produce a predator-free pond.

One problem encountered in our work with the private sector is their reluctance to report actual harvest record. Fear of getting their harvest report used for tax purposes is hard to overcome despite assurance of confidentiality.

Fig. 31. Relationship between pond salinity and size at harvest of *P. monodon* r = 0.72 with 9 d. f. The data are based upon harvest data reported by 11 members of the First Cooperators' Program.

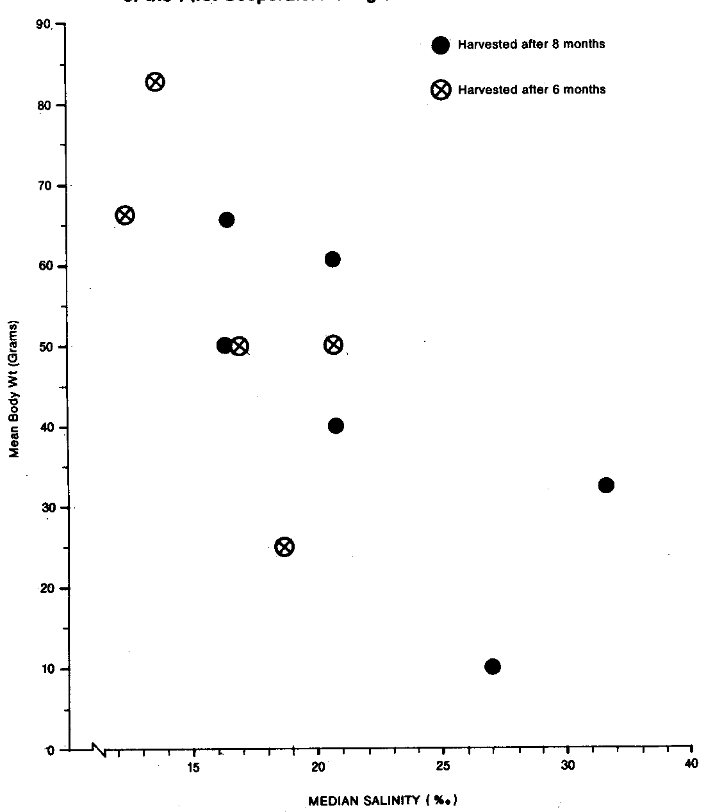
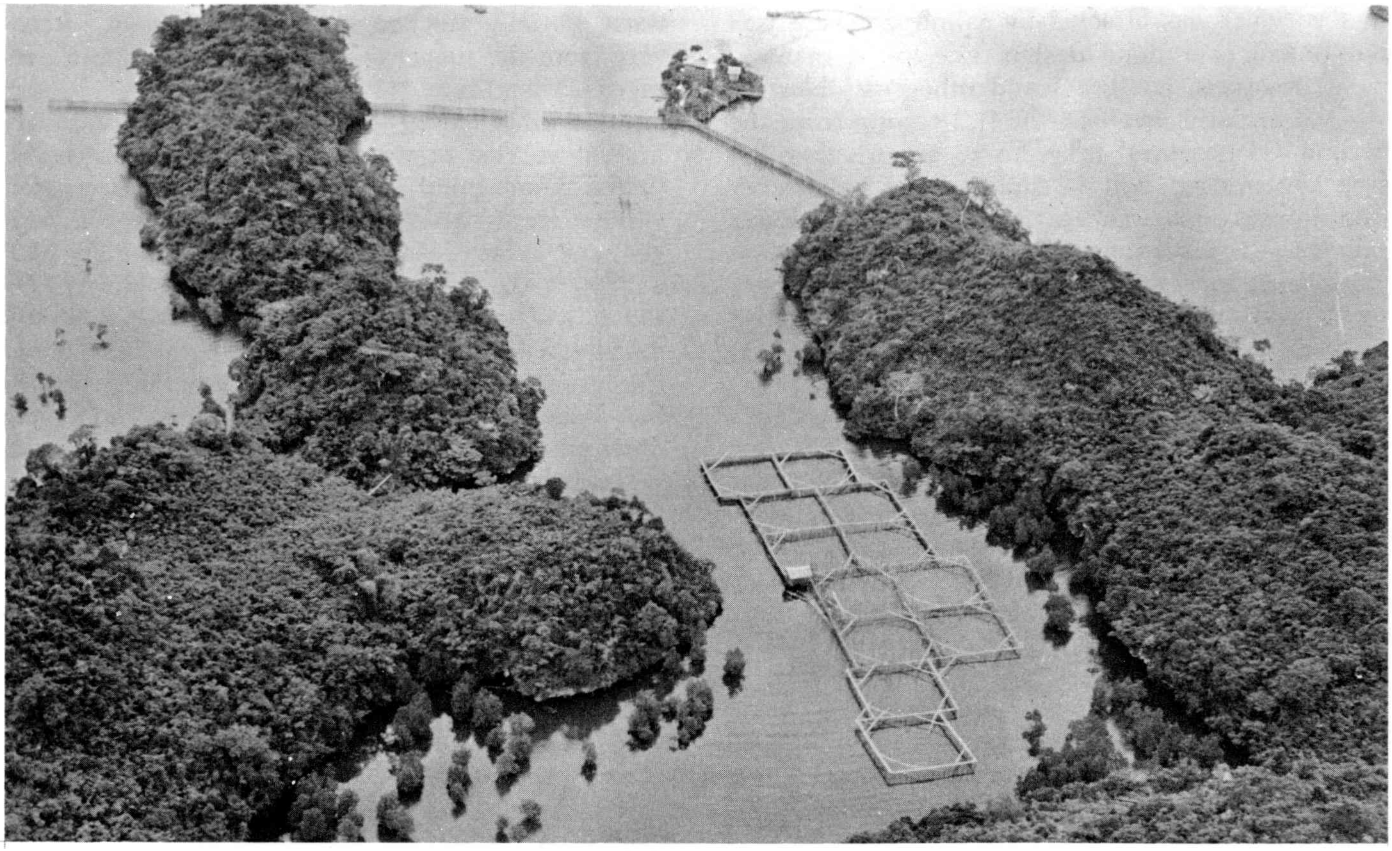


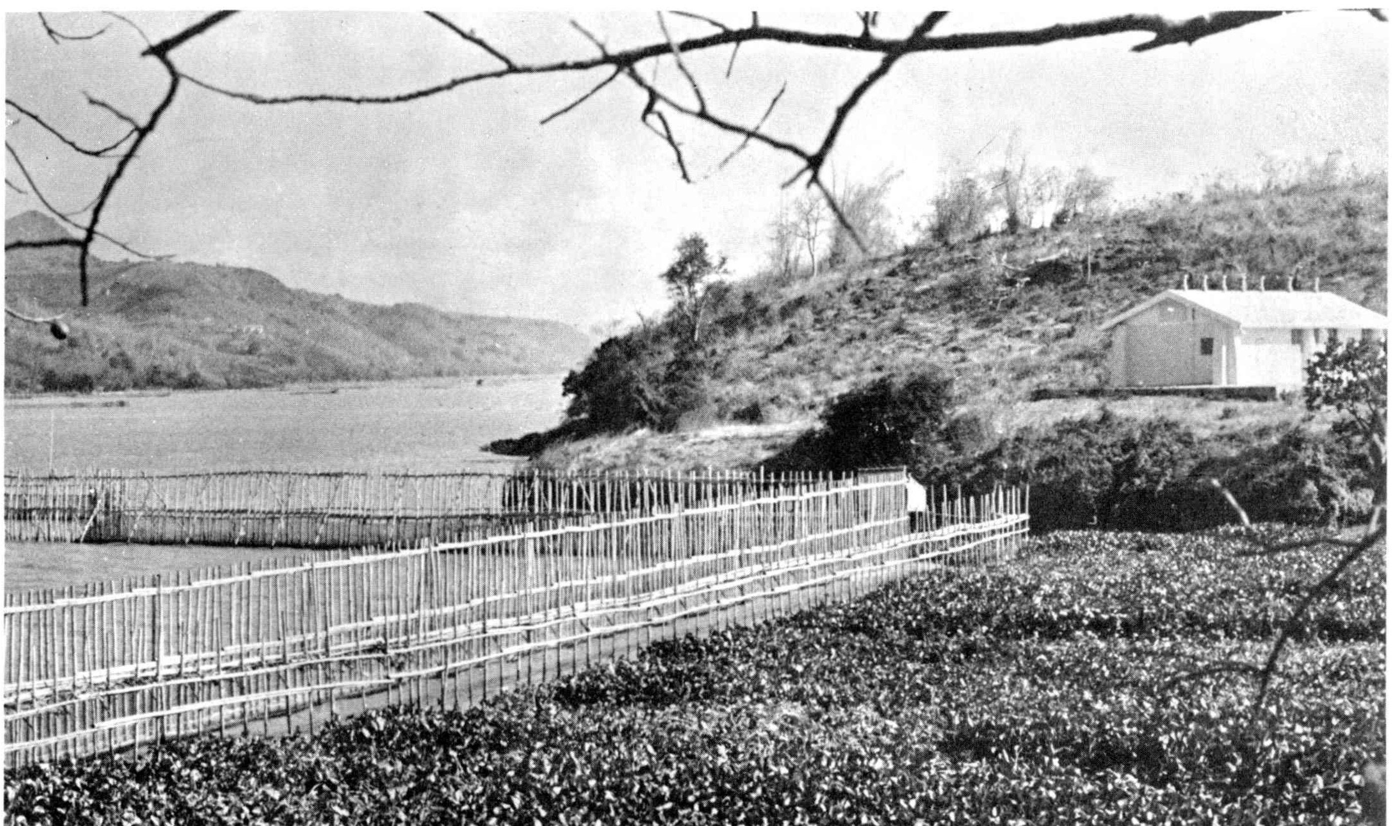
Table 21. Comparison of the survival rate at harvest of prawn fry initially stocked in suspension nets and directly stocked in ponds.

Pond No.	Initial Count	Count after 30 days In hapa net	% Survival at Transfer	Count during Harvest	% Survival at Harvest
A. With Suspension Net					
1	30,000	5,001	16.67	317	1.1
2	40,000	8,350	20.88	850	2.1
3	40,000	7,551	18.88	No data	
4	40,000	16,613	41.53	3,000	7.5
5	40,000	10,305	25.76	4,000	10.0
6	40,000	9,100	22.75	6,300	15.8
7	40,000	8,400	21.00	No data	-
8	40,000	6,800	17.00	No data	-
9	40,000	15,300	38.25	No data	-
B. Direct Stocking					
10	40,000	-	-	4,463	11.2
11	40,000	-	-	2,256	5.6
12	40,000	-	-	7,260	18.2
13	40,000	-	-	8,511	21.3
14	40,000	-	-	25,505	63.8
15					
AVERAGE:	Suspension Net	-	24.8		7.29
	Direct Stocking	-	-		24.00



Igang Bay, Guimaras Island offers numerous sheltered coves with oceanic conditions ideal for sea farming experiments. Maturation pens and station house can be seen near center.

Temporary laboratory building of the Freshwater Aquaculture Center at Tapao Point, Binangonan, Rizal, overlooking a fishpen in Laguna de Bay.



CULTIVATION OF OTHER SPECIES

Farming Lakes, Rivers, Seas

Mangrove swamps suitable for brackishwater ponds are a finite resource. The quest for greater production leads towards using freshwater bodies, sheltered coves and shallow bays as culture areas. There is therefore a need to study species suitable for cultivation in each of the different habitats.

Southeast Asia is endowed with an extensive freshwater system consisting of rivers, lakes and reservoirs which are potential protein-producing areas. Hence we are extending our operations to include freshwater aquaculture. While awaiting the establishment of a freshwater aquaculture station, we have started studies on the giant freshwater prawn, *Macrobrachium rosenbergii.*

At present a great portion of the fish harvest is caught from bays and coves. The shallow bays are very productive areas but they are subject to overexploitation and depletion. Their utility could be upgraded from hunting grounds to controlled farming grounds.

We have taken two steps towards farming the bays. One, with the assistance of the Government of New Zealand, we are conducting biological studies on mussels which are well-known for their productivity and potential as cheap protein food. Two, we are developing our Igang substation, where our prawn maturation and rematuration experiments were successfully carried out, into a laboratory complex for researches on sea-farming.

The Freshwater Aquaculture Station

The freshwater station will be built on a 43-hectare site located in Tapao Point, Barrio Pipindan, Binangonan, Rizal along the shores of Laguna de Bay, the largest freshwater lake in the Philippines. The plan to put up the station was approved during the Seventh SEAFDEC Council Meeting held in Manila in December 1975.

The objectives of the freshwater station are the following:

1) Undertake intensive research and mass propagation by natural and artificial breeding of such suitable species as carps (Asiatic, Indonesian and Indian species), channel catfish, native catfish, tilapia, milkfish and giant freshwater prawn;

2) Work on systematic limnological, ecological and basic productivity studies in other inland freshwater lakes, swamps and rivers in the country and possibly in Southeast Asia;

3) Implement adequate pilot and experimental programs on fish species using fishpens and experimental ponds;

4) Conduct research and development projects to maintain or improve the ecological balance of the lake;

5) Establish freshwater aquaculture substations at strategic locations in the Philippines and Southeast Asia; and

6) Provide training facilities for pond and pen operators and researchers on freshwater aquaculture.

We have made contacts with West German and Danish officials to explore possibilities of support for this new freshwater aquaculture station.

The formal signing of a Presidential Proclamation reserving some land for the freshwater station is still being awaited.

Construction of the buildings and facilities will start January 1976 and is expected to be completed July 1977. In preparation for the implementation of the Project, we have dispatched a technical team to Japan to conduct a survey of needed facilities as well as observe techniques of breeding and culture of freshwater species.

We are establishing tie-ups and linkages with other fisheries agencies and institutions including private aquaculture enterprises for the exchange of technical information on freshwater aquaculture.

As envisioned in our five-year projection of activities (1976-1980), the Project will require a total budget of US$24 million of which US$5 million will constitute the foreign exchange component and the balance of US$19 million from the Aquaculture Department and other sources.

