SEAFDEC AQUACULTURE DEPARTMENT

Annual Report 1979

The Administration Building of the SEAFDEC Aquaculture Department

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AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
Tigbauan, Iloilo, Philippines P.O. Box 256, Iloilo City

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Summary of Activities

NEW CHIEF

The sixth year of operation of the Aquaculture Department of SEAFDEC was marked by a turnover of stewardship. Dean Rogelio O. Juliano of the University of the Philippines College of Fisheries took over on July 9 from Dean Domiciano K. Villaluz who retired after serving as chief of the Department for 6 years.

NEW RESEARCH THRUSTS

The Department has overhauled its research program and, starting 1980, is embarking on a new direction. Essentially the new thrust has a 10-year horizon although its formulation was basically influenced by a 20-year scenario of the fisheries and aquaculture industries of the world and the Asian region in general and the Southeast Asian region in particular.

The new research thrusts and priorities were evolved in a 3-day (Aug. 8-10) workshop among the Department's research staff, administrators, selected support personnel, and resource persons from other institutions.

The research program consolidates the existing commodity-oriented-programs – milkfish, prawn, seafarming, freshwater, and aquaculture engineering – into three aquaculture systems-oriented R & D research areas which give primary consideration to the environment and the production systems deriving from such environment. These three are: *brackishwater*, *freshwater* and *mariculture*.

TRAINING PROGRAM EXPANDED

The scope of the training program of the Department has been broadened with the expansion in the coverage of the various courses and an increase in the number of countries that have been sending trainees to the Department. More than 600 fishfarmers, technicians, government workers and technologists from a dozen countries of the third world attended various courses conducted by the Department in 1979.

SEAFDEC Aquaculture Department Chief Rogelio O. Juliano (right) receives from New Zealand Ambassador to the Philippines Barbara Angus one of the research equipment donated by the New Zealand government to the Department. Ambassador Angus visited the Department in August 1979.

Indian aquaculture researchers observe prawn hatchery operations at the Department's substation in Batan, Aklan. Briefing them is Mr. Rolando Platon, Barangay (Village) Hatchery Project Leader. The observation is part of the Indian scientists' 3-month training course on prawn breeding and culture held from November 1978 to February 1979. The training is the first to be held under a collaboration work plan for scientific and technical cooperation between the Indian Council for Agricultural Research (ICAR) and the SEAFDEC Aquaculture Department.

TECHNOLOGY DISSEMINATION INTENSIFIED

Aquaculture research results and technology developed at the Department now reach more end-users at a faster pace with the setting up of a communications/publications unit under the SEAFDEC Institute of Aquaculture. The *Asian Aquaculture*, the Department's monthly newsletter reaches 1,800 institutions and individuals in 84 countries. The *Fish Farm News*, the only fortnightly news service catering solely to fishfarmers in the Philippines, is subscribed to by more than 700 individuals composed of fishfarmers and people involved in bringing aquaculture knowledge and technology to the fishfarmers. During the year, more extension manuals were produced and distributed in the Philippines and other countries.

AQUADOC AND SCIENTIFIC LITERATURE SERVICE LAUNCHED

To hasten more effective exchange of aquaculture information, the Department launched the AQUADOC (Aquaculture Documentation) and the Scientific Literature Service (SLS) projects. AQUADOC undertakes to track, document and where possible, photocopy relevant aquaculture information in universities, fishery schools, research institutions and in the private collections of aquaculture scientists and development workers in the Philippines. Panay as a pilot area was ex-

tensively covered with a total of 7,500 materials documented. Outreach information addressed to research institutions in the Philippines that are far from big libraries and information centers was initiated with the Scientific Literature Service. Around 5,000 pages of photocopies of journal tables of contents are sent out every month.

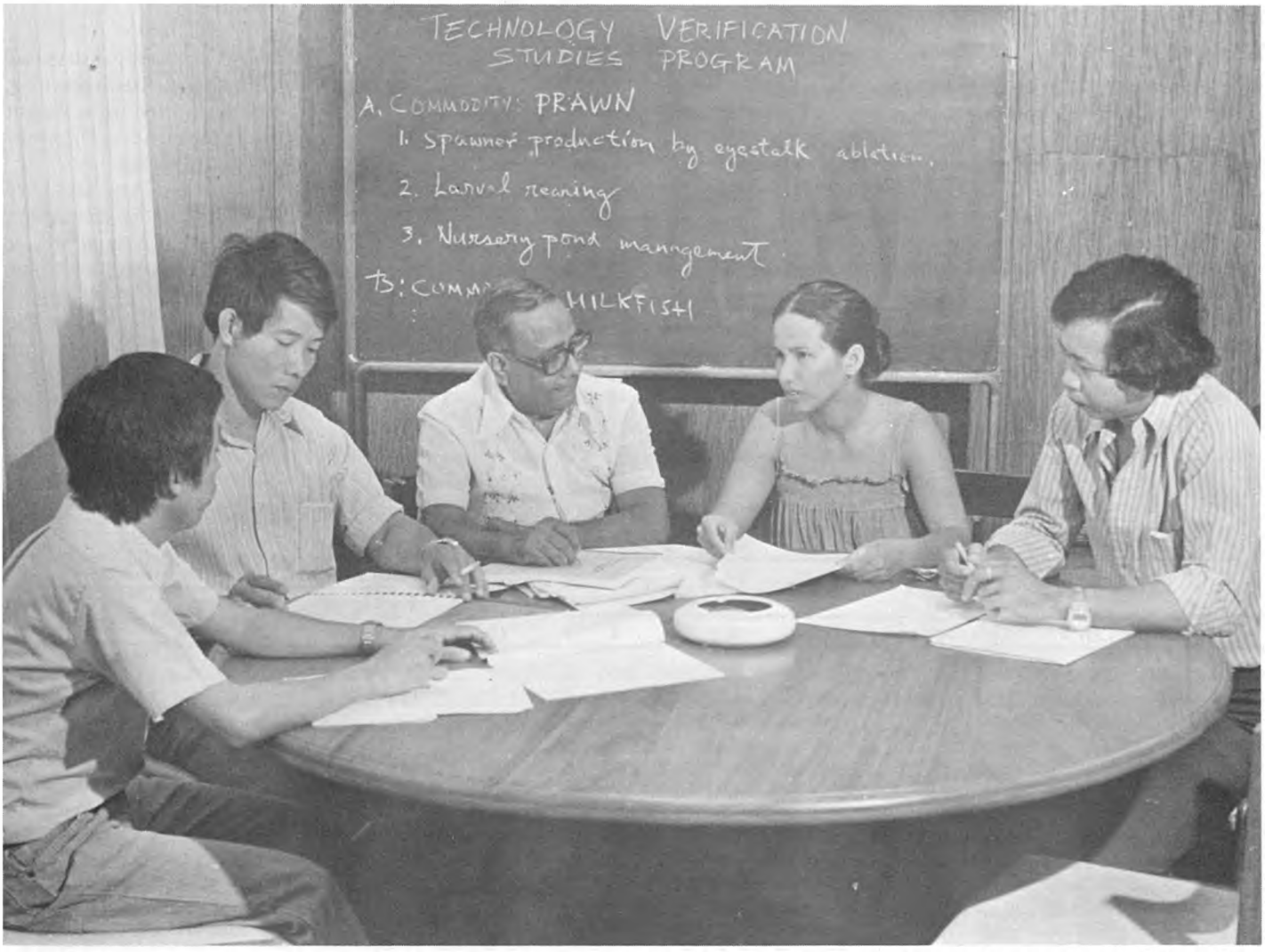
TECHNOLOGY VERIFICATION INITIATED

A technology verification program was formulated during the year. The Department's researchers and some private sector representatives were enlisted in the planning and would be involved in the implementation. So far, two projects have been started in cooperation with two Philippine institutions: The Cagayan Integrated Agricultural Development Project (CIADP) and the Mariano Marcos State University.

IDRC GRANT FOR MILKFISH RESEARCH EXTENDED

The milkfish research program of the Department received another big boost from the International Development Research Centre of Canada (IDRC) through a Cdn. $398,000 grant to cover a 3-year research program.

Research on milkfish continues with ample support from the International Development Research Centre of Canada.



SEAFDEC researchers discuss the technology verification program. From left: Fred Yap, mollusc project team leader; Chhorn Lim, fish nutrition specialist; Hiralal Chaudhuri, deputy director of the SEADEC Institute of Aquaculture; Jurgenne Primavera, head of the prawn land-based broodstock development project; and Rolando Platon, leader of the barangay hatchery project.

Research

Milkfish Program

ECOLOGY

A study on milkfish ecology was conducted to: a) locate the spawning grounds and know the spawning behavior of milkfish; b) understand the behavior of fry appearance in shore waters; and c) know the habits and habitats of juvenile and adult milkfish in the wild.

Results of the study showed that there are latitudinal differences in the spawning seasons of milkfish, as evidenced by the fry occurrence patterns in the tropical and sub-tropical Indo-Pacific region. In Panay, the spawning grounds are mostly located in the open sea with relatively clear, shallow waters and sandy or coralline bottom. Though it is not yet defined, milkfish spawning activity seems to be more pronounced during the first- and last-quarter moon periods. In the wild, milkfish usually spawn around midnight and incubation period for the egg is about 20 hours. The eggs are evenly distributed from the surface down to at least 20 meters. After spawning, spawners apparently migrate to the coast, often to be caught by coastal traps such as fish corrals and otoshi-amis. They may spawn more than once during one spawning season.

Shore-caught milkfish fry were found to have an injury rate of more or less 20% regardless of weather conditions, topography and gear used for collecting fry. Their survival rate was 98-99% after being stocked for ten days with supplementary feeding (Table 1).

It has been observed that milkfish juveniles use, and so most probably require, mangroves, nipa and coral lagoons, estuaries, bays and similar habitats having rich bottom deposits and relatively still and shallow waters as nursery feeding grounds.

Table 1. The degree of injury in milkfish fry collected from shore waters under different conditions with different gears, and the survival in samples stocked for ten days with food.

Condition of Collection				Injury %*				Survival after 10 days stocking with food			
								Mortality	Fork length	Body weight	Condition factor
Place	Date	Sea condition	Gear	0	1	2	3	(%)	(mm $\bar{x}$ ± SE	mg $\bar{x}$ ± SE	$\bar{x}$ ± SE
Guimbal, Iloilo	10-15-78	rough, just after	sweeper	52.0	20.0	28.0	0				
Tigbauan, Iloilo	10-15-78	a storm	sweeper	54.0	32.0	14.0	0				
Tigbauan, Iloilo	10-18-78	calm	sweeper	46.0	30.0	24.0	0				
Hamtic, Antique	5-15-79	rough, after storm	sweeper	78.3	12.0	8.4	1.2				
Pandan, Antique	5-17-79	slightly rough	sagyap	65.4	19.2	15.4	0				
Pandan, Antique	5-18-79	calm	sagyap	64.0	16.0	20.0	0				
Pandan, Antique	5-20-79	calm	sweeper	50.0	33.3	16.7	0				
Pandan, Antique	5-24-79	rough	sweeper	74.0	10.0	12.0	4.0	1.0	15.51 ± 0.6920	15.41 ± 3.5946	4.064 ± 0.5564
Pandan, Antique	5-24-79	rough	sagyap	70.0	20.0	8.0	2.0	1.0	15.11 ± 0.6236	16.22 ± 3.0397	4.647 ± 0.3221
Pandan, Antique	5-26-79	calm	sagyap	35.4	41.7	18.8	4.2	1.0	15.26 ± 0.5817	13.94 ± 2.7529	3.870 ± 0.4166
Pandan, Antique	5-27-79	slightly rough	tangab	76.5	17.7	2.0	4.0	2.0	14.92 ± 0.8352	18.47 ± 4.0775	5.470 ± 0.4857
Pandan, Antique	5-27-79	calm	sweeper	60.0	34.0	2.0	4.0	1.0	14.69 ± 0.5665	15.64 ± 2.7134	4.890 ± 0.4695

*Degree of injury: 0 — no injury at all; 1 — slight or negligible; 2 — disruptive; causes change in behavior; 3 — serious; may cause death.

BROODSTOCK

Milkfish reared for 2-4 years in an enclosed cove increased in weight from an average of about 1.5 kg to about 2.5 kg after 6 months in floating cages and fed commercial fish pellets and crustacean pellets. Spent male and female sabalo kept in floating cages for 6 months and fed as above had no gonadal development. Hormonal administration by pellet implantation on 2-4 year old milkfish kept in floating cages and on spent sabalo in canvas tanks is now in progress.

INDUCED SPAWNING

Seventeen sabalos – 7 females and 10 males – caught from the wild were injected with gonadotropic hormones to induce them to spawn in captivity. They were chosen based on their physical condition and stage of gonadal development. A mixture of acetone-dried pituitary gland homogenate of salmon (SPH) and human chorionic gonadotropin (HCG) was injected into the females. The males were injected only with HCG. Vitamin B complex was also injected to some males and females to counteract the effect of stress from capture and handling.

Results showed that a total dose of 140 mg of SPH and 20,000 IU of HCG per fish given in two injections was effective in inducing the female sabalo to ovulate. A dose of 5,000 IU HCG/fish proved to be effective in inducing spermiation. Some males, however, needed a second injection to maintain their milting condition.

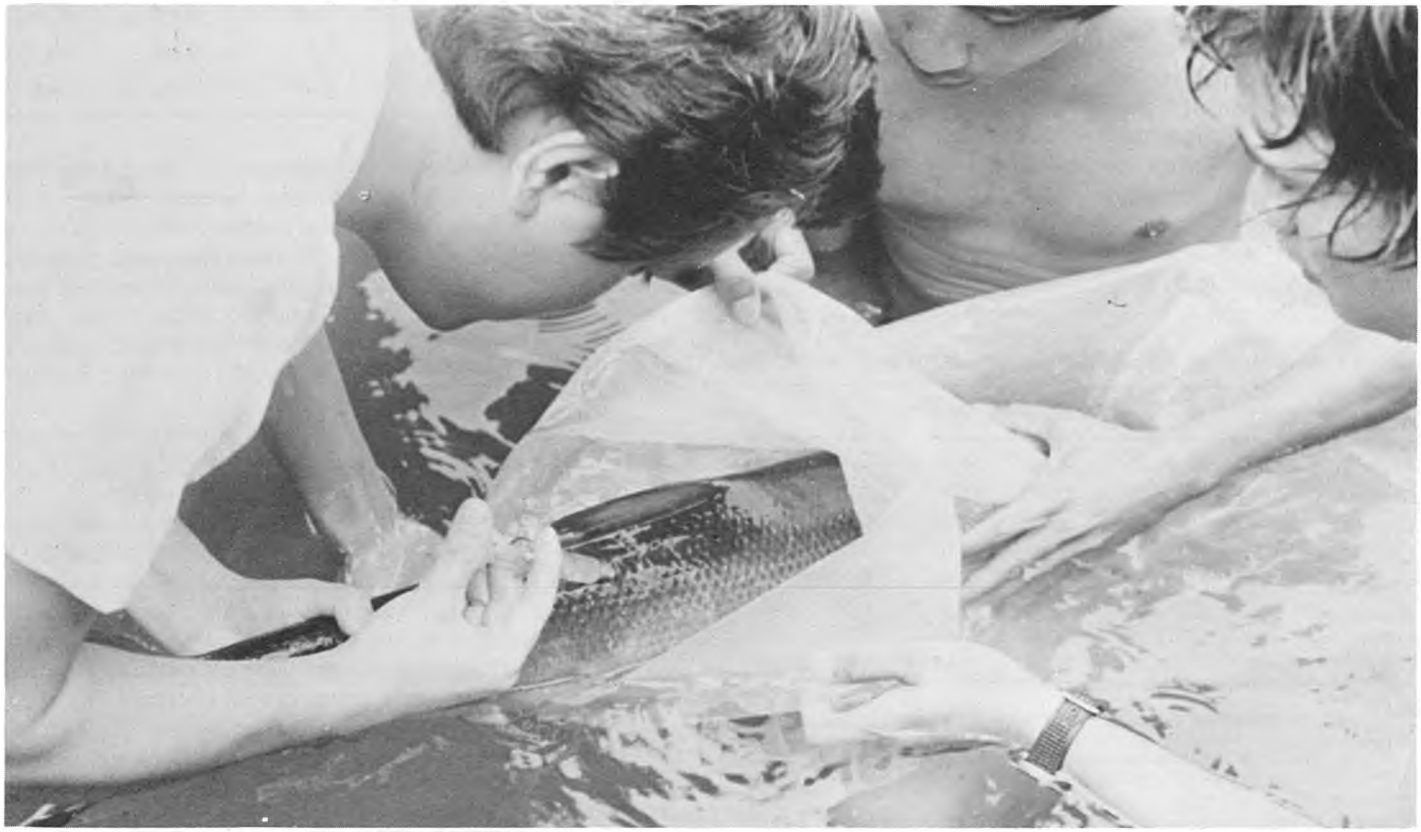
Two of the injected females spawned. The eggs were fertilized by using the milt of injected males. Due to the absence of newly caught males only the eggs from the second spawner were fertilized. Fertilization rate was estimated to be 59.4%.

