ANNUAL REPORT 1985

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

AQUACULTURE DEPARTMENT

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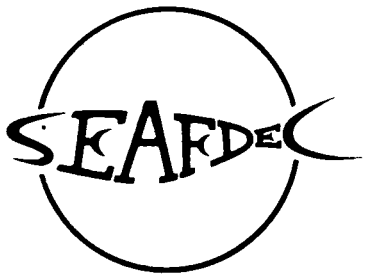

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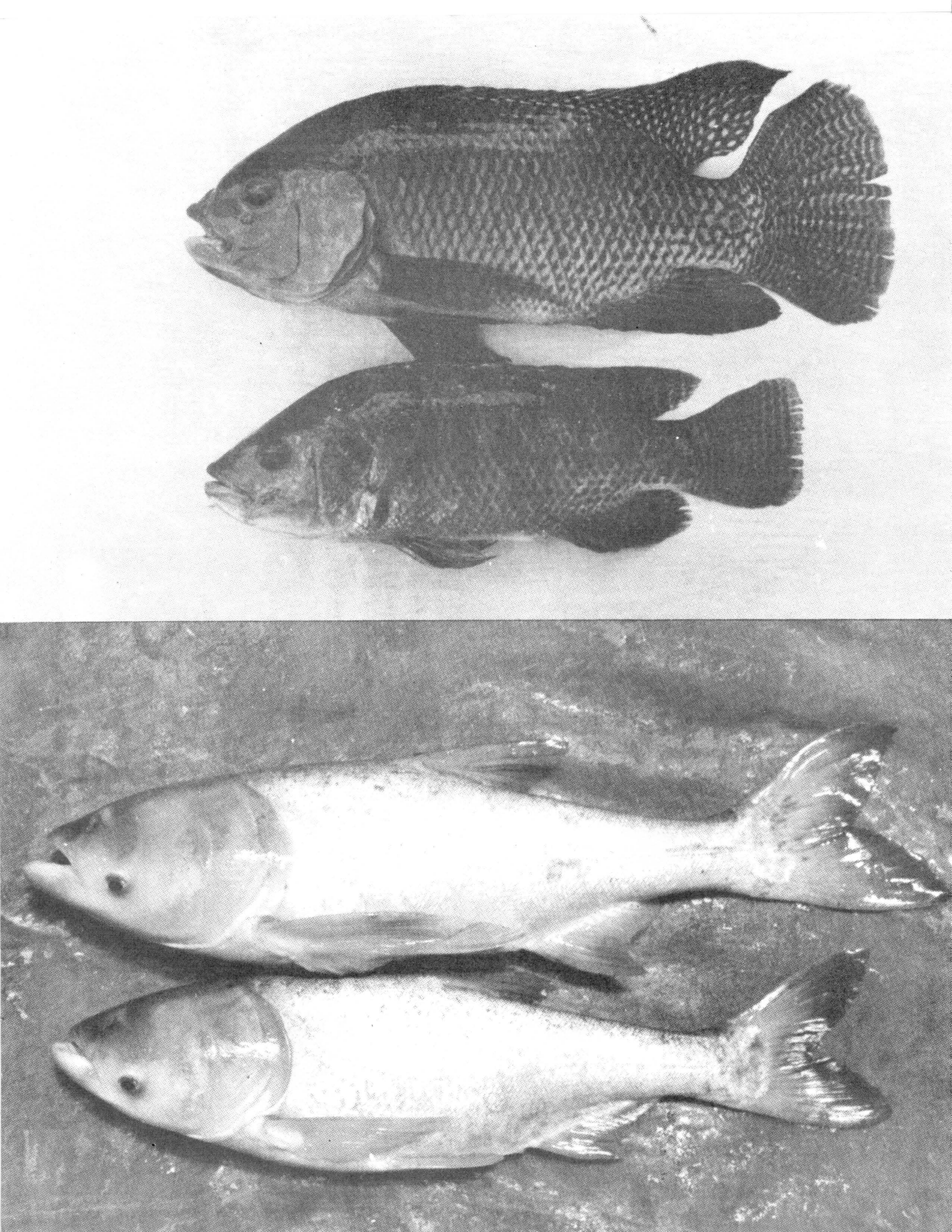
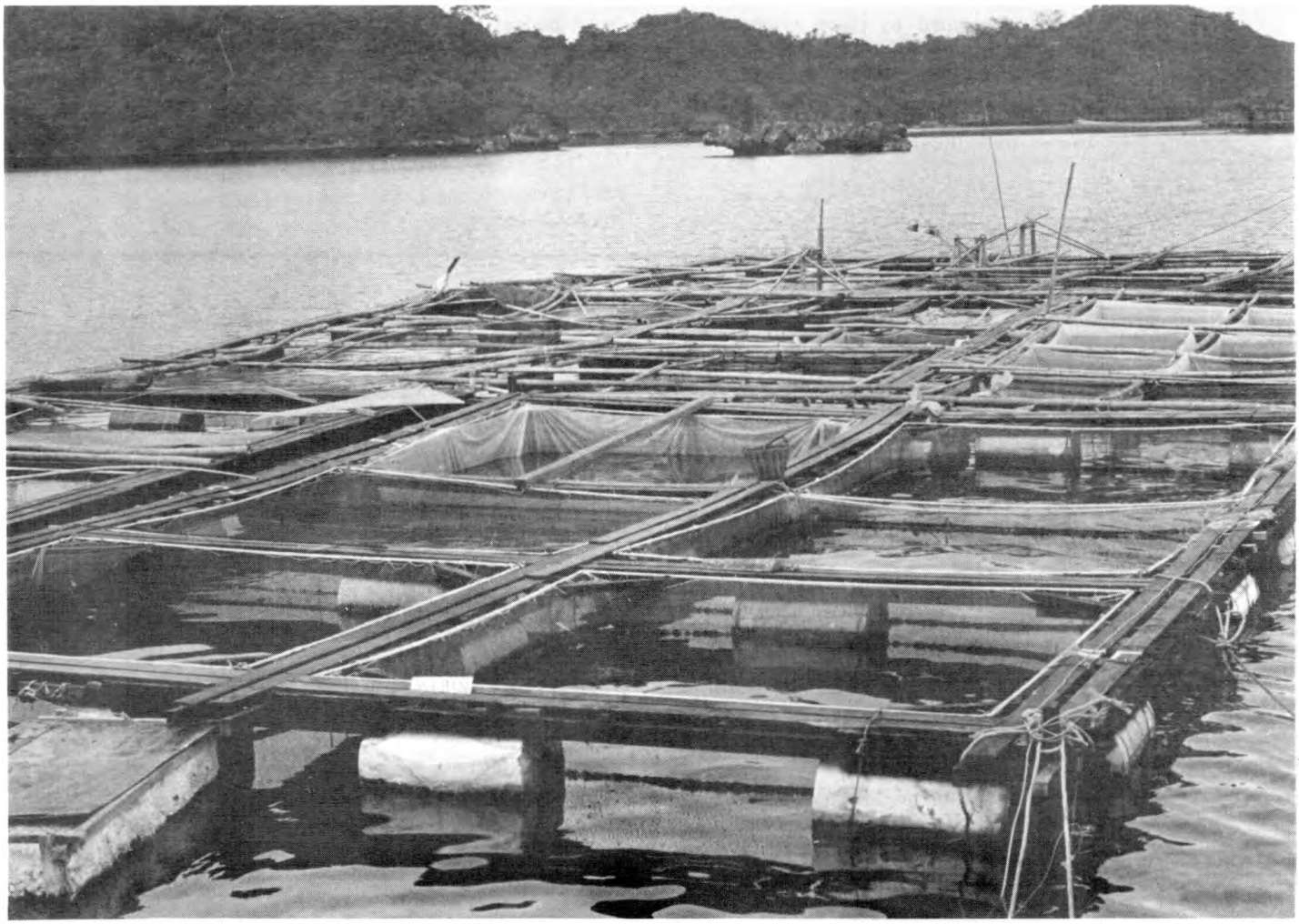