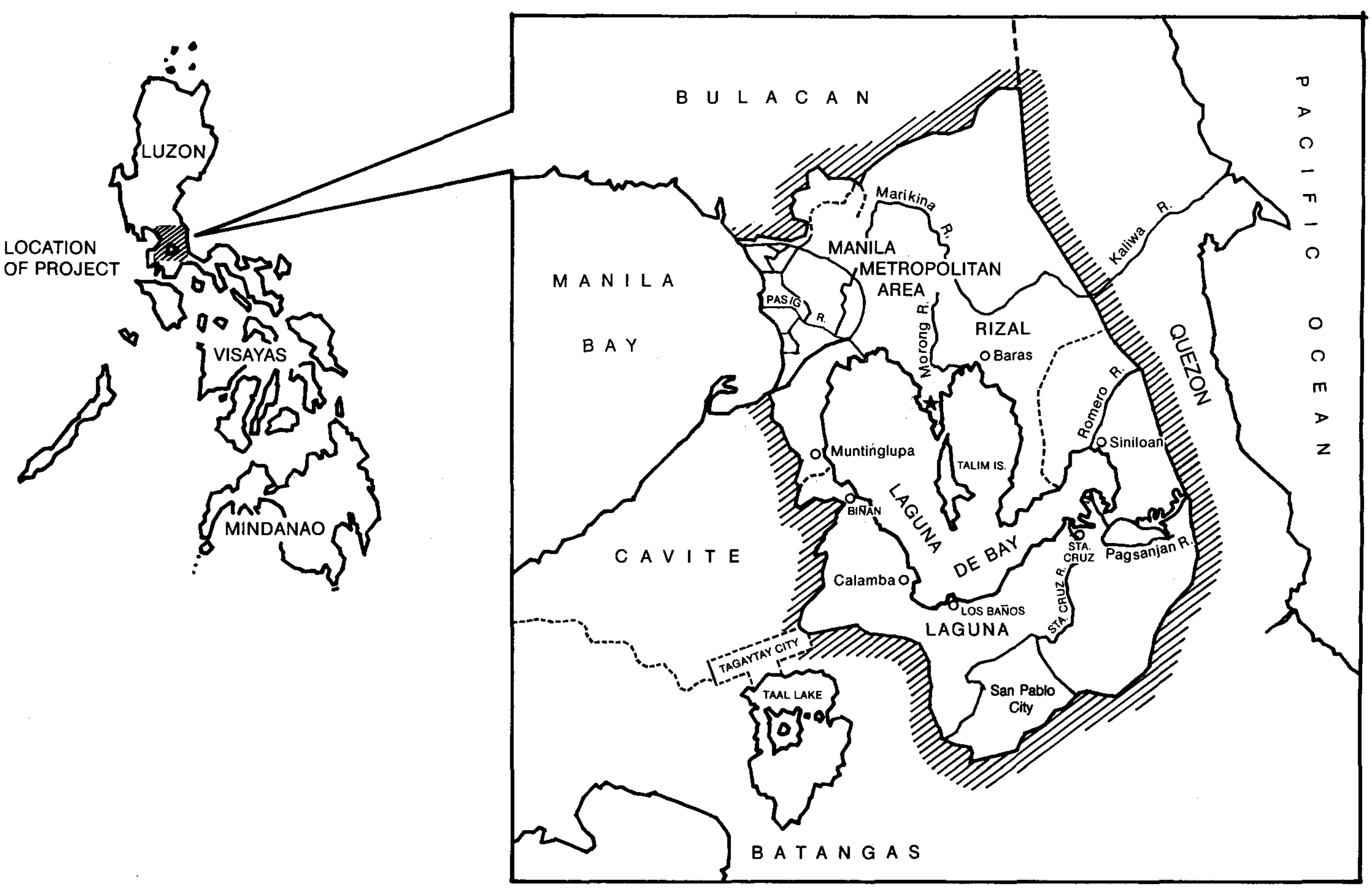
Giant Freshwater Prawn

The giant freshwater prawn *(Macrobrachium rosenbergii)* is considered one of the commercially important prawn species. Widely distributed in the Philippines, it is found particularly in several big river systems in the island of Panay. It commands a good price (about P25.00 per kg) but the supply which is all from the wild hardly fills the demand.

The berried female prawns we used for the experiment were caught by bamboo traps from Jalaud River of Zarraga, Iloilo. Female prawns laden with orange to grey-colored eggs were brought to the laboratory in 60-liter plastic containers with about 20 liters of previously aerated water.

Eggs that are ready to hatch are grey-colored while newly-spawned eggs are light orange. Females laden with grey-colored eggs were stocked in 200-liter hatching aquaria with water of about 5 ppt salinity until the eggs hatched. Females laden with orange-colored eggs were held in one-ton tank with freshwater until the eggs turned grey — at which time they were transferred to the hatching aquaria.

Location of the proposed freshwater aquaculture station, Binangonan, Rizal, Philippines.



Females ranging from 30 to 60 grams produced an average of 30,000 larvae. The newly-hatched larvae were siphoned from the hatching aquaria and stocked in one-ton fiberglass tanks for experiments on optimum salinity levels, stocking density and feeding.

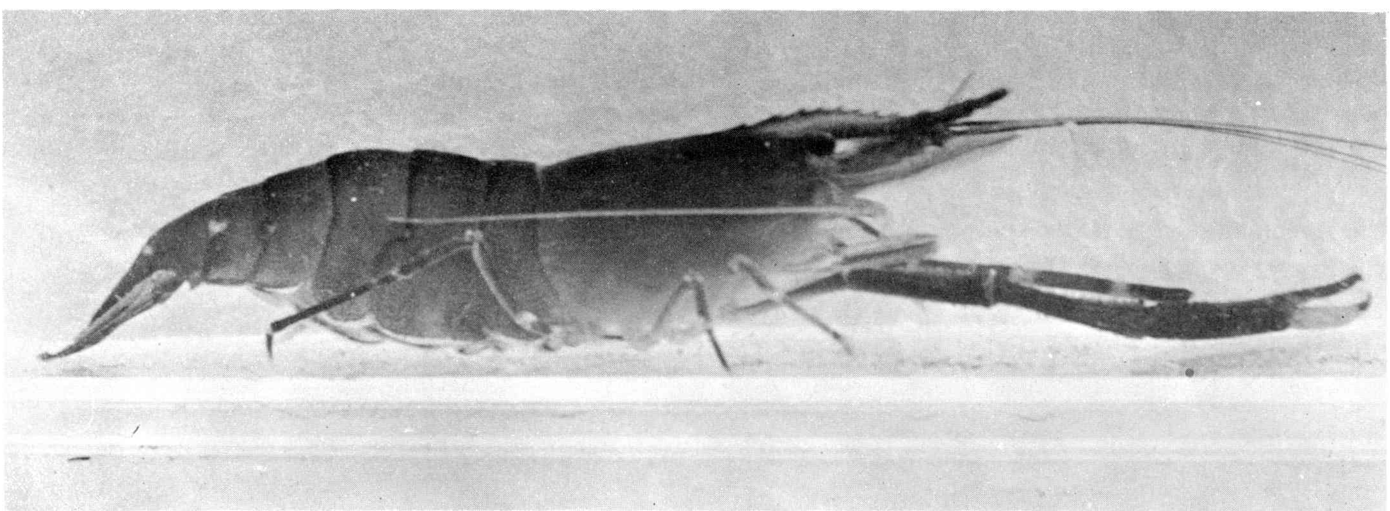
We found salinity levels of 10-18 ppt to give the best results. This result is consistent with those obtained by other workers. We have determined an initial stocking density of 10 to 20 larvae per liter to be desirable. We have also found that it is possible to initially stock as much as 100 larvae per liter provided the density is reduced to 10 larvae per liter when the larvae reach the 5th stage.

The larvae at stages 1 to 5 developed faster when fed a combination of brine shrimp and rotifer than when fed only brine shrimp. A combination of strained fish flesh and brine shrimp nauplii gave comparable results with a combination of hard boiled egg yolk and brine shrimp nauplii. The egg yolk has the advantage of being easier to prepare. We are currently experimenting on the suitability of frozen water flea *(Moina macrocopa)* as a substitute for the expensive brine shrimp nauplii.

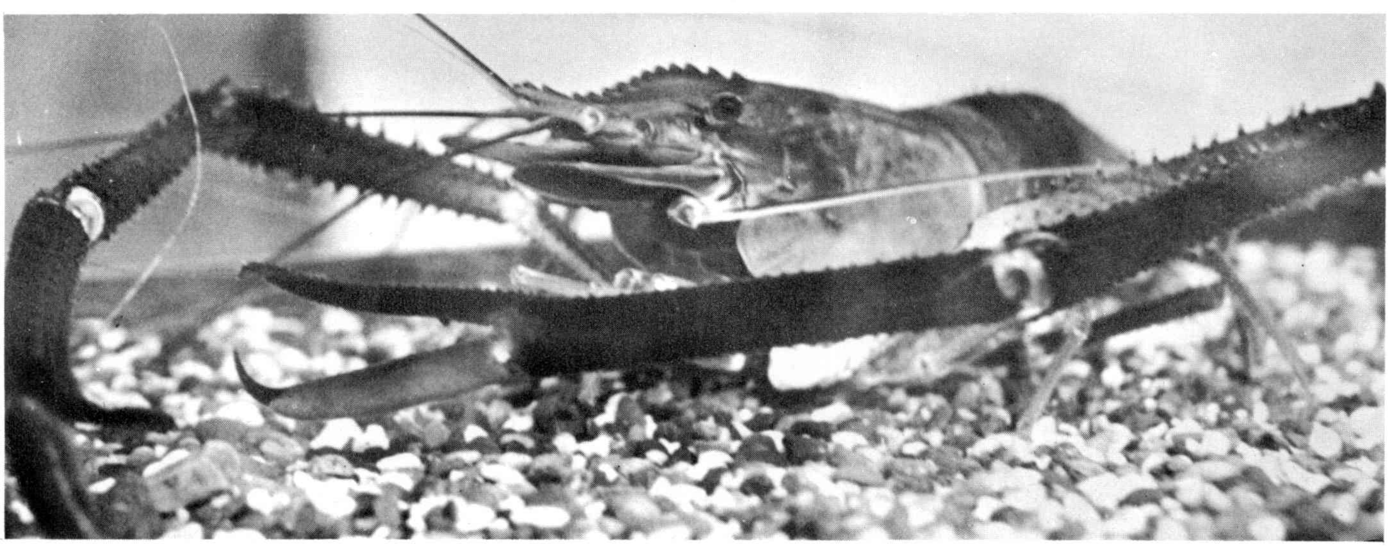
The larvae of *M. rosenbergii* undergo 11 larval stages before they metamorphose to postlarvae. The first postlarva may appear in 22 days at optimum conditions while some may not metamorphose for as long as 50-60 days. Normally, one rearing cycle takes about 45 days.

With the present method of rearing, the average survival rate from Stage 7 is about 70%, but there is a very abrupt decline of population from Stage 7 until postlarvae. We are now studying the possible factors that cause such high mortalities in later stages. Emphasis is placed on the method of maintaining good water quality throughout the rearing cycle.

We found that more than 50% of both field and tank-reared *M. rosenbergii* suffer from tail-rot. This disease is manifested by gradual erosion of uropods and usually culminates in the shedding of exoskeleton, exposing the entire tail musculature as was the case of one spawner. We still



Huge claws distinguish the male Macrobrachium from the smaller female.



do not know whether this is the advanced form of the more widely spread "carapace rot", which is characterized by whitish discoloration on the exoskeleton especially on the carapace and less frequently on the abdominal segments. This discoloration later intensifies, leading to orange or pink patches that eventually become brown. The affected portion of the carapace and the outermost portion of the musculature become rough. During molting the symptoms are lost but they recur soon thereafter on the same spot as before.

Our isolation and characterization studies have so far revealed the association of *Photobacterium*, *Lucibacterium* and *Plesiomonas* known in literature to be non-pathogenic. But we have not been able to isolate the widely-known *Aeromonas* and *Vibrio*, two pathogens causing various diseases in crustaceans. We hope that the identity of the pathogen will soon be fully established.

Mussel Research

From September to October 1975, we conducted a survey on the status of mussel farming in the Philippines. We found Bacoor Bay, which is within the south coast of Manila Bay, to be the only place where the farming of the green mussel *Mytilus smaragdinus* is well established. There, bamboo poles, driven about 2 m into the mud and spaced some 2 m apart in waters 5 m deep, are capable of producing as much as 12.5 kg of mussel per meter of bamboo after only 5 months.

In Sapian Bay, on the island of Panay, a pilot farm of the town of Sapian, Capiz province uses webs of 12 cm polypropylene rope as culture substrate. The project is doing so well that a well-known Manila-based company has now put up a one-hectare farm within the same area.

The farming techniques used in the Bacoor Bay and the Sapian Bay farms are all of the shallow water, fixed structure types which are not amenable to husbandry.

To introduce innovative techniques in mussel farming, we are conducting a baseline study on various aspects of mussel biology. The mussel research project which we started in October 1975 will last about two and a half years. For the first 15 months our work is centered around reproductive biology, seasonal condition, growth rates, and larval settlement behavior of both mussels and competitor organisms. We are testing four different materials for their attractiveness to mussel spats: black polypropylene film rope, blue polypropylene fiber rope, coir rope and fibrillated polypropylene film. Farming techniques used successfully in other countries are also being assessed under local conditions.

The program is not limited to the green mussel *Mytilus smaragdinus;* it includes the lesser known

The green mussel Mytilus smaragdinus.

brown mussel *Modiolus metcalfei*. This mussel, an inhabitant of mudflats, is found even in areas where the green mussel is absent. Up to now it has only been gathered without any attempts at farming.

Our work on the biology of the green mussel is conducted at the Sapian Bay pilot farm. We have also established spat monitoring stations in Binalbagan, Negros Occidental and in Maqueda Bay, Samar. Banate Bay is our study site for *Modiolus metcalfei*.

In addition to the biological study, we are doing proximate analysis in cooperation with the Food and Nutrition Research Institute (Manila) to determine changes in food value from season to season. Work on salinity tolerance and survival of mussels out of water will also be undertaken.

After initial biological studies, we plan to establish a pilot farm to provide opportunity for further studies in farming techniques. Aspects we plan to look into include harvesting, transporting, marketing and possibly even processing. The farm will also be used as a demonstration site for training fisheries technicians from the Philippines and other SEAFDEC participating countries.

Sea-Farming Station

The present station is located in one of the 26 islets in Igang Bay, Guimaras Island. The entire project site reservation is about 345 hectares of which two-thirds is covered by water. A speedboat ride from the Tigbauan main station to Igang takes about 35 minutes. Igang is also accessible by ferry boat from Iloilo City and by land route via the Municipality of Jordan.

The site is suitable for mariculture research and development under tropical condition because it is sheltered from the prevailing strong winds from the Northeast and Southwest. The water is typically marine and free from possible agricultural, domestic and industrial pollution. Salinity ranges from 29 to 31 ppt and the surface temperature ranges from 24.5° to 29°C. Tide level is from 0 to 6.0 ft. The bottom is generally sandy and coraline except for the inlets and coves which are generally sand and mud.

There are 14 coves ranging in sizes from 3 to 5 ha which are ideal for enclosures for commercial finned fishes and shellfishes as well as other potential aquaculture species. There are some 26 coraline islets ranging in sizes from 200 sq m to 10 hectares including some mangrove areas for conducting ecological studies.

Potable water for domestic and laboratory use could be made available by well drilling in the main island of Guimaras.

A proposal for assistance in the development of our sea-farming station has been submitted to the Government of Australia.

Divers drive long bamboo stakes into the muddy substrate for a mussel farm in Bacoor Bay, Cavite.

Lone gatherer pushes a fry collecting trawl, while a pair drags a seine for milkfish fry.

SOCIAL ASPECTS OF AQUACULTURE

Aquaculture is for People

The most important aspect of aquaculture in the final analysis is its influence on man. Who are dependent on aquaculture; how do they fare economically; are they satisfied with their present condition — all these questions need to be answered. After all, it is for the people that science and technology ought to be oriented. It is with this in mind that we are conducting jointly with PCARR a study entitled "Socio-Economic Survey of the Aquaculture Industry in the Philippines".

The study covers various aspects of aquaculture from fry gathering up to rearing and also covers the culture of seaweeds, oysters, mussels and eels in addition to milkfish and prawns. We have completed one part of the study — the gathering of fry, which involved the interview of 229 fry gatherers from 44 provinces representing 10 regions. All the data cited were collected in 1974.

Profile of Fry Gatherer

A fry gatherer in the Philippines is likely to be male, about 39 years of age, has been to elementary school, and has resided in his community for almost all his life (Table 22). Of the 229 respondents, 163 gathered purely bangos fry, 17 prawn, 15 eel, and 34 gathered combinations of bangos and crab, bangos and prawns, or crab and prawn.

Most manage to send their children to school with Central Visayas having the largest percentage (87%) of children in school. In contrast, only one out of ten children is in school in Western Mindanao. The national average is 52%.

Seasonal Pattern

Fry gathering is seasonal. During the year, fry gatherers spend three months gathering and about 6 months in other occupations, with the majority going into fishing. Others work as farmers or laborers. The rest of the time many are not gainfully employed.