LARVAL REARING

On April 4, 1979, one female sabalo was induced to ovulate in captivity by injecting it with a combination of acetone-dried pituitary gland and human chorionic gonadotropin in 1% sodium chloride solution. About 1,410,000 eggs were stripped. The stripped eggs were fertilized by the sperms from three injected males. However, the fertilization rate was estimated to be only 59.4% and the hatching rate was estimated to be 39.7%.

Larvae were reared in six 400-liter fiberglass tanks at a temperature range of 25.8 to 28.9°C and salinity range of 28.35 ppt. Larvae were fed solely with rotifers during the first 9 days of rearing. Copepod nauplii were added on day 10 and *Artemia* nauplii on day 20. *Chlorella* was also added throughout the entire rearing period to maintain good water quality in the rearing tanks. Larvae which came from the eggs fertilized by the first male sabalo sperms were very weak and were discarded on day 4 of the rearing period. A total of 1,234 larvae were harvested from the 26,692 that were originally stocked.

Experiments on the effect of salinity on the hatching rate of larvae were conducted in 1-liter beakers. The different salinities tested were 5, 10, 15, 20, 25, 30, 35 and 40 ppt. Fertilized eggs were observed to be at the bottom of all the beakers except in the beaker with 40 ppt, where some eggs floated on the surface. Highest hatching rate of 61.3% was observed at 15 ppt, followed by 10 ppt with 60%. The lowest



Injecting a sabalo with hormones to induce spawning.

hatching rate of about 40% occurred at 40 ppt for the eggs at the bottom. On the other hand, the floating eggs had a hatching rate of 92.%. Results of this experiment is not conclusive since only one trial run was conducted.

The effect of salinity on the survival rate of larvae was studied in 30-liter fiberglass aquaria. The different salinities used were 10, 20, 30, 35 and 40 ppt. Newly hatched larvae were acclimatized from 4 to 32 hours depending on the salinities where they were supposed to be transferred for experimental purposes. Results showed that larvae reared at 10 ppt survived for 12 days – the longest so far. However, it was noted that the experimental animals suffered from the phy siological stress of handling and transport.

NUTRITION AND FEED DEVELOPMENT

A research project to determine the energy-protein requirement of milkfish fingerlings was started in February 1979 with financial support from the stockholm–based International Foundation of Science (IFS). Under this project, two experiments were conducted during the year.

Experiment 1. Milkfish fingerlings with an average weight of 2.5 g were fed chemically defined diets for a period of 5 weeks. The diets (Table 2) contained 50 g protein, 15 to 25 g carbohydrate and 5 to 10 g fat. Kilocalories per kg of diet ranged from 2530 to 3185.

Table 2. Composition of the diet for milkfish fingerlings in percent (Experiment 1).

	DIETS				
	1	2	3	4	5
Casein	54.34	54.34	54.34	54.34	54.34
Dextrin	15.00	15.00	15.00	20.00	25.00
Cod liver oil	5.00	3.75	2.50	5.00	5.00
Corn oil	5.00	3.75	2.50	5.00	5.00
Vit mix[1/]	1.34	1.34	1.34	1.34	1.34
Mineral mix[2/]	5.66	5.66	5.66	5.66	5.66
Carboxymethylcellulose	3.00	3.00	3.00	3.00	3.00
Cellufil	10.66	13.16	15.66	15.66	0.66

mg/kg diet

1/ Type 500, Vit. A – 1.1000, Vitamin D_2 – 0.0025, Vitamin E – 6.7120, Vit. K_3 – 1.000, Choline Chloride – 58.200, Niacin – 10.00, Riboflavin – 2.00, Pyridoxine-HCl – 2.000, Thiamine-HCl – 2.000, D-Calcium Pantothenate – 5.000, Biotin – 1.000, Folacin – 0.5000, Vit. B^{12} – 0.200, Ascorbic acid – 10.000, Inositol – 10.000, Celufil – 1231.40

g/kg diet

2/ $CaHPO_4$ – 1.637, $CaCO_3$ – 1.480, KH_2PO_4 – 1.000, KCl – 0.100, NaCL – 0.600, $MnSO_4.H_2O$ – 0.035, $FeSO_4.7H_2O$ – 0.050, $MgSO_4.7H_2O$ – 0.6137, KIO_3 – 0.001, $CuSO_4.5H_2O$ – 0.003, ZnH_2O – 0.0347, $CoCl_2.6H_2O$ – 0.0031, $Na_2MoO_4.2H_2O$ – 0.0083.

Prior to the feeding experiment, the fingerlings were acclimatized in the laboratory for 1 week on a pelleted practical diet. At the start of the experiment, 20 fingerlings were randomly weighed on a top loading balance after they were anesthesized with 100 ppm of 2-phenoxy ethanol. They were placed in fiberglass aquaria containing 20 liters of water with a flow–through system. There were five treatments each with three replications. A randomized complete block design was followed. Analysis of variance to determine differences between treatment means was carried out.

The highest survival rate and weight gain were obtained by those fed Diet 1, the diet with 15% dextrin (Table 3). The lowest survival rate was observed among those fed Diet 5 which contained 25 g dextrin, while the lowest weight gain was observed among those fed Diet 3 which contain 15% oil. Salinity ranged from 32 to 34 and temperature ranged from 26.5 to 30. Data is inconclusive.

Table 3. Mean initial and final weight, percentage weight gain and survival rate of *Chanos chanos* fingerlings fed a purified diet. (Experiment 2)

Diet Treatment	Initial Mean Weight (g)	Final Mean Weight (g)	Weight Gain (%)	Survival Rate (%)
IFS 1	2.35	3.16	40.6	63.3
IFS 2	2.60	3.12	19.8	58.3
IFS 3	2.58	3.08	19.4	41.7
IFS 4	2.45	3.11	27.8	58.3
IFS 5	2.50	3.30	31.4	25.0

Experiment 2. Milkfish fingerlings weighing 4-5 g from ponds were brought to the laboratory where they were acclimatized for a week on a pelleted practical diet in a 300-liter fiberglass tank. After a week, 30 fingerlings were randomly chosen and weighed on a top loading balance after they were anesthesized with 175 ppm of 2-phenoxy ethanol. They were stocked in 35 liters of filtered sea water in a flow-through system. The fingerlings were not fed for 24 hours prior to weighing.

The diets contained protein at 35, 40, 45 and 50 g levels, carbohydrates from 15 to 25 g, and fat at 5, 7.5 and 10 g levels (Table 4). Kilocalories per kg of diet ranged from 2530 and 3185. The moist diet was stored in plastic covered jars in a refrigerator at 4°C. Feed weighing about 20% of total body weight was given daily, about 2/5 at around 9:00 A.M., 2/5 at about 1:00 P.M. and the remaining feed at about 4:30 P.M. Diets were prepared in 500-g portions once every 8-10 days.

Although mean weight gains were not statistically different from each other, some trends can be discerned (Table 5). After 4 weeks of feeding, fish fed Diet 4 gained the heaviest weight followed by those fed Diets 5, 2 and 3. However, after 8 weeks of feeding, mass mortality occurred in fish given Diet 4; weight gain was highest among the fish fed Diets 5, 6 and 1, respectively, in descending order. At the end of 10 weeks, weight gain was highest among the fish fed Diet 5, followed by those fed on Diets 6 and 2.

Weighing a sabalo.

Table 4. Percentage composition and proximate analysis of the diet.

PRO. CHO. LIPID Levels / Ingredients	50-15-10 1	50-15-75 2	50-15-5 3	50-20-10 4	50-25-10 5	35-15-10 6	40-15-10 7	45-15-10 8
Casein	52.8	52.8	52.8	52.8	52.8	37.	42.2	47.5
Dextrin	15.0	15.0	15.0	20.0	25.0	15.0	15.0	15.0
Fish oil	5.0	3.75	2.5	5.0	5.0	5.0	5.0	5.0
Corn oil	5.0	3.75	2.5	5.0	5.0	5.0	5.0	5.0
Vit. mix[1]	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
Min. mix[2]	5.66	5.66	5.66	5.66	5.66	5.66	5.66	5.66
Celufil	12.2	14.70	17.20	7.20	2.20	28.0	12.8	17.5
CMC	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Protein as analyzed (%)	49.61	50.5	50.5	50.58	50.19	35.31	40.17	45.89
Fat as analyzed (%)	9.98	7.38	5.03	9.83	10.21	10.21	10.53	10.22
Ash as analyzed (%)	5.67	5.71	5.75	5.48	5.5	5.44	5.45	5.55
Metabolizable energy as calculated[3]	350	355	301	362	384	289	315	331

1/ Vitamin mix (mg/kg diet)
Vit. A, 10.99 mg., Vit. D_2, .025 mg., Vit. E, 67.12 mg., Vit. K_3, 10 mg., Choline chloride, 581.52 mg; Niacin, 99.92 mg; Riboflavin, 19.98 mg; Pyridoxine HCl, 19.98 mg; Thiamine HCl, 19.98 mg; D. Calcium pantothenate, 49 96 mg; Biotin, 10.0 mg; Folacin, 5.0 mg; Vit. B_{12}, 2.0 mg; Ascorbic acid, 100.0 mg; Inositol, 100.0 mg; Callufil, 12314.585 mg.

2/ Mineral mix (g/kg diet)
$CaHPO_4$, 16.37; $CaCO_3$, 14.8; KH_2PO_4; 10; KCl, 1; NACl, 6; $MnSO_4H_2O$,35; $FeSO_4.7H_2O$, .50; $MgSO_4.7H_2O$, 6.137; KIO_3, .01; $CuSO_4.5H_2O$, .03; 2n $SO_4.7H_2O$, .347; $CaCL_2$, .$6H_2O$, . .031; $Na_2MoO_4.2H_2O$, .083; Cellufil, 1.045.

3/ 4 KCal/g protein
4 KCal/g carbohydrate
9 Kcal/g fat

Table 5. Mean initial weights, mean weight gain/fish at 4, 8 & 10 weeks and percentage survival rate.1/

Diet	PRO CHO LIPID LEVEL	Mean Initial Wt.	Mean Weight Gain 4 wks	8 wks	10 wks	7 Survival Rate 4 wks	8 wks	10 wks
1	50-15-10	4.52	4.74	8.21	3.00	98	53	48[a]
2	50-15-7.5	4.55	5.71	7.92	3.31	100	54	43[a]
3	50-15-5	4.54	5.20	6.47	3.20	96	81	71[a]
4	50-20-10	4.56	6.89	—	—	96	—	—
5	50-25-10	4.53	6.00	9.47	2.38	87	80	67[a]
6	35-15-10	4.47	4.68	8.51	3.54	99	98	81[a]
7	40-15-10	4.52	4.31	6.85		99	57	
8	45-15-10	4.64	4.79	6.30	0.95	100	54	33[a]

1/ Figures with the same superscripts are not significantly different from each othe ($P<0.05$)

Diets 1 to 3 had constant protein and carbohydrate levels while fat varied. When these three diets were compared, the diet with 7.5 g fat produced the highest weight gain. Diets 1, 6, 7 and 8 had constant carbohydrate and fat levels but protein varied from 35 to 50 g respectively. Fish fed Diet 6 which contained the lowest protein content, gained the most weight.

Survival rate did not follow the same pattern. The group fed the lowest fat content (Diet 3) had the highest survival rate among the groups fed Diets 1 to 3. Among the diets with varying level of carbohydrate the diet with the highest carbohydrate content gave the highest survival rate. In contrast, the diet with the lowest protein content produced the highest survival rate among diets with varying levels of protein. Surprisingly, fish fed the 40 and 45 g protein (Diets 7 and 8) had low survival rates.

Feed conversion and protein efficiency were best for Diet 6 followed by Diets 1 and 5 (Table 6).

Only the protein content of the fish showed statistically significant differences among the parameters measured. Fish fed on diet 3 had the highest protein deposition while carcass of the fish fed the 25 g carbohydrate diet (Diet 5) had the least amount of protein although both diets contained 50 g protein. However, fish fed on diet 5 had the highest fat deposition.

Kilocalories per protein in the diet was highest in Diet 6 followed by Diet 5.

Preliminary analysis of tissues from four milkfish with bulging eyes showed the presence of gram-positive organisms scattered around the eye tissues. The exact nature of the organisms could not be identified yet; the organisms are too big for bacteria, nor can they be claimed as fungi (or fungal spores) because of the absence of hyphae. Further analysis is needed to diagnose the opaque and bulging eye manifestation.

Table 6. Average Weight Gain/Fish at end of Experiment, % Weight Gain, Feed Conversion, Protein Efficiency Carcass Composition (moisture, protein, fat, ash) and KCal per Gram Protein.

Diet	PRO-CHO LIPID LEVEL	Average Wt. Gain/ Fish	% Weight Gain	Feed Conversion	PER	Carcass Composition % % Dry Matter				KCal/PRO	
						Moisture	Pro	Fat	Ash	M.E.	D.E.
1	50-15-10	15.41	331.0	3.38[a]	12.5	74.93[a]	63.01[ab]	22.94[a]	11.31[a]	61	59
2	50-15-7.5	16.70	377.0	3.74[a]	13.0	73.60[a]	61.95[ab]	22.24[a]	11.28[a]	65	55
3	50-15-5	14.87	328.52	3.64[a]	12.0	75.49[a]	65.35[a]	20.11[a]	11.61[a]	70	51
4	50-20-10									74	61
5	50-25-10	17.85	394.5	3.39[a]	15.0	74.39[a]	61.22[a]	24.62[a]	11.46[a]	78	64
6	35-15-10	16.73	374.0	3.12[a]	20.0	74.39[a]	65.43[a]	21.15[a]	11.21[a]	83	69
7	40-15-10									77	64
8	45-15-10	11.57	246.2	7.84[a]	11.0	74.27[a]	63.29[ab]	20.04[a]	12.43[a]	73	61

[1] Figures with the same superscripts are not significantly different from each other $P<0.05$.

DIGESTIVE PHYSIOLOGY

Crude extracts from various regions of the digestive tract of pond-grown milkfish were tested for their ability to catalyze the hydrolysis of various carbohydrates. The most active carbohydrates were those involved in the hydrolysis of α-glucosidic bonds. Maltose, trehalose, dextrin, starch and glycogen were rapidly hydrolyzed in the presence of crude extracts from the intestines and the pyloric caeca. High amylase activity was observed in extracts from the intestines, pancreas, pyloric caeca and liver. The intestinal amylase had optimum activity at pH 6.2 and a temperature of about 50°C. It was active at a chloride concentration of 10 to 40 ppt. The amylase activity in the intestines consistently peaked at about noon when the milkfish gut was full. In contrast, enzyme activity was significantly lower at 0300 hours when the gut was empty. These results are consistent with earlier observations that the milkfish is a daytime feeder and suggest further that intestinal amylase secretion is in phase with the feeding activity of the milkfish. Although the fishes used in this study fed mostly on the naturally occurring algae in the ponds, no cellulose activity was detected in any region of the digestive tract. Less active carbohydrates that were detected include a B-glucosidase and B-galactosidase, both of which were of limited substrate specificity.

HEMATOLOGIC STUDIES

Milkfish hemoglobin and plasma proteins were studied by spectrophotometry and electrophoresis, to determine possible biochemical markers of physiologic and reproductive development.

The absorption spectra of milkfish hemoglobin at pH 7.0 in 1 nm TRIS-EDTA buffer showed two bands in the visible region with wavelength of maximum absorption at 576 nm (α-band) and 540 nm (β-band). In the Soret region, maximum absorption occurred at 410 nm. The spectral properties of milkfish hemoglobin is similar to those of mammalian hemoglobin and comparable to some other fish hemoglobins. Milkfish hemoglobin exhibits intraspecific variations when subjected to electrophoresis at pH 8.9. The variations appear to be associated with increase in body weight and possibly with reproductive development.

The electrophoretic resolution of the plasma proteins of milkfish shows more than six different fractions. A highly anionic fraction, considered to be serum albumin is the major protein fraction in juvenile milkfish. This fraction is markedly reduced in sexually mature male and female milkfish.

POLYCULTURE

1. Evaluation of milkfish (*Chanos chanos* Forsskal) and prawn (*P. monodon* Fabricius) in polyculture systems. The growth, survival and profitability of milkfish and prawns (averaging 3.1 g and 0.3 g respectively) grown in five different combinations for 100 days in 500-sq m brackishwater ponds in the SEAFDEC station at Leganes, Iloilo, Philippines were assessed. The treatments with three replicates were (I) 2,000 milkfish/ha; (II) 4,000 milkfish/ha; (III) 6,000 milkfish/ha; (IV) 2,000 milkfish with 6,000 prawns/ha and (V) 4,000 milkfish with 6,000 prawns/ha. The competition of prawns to milkfish as expressed by the competition index (CI) was (0.03 and 0.15) compared to the competition exerted by milkfish to prawn (0.48 and 0.67). Mean weight gain of milkfish at 2,000/ha was significantly higher ($P<0.05$) than those at 4,000/ha in both monoculture and polyculture systems. The monoculture of prawn (treatment III) was significantly higher ($P<0.05$) than that of prawns in polyculture with milkfish (treatment IV and V). Likewise, prawns with milkfish at a lower stocking density (treatment IV) grew significantly faster than those at higher stocking density (treatment V). Profitability wise, the monoculture of prawns (treatment III), attained the highest net income due to its high market price.