Contents

OVERVIEW OF 1985 ACTIVITIES



Floating cages for milkfish broodstock in Igang Substation.

Research activities continued along the three major programs: Finfish, Crustaceans, and Molluscs and Seaweed. Applied research studies on broodstock development and seed production were intensified. Culture techniques were continually refined, placing more emphasis on the economic component.

Significant accomplishments include the spawning of rematured milkfish in cages in Igang, seed production of seabass and siganids at the Leganes and Tigbauan Research Stations (LRS, TRS), and the induced spawning of Chinese carps at the Binangonan Research Station (BRS). These accomplishments show that technologies that have been developed are suitable to local conditions, thus leading us a step closer to solving the major problem of fry availability. The successful induced spawning of seabass, siganids, and carp shows promise for the breeding of other commercially important species. The modular culture system for prawn and the technology in *Artemia* production, processing, and utilization are being field-tested and verified in selected sites. Post-harvest treatments on oysters and mussels gave encouraging results.

Training and extension activities as well as technology verification projects were broadened. New training programs were developed and production oriented projects in collaboration with government and international agencies were strengthened. Information dissemination programs were undertaken in collaboration with local and national media.

Administrative services were improved through the efficient implementation of management policies, systems, and procedures. Cost-cutting measures were adopted in all stations to meet budgetary constraints and to optimize resources.

RESEARCH

Research activities continued to place emphasis on problem areas identified by various sectors of the aquaculture industry. Manpower, technical, and financial resources were optimized to meet these pressing needs.

Seventy-nine studies were implemented in 1985 with a total budget of P3,778,500. Of this number, 46 studies were undertaken under the Finfish Program, 27 under the Crustacean Program, and 6 under the Molluscs and Seaweed Program. Significant findings and indications from completed and ongoing studies are reported here.

Finfish Program

BROODSTOCK DEVELOPMENT AND GONADAL MATURATION

Hormonal manipulation to initiate gonad development and rematuration in milkfish

About 54% of the sexually regressed milkfish, *Chanos chanos,* implanted with testosterone capsules/ pellets in February were found to be mature when sampled in April. However, it is not certain that the testosterone implants induced maturation since most of the control fish were also mature. Five-year old immature milkfish did not respond to the testosterone and luteinizing hormone releasing hormone-analogue (LHRH-A) pellet implants.

Maturing or recently spent milkfish implanted with long acting LHRH-A pellets developed tertiary yolk oocyte from 4 to 11 weeks after treatment. Control fish regressed. All fish with yolky oocytes were injected with 10 ug/kg LHRH-A to induce spawning. The different responses to the spawning injection were oocyte hydration, ovulation, partial spawning, and complete spawning.

Development of an efficient method for collecting naturally spawned milkfish eggs in floating cages

Three different types of egg collecting devices were fabricated. These are:

1. Permanently mounted funnel-shaped egg collectors, measuring 1 m x 2 m at the opening, and 0.5 m in diameter at the exit side where a detachable plankton net (mesh 0.80 mm) is attached. Plastic coated straw cloth barriers are placed along the perimeter of the floating cages to minimize dispersal of spawned eggs. Collection of the eggs is facilitated by tidal currents.
2. Seine nets (1 m x 10 m, 0.80 mm mesh) are operated manually inside the cages which are lined with plastic coated straw cloth to keep spawned eggs inside.
3. The sweeper-type collector is operated manually by turning a guide pole attached to a "sweeper" inside a cage lined with plastic coated straw cloth.

Adult milkfish or Sabalo

Egg collection from milkfish floating cages in Igang

Through the use of the above collecting devices, almost 6 million naturally spawned milkfish eggs were collected in 1985. The efficiency of each collecting device has yet to be determined.

Induced spawning of seabass

Twelve female seabass, *Lates calcarifer* with oocyte diameters of at least 0.4 mm were induced to spawn from April to October using an LHRH Analogue (D-Ala 6-mammalian), administered as intraperitoneal injection, pellet or osmotic pump. Males were injected with the same analogue intraperitoneally. Among the 12 females, 6 were injected, 2 implanted with pellets, 3 with continuous osmotic pump and 1 with pulsatile osmotic pump.

Ten of the females spawned two days after hormone administration. Ten of the 3 females given continuous osmotic pump in April and August spawned for 4 to 5 consecutive nights. The female given pulsatile osmotic pump did not spawn, but the oocyte diameter increased from 0.4 to 0.53 mm. Females given injection in May spawned once; in July for 4 consecutive nights; in August for 2 consecutive nights; and in October once. Females implanted with pellets in April spawned only once. A summary of the hormone treatment and results are given in Table 1.