Bangos fry are gathered from February to December with the peak season occurring from April to June. Prawn fry are gathered the whole year round with the peak occurring in June (Fig. 32). The few crab fry gatherers are found in Southern Luzon and Bicol, each collecting monthly average ranging from 600 fry in December to 3,200 in August. Price is usually within ₱25/thousand but can go up to ₱112/thousand. Eels are collected only from Cagayan Valley and are caught monthly from October to December.

Economics of Gathering

Price of bangos fry, aside from varying with season, also varies with region (Fig. 33) and with the type of buyer. The price is dictated by concessionaires according to 57% of the fry gatherers;

by the dealer according to 19%. Only 10% reported that they determined the selling price themselves. The concessionaire offers the lowest price at ₱25 per thousand. Fry grounds are leased yearly to the concessionaire giving the highest bid. Under the law, all gatherers have to sell to the concessionaire who has the exclusive privilege of gathering bangos fry within the area. Rearing and nursery pond operators pay ₱40.47 and ₱41.59 respectively while dealers pay as much as ₱51 per thousand. Only 2% of the gatherer sell to the dealer. The majority (61%) sell to the concessionaires who dominate the market.

For prawn fry, however, the rearing pond operator pays as much as ₱102 per thousand, more than twice that paid by concessionaires and dealers which is ₱43 and ₱45 respectively. Two-thirds of the prawn fry gatherers sell to the dealer and concessionaire. Like the bangos fry, the prawn fry price also varies with the month and the region (Fig. 34).

The fry gathering business requires a relatively small amount of capital investment. Assets are simple and consist mainly of catching gears; basins, pails and cups; earthen jars; small items like pandan bags, lamps, dyeing materials, etc. A few own bancas or rafts. The catching gears represent the largest item of capital investment at 58%, Table 23. Bancas and rafts constitute the second largest item. Gross returns are high when compared to investments but low on an absolute scale.

FIG. 32 Monthly fry catch per gatherer and price per thousand fry, Philippines, 1974.

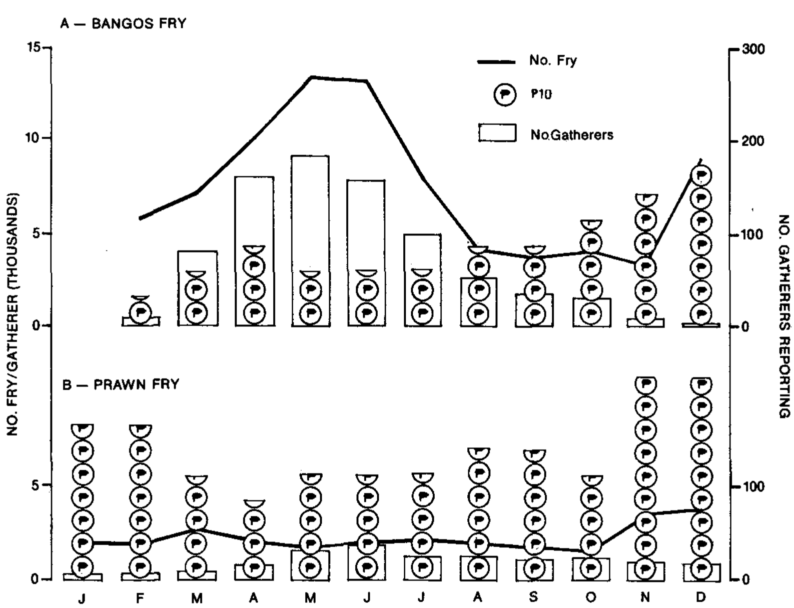


Fig. 33. Price of bangus fry per thousand in various regions, Philippines, 1974.

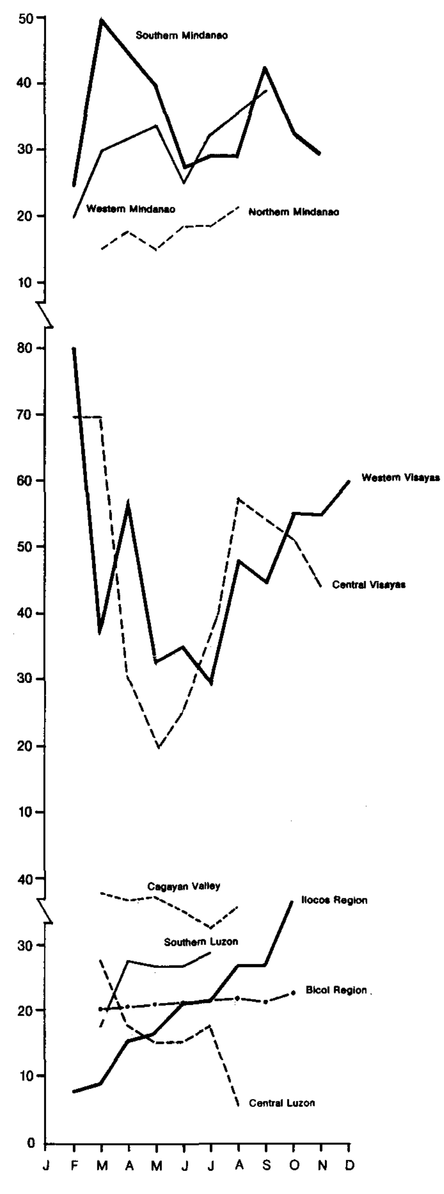


Table 22. Characteristics of fry-gatherers in the Philippines based upon interview with 229 respondents, 1974.

Region	% Male	Age	Number of Years In Community	Number of Years In School	% Children in school	Size of Household
I. Ilocos	86	46	38	6.4	58	6.7
II. Cagayan Valley	85	41	36	7.0	57	6.7
III. Central Luzon	88	51	49	4.0	28	5.1
IV. Southern Luzon	83	38	29	4.5	44	6.3
V. Bicol	88	27	27	6.0	67	4.5
VI. Western Visayas	72	41	29	4.6	46	6.4
VII. Central Visayas	66	37	39	6.4	87	6.7
IX. Western Mindanao	83	26	20	6.2	10	6.9
X. Northern Mindanao	31	36	27	5.8	62	6.8
XI. Southern Mindanao	86	35	19	6.1	64	6.3
Philippines	78	39	31	5.6	52	6.4

Fry gathering is a full time job when fry is in season (Table 24). The number of man-days spent per month (about 19) is pretty much the same throughout the year, except in November and December when they work almost all weekdays. Many ask members of their families to help.

Expenses in fry gathering may be classified into cash and non-cash. Cash expenses consist of purchase of gathering materials, handling and transportation, municipal fee and a few other small items. Non-cash expenses consist of the imputed value of the labor of the gatherer and his family and depreciation of gears and other assets. With these considerations, the expenses and returns are summarized in Table 25.

Relationship with Concessionaires

In many cases, the relationship between the fry gatherer and the concessionaire appears to bear a resemblance to the landlord-tenant relationship of the agrarian system prevailing in the Philippines. Ninety-one per cent of the fry gatherers were under concessionaires, of whom 26% reported having received amenities in the form of basic needs, medical needs, educational needs or gifts on special occasions.

Seventeen per cent of the fry gatherers had some kind of financial arrangements with the concessionaire, in the form of cash advances. Such advances were usually repaid during the same fry season that they were incurred. No interest was

Table 23. Value of catching gear and gross return per fry gatherer by region. Values of the gears are depreciated values, taken as an average of the value at the beginning and end of the year.

	REGIONS										
	I	II	III	IV	V	VI	VII	IX	X	XI	Phil.
Gears:											
Sagap	44	16	23	10	3	14	3	4	—	3	7
Sayod 55	55	167	76	20	—	9	—	30	22	—	20
Saplad	47	30	—	40	—	23	—	29	22	53	23
Gross Returns:											
Bangos	₱1,932	870	1,808	548	1,081	1,010	912	523	706	798	1,061
Prawn	—	—	—	404	—	853	—	—	—	—	562

Fig. 34. Price of prawn fry gathered by month in various regions, Philippines, 1974.

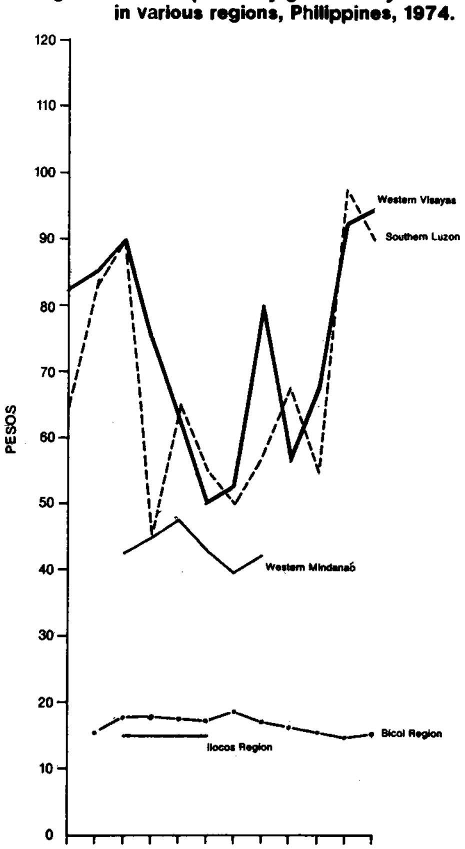


Table 24. Frequency and usual time of gathering by region, Philippines, 1974.

Region	Morning	Morning till afternoon	Morning till evening	Afternoon	Afternoon till evening	Evening	Frequency of Gathering
			percent				days/week
I. Ilocos Region	—	90	7	3	—	—	6.43
II. Cagayan Valley	19	63	7	4	7	—	6.14
III. Central Luzon	—	50	13	38	—	—	4.87
IV. Southern Luzon	—	27	65	6	—	2	5.84
V. Bicol Region	—	—	78	22	—	—	5.44
VI. Western Visayas	44	56	—	—	—	—	6.55
VII. Central Visayas	—	100	—	—	—	—	4,22
IX. Western Mindanao	6	88	6	—	—	—	5.27
X. Northern Mindanao	31	54	15	—	—	—	4.84
XI. Southern Mindanao	57	86	7	7	—	—	4.86
Philippines	13	61	20	5	1	a/	5.74

a/ Less than 0.5 percent.

usually charged and in three fourths of the cases the fry collection was used as security. The cash advance was usually used to purchase the gear and other materials for gathering. The degree of satisfaction of the fry gatherer as regards their relationship with their concessionaire is summarized in Table 26.

Living Conditions

Fifty-eight per cent of the fry gatherers owned their residential lot, 25% rented and in 10% the lot was provided by a relative, a coconut landlord, or a fishpond owner. Ilocos and Mindanao had the highest proportion of gatherers who owned their residential lots while Southern Luzon and Western Visayas had the least.

A radio was owned by almost three out of four fry gatherers. Only one respondent from Central Luzon reported owning a TV set. Most used the traditional wood stove for cooking. Only one-fifth had a kerosene stove and 3% had an LPG stove. Most depended upon kerosene lamps for light.

One indicator of level of living is the adequacy of family income. An average fry gatherer earns only a net income above cash expenses of ₱1,029 per year, supplemented by earnings from other occupation which amounted to ₱2,225 per year. Their total yearly income falls below the national average family income of ₱3,736 per year. When queried more than 27% felt their income was not adequate, Table 27.

Problems and Solutions

Marketing problems such as low and fluctuating prices, inaccessibility of buyers and insufficient storage materials plagued most of the fry gatherers. Lack of adequate and proper storage materials compels most gatherers to sell immediately after gathering even when supply is large.

Out of 156 gatherers who encountered problems in fry gathering especially financing, 145 did not make any attempt to solve the problem. This is understandable in the light of the fact that 50% of the gatherers had no idea what form of assistance they ought to receive in order to improve fry gathering. Those who did have an idea specified assistance in forming cooperatives, demonstration of methods of fry gathering and credit. A few others suggested a change in the bidding process, strict enforcement of fishery laws and non-interference with fry prices.

Table 25. Cost and returns per gatherer of fry, gathering by type, in pesos, 1974.

Item	Bangus only	Prawn only	Eel only	Bangus Prawn	Bangus Crab	Prawn Crab
Gross Returns	1,061	562	351	1,525	3,375	1,999
Expenses						
Cash	42	15	5	7	—	65
Non-cash	886	843	524	1,522	1,627	531
Total	928	858	529	1,529	1,627	596
Net Returns						
Over cash expenses	1,019	547	346	1,518	3, 75	1,934
Over total expenses	133	-296	-178	-4	1,748	1,40

Table 26. Rating by fry gatherer of his present relationship with concessionaire by region, Philippines, 1974.

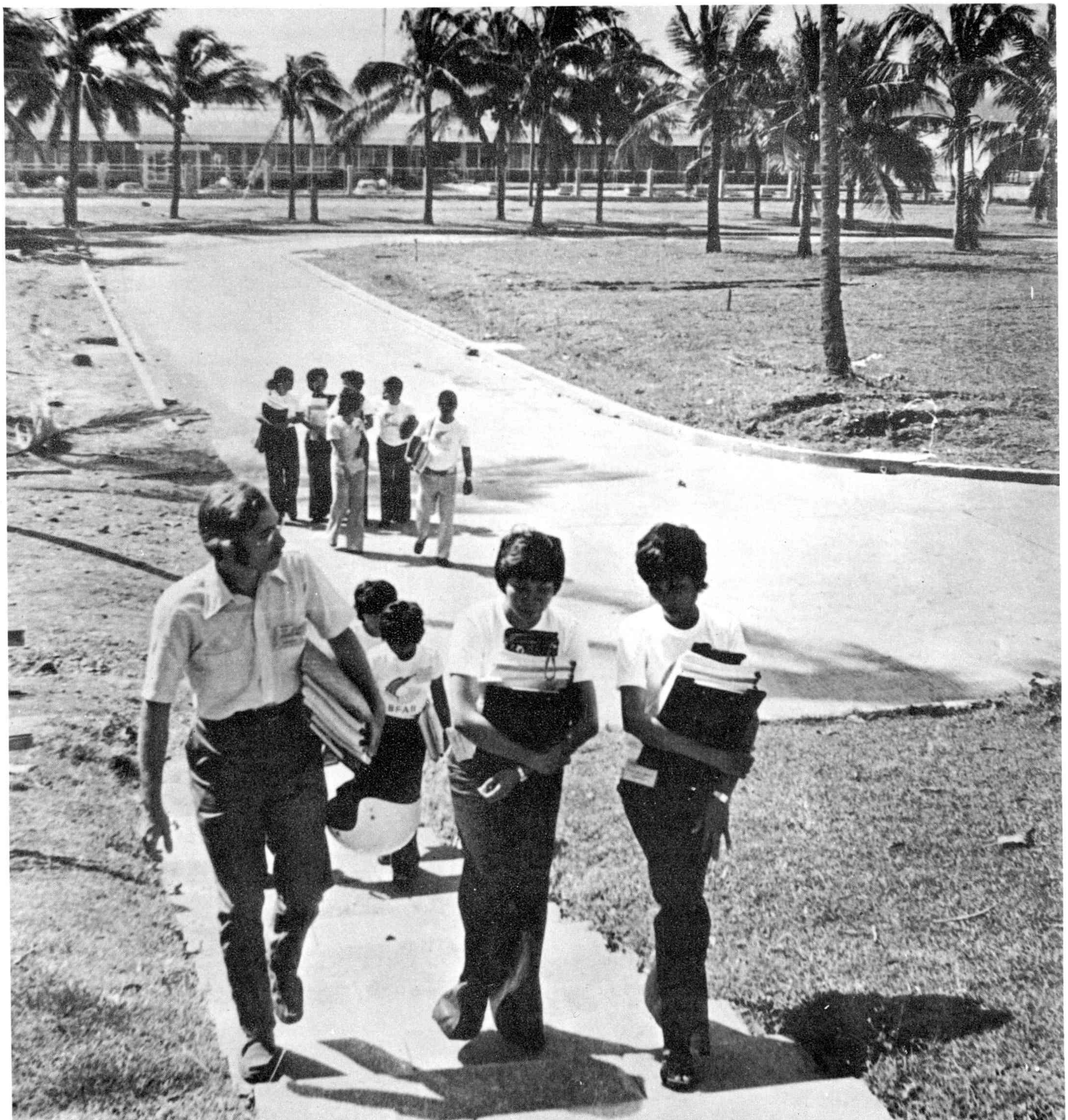
	Very satisfied		Fairly satisfied		Slightly satisfied		Not satisfied at all	
	No.	%	No.	%	No.	%	No.	%
Ilocos Region	6	22	11	41	7	26	3	11
Cagayan Valley	6	22	10	37	11	41	-	-
Central Luzon	1	13	5	63	1	12	1	12
Southern Luzon	10	22	15	33	13	29	7	16
Bicol Region	-	-	9	100	-	-	-	-
Western Visayas	10	26	9	23	14	36	6	15
Central Visayas	1	10	7	70	2	20	-	-
Western Mindanao	5	31	6	38	3	19	2	12
Northern Mindanao	2	15	10	77	1	8	-	-
Southern Mindanao	6	40	7	47	2	13	-	-
Philippines	47	22	89	43	54	26	19	9

Table 27 Adequacy of family income of fry gatherers by region, Philippines, 1974.