2. Effect of different stocking combinations on growth, production and survival of milkfish (*Chanos chanos* Forsskal) and prawn (*P. monodon* Fabricius) in Polyculture in brackishwater Ponds. Milkfish and prawn were stocked in 500-sq-m earthen ponds from 12 November 1978 to 15 March 1979 at the following combinations: 2000 milkfish fingerlings/ha (treatment I); 2000 milkfish fingerlings/ha plus 4000 prawn juveniles/ha (treatment II); and 2000 milkfish fingerlings plus 8000 prawn juveniles/ha (treatment III); with three replicates per treatment.

Highest combined net milkfish and prawn production was obtained in treatment III with 492.1 kg/ha followed by treatment II with 404.1 kg/ha, and treatment I (milkfish only) with 280 kg/ha. Differences in combined net production between treatments III and I and between treatments II and I were statistically significant at the 5% level. Average net production of milkfish alone was highest in treatment III followed by treatment II and treatment I, although differences were not significant. Average net production for prawn was also better in treatment III than treatment II but the difference was not significant. However, mean weight of prawn was higher in treatment II compared to treatment III. Average survival rates were high for milkfish in all treatments ranging from 90 to 96% but low for prawn at around 50% for both treatments. There was no significant difference in survival rates of milkfish among the treatments and of prawn between treatments II and III. The competition index between milkfish and prawn at the given stocking combinations was negative indicating a positive, advantageous influence of prawn on milkfish production.

3. Polyculture of milkfish and tiger prawn (*P. monodon* Fab.) with and without supplemental feeding. The result of this trial is not encouraging. Lab-lab did not grow well in the ponds even after proper pond preparation and subsequent fertilization. The low production and survival rates obtained in this study were caused by lack of natural food and high salinity (30-46 ppt) during the first month of culture; *P. monodon* suffered a high mortality during this period. It was suspected that the experimental ponds were affected by acid sulfate conditions as shown by the reddish orange coloration of the pond bottom. However, the results indicate that high yields maybe obtained from the combination of the two species given good growth of natural food and favorable water conditions.

4. Polyculture of milkfish *Chanos chanos* and Mud crab *Scylla serrata* at two stocking densities. Mud crabs were cul-

Preparation of concrete ponds at the Leganes brackishwater research station.

tured in ponds, singly and in combination with milkfish, to compare the growth, survival and yields. Milkfish were stocked at 2,500/ha and crabs at 5,000 and 10,000/ha in the monoculture and polyculture, respectively. In the polyculture system growth response of milkfish was repressed. On the otherhand, crabs exhibited a no statistical difference in growth rates in the monoculture and polyculture system and at the two stocking rates tested. There was, however, a marked difference in survival rates. The highest yield was obtained in the polyculture with 5,000/ha of mud crab.

5. A Comparative Study on the growth and survival of stunted and non-stunted milkfish fingerlings. Growth rate and survival response of 7-month stunted and newly grown milkfish fingerlings were compared. The stunted fingerlings exhibited a faster rate of growth during the initial stage of culture for about 45 days from release into the grow-out pond. Thereafter and until about 80 days, growth diminished in both types of fingerlings resulting in a non-significant difference. Over the entire culture period, production obtained from the stunted fingerlings was significantly higher by about 75 kg/ha. Survival in both stunted and newly grown fingerlings ranged from 94.7 to 97.2%.

Table 7. Survival rate of fry to fingerling after 69 days of culture period in the nursery at two stocking densities.

Stocking Density (per ha.)	Nursery Pond No.	Estimated Number Stocked	Total Number Harvested	Survival (%)	Mean Survival (%)
500,000	BNP1	37,500	34,050	90.80	
	BNP2	37,500	32,478	86.60	89.97
300,000	BNP3	45,000	39,877	86.08	
	BNP4	45,000	42,251	93.87	88.70

Harvesting milkfish.

FINGERLING PRODUCTION

Survival rate of fry to fingerling after 69 days of culture at two stocking densities are shown in Table 7. Highest survival rate of 93.87% was obtained in the nursery pond BNP4 at a stocking rate of 300,000 fry/ha. A high survival rate of 90.80% was also obtained in BNP1 with a stocking density of 500,000 fry/ha. On the average, a survival rate of 89.97 and 88.70% were obtained at stocking densities of 300,000 and 500,000 fry/ha, respectively. The difference in survival rate, however, was not significant at the 5% level. Results showed that a comparable high mean survival rate of 88.7% can be attained at a high stocking density of 500,000 fry/ha although on the average the fingerlings produced were smaller compared to a stocking rate of 300,000 fry/ha (Table 8).

It was demonstrated that using available technology, fish farmers can successfully mass produce bangus fingerlings in brackishwater ponds with survival rate of as high as 93.87% This value can probably be increased by exercising proper control of predators and other unwanted species that prey or compete with the bangus fry.

Table 8. Bimonthly mean length and weight measurement of 20 random samples of bangus fry stocked at two stocking densities.
Date of stocking: May 9, 1979
Mean weight (g): 0.004
Mean length (mm): 14.00

Sampling date	Stocking density (per ha)			
	300,000		500,000	
	BNP3	BNP4	BNP1	BNP2
a) Weight (g)				
May 14	0.015	0.014	0.021	0.048
28	0.87	1.32	.052	0.70
June 11	1.09	3.81	1.97	1.54
27	1.38	3.59	1.40	1.80
July 9	1.41	5.13	1.61	1.48
14-17	1.50	3.20	2.00	1.90
Gain in weight	1.496	3.196	1.996	1.896
Mean	2.346		1.946	
b) Length (mm)				
May 14	15.40	15.00	16.65	14.50
28	45.30	51.80	39.70	42.15
June 11	53.26	82.40	63.60	58.20
27	54.97	83.16	56.55	61.64
July 9	53.06	82.15	59.30	56.50
14-17	54.00	69.00	54.00	55.10
Gain in length	40.00	55.00	40.00	41.10
Mean	47.50		40.55	

Prawn Program

ECOLOGY AND LIFE HISTORY

1. New species. Two new species of penaeid prawn which are commercially important were discovered in Philippine waters. They were examined and described as follows:

Trachypenaeus villaluzi (Fig. 1) has mastigrobranchia on the second and third pereiopods, but not on the first. The anterior plate of its thelycum is deeply concave. Also concave is the lower margin of the distolateral projections of the petasma.

The second species, *Metapenaeus philippinensis* (Fig. 2), has a petasma which superficially resembles that of *M. ensis.* However, the petasma of the two species markedly differ in details. The distomedian lobes of the new species have rounded postero-lateral corners and the denticles are borne on a crescentic ridge in the disto-medial aspect of the lobes. The thelycum is also distinctive, with lateral tufts of setae and two conical pillar-like prominences at the posterior end of the lateral plates and a characteristic median plate which is broader posteriorly than anteriorly. The new species is devoid of dorsal carina on the first three abdominal segments.

2. Seasonal occurrence of *P. monodon* caught in fish corrals. It was observed that *P. monodon* spawns throughout the year with three peaks, first in April, second in August and third in November. Females are generally larger than males with modal carapace length of 60 and 48 mm, respectively.

3. Seasonal occurrence of *P. semisulcatus* caught in fish corrals. *P. semisulcatus* is abundant during three periods of the year – March, June to August and October to November. This indicates large annual fluctuations of the prawn although it appears all year-round.

Spawning of *P. semisulcatus* takes place throughout the year with three peaks: April, June and September, with considerable fluctuations from year to year.

4. Sugpo (*P. monodon*) fry occurrence in the Philippines. This study was started on April 25, 1979 and is expected to be completed after two years. The findings after the end of 1979 showed that sugpo fry seem to seek brackishwater areas as their nursery ground. The fry are seldom found in outer littoral area and upstream of a big river. A survey of local fry collectors in the Philippines was conducted revealing the places and time of fry availability (Table 9).

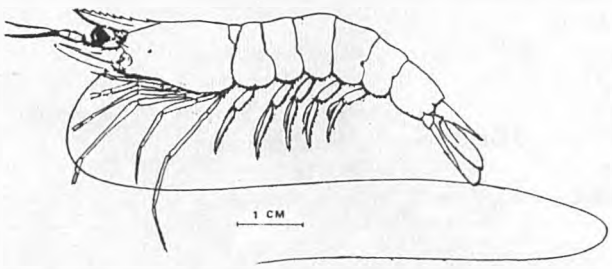


Fig. 1. Lateral view of female *Trachypenaeus villaluzi* (CL 14.9 mm.

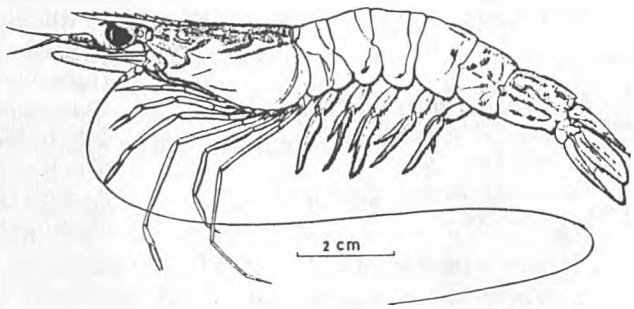


Fig. 2. Lateral view of female *Metapenaeus philippinensis*, sp. nov., CL, 28.0 mm.

5. Relations between size, sexual maturity and fecundity of the giant tiger prawn *P. monodon*. Samples of *P. monodon* were collected in Batan Bay and its adjacent waters. Results of the study showed that *P. monodon* males sexually mature at a smaller size than females by 10 cm carapace length (CL). Males of 37 mm CL and greater usually possess spermatozoa, while most females of 47 mm CL and greater are inseminated.

Spawning was observed to start in prawns having a minimum size of 48 mm CL. The majority of those who spawned, however, had about 60 mm CL. Analysis of size distribution indicated spawning four times during the prawn's life span – at 53, 60, 66 and 71 mm CL.

The fecundity or number of eggs shed by females varied from 248,000 to 811,000 with an average of 457,000.

6. Temperature and stability tolerance of post-larval and juvenile *P. monodon*. This study was conducted to assess the mortality of post-larval and juvneile *P. monodon* when subjected to extreme variations of temperature and salinity. At low temperature, the first mortality occurred when the temperature was lowered about 13°C. Fifty percent mortality occurred at about 9°C. No mortality occurred when the temperature rose to 41°C. All died before the temperature reached 42°C.

More than 60% survival was noted at 0‰ salinity. The first mortality occurred at about 40‰. As salinity rose, higher mortality occurred. Fifty percent mortality occurred at about 60‰, total mortality occurred at about 80‰.

7. Diet fluctuations in catch postlarval *P. monodon*. From Feb. 23 to 27, 1979, samplings of postlarval *P. monodon* were made with the triangular push net every 2 hours over a 96-hour period. The sampling site was a muddy sand or fine gravel area (varying 50 to 120 cm deep) adjacent to the shoreline of Tigbauan, Iloilo, Philippines.

Major peak catches of postlarval *P. monodon* occurred at night (1800-2000 hours), 2 to 4 hours before the highest tide, as the water temperature was falling. Minor peak catches were noted during the day (0800-1200 hours), 0 to 4 hours before the high water when water temperature was rising. It appears that postlarval *P. monodon* are carried shoreward by the incoming tidal currents mostly at night and reached peak abundance 2 to 4 hours before high water. No relationship between larval occurrence and water salinity was found due to almost constant values of salinity (33-35‰).

8. Diel fluctuations in catch of postlarval *P. merguiensis* **group**. In general, there were two peak occurrences of *P. merguiensis* daily associated with tidal elevations. The first occurred during flood tide, 2 to 6 hours before higher high tide and the other, more or less during low tide. Both occurred when water temperature was falling or lowest. There was a significant difference in the occurrence of postlarvae between day and night ($P<0.01$) showing greater number caught during the day than

Table 9. Local and seasonal occurrence of *P. monodon* fry, based on reports from local fry collectors in the Philippines.

No.	Place	Collection period	Peak season
	LUZON		
1.	Dalahican, Quezon	Southeast monsoon	August
2.	Atimonan, Quezon	Northwest monsoon	February
3.	Calauag, Quezon	Year round	Northeast monsoon (February to June except March and April)
	VISAYAS		
4.	Batan, Aklan	Year round	November to February
5.	Barotac Nuevo, Iloilo	June to October	August
6.	Villa & Tigbauan, Iloilo	May to December	October to November
7.	Bolanon-Danao, Pontevedra, Negros Occ.	March to September	May to June
8.	Tabao-Caingin, Valladolid, Negros Occ.	Northwest (December-February) & Southwest monsoons (June-November)	August-October
9.	Aguisan, Himamaylan, Negros Occ.	Year round	November
10.	Bocana-Tabla, Ilog, Negros Occ.	July to December	August to September, November
11.	Sipalay, Neg. Occ.	March to June, October to December	June, November
12.	Malabugas, Bayawan, Negros Or.	April to December	May to June
13.	Polo, Negros Or.	March to June, October-December	June, November
	MINDANAO		
14.	Dapitan, Zamboanga del Norte	Year round	September to October
15.	Dipolog, Zamboanga del Norte	Year round	September to November
16.	Ozamis, Misamis Occ.	Northeast & Southwest moonsoons	July, November to December
17.	Zamboanga, Zamboanga del Sur	September-November	
18.	Tagum, Davao del Norte	Northeast & Southwest monsoons	April to May, October to November
19.	Matina, Aplaya, Davao del Sur	Northeast monsoon	April to May

at night.

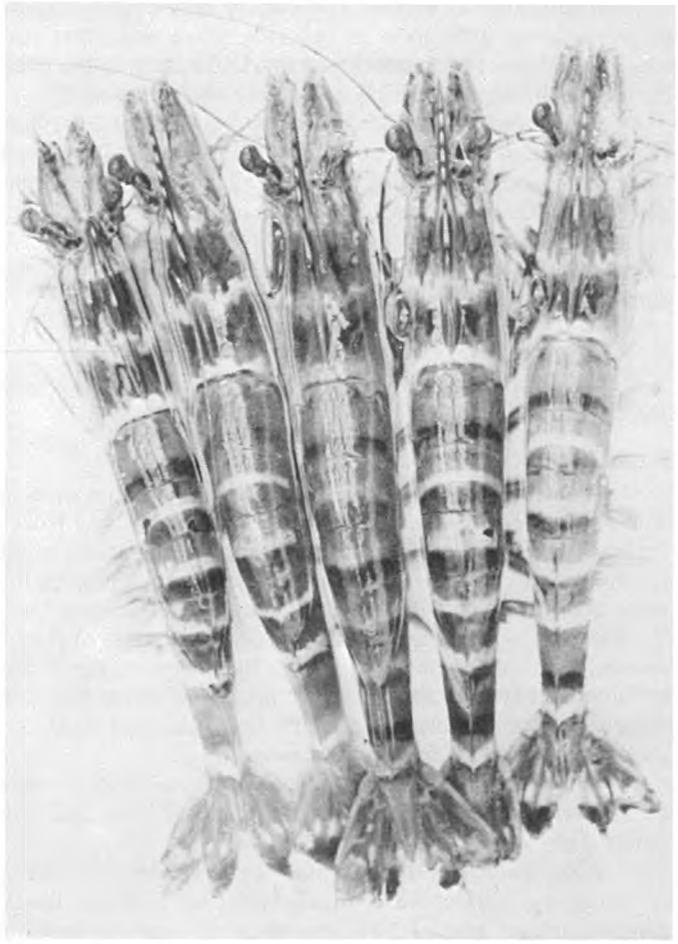
9. Diel fluctuations in catch of postlarval *P. semisulcatus*. Major peak occurrence of postlarval *P. semisulcatus* was observed at night (2000-2400 hours), 0 to 2 hours before the higher high tide as the water temperature was decreasing. Minor daily peak catches occurred at night (0400-0600 hours), 0 to 2 hours before the lower low tide when water temperature was lowest. Postlarval *P. semisulcatus* seem to be nocturnal.