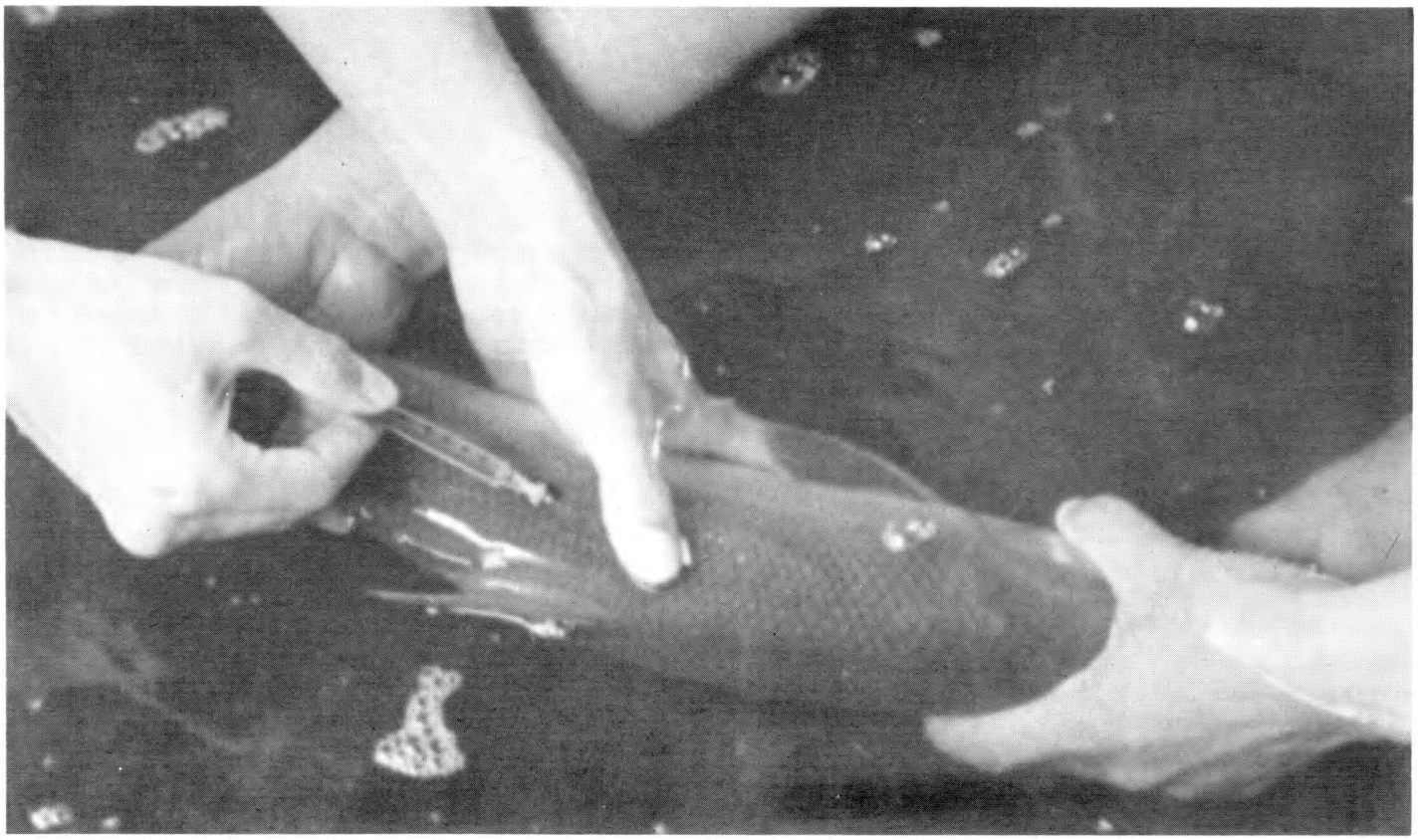
Induced spawning in milkfish *(Chanos chanos* Forsskal)

The response of mature captive milkfish to mammalian and salmon analogs of gonadotropin releasing hormone (mGnRH-A, and sGnRH-A) was investigated. Six groups of 3 females were administered the following: (1) mGnRH-A osmotic pump Intraperitoneal (IP) implant; (2) mGnRH-A cellulose-cholesterol pellet IP implant; (3) mGnRH-A intramuscular (IM) injection; (4) sGnRH-A osmotic pump IP implant; (5) sGnRH-A cellulose-cholesterol pellet IP implant; and (6) cellulose-cholesterol pellet IP implant.