	Not adequate		Just enough		Moderate		Very adequate	
	Number	%	Number	%	Number	%	Number	%
Ilocos Region	--	--	24	80	5	17	1	3
Cagayan Valley	5	18	21	78	15	4	-	--
Central Luzon	4	50	2	25	1	13	1	13
Southern Luzon	13	27	27	56	8	17	-	-
Bicol Region	-	-	8	89	1	11	-	-
Western Visayas	24	56	16	37	2	5	1	2
Central Visayas	6	33	11	61	1	6	-	-
Western Mindanao	5	28	10	56	3	16	-	-
Northern Mindanao	4	31	10	77	1	8	-	-
Southern Mindanao					2			
Philippines	61	27	140	61	25	11	3	1

A bountiful harvest of bangos.

Trainees returning to the dormitory from the lecture hall.



EXTENSION AND TRAINING

Cooperators' Program

We designed the cooperators' program as a research-production scheme to undertake studies on pond management practices in actual pond conditions. Under the scheme, we give free research materials in the form of prawn fry to private pond owners who undergo training as cooperators. In addition, our technicians assist them in collecting data on environmental conditions in ponds. Each pond owner sets aside one hectare of his ponds, makes available the caretakers, and provides all the inputs necessary for culture. The harvest goes to the pond owner while the data monitored remain with SEAFDEC. Hopefully, the program will serve as mechanism through which improved technology can be transferred from the researchers to the pond owners and serve as a feedback information system.

The cooperators' program hopes to achieve the following objectives:

1) To involve the private sector as active partners in the search for improved pond culture technology;

2) To collect benchmark information on existing pond management practices from pond owners;

3) To facilitate the transfer of fisheries technology from researcher to pond culturists;

4) To provide an information feedback system on the results of applied technology introduced to pond operators as well as on the problems they encountered during culture;

5) To promote the organization of fishpond cooperatives;

6) To accelerate and enhance the research capability of the Department.

We entered into an agreement with BFAP and PFRS to jointly undertake the program. This was done immediately to institutionalize the linkage with the private sector. It is planned that as we expand our program, we shall relate with existing organizations in other provinces or regions.

Technician Training Program

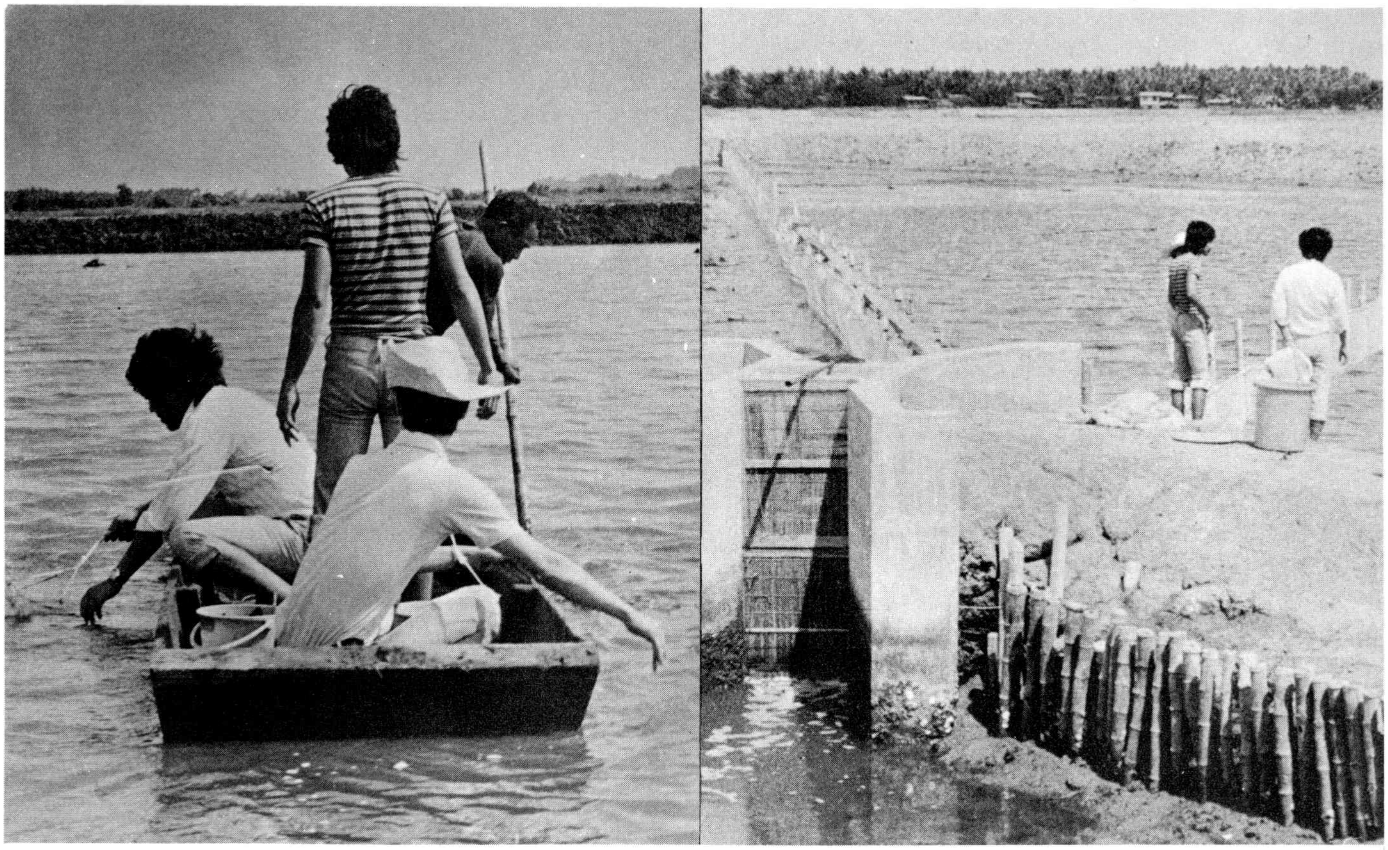
The Technician Training Program is designed primarily for private pond technicians. Using the same methodology as the cooperators' program, technician trainees shall formulate the research design and collect data for analysis during the culture period. BFAR extension workers will follow up and provide technical guidance and assistance. The pond owner shall provide the management and care of the ponds and animals including all inputs required for culture.

The objectives of this training are:

1) To generate interest in the adoption of improved methods in prawn culture;

2) To provide the requisite knowledge and information on the culture and rearing of prawns;

3) To equip the technicians with the necessary skills and expertise on the rearing and culture of prawns.



Training program includes actual work at the Department's fishponds in Leganes.

Training program aims at upgrading skills of BFAR extension workers.

Training on Prawn Culture

To enable BFAR extension workers to perform their functions competently and confidently, they should also be trained in the techniques of prawn culture. Participants in this exercise shall undertake a combination of theory sessions, group discussions, demonstrations, laboratory exercises, field trips and practicum.

The theory seminars will provide inputs of knowledge and information while group discussions allow for exchange of knowledge and experiences. Demonstrations and field trips strengthen the conceptual framework; laboratory exercises and practicum provide a mechanism for the acquisition of skills in the different aspects of prawn culture.

We conducted a series of seminars on prawn culture in cooperation with BFAR to generate interest in the adoption of improved methods in prawn culture; provide requisite knowledge and information, and equip participants with skills on the rearing and culture of prawns.

The seminar series consists of six sessions between November 1975 and July 1976. The first session was conducted to train 20 BFAR extension workers for the Panay-Negros region. Succeeding sessions are intended to train BFAR extension workers in other regions.

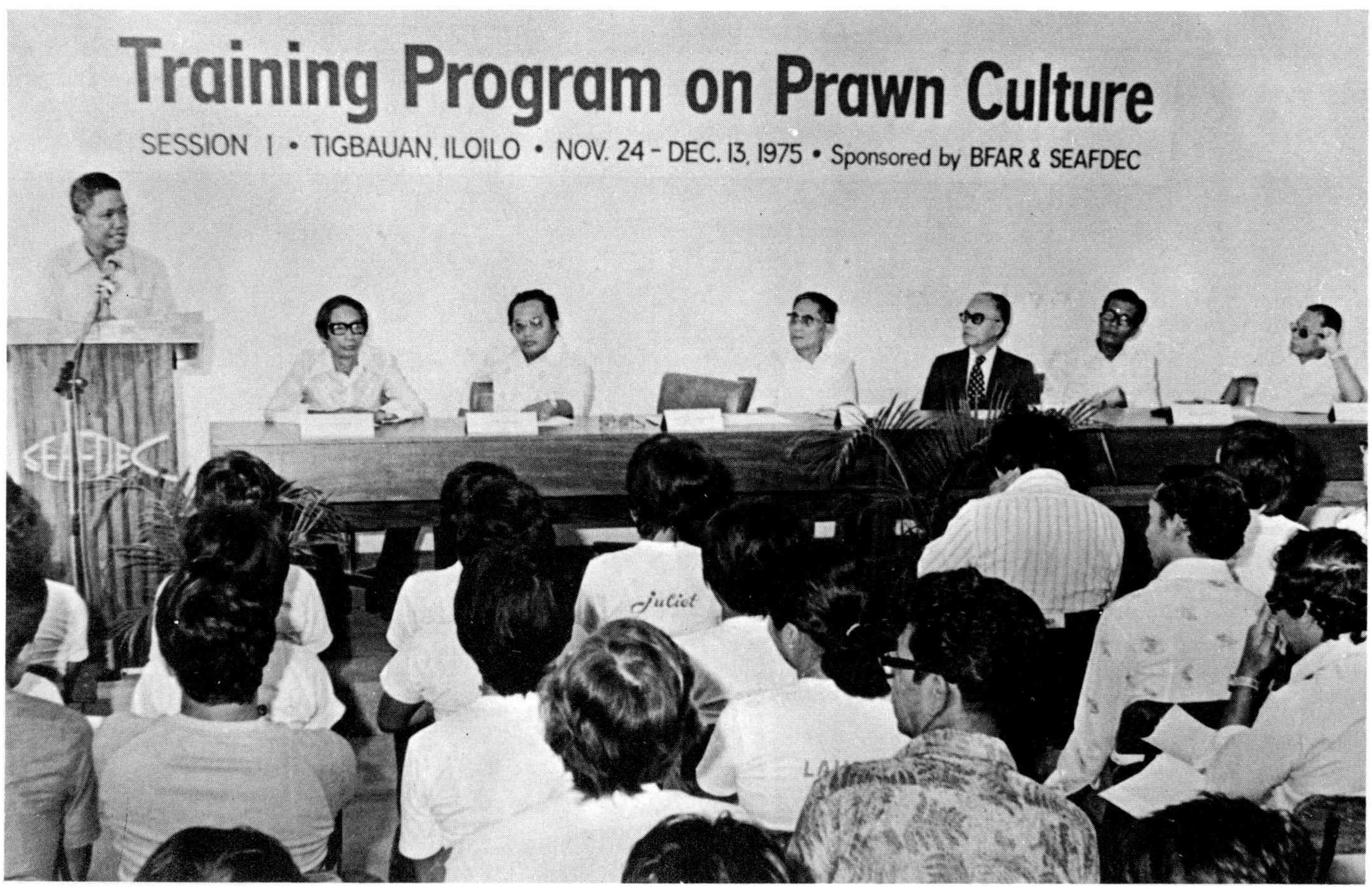
Training on Aquaculture Research

During the year we planned to start the first foreign training program in aquaculture research. This 10-month program will be conducted starting April 19, 1976 with initial emphasis on prawn culture. As planned, it will be expanded into a degree program leading to post-graduate studies in aquaculture. The program seeks to upgrade the aquaculture manpower situation by emphasizing basic and applied research, and training for extension work. Twenty-five participants from Southeast Asia will attend these training sessions at our research complex in Tigbauan and Leganes.

Each participant shall receive study grants sufficient to cover board and lodging expenses; roundtrip plane fare, training materials and stipends.

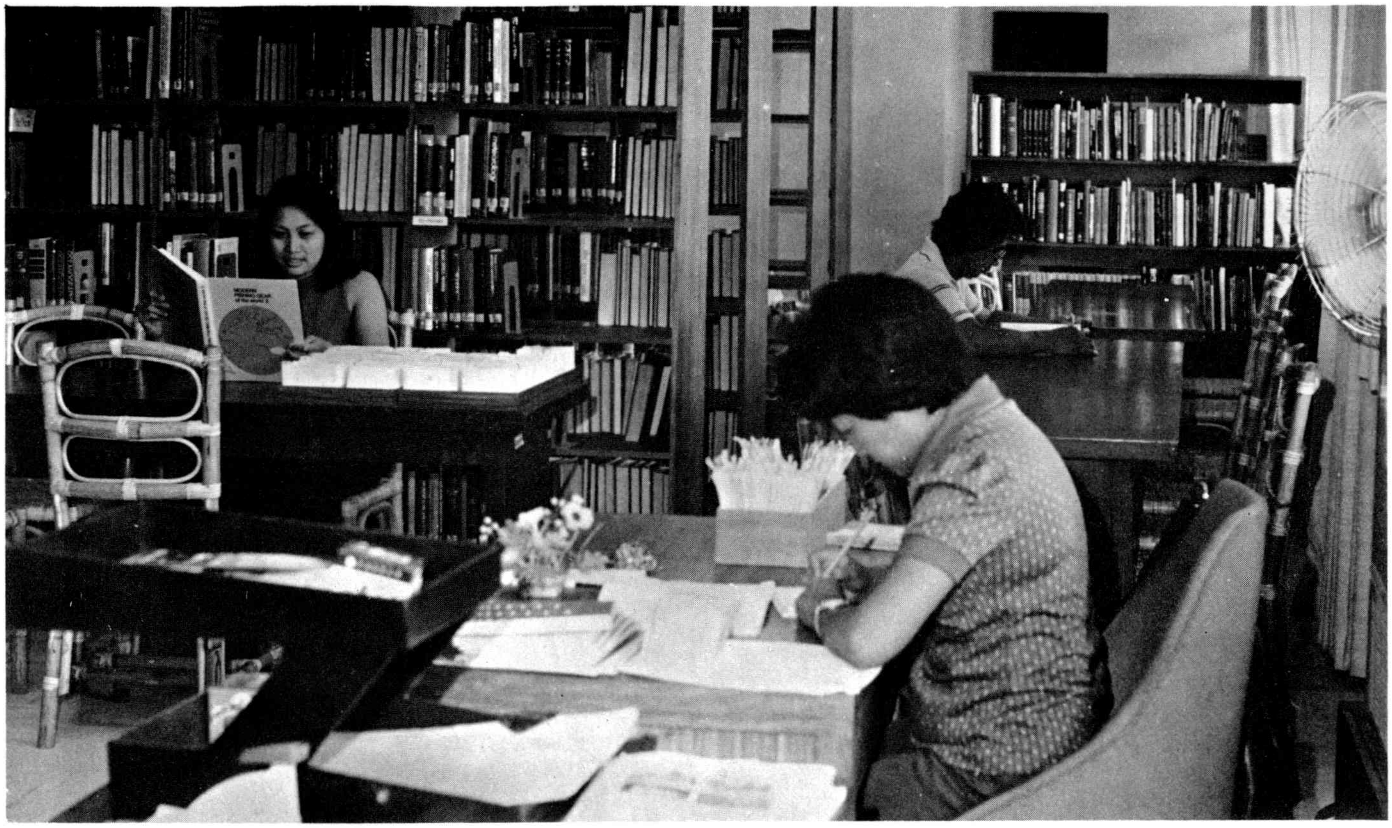
The training program will involve lectures and laboratory sessions on aquaculture research. Each participant will undertake research on a specific problem area under the supervision of our resident researchers. The courses offered will include principles of aquaculture, research methodology, breeding and seed production, nutrition and diseases, and production farming.