BROODSTOCK DEVELOPMENT

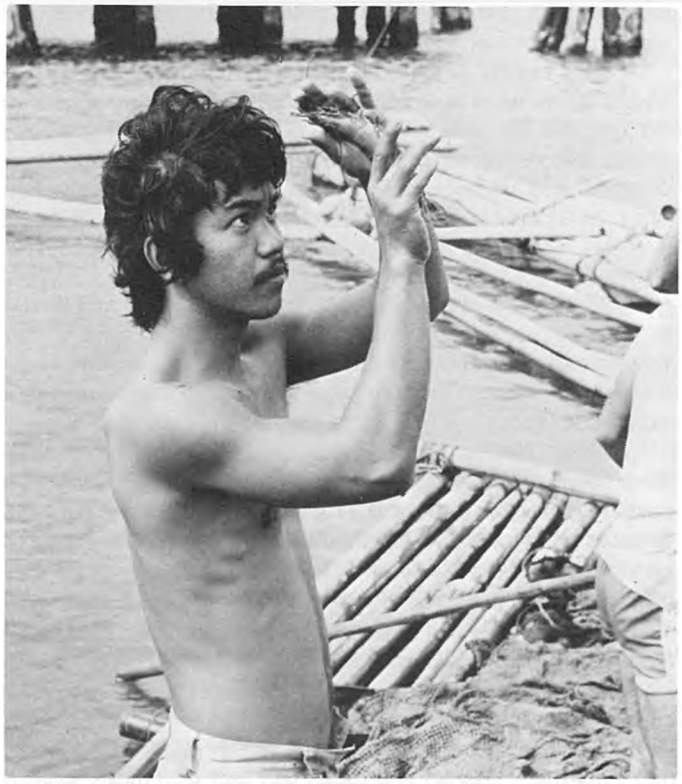
1. Management of ablated *P. monodon*. Four studies on the management of ablated *P. monodon* broodstock were conducted during the year.

The first study was conducted to determine the minimum number of males per female that would ensure regular fertilization and therefore high hatching rates. Wild stock *P. monodon* were stocked in 12 cu m circular tanks at different sex ratios (0:1, 1:1, 1:2, and 1:4 male to female) for a duration of 55 days. All females were ablated on one eyestalk while males remained unablated. The 1:2 male-female ratio is recommended on the basis of highest percentage of first, second and third spawnings and total and average fecundity. In the all-female treatment (0:1 ratio), 19.65% of the females spawned, but the 3.3 million eggs produced were not fertilized, resulting in a zero percentage hatching rate.

The second study was to find out the effect of age of pond-stock *P. monodon* on maturation, spawning, fecundity and hatching rate and quality after ablation. Five-month old pond-stock *P. monodon* taken from Altavas, Aklan were ablated unilaterally and reared for 62 days. Total prawn survival was 93.33%, the males having slightly higher rates over the females. Out of 40 ablated females, 60% spawned, having a total fecundity of 5,175,000 eggs and 1,032,000 nauplii or an average hatching rate of 19.94%.



Prawn spawners.



Examining *P. monodon* broodstock reared in maturation pens in Batan, Aklan.

The effect of substrate color on survival and maturation of ablated *P. monodon* was determined in the third study. Wild *P. monodon* broodstock from Makato and Batan were unilaterally ablated and reared in two 12-cu m circular tanks with different substrates (black gravel vs. white coralline sand) for 62 days. Survival of males was consistently higher than that of the females for both runs and treatments. This was due to the fact that females are exposed to additional stress during sampling, spawning and tagging. During the first experimental run, the black substrate excelled over the white in percentage of survival, % spawners, average fecundity, nauplii produced, and average hatching rate. This was because the tank used for the white substrate was wooden, which was found less efficient for broodstock survival and maturation compared to the ferrocement tanks. In survival percentage alone, the females in the white substrate tank showed much lower rates than those in the black substrate tank, thus a lower maturation rate. However, when both ferrocement tanks were used during the second run, the white substrate gave higher % spawners, average number of nauplii and average hatching rates over the black substrate. However, female survival was higher in the black substrate.

The fourth study revealed that rematuration rates for wild ablated *P. monodon* have considerably increased in 1979. It further showed that total fecundity and nauplii produced also increased. These results may be due to greatly improved tank and handling conditions.

2. Histological studies. Preliminary ovarian histological studies showed differences in cell size, shape and other features for different broodstock sources. Differences in the setae during the different moulting stages were also observed.

3. Induced maturation and spawning of other penaeids. Four species of penaeids other than *P. monodon* have been stocked in 12-cu m circular ferrocement tanks at a maximum density of 300 individuals per tank since 1978. Results consistently showed that *P. indicus* (ablated and unablated) gave more spawnings than any other species, with *P. merguiensis* coming in second.

HATCHERY

1. Pilot small-scale hatchery. Results of studies showed that *P. monodon* larvae can be reared fairly well using frozen feeds. This can simplify to a great extent the operations in the hatchery as it would no longer be necessary to synchronize the mass production of *Chaetoceros*, *Tetraselmis*, *Brachionus* and the hatching of brine shrimp at specific larval stages of *P. monodon*. It was observed that, although there were no significant differences between their survival rates, the larvae fed with frozen feeds metamorphosed to the first postlarval stage two days later than those fed with live feeds.

In another experiment, *Brachionus* concentration reached an average of 300 individuals per ml after being fed with frozen *Tetraselmis* for 8 days.

A comparative study was made between the use of water recycling and normal water management for hatchery operation. A survival rate of 19% was obtained from N_4 to P_1 in normal water management while 6% was obtained with the use of recycling system.

Chlorination and dechlorination of sea water as water treatment for hatchery were also studied. Chlorine was completely evolved after 24 hours at 2 and 5 ppm while those at 10 and 15 ppm took 2 to 3 days to evolve. Using charcoal for absorption of chlorine, concentration was lowered to .70 ppm at 5 ppm; 3.27 ppm at 10 ppm; and 6.54 ppm at 15 ppm after 60-minute durations. Those at smaller size absorbed residual chlorine better than those using bigger sizes.

2. Establishment of pilot small hatcheries in different sites. Hatchery runs were conducted at the SEAFDEC station in Batan, Aklan by trainees of the small-scale hatchery management course. Out of 135,000 nauplii stocked, 98,600 postlarvae were harvested representing a survival rate of 73%. A second batch of trainees from different countries also conducted hatchery runs. They harvested 65,000 postlarvae out of 300,000 nauplii resulting in a survival rate of 22%.

The Department assisted some private hatchery operators in the establishment and management of prawn hatcheries. In this connection, studies were conducted on the hatchery sites, particularly on site suitability, water quality and availability of desirable algae as larval food. A graduate of the 2-month training program on barangay hatchery was assisted by SEAFDEC technicians in establishing a prawn hatchery. Using the barangay hatchery technology developed at SEAFDEC, the initial hatchery runs of the hatchery located in Pan-ay, Capiz obtained an average survival rate of 39% from nauplii to postlarval stage. This survival rate was considered good since the larval rearing tanks used have not been well conditioned yet for the first run.

The researchers of the barangay hatchery also found that sea water in Batan, Aklan is good for hatchery operations. It contains various diatoms which can easily be propagated and used as larval feed. Some of these have been identified, e.g. *Chaetoceros*, *Navicula* and *Nitzschia*, but others have yet to be identified.

3. Mass production of *P. monodon* fry (big hatchery). The technology for mass seed production of *P. monodon* in large tanks developed over the last 5 years was further studied in 1979 for refinement and simplification. A total of 5,010,000 postlarvae was produced. The hatchery operation also yielded the following results:

a. Mortality rate from nauplius to postlarval stage of *P. monodon* was high during the dry season due to high water salinity. The survival rate during the dry season was 18% compared with 50.2% during the wet season.

b. Rearing *P. monodon* larvae up to P_5 with diatoms and *Brachionus* alone without *Artemia* gave only 0.02 and 2.0% survival.

c. Cultured bread yeast with sea water is effective as supplemental feed for the larvae.

d. Contamination of blue green algae in *Chlorella* culture was solved using chlorine.

NUTRITION AND FEED DEVELOPMENT

1. The effect of various ratios of protein and carbohydrate sources on the growth and survival of *P. monodon* juveniles under laboratory conditions. Nine diets were tested on *P. monodon* juveniles weighing 0.6 to 2 g to determine the effect of various levels of corn oil and cod liver oil on the growth of the juveniles (Table 10). The best diet tested in previous studies in 1978 was used as the control diet (Diet 11). This diet consists of 20% fish meal, 40% shrimp head meal, 14% rice bran, 5% sago palm starch, 10% breadflour, .5% cholesterol, 1.5% corn oil, 1.5% cod liver oil, 2% vitamin mix, and 5% mineral mix.

The results (Table 11) showed that mean percentage weight gains were low when corn oil was the only source of fat in both 3% and 5% levels (Diet XV and XVIII). Higher weight gains were observed among juveniles fed with cod liver oil at 3% and 5% levels (Diet XVI and XIX). Percentage weight gains were similar when a combination of corn oil and cod liver oil were used in equal amounts at 3% and 5% levels. Prawn fed Diet II gained the highest weight. Highest survival rate (97.8%) was observed in the group fed Diet II and lowest in the diet that did not contain any fat (80%). Results further showed that Diet II gave the best growth and survival. However, none of the treatment means was significantly different from each other.

Using similar procedure as the foregoing experiment, three levels of cholesterol in the diet were fed to *P. monodon* postlarvae weighing about 0.17 g. Although no significant differences were noted, results indicate a trend on the effect of varying levels of cholesterol. Prawns fed on diet with 1% cholesterol gained highest weight increase, had best feed conversions, and survival rate (Table 12). Those fed on diets containing 0.5% cholesterol ranked next while the group fed on diets with 1.5% cholesterol gained the lowest in weight, feed conversion and survival rate.

2. The effect of combination of fish meal, shrimp head meal, ipil-ipil (Peruvian and local) leaf and seed meals, soaked and unsoaked on the growth and survival of *P. monodon*. Post-

Table 10. Diet composition in percent for *P. monodon* juveniles.

Diet Code	II	XI	XIV P/C 1	XV P/C 2	XVI P/C 3	XVII P/C 4	XVIII P/C 5	XIX P/C 6	XX P/C 7
Fish meal	20	16.7	16	16	16	16	16	16	16
Shrimp head meal	40	33.3	32	32	32	32	32	32	32
Rice bran	14	24.0	24	24	24	24	24	24	24
Sago palm starch	5	5	5	5	5	5	5	5	5
Breadflour	10	10	10	10	10	10	10	10	10
Cholesterol	1	1	1	1	1	1	1	1	1
Corn oil	1.5	1.5	1.5	3	–	2.5	5	–	–
Cod liver oil	1.5	1.5	1.5	–	3	2.5	–	5	–
Vitamin mix	2	2	2	2	2	2	2	2	2
Mineral mix	5	5	5	5	5	5	5	5	5
Rice hull	–	–	2	2	2	–	–	–	5

Table 11. Mean initial and final weights, weight gain, and survival rate of juvenile *P. monodon* fed various amounts of oil.

Diet Code	Mean initial Weight	Mean Final Weight	Weight Dif.	Weight Gain	Survivors No	Survivors %
	g	g	g	%		
II	0.96	2.067	1.1	118.5	14.7	97.78
XI	0.95	1.98	1.03	112.4	13.7	91.11
XIV P/C 1	1.12	2.31	1.19	113.3	13.3	88.87
XV P/C 2	1.24	2.06	0.82	69.5	14.0	93.33
XVI P/C 3	1.2	2.34	1.14	94.8	13.3	88.87
XVII P/C 4	1.24	2.63	1.39	112.0	12.7	84.45
XVIII P/C 5	1.03	1.82	0.79	75.9	13.7	91.11
XIX P/C 6	1.20	2.54	1.34	113.0	13.0	86.67
XX P/C 7	1.12	2.12	1.0	93.1	12.0	80.0

Table 12. Mean weight gain, feed conversion and survival of *P. monodon* fet diets containing different levels of cholesterol.

Level of cholesterol %)	Weight gain (%)	Feed Conversion	Survival (%)
1.0	66.35[a]	4.63	91.67[a]
0.5	59.43[a]	5.83	85.00[a]
1.5	44.61[a]	7.47	81.67[a]

larvae *P. monodon* weighing between 0.5 to 1.1 g obtained from the wild were fed diets containing soaked ipil-ipil leaves for 8 weeks. There were two runs whereïn 1/3, 1/2 or 2/3 of the diet contained soaked ipil-ipil leaves. Although there were no significant differences between treatment means in both growth and survival, results indicate that survival rate was always lowest in the group fed the diet that did not contain ipil-ipil (control). Percentage weight gain was lowest in the control diet in run 1 but was highest in run 2. On the other hand, percentage weight gain was highest in the group fed with the diet containing 1/2 of total diet as ipil-ipil in run 1 but was lowest in run 2. Results were very poor for growth and survival in general

NATURAL FOOD

A study was conducted on natural food of larval penaeids which could be useful in establishing criteria for an ideal hatchery site. Survey and identification of sampling stations were conducted in Batan Bay, Aklan; 12 were assigned as plankton collecting areas and 7 for larval collection. Samplings were done once a month, during which physico-chemical parameters were recorded.

Preliminary plankton investigation showed that there was an abundance of both phytoplankton and zooplankton in all areas. However, it was observed that for the first three months of collection, there was a decrease in number and in kind of the plankton population from July to September.

Among the organisms seen were those belonging to the phyla: *Bacillariophyta, Cyanophyta, Protozoa, Coelenterata* and *Protochordata.* Among the phytoplanktons, diatoms were predominant while the copepods were the most abundant zooplankton.

A method of harvesting and preserving algae was developed and evaluated. Test algal species consisted of two diatoms, *Chaetoceros calcitrans* and *Skeletonema costatum*, and two flagellates, *Tetraselmis chuii* and *Isochrysis galbana*.

Chemical flocculation using alum, lime and sodium hydroxide, were evaluated as methods of harvesting algae. Alum and lime flocculation were found effective for *Chaetoceros*, *Tetraselmis* and *Skeletonema* but ineffective for *Isochrysis* sp. Among the chemical methods, pH-adjustment with sodium hydroxide in simulated auto-flocculation process effected the highest recovery of algae.

Techniques of freezing and sun-drying were investigated as methods of preservation. Viability tests were done on frozen samples to determine the maximum storage effectivity of each test species. Results showed that freezing the harvested algae with cryoprotectants successfully preserves their viability except *Isochrysis* sp. *C. calcitrans* remained viable up to 18 months; *T. chuii* up to 4 months; and *S. costatum* up to 2 months.

It was concluded that sun-dried algae show satisfactory results as larval food and thus may be used as substitute or supplement for fresh algae during periods of scarcity. Larval survival and development were best with sun-dried *Chaetoceros* among the algal species tested.

The macronutrient composition of natural food organisms that are mass cultured in the SEAFDEC Aquaculture Department, was determined by chemical analysis. The food organisms included five species of marine phytoplanktons, namely: *Chaetoceros calcitrans, Skeletonema costatum, Tetraselmis chuii, Chlorella virginica, Isochrysis galbana,* and two zooplanktons: *Artemia salina* (nauplii, San Francisco strain) and *Brachionus plicatilis.* The algal species were grown in batches and processed for analysis during the exponential phase of growth using a procedure in which cellular integrity was preserved and cell lysis avoided. Each species was analyzed for proximate content of protein, lipid, fiber, ash, calcium and phosphorus. Carbohydrate content was determined by difference. For the five algal species the protein, lipid and carbohydrate content ranged from 22.30 to 48.42%, 2.56 to 16.04% and 14.15 to 29.45%, respectively. The two zooplanktons had higher protein and lipid content than any of the phytoplankton species. On the other hand, the phytoplanktons contained relatively greater quantities of carbohydrates and inorganic matter.

POND PRODUCTION

Effects of water movement and aeration system on the survival and growth of hatchery bred sugpo (*P. monodon* Fab.)

Small-scale prawn hatchery tanks at the Department's substation in Batan, Aklan.

Growth studies were done on five cultured algae commonly used for larval food. The test organisms included two bacillariophytes: *Skeletonema costatum* and *Chaetoceros calcitrans*; two chlorophytes: *Tetraselmis chuii* and *Chlorella virginica*; and one chrysophyte: *Isochrysis galbana.* Data on growth phases were taken by monitoring growth rates expressed as units of divisions per day obtained from serial optical density readings which were converted to logarithmic values, plotted against time and each phase of growth identified.

Based on the behavior of the growth rate, the growth cycle for each species has been observed as a sigmoid curve. This is divided into several phases, namely: exponential, lag, declining and stationary phases. Under specific culture conditions, each phase has been defined so as to precisely determine the time for harvesting the algae for different purposes such as chemical analysis, feed inoculum, etc.

in earthen nursery ponds. *P. monodon* fry were reared from P_4P_5 to $P_{32}P_{33}$ in earthen nursery ponds complete with reservoir pond, water supply/control/screening and aeration facilities. Sixteen 192-sq m pond units were utilized. Four treatments were tested as follows: Treatment A, flow-through 6 hr/day, without aeration; B, flow-through 6 hr/day + 6 hr/day aeration; C, flow-through 3 hr/day + 3 hr/day aeration; and D, flow-through 3 hr/day, without aeration. A dry formula feed containing 54.7% crude protein was given starting the second week of culture period at the rate of 20% of estimated prawn biomass. The amount was reduced to 10 and 8% by the third and fourth week, respectively.