The analogs appear to be equally effective in inducing ovulation in milkfish. Fish which ovulated spawned spontaneously. Control fish regressed. The response to GnRH-A however varied with individual fish. All females injected or

Table 1. Induced spawning of seabass

Month	Body Wt. (kg)	Average Egg diameter (mm)	Dose (mg LHRH/ fish)	Administration	Eggs Collected	Larvae (Collected)
April	3	.47	400	continuous osmotic pump	3,667,000	1,800,000
	6	.38	400-500	pulsatile osmotic pump	no spawning	
	6	.42	100	Pellet	640,000	
	—	.53	100	Pellet	168,000	
May	6	.47	60	Injection	1,686,000	
July	6	.44	100	Injection		3,066,000
	6	.44	100	Injection	2,140,000	650,000
August	5	.49	100	Injection		3,686,000
	5	.49	400	continuous osmotic pump		5,920,000
October	5	.49	400	continuous osmotic pump	no spawning	
	3	.50	100	Injection		1,177,000
	2.5	.49	100	Injection		308,000



Injecting hormones to induce milkfish maturation

pellet-implanted showed some response to the analogs and about 75% (6/8) ovulated and spawned, while only half of the osmotic pump implanted fish spawned. Spawning occurred from 18 hours to 36 hours from treatment.

Monitoring gonad development in seabass broodstock

Monthly sampling of two and three-year old seabass broodstock indicate that sexual maturation begins in January, peaks in February to August. The number of mature males and females steadily decreased in October and November. Males appeared to undergo gonadal regression earlier (in October) than females (in November). About 51% of the two-year old broodstock sampled in June were early maturing males. Sex and gonad state of the remaining two-year old seabass could not be determined. Two females sampled in August had ovulated eggs and empty ovarian follicles, indicating that seabass spawned naturally in the floating cages.

Development of hybrid and outbred strains of tilapia for freshwater production.

Morphological variations in broodstocks of four species of tilapia were studied. Dorsal and ventral body color differed in all the species. *Oreochromis niloticus, O. aureus* male, and *O. mossambicus* exhibited black tip coloration of the dorsal fin. *O. mossambicus* and *O. niloticus* had blackish pectoral fins; red tilapia and *O. aureus* had orange and yellowish pectoral fins. Anal fin color differed in all species. Eye coloration in the inner choroid varied from gold to red; outer choroid was brown in all species, except in red tilapia.

O. niloticus had eight body stripes, *O. aureus* had six. Dorsal fin stripes were also prominent in the two species. Anal fin stripes were seen only in *O. niloticus.*

The following crosses were compatible.

O. mossambicus x red tilapia
O. mossambicus x *O. niloticus*
red tilapia x *O. niloticus*
O. niloticus x red tilapia
O. niloticus x O. aureus
O. mossambicus x O. aureus

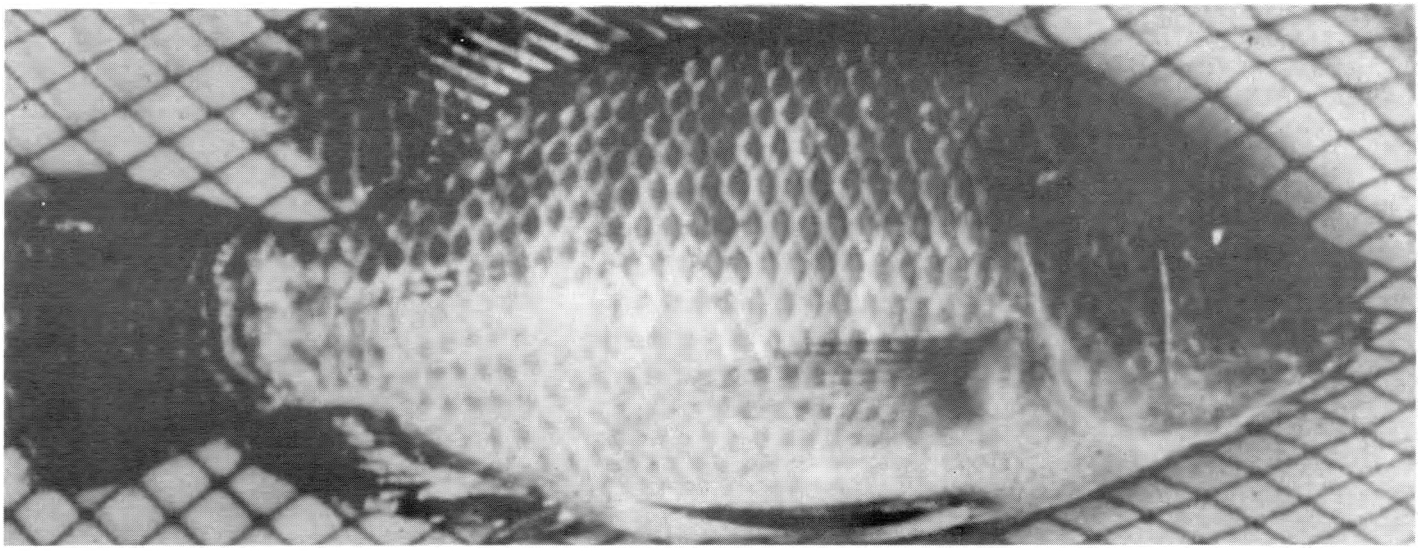
Colored progenies were noted only in red tilapia crosses.