Opening session of the Training Program on Prawn Culture.



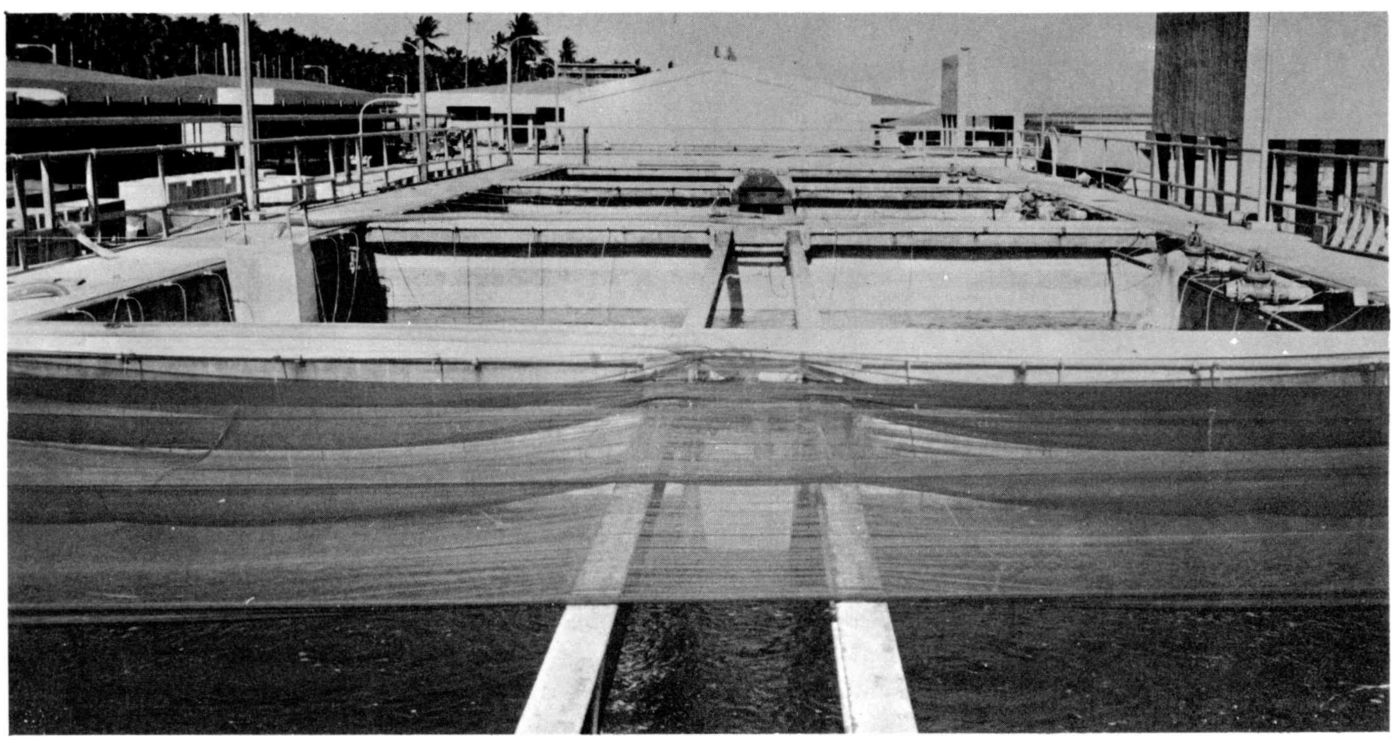
Library Development

During the year, our library has acquired 1,000 titles of books and subscribed to important journals in fisheries and marine sciences. These had been classified and organized using the Library of Congress system. In addition, a list of important titles was prepared for immediate purchase locally and abroad. We are also acquiring microfilm and microcard readers for out-of-print materials. Our library collection will soon be housed in the library and training complex which is scheduled for completion in May 1976.



Growing collection is fast filling up temporary library.

Outdoor hatchery tanks with 200-ton capacity.



PERSONNEL

Staffing Pattern

As of December 31, 1975, our present personnel strength at Tigbauan and other stations, including the Metro Manila offices, has grown to 350. Of this number, some 150 are directly involved in research and supporting services; the rest are distributed in other units of the Department such as training and extension, physical plant, auxiliary services, planning and development. About 70% of the personnel complement are based in our Tigbauan station which operates not only as a research laboratory but also as a self-contained international research community. We provide the services to sustain the requirements of such a community, including water, electricity, sewage disposal, road maintenance, security, housing and cafeteria service.

New Appointments

Mr. TATSUO KAWACHI upon his nomination as Deputy Chief of the Department and the subsequent approval by the SEAFDEC Council of Directors, assumed his position in mid-October this year. Mr. Kawachi is a seasoned diplomat in the Japanese Foreign service and was consul-general at Medan in Indonesia until his appointment to the Department. His previous experience includes assignments to diplomatic and trade missions in South and Southeast Asia, New York City and Washington, D.C.

Foreign researchers assigned to the Department during the years are as follows: Dr. WILLIAM F. VANSTONE, Canadian specialist in reproductive physiology for a period of 30 months beginning May 22, 1975; Dr. PHILIP TORTEL, mussel expert from New Zealand for a period of three months beginning August 30, 1975; and Mr. TSUGUHIRO YOKOKAWA, a microbiologist assigned to the Department by the Government of Japan for a period of 2 years beginning March 28, 1975.

Including the Deputy Chief, the present Japanese complement in the Department is now eight.

Other expatriate scientists on short-term consultancies were as follows: Dr. ROBERT WEAR from Victoria University at New Zealand, who undertook periodic evaluations of the project on prawn gonadal development; Dr. TAKEICHIRO KAFUKU from Japan, who participated in the project on milkfish research; and Dr. JOHN HALVER from the Fish and Wildlife Services of the United States Department of the Interior, who served as consultant on fish feeds and nutrition.

Most of the major appointments in the research staff came from Mindanao State University and included the following: Dean RUFINO S. IGNACIO (M.S. Electrical Engineering), formerly Vice-President for Academic Affairs and Dean of the College of Engineering; Dean PASTOR TORRES (M.S. Electrical Engineering) formerly Dean of Faculties; Prof. ALEXANDER BUENAFE (Ph.D. Mathematics), formerly Chairman of the Department of Mathematics; Prof. JURGENNE PRIMAVERA (M.A. Zoology), formerly Chairman of the Department of Biology; Prof. ROLANDO PLATON (M.S. Sanitary Engineering), formerly Dean of Engineering; Prof. JOVENAL LAZAGA (M.A. Philosophy), formerly Chairman of the Department of Philosophy; and Prof. ROGELIO GACUTAN (M.S. Microbiology), Department of Biology.

Other appointees were Mrs. FELICITAS PASCUAL (Ph.D. Nutrition), formerly with the Philippine Atomic Energy Commission; Miss LINA VILLACARLOS (M.S. Entomology), formerly with the University of the Philippines; Mr. RODOLFO MATEO (B.S. Zoology), formerly with the Department of Biology of the University of the East, Manila; and Mr. WILFREDO YAP (M.S. Oceanography), formerly with Xavier University, Cagayan de Oro City.

Key administrative positions in the various financial, supply and physical plant units were also filled up, including that of the Chief Librarian.

Staff Development

To upgrade the level of expertise and provide new opportunities for self-development, the following research staff were sent abroad for advanced training:

1) Messrs. JOSE LLOBRERA and HENRY DEJARME for a workshop on Macrobrachium spawning and culture at the EWC in Honolulu on June 25 to September 5, 1975;

2) Mr. PORFIRIO GABASA, JR. for training on hatchery operations in Japan on August 2 to October 31, 1975;

3) Miss VIRGILIA TALABOC for studies on fisheries statistics in Japan from July to September 14, 1975,

4) Mr. EMMANUEL ENCARNACION for a research methodology workshop on food production, diversification and trade at the EWC in Honolulu on October 20 to December 12, 1975;

5) Dr. FRANCIS CATEDRAL for special research studies on mullet spawning at the Oceanic Foundation in Hawaii early 1975;

6) Messrs. ARTHUR SANCHEZ and NESTOR VALERA for graduate studies leading to advanced degrees in Chemistry at the University of Washington and Ohio State University, respectively.

7) Messrs. SALVADOR ENANO and LEON EDRALIN in October 1975 for training in Japan in the operation of SEAFDEC II, the 20-ton research vessel donated by the Government of Japan.

In cooperation with the Government of Japan the following were sent for observation studies or conferences abroad:

1) Messrs. NOBORU HOSHINO and HIROSHI MOTOH on prawn hatchery and culture operations in Japan and Thailand, after attending a conference with Japanese Government officials in Tokyo;

2) Messrs. UTAO KOBAYASHI and YOSHITETSU NUKIYAMA on mass shrimp culture in Thailand;

3) Messrs. SHIGEMI KAMBARA and TSUGUHIRO YOKOKAWA on mass shrimp culture in Thailand and Singapore;

4) Messrs. SHIGERU KUMAGAI and HIROSHI MOTOH for a scientific fisheries conference in Japan while on home leave;

5) Messrs. RUFINO IGNACIO, ANDRES MANE and ANASTACIO BERNAL for a survey of freshwater aquaculture facilities and observation of techniques of breeding and culture of freshwater species in Japan.

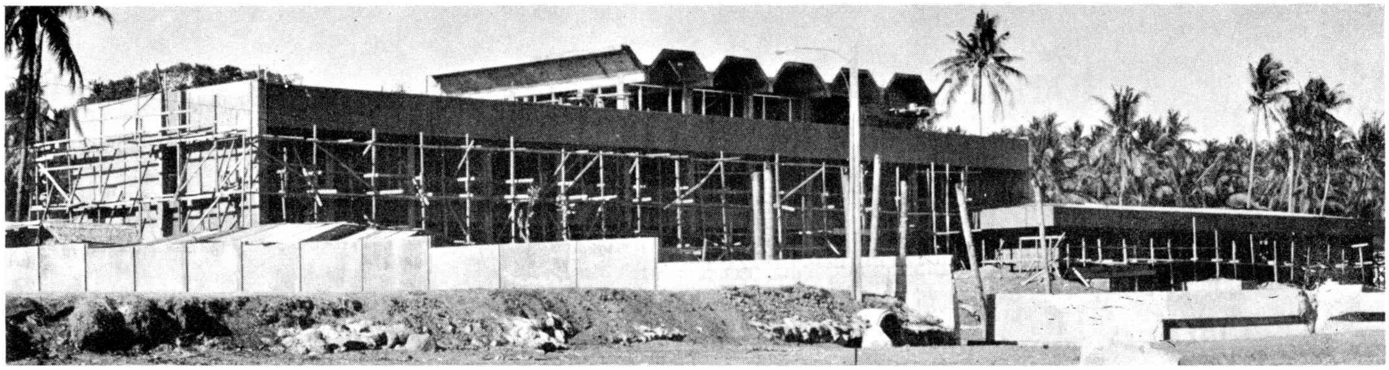
Research and administrative personnel are provided the opportunity to broaden their knowledge and skills through training seminars organized by the Training and Extension Unit.

A supervisory training for executive leadership was undertaken in July 1975 to upgrade the knowledge and skills of our 30 middle level supervisors and researchers. Resource speakers from the U.P. College of Public Administration were invited to facilitate group discussions on topics relevant to research management and team efforts.

A trainors' training seminar was held in October 1975 to develop instructors and researchers who may be tapped in future course programs. This seminar is necessary for making more effective the training aspect of our activities by providing trainors and resource persons with the tools for relating with adults and understanding the dynamics of the teacher-learner relationship.

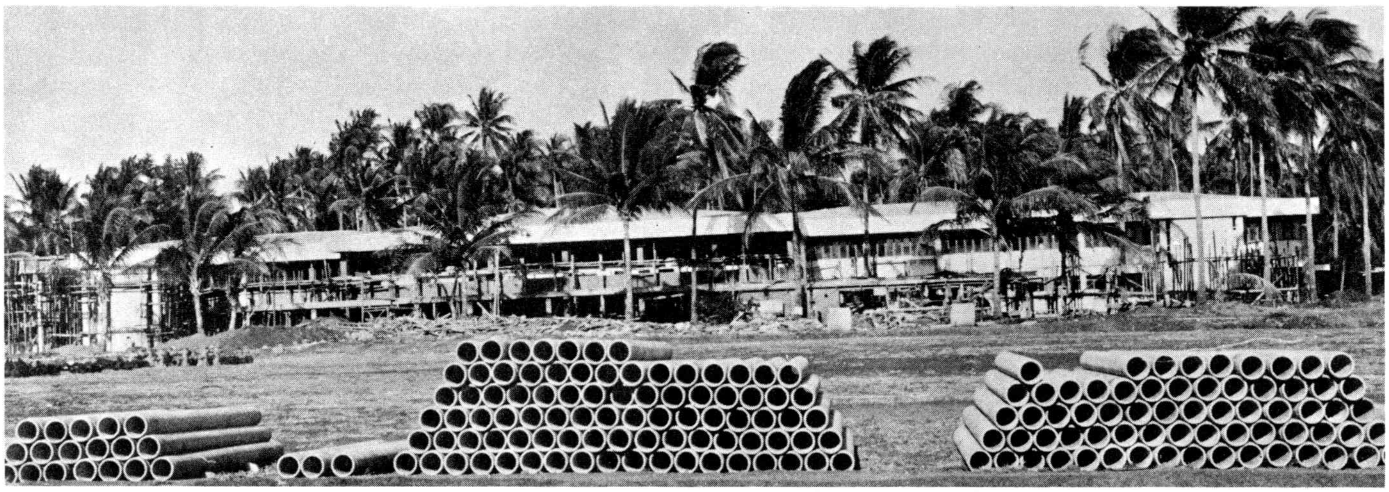
The trainors' training seminar was held in preparation for the series of training seminars to be conducted in the succeeding months. Seminar topics discussed during the 2-day sessions included techniques and methods of teaching adults, preparation and use of audio-visual aids, the conduct of demonstration, planning and implementing field trips, the psychology of adult learners and the teaching-learning process.