Higher survival rates were attained in treatments B and C (68.6 and 61.9%, respectively) compared to treatment A (51.6%) and treatment D (46.0%). Aeration (Factor B) showed a significant ($P<0.10$) effect on survival rate of fry while water movement rate (Factor A) showed no significant ($P<0.10$) relationship with survival. No interaction effect was observed

between factors A and B. In terms of growth, the final average body weight varied inversely with survival, so that treatment B obtained the lowest mean weight at 365 mg, followed by C, 393 mg; A, 420 mg; and D, 478 mg. The differences, however, were not significant, thus, total prawn biomass was still directly related to survival. Overall results showed a more promising trends for treatments B and C in terms of survival and total yield compared to treatments A and D. Simple economic analysis, however, showed better economic viability for treatments A and B over C and D.

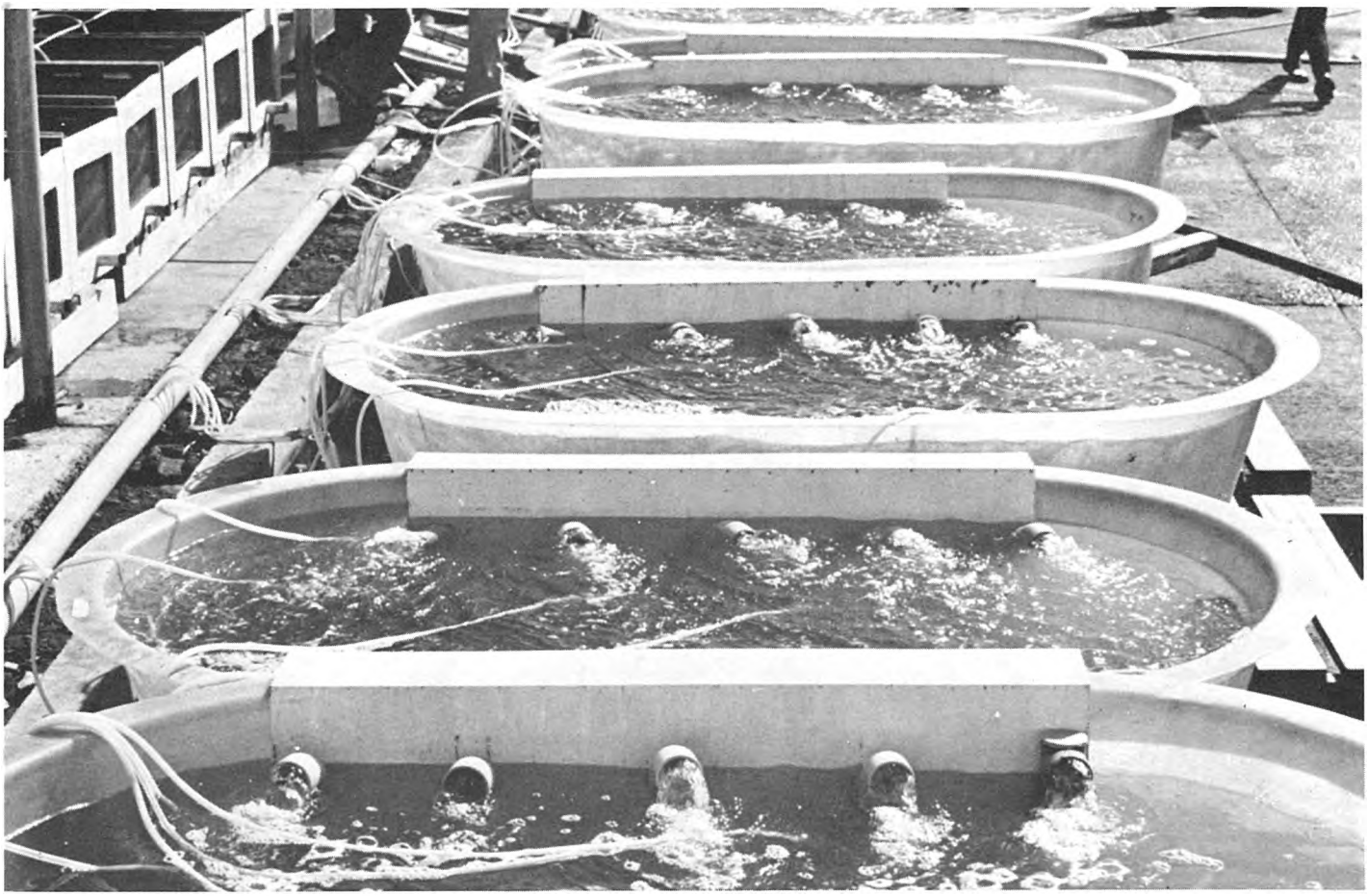
Survival, growth and production of *P. monodon* at different stocking densities in earthen ponds with flow-through system and supplementary feeding. Twelve 200-sq m nursery ponds with water exchange rate of 5-10% daily were stocked with $P_{53}P_{54}$ prawn juveniles (0.45 g average weight and reared for 3.5 months. Stocking density levels at 2.5, 5.0, 10 and 20 prawn/sq m were designated as treatments A, B, C and D, respectively. Pelletized formula feed was given daily one week after stocking at 10% BW. Feeding rate was subsequently reduced bi-weekly by 1% up to a limit of 5%.

The overall average survival obtained was 92% with a mean range of 82.75-100%. Highest survival was achieved in treatment A, with 98.6%, followed by treatment B, 95.3%; treatment D, 87.6%; and treatment C, 86.5%. There were significant differences ($P>0.05$) in survival means among all paired treatments except between treatments A and B, and C and D.

The final average body weight obtained varied indirectly with stocking density. The highest mean weight was achieved in treatment A with 23.4 g; followed by treatment B, 18.22 g; treatment C, 11.22 g; and treatment D, 7.24 g. The results also showed significant differences ($P>0.05$) among all paired means of the final weights except between treatments C and D.

Pond conversion rates and production rates varied directly with stocking density, though quality of the harvested prawns in terms of size diminished with increasing production rates.

Feeding behavior and food preference of *P. monodon* Fab. with scrap tilapia. The time of day during which *P. monodon* feed intensively at different depth levels in earthen ponds, and its preference with three types of tilapia feeds (dry, fresh and fermented) were determined. The experiment was conducted in 600-sq m rectangular reservoir pond originally stocked with 4,000 *P. monodon* juveniles (1.3 g average weight). Eighteen sets of prawn traps were utilized, 9 of which were set at the pond bottom and another 9 sets at subsurface, 10 cm below the water surface. The traps were equally spaced at a distance of 2.4 meters and each had 200 g of either dry, fresh or fermented tilapia chopped and wrapped loosely in plastic screens as lure. Three independent experimental runs were conducted on November 27,1978. It was observed that *P. monodon* concentrated at the bottom beds during the day and along the periphery of dikes during night time, with a slight tendency to swim and feed towards the surface as dark periods increased. *P. monodon* showed special preference for dried tilapia as compared to fresh and fermented ones, which further confirmed its being a carnivorous scavenger. *P. monodon* also showed adaptability for platform method of feeding especially during night time.



Algal culture tanks in Tigbauan station.

Seafarming Program

MUSSEL

Studies on fouling organisms of mussel farms in Himamaylan, Negros Occidental were conducted to: identify fouling species in mussel farms, determine the conditioning period needed for maximum "attractiveness" of spat collectors, and determine settlement/colonization patterns of fouling organisms.

Three spat collecting ropes, each half-meter long and with five strips of coconut husks wedged between rope strands, were hanged in the water every month. Two of the ropes were collected after one month in the water while the third rope was inspected and returned to the water. All organisms that settled on the ropes and coconut husks were sorted and identified.

The composition of the principal fouling animal communities was simple in the earlier months of the year and the number of species increased in developed communities during the warmer months of April and May.

All the spat collectors laid out at the start of the study were heavily infested by boring bivalves *Phelas* spp., *Parapholas quadrizonata* and *Crytopleura* spp. These borers caused the deterioration of the coconut husks. The succeeding ropes placed in the water, however, were not infested by these borers enabling other organisms to colonize the new ropes.

During the development of the fouling communities, a succession of different species was observed. After some time in the water, the ropes and coconut husks were covered with silt; some were evergrown by algal materials. The algal materials were found to be composed of chlorophytes and oyanophytes and some associated epiphytic forms.

It was also found that algal materials on the collectors act as traps for the planktonic larvae of the sedentary marine forms. In this way, during spatfall, the metamorphosing larvae attach to the substrate.

The second phase of the colonization patterns on new substrates started when other organisms settled on the algae-covered collectors. The hydroids *Obelia* and *Pennaria* settled

Harvesting mussels grown in bamboo rafts at the Department's experimental farm in Himamaylan, Negros Occidental.

A brackishwater pond stocked with milkfish and mussels. Note mussels attached to ropes hanging on to bamboo stakes.

next. The presence of these organisms also helped trap mussel larvae and thus aided in the settlement of the mussel spats.

Mats of bryozoans and tunicates also grew on the new surfaces. These bryozoans and tunicates spread so fast that the growing mussel spats were easily smothered.

Barnacles were found to be the fiercest competitors of mussel spats for settlement spaces. Usually, the mussel spats are left out from these spaces and perish.

Crab Predation

Another study on mussel was conducted to evaluate the effects of crab predation on mussels *Mytilus smaragdinus* Chemmitz (*Perna viridis* Linne). Five crab species were found to be dominant in the mussel farms at Himamaylan, Negros Occidental. These were *Portunus pelagicus, Charibdis helleri, Thalamita crenata, Ozius* sp. and a grapsid crab. Three other species were caught in the crab pots: *Scylla serrata, Charybdis cruciata* and *Charybdis* sp.

Predation experiments done in the laboratory indicate that mussle shells are easily crushed and the meat eaten by all eight brachyuran species.

Milkfish-Mussel Polyculture

A preliminary study was conducted to find out the feasibility of culturing green mussels together with milkfish in brackishwater ponds in the Department's Leganes station.

Using the plankton method of culture (1-meter water depth), two treatments with four replicates were tested for 90 days. Each treatment consisted of monoculture of milkfish at 150 fingerlings per 500 sq m (or 3000/ha) and polyculture of milkfish and mussels at 150 fingerlings per 500 sq m and 34,000–35,000 mussels. The horizontal-hanging method was used in growing the mussels.

Results gave encouraging indication that mussels could be grown together with milkfish in brackishwater ponds. The difference in mean milkfish yields between monoculture and polyculture was very slight. Monoculture yielded 16.6057 kg while, in polyculture, 15.5215 kg of milkfish were harvested. In one polyculture pond, a recovery of 52.1% was obtained from the mussels for a total harvest of 110 kg. The condition index was 38.87% which is inferior. [Maclean (1975) stated that only mussels with condition index above 40% are considered fat and ready for marketing.). This could be a result of insufficient food supply due to competition.

It was noted that for milkfish-mussel polyculture to be successful, proper water management should be observed such as regular replenishment of water through tidal fluctuations, and if necessary with the use of water pump.

A study on the larval and post-larval biology of the green mussel (*Perna viridis* Linneaus) yielded the following results:

Mature mussels were induced to spawn in the laboratory and the fertilized eggs reared to post-larvae (spats) in 26-30°C seawater of 30 ppt salinity. Settlement on artificial substrates occurred on the 17th day after fertilization.

The study described the laboratory procedures for maintaining a brood stock of mature mussels, for inducing the mussels to spawn, and for rearing the larvae. The identifying characters of the mussel larvae were also given.

Harvesting mussels grown together with milkfish in a brackish-water pond. The rope is 10 meters long.

Reproductive Cycle

The reproductive cycle of the green mussel, *Perna viridis* Linneaus, was investigated in the Department's experimental farm in Himamaylan, Negros Occidental. The study revealed that unlike mussels in the temperate regions, the *Perna viridis* Linneaus has a less defined gonadal cycle. Furthermore, the gonadal cycle differs from year to year. The green mussel spawns every month in varying degrees with spawning peaks every 2 to 5 months. A spawning peak lasts from 1 to 2 months.

The green mussel does not at anytime totally attain a particular stage as evidenced by the following characterstics of the gonads: a) all stages in the gonadal cycle are visible in any mussel gonad section; b) the gonad index never reach the extreme values – zero when the population is entirely sexually indeterminate or five when completely ripe; and c) Leucocyte infiltration which normally follows a spawning phase is found in all mussel gonad sections.

Other findings:

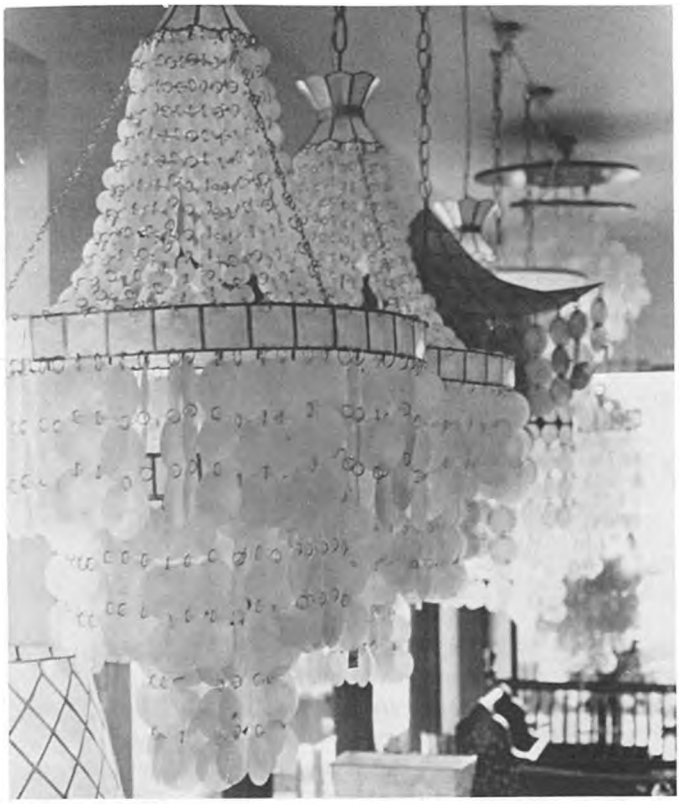
* The gonadal cycle of green mussel directly affects the condition index.
* The presence of green mussel larvae in the plankton does not reflect its spawning period.
* Temperature does not affect the gonadal cycle of the green mussel.
* Salinity appears to have an effect on the gonad index of the green mussel.
* Sex ratio of 5-month old and above green mussels shows a predominance of females in the population.
* Morphological hermaphrodites constitute a small percentage (0.19%) of green mussel population.

Newly harvested mussels after 90 days of culture in a milkfish brackishwater pond.

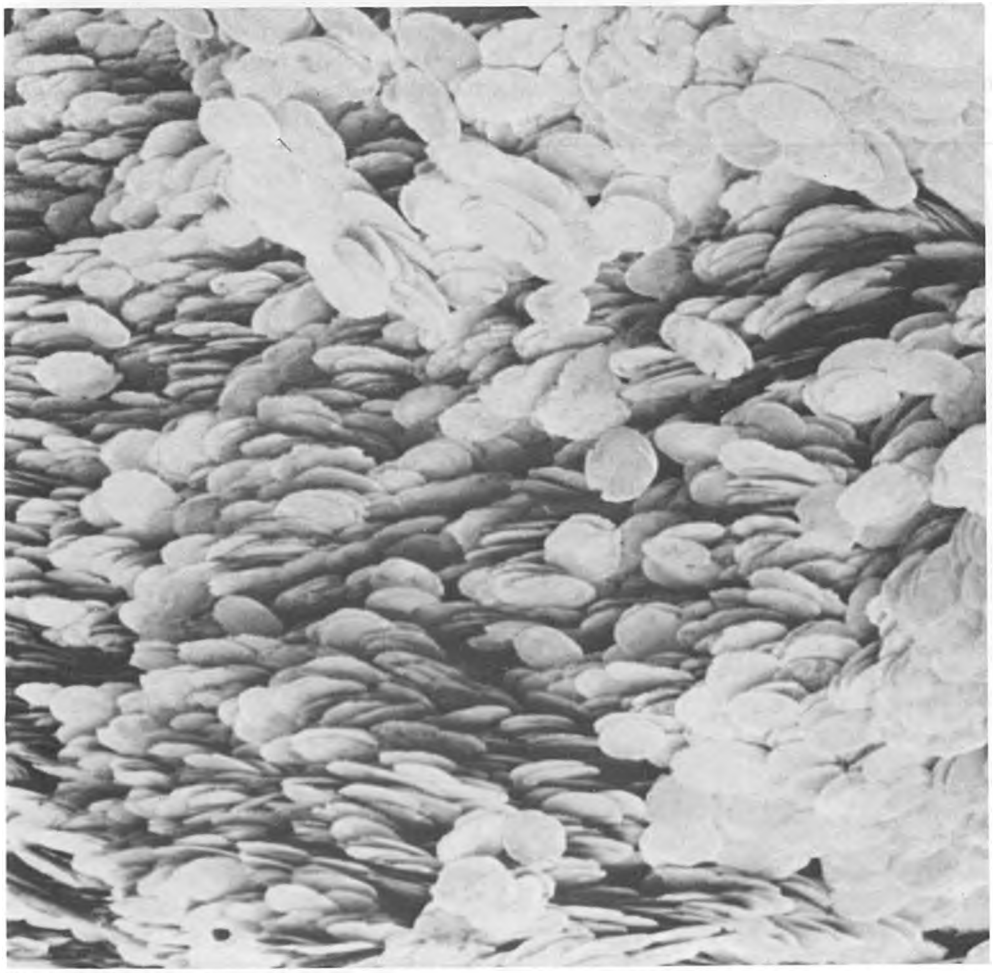
PLACUNA

A study on the biology and aquaculture potential of kapis, *Placuna placenta* was conducted within Iloilo Strait between Guimbal and Oton. The place was the site of very intense fishing of *Placuna* in 1978. However, during the studv in 1979, the investigators found no fishing activity for *Placuna.* Repeated sampling through diving and dredging showed that the *placuna* population had been fished to depletion.