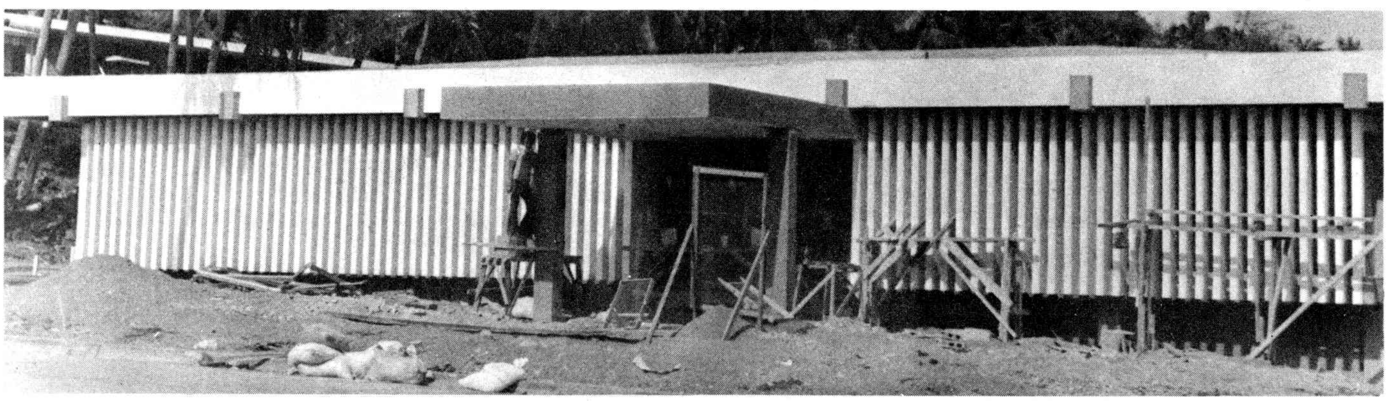
A seminar on scientific writing was also organized in October 1975 for our researchers and their assistants. The five-day course was conducted in cooperation with a couple of professors from U.P. Los Baños. The course was designed to improve skills in applying communication principles to scientific writing.



Three-storey administration building will be ready for use by mid-1976.

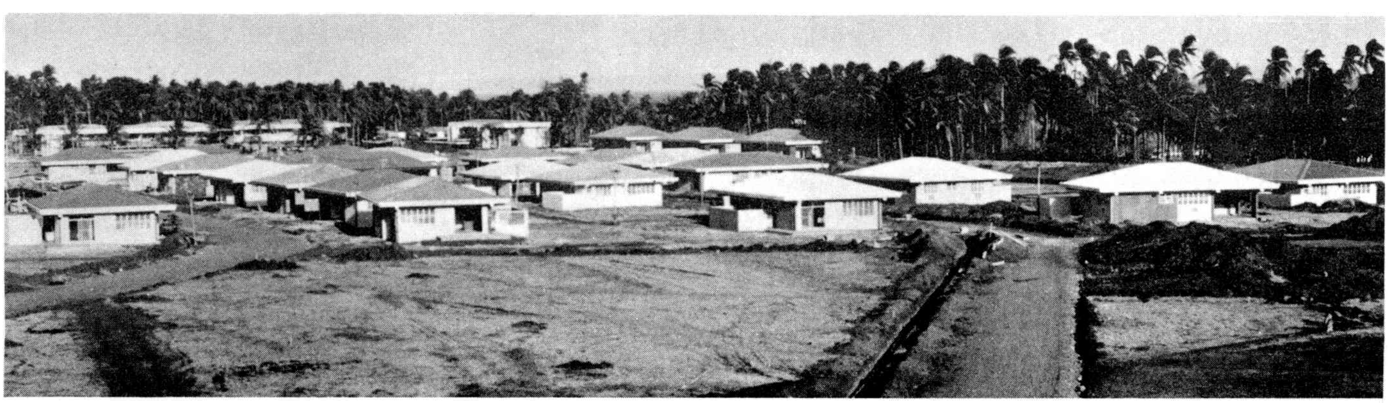
Apartment building is designed for 40 studio type units.





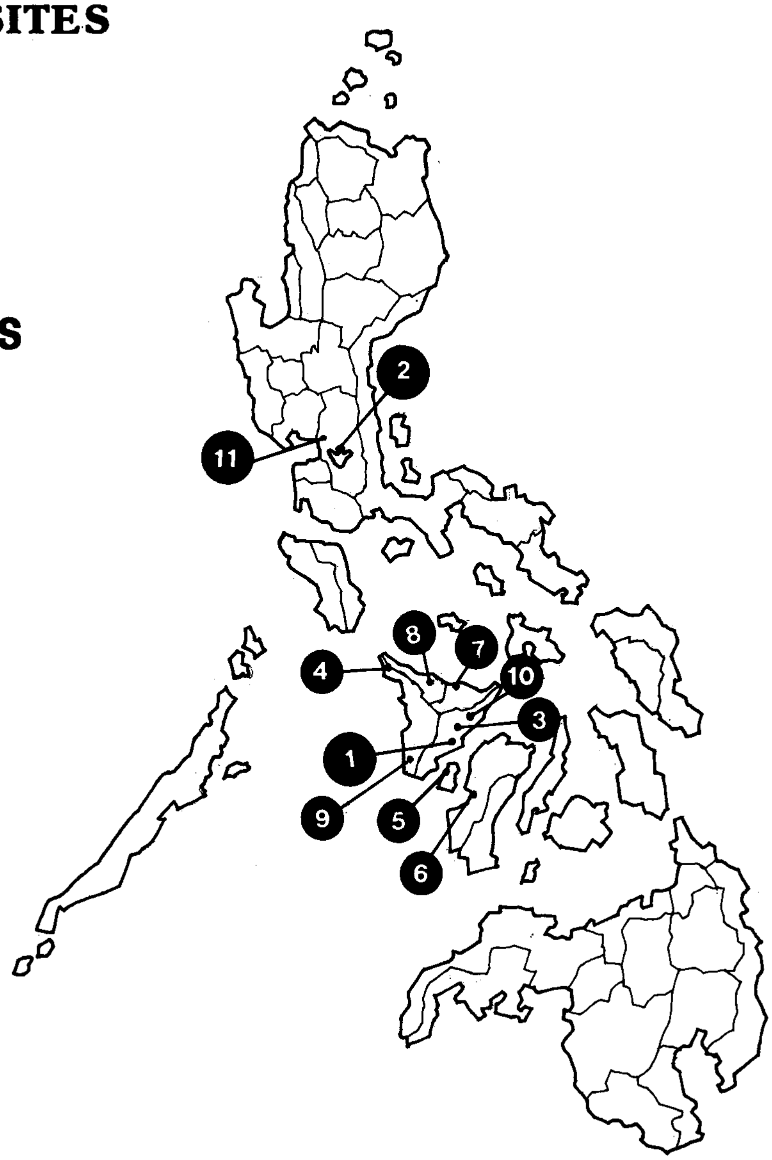
Training center will house lecture halls, audio-visual room and library.

Staff houses.



PROJECT SITES

PHILIPPINES



MAIN STATION

1. TIGBAUAN, ILOILO
Brackishwater Fisheries
Hatcheries, Laboratories, Training facilities, Administration

SUB-STATIONS

2. BINANGONAN, RIZAL
Freshwater Station
Hatcheries, Laboratories
Pens, Training facilities

3. LEGANES, ILOILO
Brackishwater Station
Experimental and
Production Ponds
Field laboratories
Training facilities
Spawner collection

4. PANDAN, ANTIQUE
Milkfish Research Station
Hatcheries, Laboratories
Ponds

5. IGANG, GUIMARAS
Sea-Farming Station
Field laboratories
Maturation and
Culture pens

6. HIMAMAYLAN, NEG. OCC.
Prawn Spawner Collection

7. SAPIAN BAY. CAPIZ
Mussel Research Study Site

8. BATAN, AKLAN
Prawn Spawner Collection

9. HAMTIK, ANTIQUE
Milkfish Fry Collection

LIAISON OFFICES

10. ILOILO CITY

11. METRO MANILA

PROJECT SITE DEVELOPMENT

Tigbauan Main Station

In April 1975, our main station in Tigbauan was formally inaugurated with the following facilities:

- Laboratory Building I (floor area: 525 sq m) for studies in food preparation, water quality and fish pond engineering;
- Laboratory Building II (floor area: 525 sq m) for studies in chemistry, biology, pond culture and seed production;
- Field Laboratory (floor area: 300 sq m) for periodic biological, chemical, and water analyses;
- Wet Laboratory (floor area: 525 sq m) for the culture of food organisms; for studies on the life cycle of crustaceans and fishes; and for bioassay studies on undesirable organisms;
- Roofed hatchery consisting of six tanks with a capacity of 50 tons each and six at 120 tons each;
- Open air hatchery consisting of four tanks with a capacity of 200 tons each;
- Nursery pond for the rearing of juvenile prawns (P_{25}) and for studies on salinity tolerance, depth variations, feeding requirements, stocking rates, predation and cannibalism;
- Open pond (floor area: 3,000 sq m) for the cultivation of juvenile prawns (4-6 months) and for experiments on mating habits and life cycle of prawns;
- Food Preparation Building consisting of three freezing compartments (floor area: 80 sq m each) and food preparation facilities;
- Dormitory (floor area: 924 sq m) with 20 rooms, 8 of which are provided with private bath for guests and lady trainees; ,g
- Cafeteria (floor area: 240 sq m) adjacent to the dormitory and connected with it by a covered walk;
- Physical Plant complex consisting of motor pool, gasoline pumping station, motor repair and maintenance shop, machine shop, carpentry shop, storerooms and offices.

During the year, we began the construction of the following additional facilities which are scheduled for completion in May 1976:

- Three-storey administration building (total floor area: 1928 sq m), centrally air-conditioned with an open space of 12 sq m at the center;
- Apartment building (total floor area: 1680 sq m) with 40 rooms, each having a bedroom and dining area, kitchen, toilet and balcony;
- Library and training complex (total floor area: 2299 sq m) consisting of offices, classrooms, audio-visual unit, library and reading room, and printing and bindery section;
- Twenty units of two-bedroom staff houses (floor area: 135 sq m each); as of year end, 13 units were completed and made ready for occupancy;
- Civil works consisting of water distribution system, sewer collection system and power distribution system.

The Alpha Company of the 552nd Engineer Construction Battalion under the 51st Engineer Brigade of the Philippine Army has been responsible for the following projects: concrete paving of roadnets, filling of low portions, backfilling, cleaning of access road, cocopile driving, road asphalting, and construction of parking spaces and drop inlets.

Some of the projects undertaken by Physical Plant personnel include the following: sea water filter, recreation hall, carpentry shop, physical plant garage, and fabrication of 100 units of 5-ton concrete tetrapods for breakwater.

In cooperation with PAGASA, a hydro-bio-meteorology station was set up in Tigbauan to gather basic information on the environmental conditions in the area.

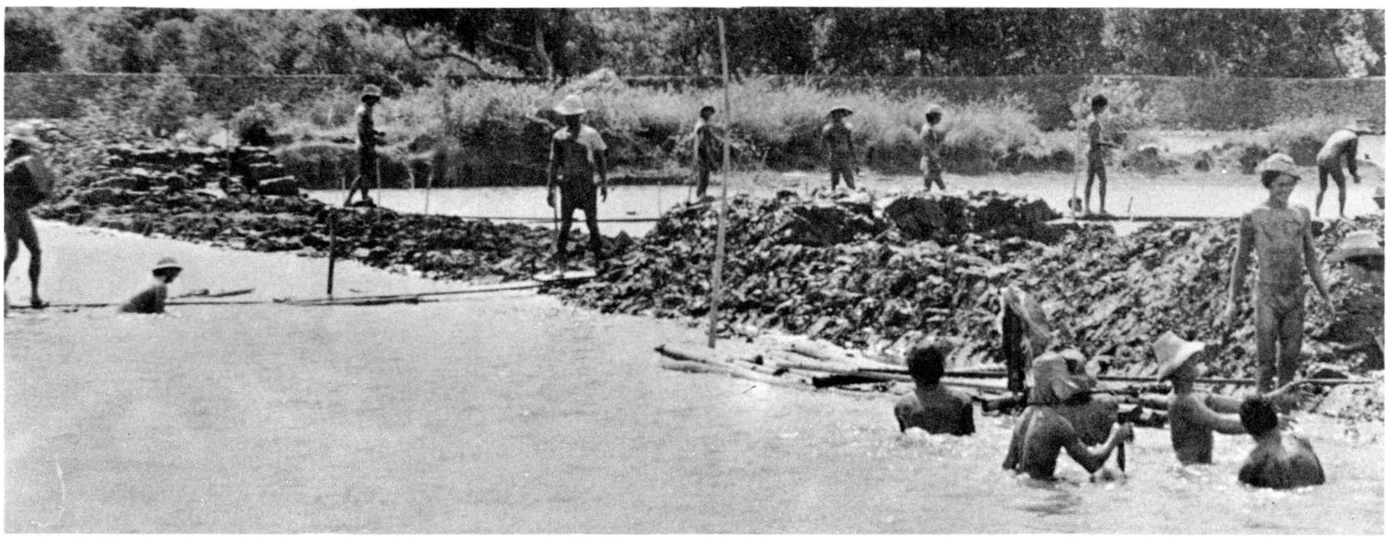
Leganes Station

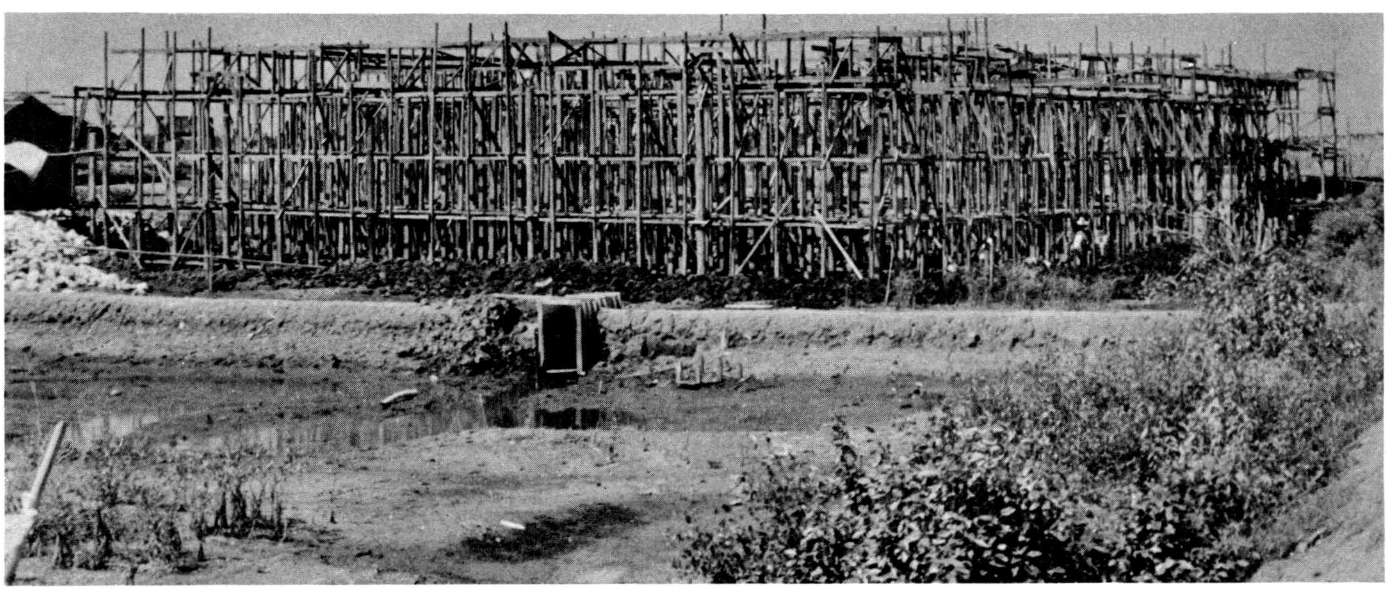
The Leganes station was established primarily to demonstrate the feasibility of producing prawns, shrimps and other cultivable species on a commercial scale. As of year end, 70 per cent of the 96 hectares of experimental ponds at Leganes have been fully developed.

A contract was signed in August 1975 with the NGV Enterprises, Inc., for the construction of the following:

- Field research laboratory complex (total floor area: 720 sq m) consisting of chemical and biological laboratory, library, seminar and projection room, administrative offices, photo darkroom, and an observation tower which will be built at the center of an open court;
- Utility building (floor area: 192 sq m) to house the electrical power and repair facilities, chemical storage and fertilizer storage;

Fishpond improvement goes on simultaneously with construction of permanent field laboratory at Leganes station.





• Duplex quarters (floor area: 160 sq m) to provide housing accommodation for the staff and visiting researchers.

Other facilities being constructed at Leganes include the dike walks, small boat landing, water supply and distribution system, septic and drainage system, electric light and power system, and landscaped open spaces.

Pandan Milkfish Station

The Pandan station was set up as part of the research program on milkfish spawning and cultivation supported by a grant from the IDRC of Canada.

Facilities at Pandan include the following: a biology-chemistry laboratory; a wet laboratory for tanks, aquaria and incubators; a dehumidified equipment room which also serves as radio room; a combined library and conference room; two guest houses for visiting researchers; two-storey living quarters for the research staff; canvas tanks of three sizes for holding the broodstock, for spawning and larval rearing, and for culturing various planktonic feeds.

The station operates a seawater pond system for stocking milkfish spawners. We are availing of an otoshi-ami for the capture of spawners from Pandan Bay.

Row of rubberized canvas tanks for rearing sabalo at Pandan milkfish research station.

Igang Sea Farming Station

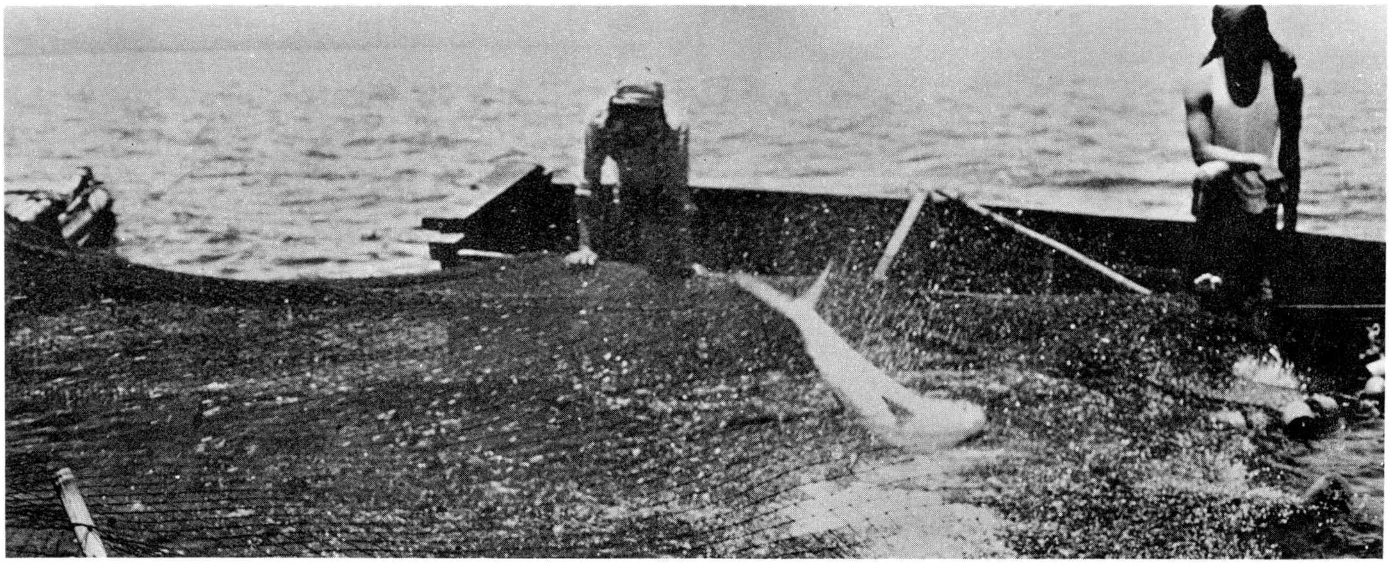
Temporary laboratory and physical facilities were set up at Igang to serve as experimentation station for the gonadal development of prawns, shrimps and other aquatic species. Cages and pens have been installed and a nearby cove fenced for brood stock purposes. We are now drawing plans to expand the station into a laboratory complex for research on sea-farming.

Freshwater Aquaculture Station

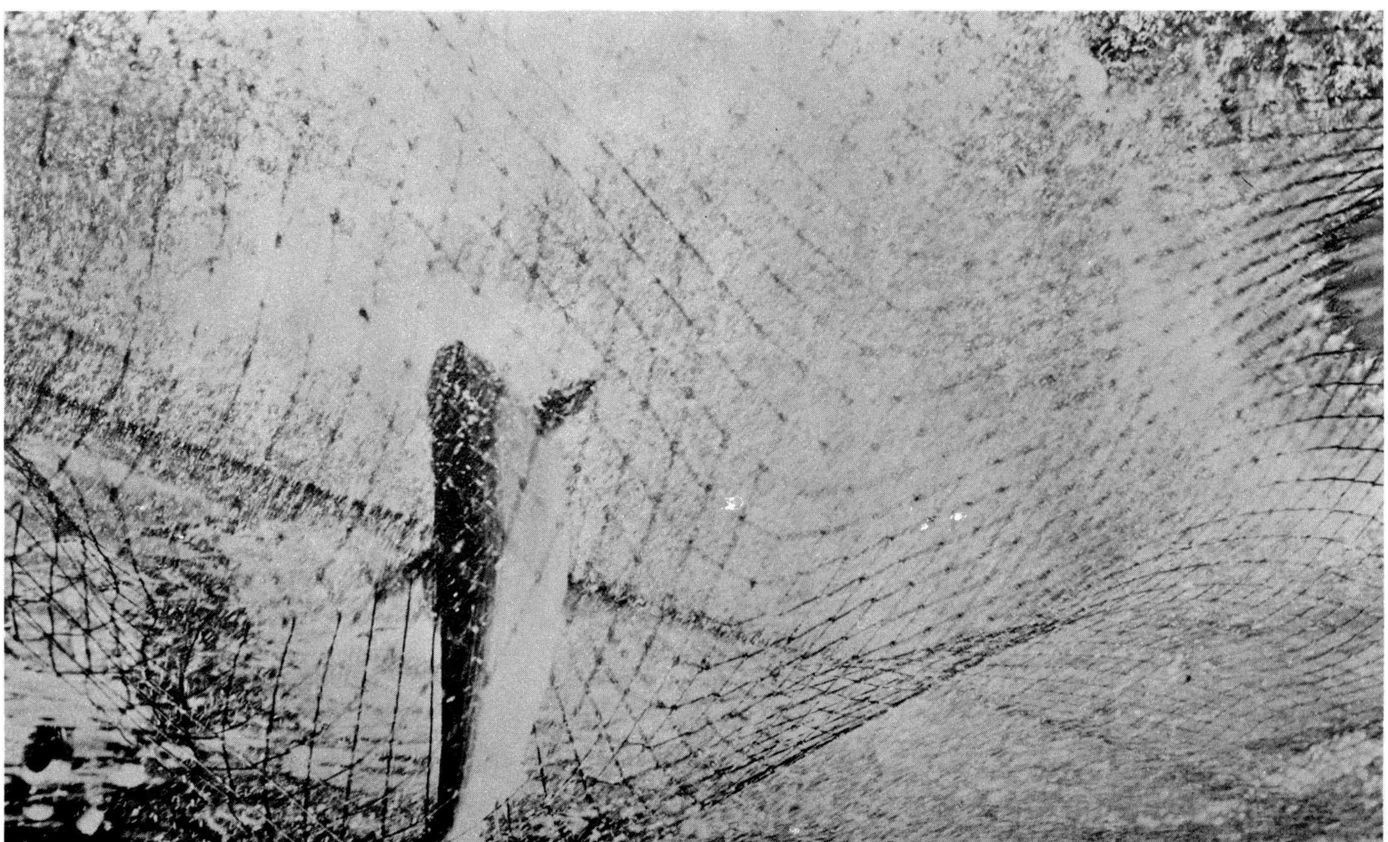
Toward the end of the year, we finalized plans to set up a freshwater aquaculture station in Laguna de Bay to complement our brackishwater stations in Panay. A 45-hectare site in Tapao Point, Binangonan, Rizal, has been identified and surveyed. Pending the issuance of a presidential proclamation reserving the area as a SEAFDEC project site, the DNR authorized SEAFDEC to use a 4-hectare area for the initial laboratory and administration facilities.

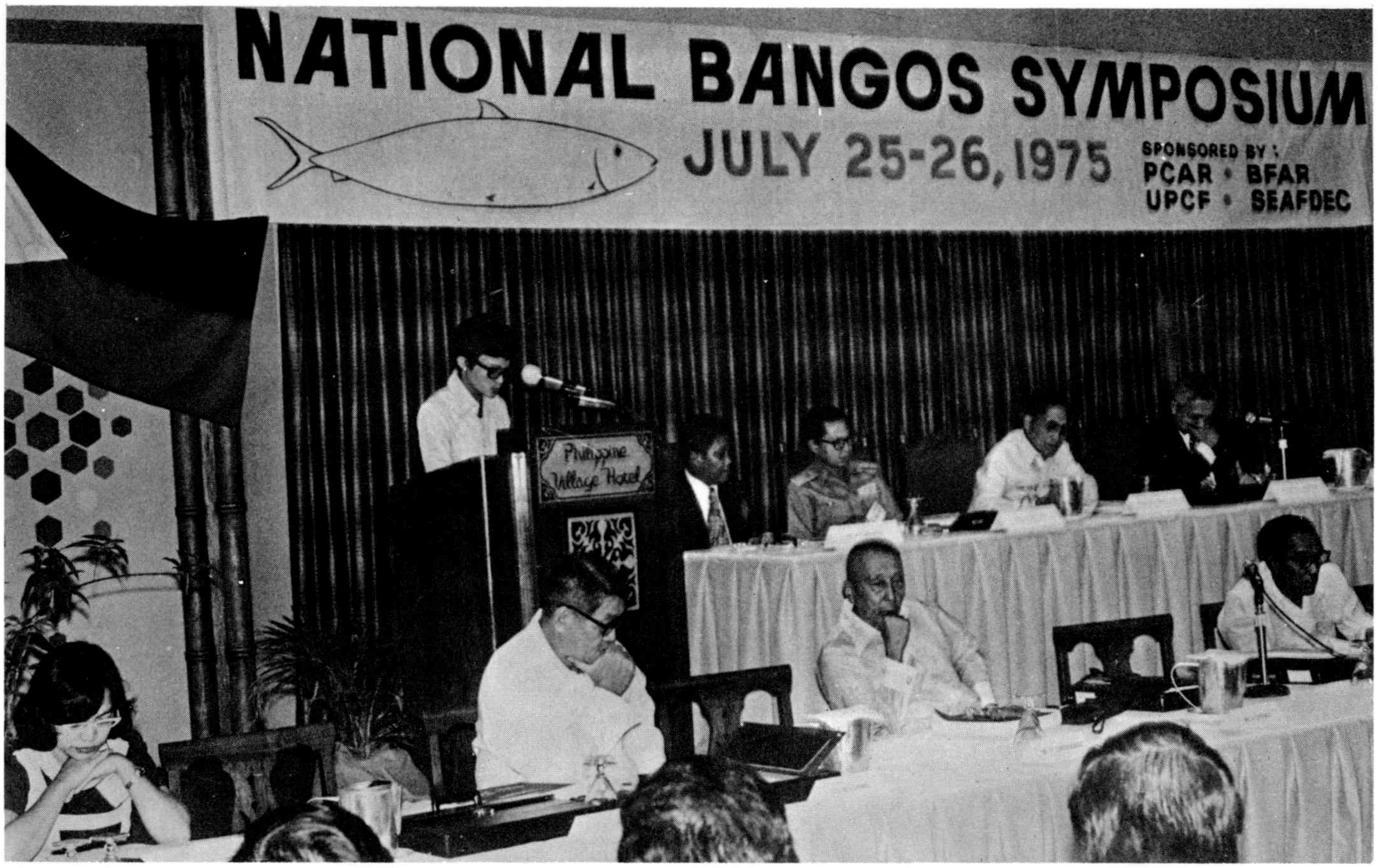
Dormitory and guest houses at the Pandan station.

Fishermen lifting the otoshi-ami at Pandan, Antique where the adult milkfish or sabalo are caught.



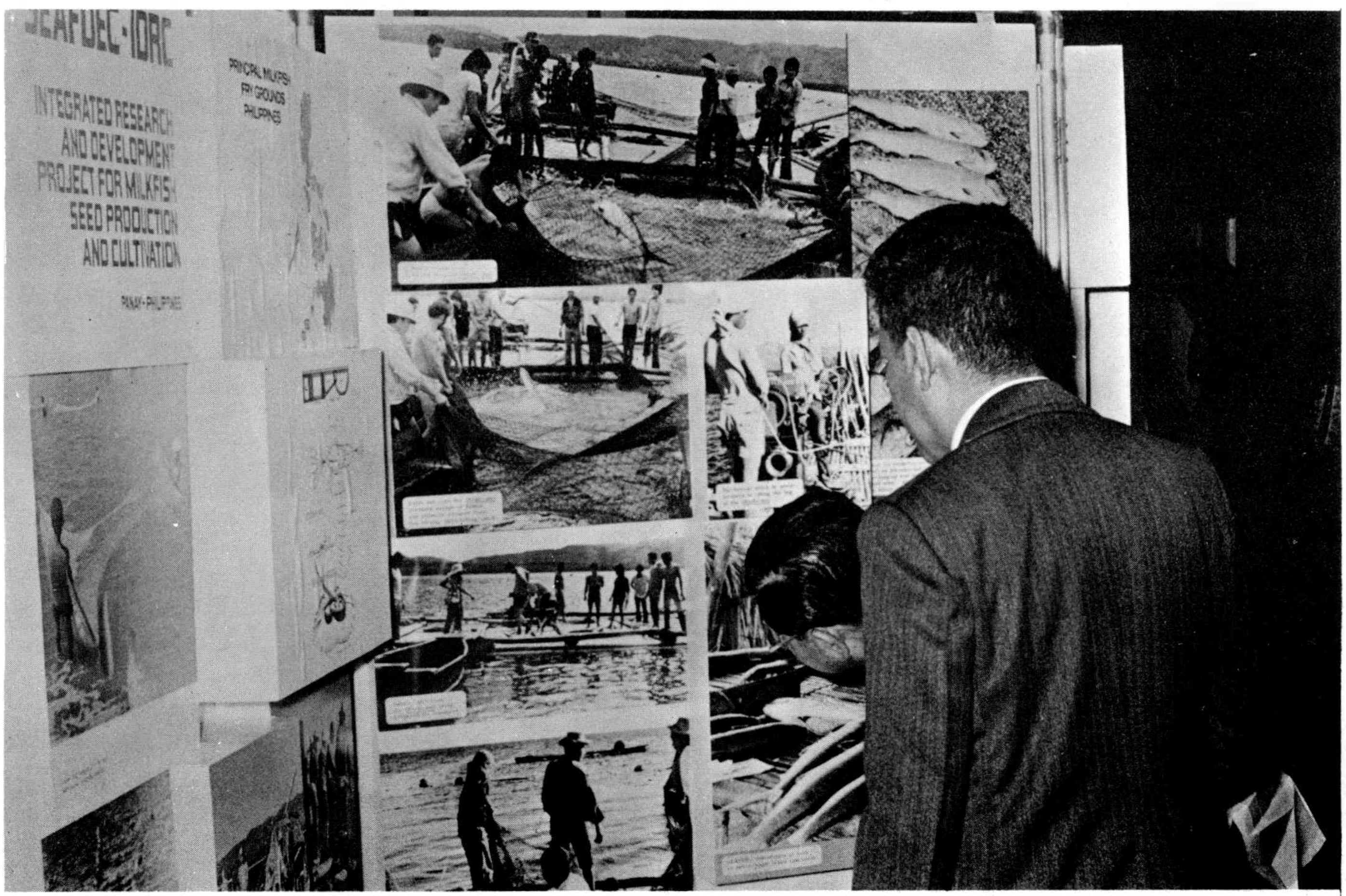
Sabalo struggles as otoshi-ami is lifted at Pandan, Antique.