Length frequency determination on eight samples collected from January 19 to May 7 showed a modal growth rate of 12 mm per month. Subsequent samplings after May 7 yielded only empty shells and the study was aborted. However, ripe *Placuna* collected during that period was successfully spawned and the larvae reared to adult stage. Success in rearing the larvae made possible a description of its larval morphology and development and provided some leads as to its settlement behavior. It took eleven days after fertilization for the larvae to settle as a spat.



Kapis products.



Kapis shells ready for marketing.

Freshwater Program

SUMMARY

The Freshwater Fisheries Station (FFS) in Binangonan, Rizal pursued seven research projects with emphasis on *Chanos chanos, Tilapia spp.,* and *Penaeus monodon.*

Pilot testing of the newly evolved technology on "Prawn Farming in Freshwater" was a major undertaking to identify the field problems and demonstrate its applicability.

The environment, Laguna Lake, was closely monitored to maintain its viability for fish production.

A socio-economic census of Bo. Pipindan, a fishing village adjacent to the project site of FFS, was also conducted. This study established baseline information on the possible impact of the new technologies developed through research.

MILKFISH (*CHANOS CHANOS*) PRODUCTION

Of the total milkfish production in the country, approximately 22 per cent come from fishpens. Amazingly high production values of as much as 10 tons/ha had been reported before. Today, however, the industry is faced with glaring problems that must be solved if sustained production is to be attained. For this reason, research at the FFS focused on the immediate solution of problems directly affecting the industry.

Cage rearing of acclimated milkfish fry in the lake resulted in fast growth. Fingerling production in improvised plastic-lined ponds and cages were compared. Results showed a significant increase in weight and a high survival rate for cage-grown fingerlings than those reared in improvised plastic-lined

The SEAFDEC Freshwater Fisheries Station in Binangonan, Rizal.

Feeding fish being grown in cages in Laguna Lake.

ponds. On the other hand, growth in length was only slightly affected. Survival in improvised plastic-lined ponds was 41%, and in cages, 66%.

Growth of milkfish was affected by cage location, stocking density, and season. The effect of three factors on the growth and survival of milkfish fry reared to fingerlings were studied. The effect of cage location on fingerling production showed significant differences between cages located at Tapao Cove and Diablo Pass. Likewise, stocking density and culture season gave significant effects on fingerling production.

Milkfish fry were effectively stunted at a stocking density of 14/1 in marine plywood tanks. Preliminary studies on growth compensation of milkfish in cages after stunting in holding tanks were conducted. Analyses of variance showed a highly significant difference in the weight of fry stunted in marine tanks at stocking rates of 10 and 14 fry/l. However, subsequent rearing of stunted milkfish fry in cages gave no significant differences in weight and length.

A high stocking rate of 10 fingerlings/sq m (10,000/ha) was demonstrated possible in Laguna Lake. The growth and survival of lake-grown milkfish fingerlings reared to marketable size in cages at stocking densities of 2, 6, and 10/sq m were studied for 60 days. Results showed a comparable increase in the growth of fingerlings and high survival values in the three stocking densities.

Acclimated milkfish fry in cages manifested optimum growth when stocked at 500/cu m without supplemental feeding. Acclimated milkfish fry were stocked in eight hapa net cages at two stocking densities of 500/cu m and 2500/cu m, with and without supplemental feeding. Results over a three-week rearing period showed that fry stocked at 500/cu m without supplemental feeding gave the highest increments in both length and weight. Analyses of variance showed significance differences among stocking densities with respect to weight and length. There was also a highly significant difference between fed and unfed fry.

TILAPIA PRODUCTION

No other species can favorably compete with tilapia in its hardiness and high reproductive capacity. That the species is one of the best for aquaculture has been demonstrated in many developing and under-developed countries where the quest for cheap protein is a matter of survival.

The FFS recently acquired improved varieties of tilapia. Continuous breeding experiments should result ultimately in better quality fish. This would increase the popularity of tilapia in the country as the most available and low-cost animal protein source.

Tilapia research efforts in the Station came up with the following results:

Crossbreeding and inbreeding of tilapia species showed promising results. The cross of red tilapia and *T. nilotica* produced uniform-sized progenies with faster growth and high percent survival. The FFS has acquired four species of tilapia, namely: *T. nilotica, T. mossambica, T. aurea,* and red tilapia. All possible crosses were made among the four species. At the same time, individual species mated at random and their progenies were used as control in comparison with the crosses made. Initial results showed that the cross between red tilapia

and *T. nilotica* produced offsprings with uniform sizes, faster growth rate, and more efficient food utilization.

Natural spawning of *T. nilotica* in cages produced an average of 500 fry per spawner every two to three weeks using a sex ratio of six female to one male. Intensive spawning of *T. nilotica* in hapas in the lake showed promising results. Cages were stocked with tilapia breeders at varying sex ratios of male to female (1:2, 1:3, 1:4, 1:5 and 1:6). Initial results showed that at a sex ratio of one male to six females, an average of 500 fry per spawner were produced every two to three weeks. Harvested fry were sorted and reared in hapas until they were ready for transfer to grow-out cages.

Tilapia fry reared in cages without supplemental feeding showed better growth at a lower stocking density of 500/cu m than at higher stocking rates of 1500 and 1000/cu m. The growth response and survival of *T. nilotica* fry in cages at stocking densities of 500, 1000, and 1500/cu m were studied. Preliminary results showed that increase in weight of tilapia fry was higher at a lower stocking density of 500/cu m than at higher stocking rates of 1000 and 1500/cu m. On the other hand, growth in length was only slightly affected by varying stocking rates.

Presence of substrate was favorable in growing tilapia fingerlings in cages. The effect of stocking density and substrate on the growth of *T. nilotica* x *T. aurea* fingerlings in cages were studied for three months. Fingerlings stocked in cages with substrate at lower stocking densities showed better growth than those stocked in cages without substrate. Those stocked in cages at the rate of 40/sq m obtained the highest mean weight and length, followed by those stocked at densities of 70 and 100/sq m, respectively.

Growth of *T. nilotica* fry was responsive to a high protein level of 33 percent. Results showed a corresponding increase in weight of *T. nilotica* fry as the stocking density was decreased and protein level was increased. Growth in terms of weight was highest in fry fed with 33% protein level and 15% carbohydrate level.

Analysis of variance showed significant differences in weight of fry fed with diet containing varying levels of protein.

CARP PRODUCTION

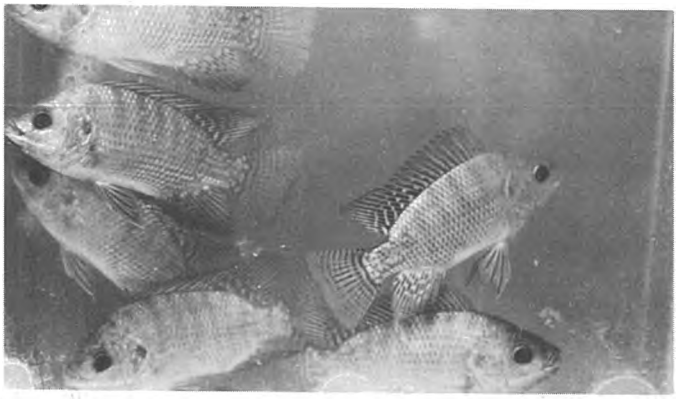
While artificial breeding and polyculture technique of freshwater aquaculture are known in other countries, its practice elsewhere, except in India, is not as wide and extensive as is found in China.

China at present can produce as much as 18,000 kg of fish/hectare a year applying the principle of polyculture (Multigrade-Conveyor Culture) and making full use of the food available in ponds. In the Philippines, however, the production performance of carps has yet to be explored. In view of this, the FFS decided to undertake exploratory studies on grass carp, bighead, silver carp, rohu, *Catla,* and common carp to determine the possibility of farming them commercially in inland waters.

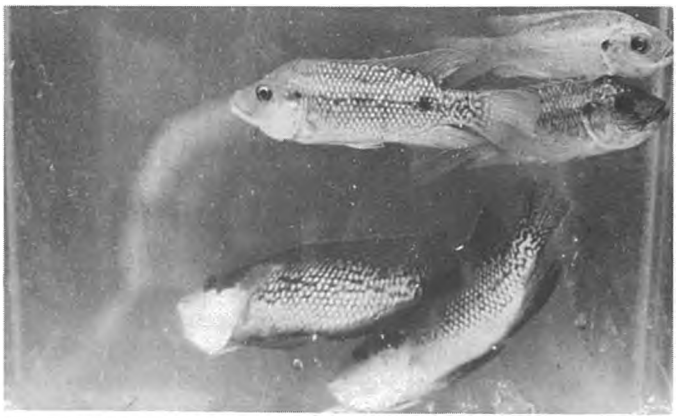
Supplemental feeding of rohu carps in cages showed no significant effects on growth and survival. ***Labeo rohita*** **fingerlings were given supplemental feeds at varying crude protein levels of 20, 30, and 40%. Growth and survival did not vary significantly at a stocking density of 50/cu m in the different treatments. Highest final mean weight (18.6 g) and survival rate (45%) were observed when fingerlings were given feed at 30% crude protein.**

Tilapia nilotica **100**

Tilapia nilotica **200**



Tilapia nilotica **300**



Tilapia mossambica

Similarly, growth and survival of rohu fingerlings given feeds of varying ratios of carbohydrates to protein (a. 55% CHO: 13% CP; b. 45% CHO: 23% CP; c. 35% CHO: 33% CP) did not reveal marked differences.

Results may be attributed to the abundance of natural food which were much "preferred" than the supplemental feeds given.

Rohu carp fry stocked at 50/cu m grew faster than those at 150 and 300/cu m. *Labeo rohita* fry were stocked at random in nine cages at three stocking rates: 50, 150, and 300/cu m. No supplemental feed was given.

Analysis of variance of weight and length means after 35 days of rearing showed significant differences between those stocked at 50/cu m against those at 150 and 300/cu m.

Highest survival rate of 53 per cent was obtained from those stocked at 150/cu m.

Supplemental feeding of common carp fingerlings at varying feeding rates did not affect growth and survival. Common carp (*Ciprinus carpio*) fingerlings stocked in B-net cages in the lake were given FFS formulated carp feed (23.29% crude protein) consisting of fish meal, ipil-ipil leaf meal, fine rice bran, and vitamin-mineral premix.

The formulated feed given at 5, 10, and 15% feeding rates did not produce any significant differences in growth and survival after 30, 60, and 90 days of culture.

Carp breeders may undergo rematuration even when out of season when proper management techniques are applied. An observational study on rematuration and artificial breeding of bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idella*) was conducted in a private fish farm in Sibul, San Miguel, Bulacan. Out of 14 bighead females six individuals possibly rematured, two of which were artificially bred on separate days. None of the injected grass carp females spawned.

PRAWN AND SHRIMP FARMING

The FFS achieved a "first" in the lake farming of *P. monodon* in freshwater. The technology has elicited interests from many people because of its potential economic returns.

Much research remains to be done to put the new technology on a stable and "minimal risk" basis. For this reason, the Station focused its attention on the immediate problems of production such as feeding. Moreover, a small pilot-testing project was pursued to test/demonstrate the viability of this new technology and continuously improve it to sustain its applicability.

The research findings on *P. monodon* are described briefly below:

Qualitative and quantitative determination of the algae population in cages during the first month of rearing of *P. monodon* showed the abundance and succession of species in the lake. The algae associated with lake farming of *P. monodon* during its first month in the lake were studied qualitatively and quantitatively. Total growth of algae attached to the sides of the cages (3.4 cu m hapa) after one month reached as high as 523 g. The amount of algae accumulation seems to be related to the flow direction.

Trainees in freshwater fishfarming learn how to construct net cages.

Diatoms (Chrysophyta) predominated during the first two weeks. This was followed by the filamentous species (Cyanophyta, Chlorophyta) after the second week. During the third and fourth weeks, the diatom population decreased. Layer filaments of *Cladophora*, *Stigeoclonium*, and *Rhizoclonium* predominated.

P. monodon was found tolerant to a combination of artificial sea water and natural sea water at a ratio of 1:1. Based on this result, the cost of acclimating postlarvae to freshwater is greatly reduced. Fifteen *P. monodon* postlarvae (P_{25}) were stocked in each of 15 aquaria containing varying proportions by volume of artificial to natural sea water. Lower mortality (4 to 20%) occurred with 50% artificial sea water. Results can be explained in terms of differences between artificial and natural sea water.

Water stability and acceptability of FFS formulated feeds were determined. Formulated feeds for milkfish and prawn were tested for water stability and acceptability. Of the different forms of prawn feeds tested, the improved extruded type of feed was most stable. After 24 hrs in the lake, the cake and pretzel forms showed 97.7% and 76.9% loss in weight respectively. Acceptability tests of different forms of feed, based on average weight gain after one month of feeding in aquaria, showed that pretzels were most acceptable.

The most common species of zooplankton isolated from lake water were cultured in a soil-water medium for natural feeding of larval stages. Zooplankton species were isolated from lake water and cultured in the laboratory using different media. *Moina macrocopa*, *Ceriodaphnia comuta* and *Brachionus calyciflorus* were cultured successfully using soil manure medium. Additional cells of Chlorella were provided as food for *B. calyciflorus*.

The different zooplankton species were described.

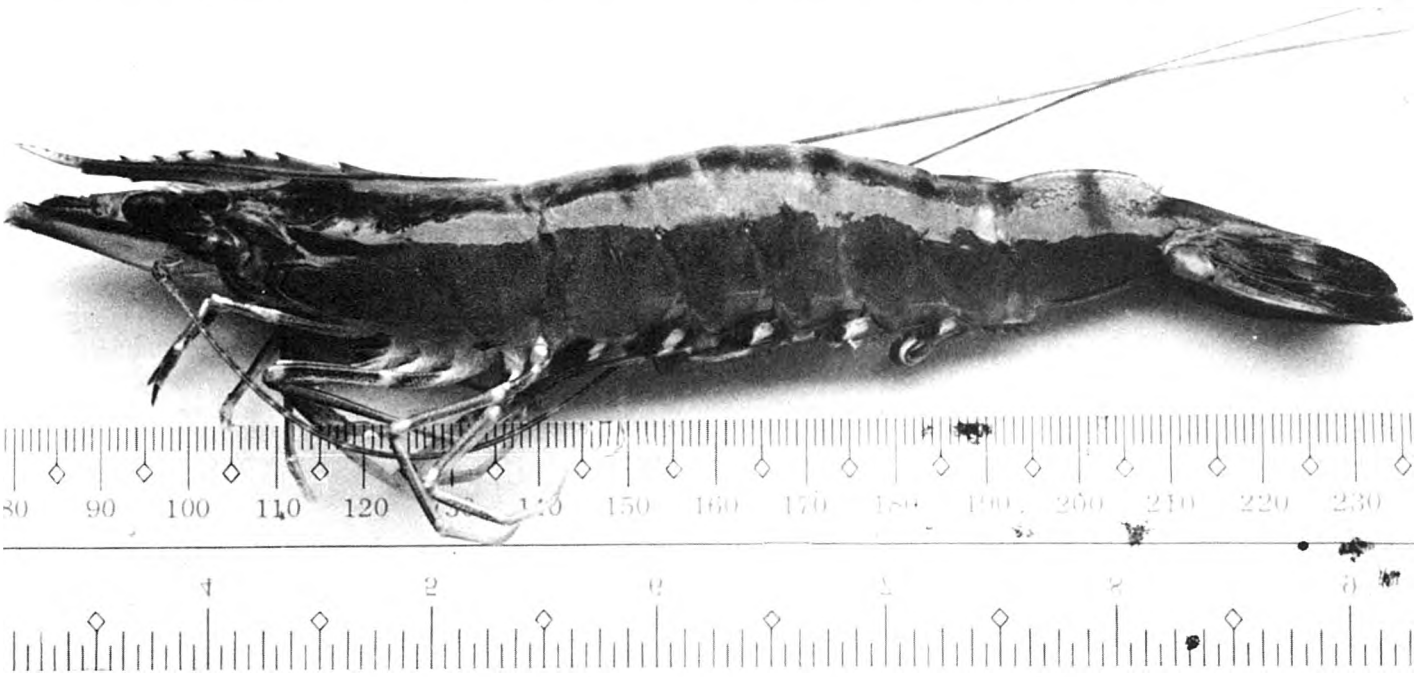
Raw, trash fish (*Therapon sp.*) was most acceptable to *P. monodon* as supplemental feed. Considering the abundance and low cost of this type of feed, prawn farming in Laguna de Bay becomes economically feasible. There were no significant differences in weight gain of *Penaeus monodon* after 58 days of feeding raw trash fish (*Therapon sp.*) at varying rates (5, 15, 25%). A 100% survival was obtained in treatments given 15 and 25% feeding rates. *P. monodon* given feed at 5% feeding rate had only 80% survival.