Opening session of the national bangos symposium.

Pictorial exhibit on the milkfish at the national bangos symposium.



LINKAGES

Conferences

First Fisheries Congress

In March 1975 Dr. Q.F. Miravite, Mr. P.R. Manacop, Atty. J. Agbayani, Jr., Mrs. Z.B. Balangue and Mr. E.N. Encarnacion attended the First PCARR Fisheries Research Congress at Legaspi, Albay. The Congress was convened to update and review the fisheries research program as part of our national efforts to increase food production. Participants from various fisheries agencies and organizations divided themselves into four commodity groups: marine fisheries, inland waters, aquaculture, and bangos.

National Bangos Symposium

In July 1975 we organized the National Bangos Symposium in cooperation with the BFAR, PCARR and UPCF. The symposium was attended by 200 participants from various universities, research institutions, government agencies and organizations involved in fisheries and food production.

The symposium aimed to achieve the following objectives: review literature and assess benchmark information on the state of technology relating to bangos culture; formulate a research and training program based on the identified problems of the bangos industry; draw up priorities and strategies for achieving the expansion-intensification potentials of the industry; and examine the socio-economic factors that help or hinder development and their implications to national development.

Among the high priority recommendations derived from the symposium are the following: location of new bangos fry grounds; adoption of motorized fry capture; establishment of fry banks in strategic locations; improvement of techniques of fry collecting, handling and transporting; and, conservation of sabalo stocks through law enforcement and effective management.

Other priority recommendations include the following: studies on ecology, biology and induced spawning of sabalo; review of all fry concession policies; updating of list of operators in developed and undeveloped areas; intensification of interagency linkages and cooperative agreements in fisheries research; studies in agribusiness as related to the bangos industry; and, establishment of a national documentation program for bangos.

13th Pacific Science Congress

In August 1975 Dean D.K. Villaluz and Dr. Q.F. Miravite, accompanied by Mrs. Z.B. Balangue and Mr. Antonio Villaluz, attended the 13th Pacific Science Congress at Vancouver, Canada.

The Congress, which aimed at assessing the changes in direction and priorities in Pacific science over 42 years, was attended by experts from research institutions and development agencies from all over the world.

Eighth SEAFDEC Council Meeting

In December 1975 Dean D.K. Villaluz and Dr. Q.F. Miravite, accompanied by Mrs. Villaluz and Mrs. Balangue, attended the Eighth SEAFDEC Council Meeting held in Bangkok, Thailand. The meeting reviewed the activities of the three SEAFDEC Departments during the year as well as approved plans for the following year.

External Relations

To cope with our expansion programs, Dr. Q.F. Miravite and Mrs. Zenaida Balangue conducted exploratory negotiations with appropriate officials of several governments and international agencies. Their trip from mid-May to early June and from mid-August to mid-September aimed at exploring additional external support to the Department.

Upon the invitation of Banco de Desenvolvimento do Rio Grande do Norte, S.A., Dean D.K. Villaluz, accompanied by Mr. Antonio Villaluz, visited Brazil from August 26 to September 9, 1975 to provide technical advice on the development of its prawn industry.

Visiting Officials and Scientists

Philippine Government officials who visited our Tigbauan main station during the year include the following:

Honorable JOSE LEIDO, JR., Secretary, DNR; Mr. J. ANTONIO AGUENZA, Assistant Secretary, DNR; Mr. LUIS BALTAZAR, Assistant Secretary, Department of Agriculture; Mr. LUIS MAGBANUA, Minister, Economic Affairs Division, DFA; Mr. JUAN AGCAOILI, Assistant Commissioner, Budget Commission; General FLORENCIO MEDINA, Chairman, NSDB; Mr. FELIX GONZALES, Director, BFAR; Dr. JOSEPH MADAMBA, Director-General, PCARR; and General AMADO SANTIAGO, Chairman, LLDA.

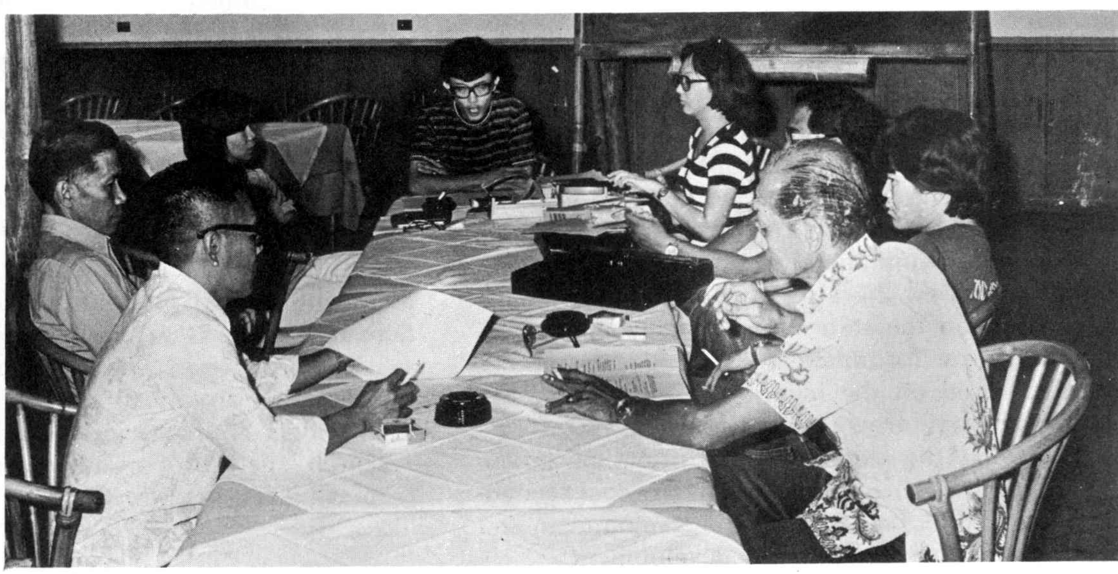
Members of the diplomatic corps who visited our main station include the following: Ambassador DANIEL NUTTER of Australia; Ambassador MASAO SAWAKI of Japan; Ambassador MAC CHAPMAN of New Zealand; Ambassador JAMES TURPIN of the United Kingdom; Mr. RICHARD BROINOWSKI of the Australian Embassy; Mr. DONALD ELLSON of the US Embassy; and Mr. BRIAN GORE of the New Zealand Embassy.

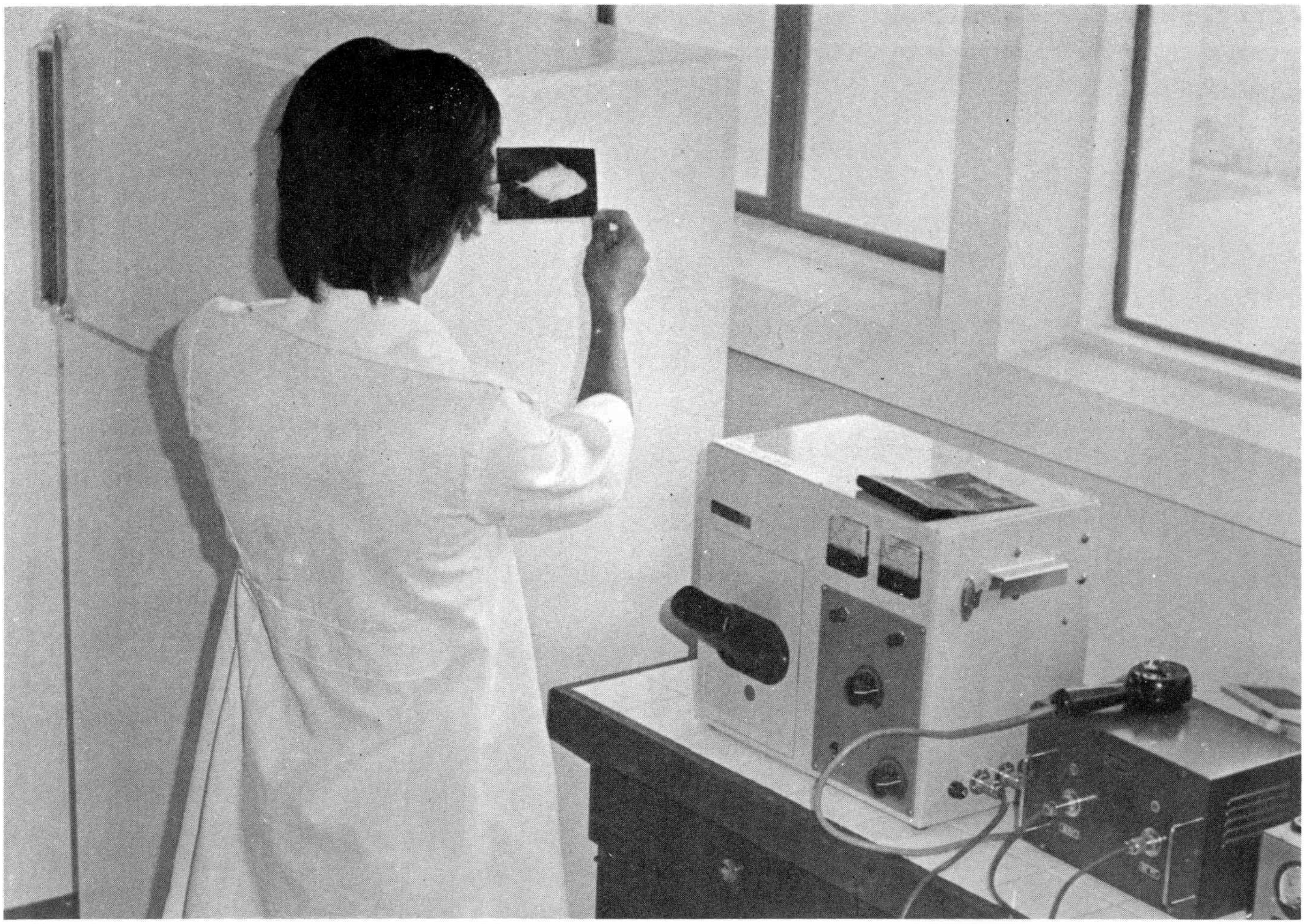
Officials from various international institutions who visited our project sites include the following: Dr. PHILIP HELFRICH, Director, ICLARM; Dr. COLIN NASH, Director, Oceanic Foundation; Dr. ARTHUR WOODLAND, Director, SCSP; Dr. D.F. BUCKMASTER, Officer-in-Charge, Freshwater Fisheries Station of Australia; Dr. LOUIS GOODMAN, Acting Director, EWC Technology and Development Institute; Mr. DONALD BERGSTROM, Resident Representative, UNDP, Manila;

Dr. W.H.L. ALLSOPP, Associate Director for Fisheries, IDRC of Canada; Dr. JAMES JOHNSTON, Associate Director for Agricultural Sciences, Rockefeller Foundation; Dr. FRANK SHEPPARD, Assistant Director for Agricultural Development, USAID; Dr. DONALD GREENE, Assistant Director, EWC Food Institute; Dr. HARLAN LAMPE, Consultant, Agricultural Development Council; Mr. ELLIOT, Program Officer, USAID Washington; Mr. KIMIO KAWASAKI, Director for SEAFDEC Affairs, JICA; Mr. LUCIEN SPRAGUE, Consultant, IBRD World Bank.

Dr. KATSUZO KURONUMA, President Ichthyological Society of Japan; Dr. AUBREY GORBMAN, President, American Chemical Society.

Participants thresh out problems on milkfish research during workshop sessions of the National Bangos Symposium.





Soft x-ray machine facilitates fish-vertebral counts.

Earth-moving is undertaken by the 51st Engineer Brigade of the Philippine Army.

Lifting of nets of prawn maturation pen at sea farming station in Igang.

FINANCIAL STATUS

In 1975 total funds received as outright grants amounted $5.6 million, an increase of 80% over the previous year. Of this amount about 70% came from the Philipine Government and the rest from the Governments of Japan, Australia, New Zealand, Singapore, Malaysia and Thailand including the IDRC of Canada.

In addition, we generated $85,000 from the distribution of prawn fry produced in the hatchery, sale of fish products harvested at the experimental ponds, income from cafeteria and dormitory service facilities, and interest on bank deposits.

The Philippine Government contribution was mainly used for the construction of additional research and other infrastructure facilities at our six stations. The rest supported operating expenses of ongoing and new programs.

Counterpart funds from the Government of Japan amounting $1.2 million represented proceeds from the sale of Japanese rice donation under the Kennedy Round, laboratory and training equipment, services of seven Japanese fishery experts and fellowship grants.

With the IDRC approval of our integrated milkfish project, $826,000 was appropriated over a three-year period beginning May 1975. Under the grant, $260,000 was released this year out of the annual contribution of $346,000. The balance of $86,000 consisting of center-administered contingency funds was included in the accounts as contribution receivable as of December 31, 1975.

Contributions from the Governments of Australia and New Zealand were also received. The Australian contribution was kept with the Secretariat in Bangkok while the New Zealand donation was utilized to purchase library books.

As of year end, we have an accumulated fund balance amounting $3.1 million and total assets of $5.9 million.

REFERRAL AGENCIES

ADB	Asian Development Bank
BFAR	Bureau of Fisheries and Aquatic Resources
DFA	Department of Foreign Affairs, Philippines
DNR	Department of Natural Resources, Philippines
EWC	East-West Center
FAO	Food and Agricultural Organization
FFA	Freshwater Fisheries Station of Australia
IBRD	International Bank for Reconstruction and Development
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre
IPFC	Indo-Pacific Fisheries Council
ISJ	Ichthyological Society of Japan
JICA	Japan International Cooperation Agency
KIFTC	Kanagawa International Fisheries Training Center
KISR	Kuwait Institute for Scientific Research
LLDA	Laguna Lake Development Authority
MSU-IFRD	Mindanao State University, Institute of Fisheries Research and Development
NSDB	National Science Development Board
OF	Oceanic Foundation
PCARR	Philippine Council for Agriculture and Resources Research
PSFR	Philippine Society for Fisheries Research
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SCSP	South China Sea Fisheries Development and Coordinating Program
UNDP	United Nations Development Program
USAID	United States Agency for International Development
UPCF	University of the Philippines, College of Fisheries

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
TIGBAUAN, ILOILO, PHILIPPINES

MDB PRINTING, MAKATI, RIZAL, PHILIPPINES