Among the different major protein sources tested for *P. monodon*, highest growth and survival rates were obtained with raw, trash fish as supplemental feed. *P. monodon* postlarvae were given formulated feeds for four months in aquaria. Feeds used contained protein ingredients taken from five different major sources, namely: fish meal, meat and bone meal, soybean oil meal, raw fish (meat of *Therapon sp.*) and the crustacean feed pellet which served as the control.

Animals given raw fish as the major protein source indicated the highest values of growth in body weight and length. These were followed by those fed with formulated feeds containing soybean oil meal, meat and bone meal, and fish meal as the major protein sources in this order. Comparable results with raw fish were obtained from those fed with crustacean feed pellet, which served as the control.

Highly significant differences exist among the five treatments. However, no significant differences were found between those fed with raw fish and crustacean feed pellet, and also among those fed with soybean oil meal, meat and bone meal, and fish meal as the major protein sources.

Pilot-testing of *P. monodon* farming in freshwater has identified critical problems in the field application of the new technology. The pilot-testing of *P. monodon* farming in cages is now in progress. The viability of this project has been greatly reinforced by several changes and modifications in the methods of farming as deduced from the problems encountered in the field. Furthermore, with the cooperation of other government agencies like BFAR, LLDA, and the private sector, a Cooperator's Program was launched as a research-production scheme.



A Jumbo Tiger Prawn *(P. monodon)* grown in net cage in Laguna Lake.

Dr. Julia Pantastico, a nutritionist of the SEAFDEC Binangonan Station, examines feed pellets.

ECOSYSTEMS RESEARCH

Laguna Lake, the largest freshwater lake in the Philippines, is a natural resource abounding with several economically important fishes, snails and other aquatic organisms. It has long been utilized as a source of food and irrigation water and as a medium of transport of thousands of families living in its lakeshore towns and barrios.

Recently, however, signs of general deterioration of the lake enrivonment have become apparent. Years of unmitigated exploitation and increasing pollution from domestic agricultural and industrial sources have brought about irreversible changes in its condition.

There is a pressing need, therefore, to monitor and assess its physico-chemical characteristics and to evaluate its productivity in an effort to improve its quality or prevent further degredation. Only through a close environmental watch and concomitant pollution control can we hope to maintain and/or enhance its viability and productivity.

It is towards this end that ecological studies are directed. It is hoped that the comprehensive, integrated and long-term ecosystems research can provide substantive and functional information for better development and management/conservation of lake resources.

Physico-chemical characteristics. Forty-two physical chemical parameters were monitored at biweekly intervals at eight sampling stations in Laguna Lake from October 1978 to May 1979.

Water level decreased by an average of 2 m since November 1978. Water temperature ranged from 25.5° to 30°C. Values of dissolved oxygen ranged from 3.3 to 10 ppm. Biochemical oxygen demand (BOD_5) rarely exceeded 3 ppm. The concentration of ammonia increased towards the end of November 1978 and towards the middle of March. Orthophosphate level decreased in the second week of December 1978, in the last week of February and in mid-March. Salinity decreased from October to January and increased from January 23 onward. Free CO_2 ranged from 0 to 8.6 ppm while pH remained slightly basic at 6-8. The highly toxic compound of hydrogen sulfide has not been positively detected. Concentrations of iron and manganese remained very low.

Benthic Fauna. Benthic organisms at selected sampling stations were collected at biweekly intervals from January to February 1979. The dominant macro benthos found were mollusks of the following species: *Stenomelania canalis, Corbicula manilensis, Tarebia granifera, Melanoides tuberculata,* and *Idiopoma angularis.* Observations showed that snails of the species *S. canalis* comprise the most abundant benthic population in the lake.

Phytoplankton Studies. Cyanophytes were observed to be the most dominant algal group with a maximum total cell count of 20×10^4 cells per ml at their peak. *Synechoccus aeruginosus* and *Synechocystis aquatilis* appeared to be the dominant species in April. The diatoms showed an increase during the fourth week which coincided with an increasing trend in silica and nitrate concentrations during the third and fourth week.

Water quality during this period was also determined.

SOCIO-ECONOMICS

A socio-economic census of Bo. Pipindan as a typical fishing village. Barrio Pipindan is a typical village adjacent to the project site of the Department's Freshwater Fisheries Station. A socio-economic census of the barrio was conducted to guide policy makers in community development specifically on sustained fishing.

A total of 235 families (97 per cent of the barrio population) was interviewed. The economic base is dependent on Laguna Lake; fishing, shell gathering, and duck raising are the main occupations. A total of 183 persons are engaged in fishing. From the experience of barrio fishermen, fish catch from the lake has declined tremendously in the past years. Barrio folks expressed great expectations from the Freshwater Fisheries Station to be the center for mass production of fish fry for distribution to fish farmers.

Other pertinent subjects such as population, family type, family size, sex, age distribution, and education were also discussed in detail.

SEAFDEC Institute of Aquaculture

Organized only on May 23, 1978, with the appointment of its first director, the SEAFDEC Institute of Aquaculture (formerly Asian Institute of Aquaculture) has scored a fairly good record along three major spots in the aquaculture technology evolution and transfer link: planning, manpower training, and technology dissemination.

PLANNING

During the period, the SIA coordinated or co-sponsored three conferences:

1. Technical Consultation on Available Aquaculture Technology in the Philippines, 8-11 February 1979. Identified, collated current available technology on milkfish, prawns, tilapia, and mussels and oysters; determined production potentials of these available technology, and pointed out technology gaps in selected aquaculture systems. Proceedings contain updated technology on these four top commodities as well as proposed technology transfer schemes. Done in cooperation with the Philippine Council for Agriculture and Resources Research, it was attended by 79 of the country's outstanding fishery and aquaculture researchers, technologists, educators, extensionists and policy makers and selected progressive fishfarmers. Fourteen institutions including fishfarmers' associations and federations were represented. Proceedings were edited, printed and disseminated by SIA.

Seventy-five aquaculture experts and fish producers attended the 4-day Technical Consultation on Available Aquaculture Technology in the Philippines held from 8 to 11 February 1979 at Tigbauan, Iloilo.

2. International Cage and Pen Culture Workshop, 12 to 22 February 1979. It generated sharing of experiences among participants, provided practical guidance on the art and techniques of cage and pen culture and stimulated projects on this field. Attended by 53 participants from 15 countries, the workshop was sponsored by the International Development Research Centre in Canada and the Aquaculture Department. SIA handled the secretariat work and organized, edited, produced and published the proceedings.

3. Agribusiness Systems for Integrated Crop-Livestock-Fish Farming, 19-25 November 1979. This symposium, a sequel to the SEARCA-ICLARM sponsored one on the same area, aimed to develop production and management strategies for a tri-commodity integrated farming system that could be worked out for small Asian farmers. Participants came from Indonesia, Japan, Korea, Taiwan, Thailand, Malaysia and the Philippines. It was jointly sponsored by PCARR and the Taiwan Food and Fertilizer Technology Center. The Aquaculture Department through the SIA participated in the planning and organization of the workshop and in the proceedings. On the basis of these planning workshops the formulation of a number of project proposals was prepared by the Department staff under general coordination of SIA.

The SIA coordinated the crystallization and refinement of 12 action project proposals for funding by international donors. A listing of the 12 proposals, including the target donors and project budgets, follows:

1. Aquaculture Technology Backstopping for Developing Projects in Selected Countries of Asia, Africa and the Middle East—to be submitted to International Fund for Agricultural Development (IFAD)
2. A proposal to Strengthen Aquaculture Research and Development Infrastructure in Developing Countries of Asia—to be submitted to German Ministry for Cooperation
3. Regional Collaborative Project in Aquaculture for ASEAN Countries—to be submitted to European Economic Community (EEC)
4. Program for Integrated Fisheries Area Development (PIFAD)—to be submitted to Canadian International Development Association (CIDA).
5. International Aquaculture Information System—to be submitted to International Development Research Center (IDRC)
6. The Asian Institute of Aquaculture Library—to be submitted to Japanese Government
7. Aquaculture Manpower Development for Asia — to be submitted to USAID
8. Establishment of Six Regional Prawn Production Centers in the Philippines—to be submitted to

The International Cage and Pen Culture Workshop was attended by 53 participants from 15 countries.

SEAFDEC trainor and researcher Porfirio Gabasa, Jr. (right) clarifies prawn hatchery problem for fishfarmers of Agusan del Norte during a mobile *(in-situ)* training held at Butuan City in 1979.

The first students from Nigeria of the University of the Philippines-SEAFDEC Aquaculture Department graduate program discuss pond management principles with Dr. H. Chaudhuri of SIA. The three are pursuing a 2-year course leading to the degree of M.S in Fisheries major in Aquaculture.

Japanese Government

9. Aquaculture Development Planning Workshops, Special Topics, Seminars and Short-Term Training Programs for the Development of Aquaculture in Asia—to be submitted to German Foundation for International Development (DSE)
10. Aquaculture Case Studies Development—to be submitted to Ford Foundation
11. Aquaculture Manpower Development for Latin American Countries—to be submitted to Inter-American Development Bank
12. Establishment of Pilot Regional Oyster Production Systems in the Philippines—to be submitted to Australian Government.

TRAINING

An expansion in the coverage of the various courses and an increase in the number of countries that have been sending participants to these training courses have broadened the scope of the training component of the technology transfer program of the Department.

More than 600 fishfarmers, private operators, technicians, government workers and technologists from a dozen countries of the third world attended various courses conducted by the SIA in 1979.

Five international training programs – aquaculture research methodology, aquaculture management for milkfish, aquaculture management for prawn, aquaculture engineering, and management and operation of small-scale prawn hatchery

– turned out 116 successful trainees mostly coming from the Southeast Asian countries of Malaysia, Singapore, Thailand, Indonesia, and the Philippines but with a significant number of fisheries technologists from Nigeria and Cuba and at least one each from Panama, Colombia, and Brunei.

The special skills training courses which were offered to fulfill linkage agreements and requests of assisting agencies were attended by 33 participants, 10 from the Indian Council for Agricultural Research, 3 IDRC-sponsored trainees coming from Sarawak, Egypt and Sierra Leone and 20 from Cuba. The special courses included prawn culture, mass production of fishfood organisms, milkfish breeding, cage and pen culture, milkfish culture, freshwater aquaculture engineering and management.

On the local level, around 65 Filipino technicians and private pond operators attended the barangay (village) hatchery operations course and two prawn culture training sessions.

Furthermore, four mobile training courses held in four separate Philippine regions brought the latest in milkfish and prawn culture technologies to 399 fishfarmers, pond technicians, and production workers.

Graduate Manpower Training Program. The Department is collaborating with the University of the Philippines System (UPS) on a graduate degree program leading to Master of Science in Fisheries major in Aquaculture. Out of the 49 students enrolled for 1978-1979, 8 graduated with an MS at the end of the academic term in April 1979. Twelve new students enrolled for 1979-80, bringing the total enrolment to 53 students.

TECHNOLOGY DISSEMINATION

SIA organized the Communications/Publications Unit to back up the training and extension programs and in specific areas, to provide the lead role in the outreach services.

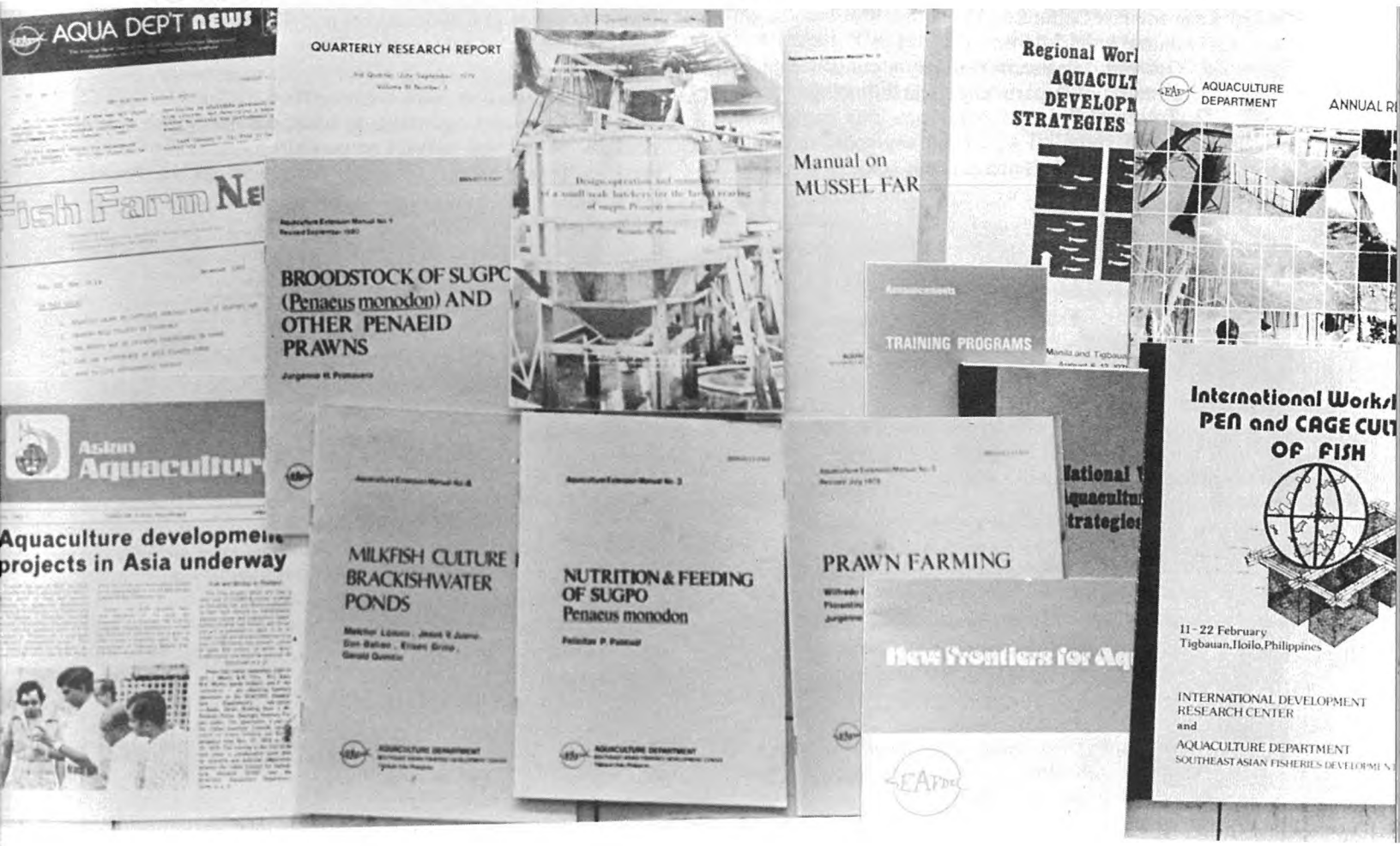
There are essentially two activities engaged in by the communications unit of SIA: production of information materials and provision of back-up services to other Department units.

The information materials being produced and disseminated are the following:

a. **Popular Publications**

1. *Fish Farm News* – a fortnightly news service to fishfarmers of the country containing ten stories per issue. Started in October 1978, it is subscribed to by more than 700 individuals including two fishfarmers associations (Iloilo and Capiz) which subscribes for their members. It is designed for broadcast but is also regularly carried by the nation's agricultural magazines and community newspapers.

2. *Popular Aquaculture Report Series* – a service for mass media the series consists of in-depth feature articles on aquaculture R & D results. Main targets are the agricultural magazines and agricultural or industrial sections of newspapers.



3. *Media Releases* – brief, single story announcements of important and fast-breaking events in the Department or the industry.

4. *Aqua Dep't News* – fortnightly internal news sheet of the Department.

b. **Semi-Technical Publications**

1. *Asian Aquaculture* – the Department's outreach newsletter which carries research and industry development information from various sources in the world. Published monthly, it reaches 1,800 institutions and individuals in 84 countries.

2. *Extension manuals* – package of technologies produced by the Department's researchers, manuals contain commodity production guidelines. Six manuals have been prepared so far: (1) Design, Operation and Economics of a Small Scale Prawn Hatchery, (2) Manual on Prawn Culture, (3) Milkfish Culture in Brackishwater Ponds, (4) Nutrition and Feeding of Sugpo *(Penaeus monodon),* (5) Manual of Operations: Sugpo Pond Culture, and (6) Manual on Mussel Farming. The manual on pond operations for prawn culture was translated into the dialect of the Panay-Negros region, printed into a manual form and distributed free to fishfarmers and fishfarm associations in the region. Extension manuals also form part of trainees' kits.

3. *Aqua Guide Series* – while manuals carry the entire range of production information for one commodity, Aqua Guide is designed to contain only one or two closely related aspects in the culture of a commodity i.e. diseases, broodstock production, feeds and feeding, etc. Two have been published: *P. monodon* Broodstock and General Information on Fish Cage and Pen Culture.

c. **Technical Publications**

1. *Quarterly Research Reports* – contain extended abstracts of Department research findings.
2. *Technical Report Series* – one issue carries a full-length technical article on any topic relevant to aquaculture. It is non-periodic.
3. *Annual Report* – the unit edits for publication the Department's annual report.
4. *Reports to the SEAFDEC Council* – include the Department's Program of Activities and Progress Report. Produced and printed by the unit for the annual council meetings.
5. *Proceedings* – edited proceedings of Department-sponsored symposia, workshops and conferences. Four have been published since the unit was organized in June 1978: Aquaculture Development Strategies in Asia; Aquaculture Development Strategies for the Philippines; Technical Consultation on Available Aquaculture Technology in the Philippines; and International Workshop on Pen and Cage Culture of Fish (with IDRC). The proceedings were edited, organized and printed by the unit.

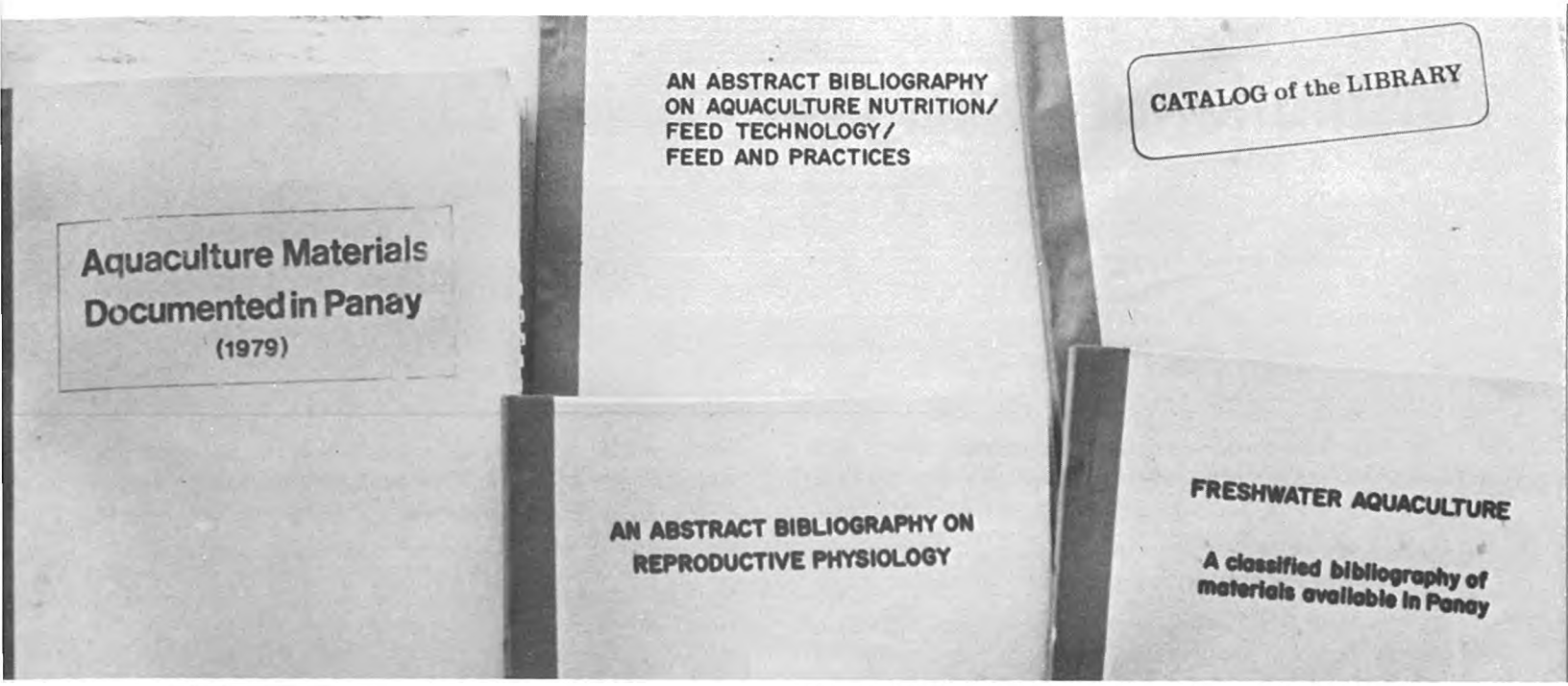
SCIENTIFIC INFORMATION

Acquisition, documentation and dissemination of scientific information on aquaculture and related subjects took a big stride with the initiation of the AQUADOC (aquaculture documentation) and the Scientific Literature Service (SLS) projects. IDRC sponsors AQUADOC while the SLS is a Department-sustained service.

Acquisition is enhanced by an active exchange program and now stands at 6,500 volumes and 416 serial titles that include 120 titles on subscription. There are 800 bound periodical volumes.

Documentation work is exemplified by the AQUADOC project. The project undertakes to track, document, and where possible, photocopy relevant aquaculture information in universities, fishery schools, research institutions and in the pri-

The Department's library acquisition has been enhanced by an active exchange program. As of the end of 1979, there are 6,500 volumes and 416 serial titles that include titles on subscription. The library has also compiled 800 bound periodical volumes.



vate collections of aquaculture scientists and development workers in the country. Panay as a pilot area was extensively covered with a total of 7,500 materials documented. Metro Manila, Luzon, the Visayas and Mindanao are being programmed for documentation.

From materials gathered in Panay, three abstract/bibliographies were prepared, namely: *Freshwater Aquaculture, Aquaculture Nutrition,* and *Reproductive Physiology. Aquaculture Abstracts* in three parts is already in press. Part I and some sections of Part II are already published. *Aquaculture Abstracts* will be published quarterly in 1980 with the first quarterly issue scheduled to come out in July.

The *Catalog of the Library* is an annual cumulation of the monthly *Acquisition Lists.* These publications are meant to bring to the aquaculture scientists and development workers the latest information along their lines of work. Outreach information addressed to research institutions in the country that are far from big libraries and information centers was initiated with the Scientific Literature Service (SLS). On photocopies of journal tables of contents, research institutions check articles they wish to receive photocopies of. Around 5,000 pages of photocopies are sent out every month. The total will increase with increased subscription/exchange receipt of journals. An informal Selective Dissemination of Information (SDI) is addressed to the senior research staff in Tigbauan. The service is envisioned to be addressed to the research staff in Leganes and Binangonan.

At the initiative of SIA, membership of the SEAFDEC/SIA Library in FAO's Aquatic Sciences and Fisheries Information System (ASFIS) is being finalized. Membership in the System carries the responsibility of inputting relevant Asian aquaculture information into the computerized information bank of ASFIS. This will enable aquaculture scientists and development workers in one country to learn what his peers in other Asian countries are doing.

TECHNOLOGY VERIFICATION

The Institute also struck out into other areas notably the crucial technology transfer link of verification.

Verification serves the purpose of field testing laboratory results in farmers/fields under given agro-climatic, cropping, and socio-economic patterns. The end result of technology verification is a package of technological recommendations that has been shaped by the tests taking into consideration all the variables in the farmers' fields.

Projects have been formulated along this area. The Department's researchers and some private sector representatives were enlisted in the planning and would be involved in the implementation. The projects could be implemented more successfully under a cooperative scheme between the Department and other interested agencies.

Two projects have already been started, namely:

1. SEAFDEC (SIA) – CIADP (Cagayan Integrated Agricultural Development Project) which involves a prawn hatchery project in the Aparri Institute of Technology in Aparri, Cagayan. This is funded by CIADP.

2. SEAFDEC (SIA) – MMSU (Mariano Marcos State University). Eight joint projects have been proposed for a Five Year Development Plan for Ilocos Norte. These will be funded by the Marcos Research Foundation. The projects are: (a) aquaculture resource assessment in Ilocos Norte; (b) integrated milkfish culture in Ilocos Norte; (c) introduction of improved methods of collecting and handling of milkfish fry; (d) verification/extension of technology for pen culture of milkfish and filter-trapping of wild species in Culili Point; (e) field testing and dissemination of porphyra (gamet) culture; (f) stock assessment and controlled exploitation of codium (pocpoclo) and, (g) hydrology and ecology of Lakes Paoay, Gilloca and Sarnap.

In June 1979, a proposal was submitted to the United Nations Food and Agricultural Organization in line with UNFAO's In-Service Training Award Programme or INSTA. The plan provides for the promotion of aquaculture development through the verification and packaging of certain research results that have been considered for pilot testing in the field. The INSTA Programme will provide 34 man years of post-masteral and post-doctoral commodity experts to join in the TVP program of SEAFDEC as soon as local funding support is assured for the proposed TVP projects.

Institutional Linkages

The Department continued strengthening tie-ups with various international and national institutions engaged in aquaculture development.

INTERNATIONAL

International Development Research Centre (IDRC) of Canada. Phase I of the IDRC grant amounting to Cdn$826,000 to support the Department's Milkfish project was completed in July 1978. However, following consultation with IDRC, the original grant period of 36 months was extended to March 31, 1979. Phase II of the IDRC grant amounting to Cdn$398,000 covers another three-year period starting April 1, 1979. Of this amount, $289,600 will be administered by the Department and $109,000 by the IDRC in consultation with Department. The IDRC-supported Milkfish project aims to: a) standardize the technology of milkfish breeding; b) improve the collection, transport, handling and storage of fry; c) develop economically viable and nutritionally effective feeds; d) improve management and culture methods; e) provide demonstration and outreach programs and short-term training for fishpond operators, technicians and extension workers; and f) transfer technology on milkfish aquaculture generated through the IDRC assisted project on a national and subsequently regional level.

Oceanic Institute (OI), Hawaii. In accordance with the AQD-OI Memorandum of Agreement, three experts, Dr. Ching Ming Kuo, Dr. Cheng-Sheng Lee and Mr. Wade Watanabe, participated in the Department's experiments on hormone-induced spawning and larval rearing of milkfish. In turn, four Department researchers headed by Dr. Jesus Juario went to Hawaii, under the exchange program mentioned in the Agreement, for two months starting June 30, 1979.

Danish International Development Agency (DANIDA). In January 1979, DANIDA sent Mr. Flemming Petersen and Mr. Bent Nielsen to the Department to assist in the freshwater aquaculture research program for a two-year period, particularly in the field of limnology. DANIDA has also allowed a three-month extension (June 1 – August 31, 1979) to Mr. Manual Carlos who is currently working on the dynamics and production of zooplanktons in the Esrom Lake in Denmark.

Indian Council for Agricultural Research (ICAR). In accordance with the existing agreement between ICAR and the Department, ICAR sent ten fishery scientists for training in the Department.

Tungkang Marine Laboratory (TML). – In its exchange program for aquaculture information and expertise with the TML in Taiwain, the Department sent some specimens of Artemia, siganids, and Tilapia for experimental purposes. Five scientists, Dr. I. Chiu Liao (breeding and larval rearing), Mrs. N.H. Chao Liao (cryopreservation of milt), Mr. H.J. Huang (water quality analysis and control), Mr. C.H. Liu (larval rearing), and Ms. T.I. Chen (histology), conducted some experiments in the induced spawning of milkfish from April 20 to June 18, 1979.

Japan International Cooperation Agency (JICA). Mr. Shusaku Kadowaki, an expert on prawn hatchery technology, served the Department from January 15 to May 14, 1979. The services of the following Japanese experts were extended: Dr. Noburo Hoshino (general administration and institutional linkage development), Mr. Shigeru Kumagai (milkfish ecology). The term of another Japanese expert, Mr. Hideo Mochizuki (pond culture of prawn) ended in May.

State Committee for Economic Cooperation of Cuba. Since May 1979, Cuba has sent 14 of its fishery research staff for training in the Department in aquaculture management, aquaculture engineering, tilapia culture, and milkfish culture. The Department in turn sent Rodolfo Tolosa to Cuba for training in ferrocement technology.

NATIONAL

University of the Philippines at Los Baños (UPLB). SEAFDEC and UPLB are implementing the freshwater aquaculture resources development program through its various projects related to monitoring and assessment of the water quality of Laguna Lake, study of aquatic biota and hydrology of the Lake.

Philippine Council for Agriculture and Resources Research (PCARR). The Department in collaboration with PCARR conducted a socio-economic survey of the aquaculture industry in the Philippines. The survey included the following areas:

1) Some insights into socio-economic conditions of fish farm caretakers in the Philippines;
2) Socio-economic survey of the aquaculture industry in Central Visayas, Western Visayas, Eastern Visayas, Mindanao, Bicol, Southern Luzon;
3) Milkfish polyculture farming in the Philippines;
4) Case studies of milkfish nursery farms in the Philippines;
5) Crab farming in the Philippines;
6) Culture of freshwater catfish in the Philippines;
7) Identification of constraints in increasing milkfish pond production in Luzon.

Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Development Academy of the Philippines (DAP) and Bureau of Fisheries and Aquatic Resources (BFAR). The Department, in cooperation with SEARCA, DAP and BFAR, has formulated an aquaculture resource management program. Its implementation is being studied.

Administrative and Personnel Development

With the appointment of Dean Rogelio O. Juliano as Chief of the Department vice Dean Domeciano K. Villaluz on July 8, 1979, the Department's organization and operations received some major changes, notably:

* The Development and Administrative Services Division (DASD) and the Auxilliary Services Division (ASD) were abolished with the creation of the General Affairs Division (GAD) and the Personnel Management Division (PMD). Under GAD are the following units: finance office (including budgeting, accounting and cashiering), physical plant office, property and supply management services, the auxilliary services (including security service, visitors service, and housing management), and the Iloilo liaison office.
* With the consolidation of the Department's research activities into three areas – brackishwater, freshwater and mariculture – three major stations were given some autonomous administrative powers: the Leganes station for freshwater research and the Tigbauan station for mariculture. The Tigbauan station, however, will continue providing the laboratory and other essential support services for the other stations.

As of the end of December 1979, the Department had a total of 638 active personnel and 34 on study grants. The 638 employees were distributed as follows: Management Group (Office of the Chief and attached offices), 21; General Affairs Division, 199; Tigbauan Research Station, 211; Leganes Research Station, 58; Binangonan Research Station, 74; SEAFDEC Institute of Aquaculture (formerly AIA), 35; Makati Liaison Office, 31; and UP-SEAFDEC project, 8.

During the year 63 staff members either retired or resigned, among them Dean D.K. Villaluz, Executive Director Q.F. Miravite, Research Director Jose Eusebio and SIA Deputy Director H. Chaudhuri.

SEAFDEC Aquaculture Department Deputy Chief Noburo Hoshino opens the fire hydrant to test the water coming from the Tigbauan station's freshwater pipeline which has supplemented the Tigbauan station's water system that relies on shallow wells and pumps. Looking on nearby are Department Executive Director Q. F. Miravite, SIA Director J. C. Madamba and Administrative Services Director J. M. Garay.

Infrastructure Development

Budgetary constraints had slowed down the infrastructure development program of the Department. The Nutrition and Reproductive Physiology Research Building was only 55% complete when its construction was halted during the year. Likewise, the Scientific Supply House remained 30% complete at the end of the year.

Some facilities, however, were completed during the year: freshwater supply system for Tigbauan Research Station; Social Hall, also at Tigbauan; 8 units of 200-sq m prawn experimental ponds at Leganes Research Station; various floating cages and fiberglass tanks; barangay hatchery at Batan substation; and renovation and fencing of laboratory school.

The Tigbauan main station's Social Hall where trainess, guests and residents of the housing units may hold parties, watch their favorite programs on TV, or play pingpong and board games.

The much needed Nutrition and Reproductive Physiology Research Building is yet to be completed. It is programmed to be completed in 1981.

About 500 milkfish broodstock are kept in these floating cages, some since 1975, in an effort to prove that milkfish can sexually mature and spawn in captivity. The cages are located in a quiet cove within the SEAFDEC Aquaculture Department's Igang substation on Guimaras Island off the coast of Iloilo, Philippines.