Criteria for genetic evaluation and selection of tilapia broodstock

Salinity tolerance tests were done on the different strains of *O. niloticus* fry available at BRS. Preliminary data showed that the Taiwan-Singapore fry had higher salinity tolerance than the Israel stock. The crossbred fry had the lowest salinity tolerance.

Carp broodstock maturation in lakes and ponds

The effects of three different stocking densities ($0.2/m^2$, $0.3/m^2$, and $0.4/m^2$) and two feeding schemes (with and without supplemental feeding) on the gonadal maturation of bighead carp, *Aristichthys nobilis* broodstock were determined. Bighead carp reared in floating cages, with or without supplemental feeding, underwent gonadal maturation. Brood-



Nile Tilapia, *Oreochromis niloticus*

stock had maturing gonads one month after they were stocked (in May) in the cages. Stage 4 females selected for induced spawning were characterized by soft, bulging abdomen and pinkish genital papillae. When pressed lightly on the abdomen, males produced oozing milt.

Twenty-five bighead carp (average weight 3.8 kg) spawned from August to December producing 577,160 post-larvae. Fertilization and hatching rates were 72% and 25%, respectively.

In a related experiment, silver carp *Hypophthalmichthys molitrix* broodstock (ave. wt: 2.2 kg) were stocked at 15 pcs/ 50 m^2 floating cage in Laguna de Bay, at a sex ratio of 1:1. Three types of BRS-formulated feeds (Table 2) were given once a day at 3% of the fish biomass. The treatments follow: Treatment I – Feed A, Treatment II – Feed B, Treatment III – Feed C, and Treatment IV – no feeding, served as control.

Initial data from this experiment showed comparatively low occurrence of fish with mature gonads. However, broodstock with developing gonads were observed one to two months after stocking. Starting on the third month until the eighth month, three gravid females were induced to spawn, producing 33,000 postlarvae. The experiment is still on-going.

In another development, two-year old bighead carp (ave. wt: 1.6 kg) and silver carp (ave. wt: 2.8 kg) breeders reared in pens and cages in Laguna de Bay were transferred to 4-unit 500 m^2 ponds in Bay, Laguna. Stocking rate was at 50 fish/-pond, 25 silver carp and 25 bighead carp. A BRS-formulated carp broodstock feed was given daily at 3% of the body weight. Two months after stocking, the breeders showed developing gonads. Nine breeders (4 bighead carp and 5 silver carp) were induced to spawn by hormone injection.

Higher fecundity (ave: 270,000 eggs/female) was shown by silver carp as compared to bighead carp (ave: 81,000 eggs/ female). Fertilization rates for silver and bighead carps ranged from 78 to 87%, and 65 to 87%, respectively. Hatching rates ranged from 22 to 40% for silver carp, and 24 to 33% for bighead carp.

Table 2. Composition of formulated feeds used for silver carp broodstock

Ingredients	Feed A	Feed B (gram/100g m diet)	Feed C
Fish meal	15	–	22
Soybean meal	35	35	28
Corn gluten meal	20.6	22	10.818
Meat and bone meal	–	20	–
Rice bran	20.4	14	25.26
Corn meal yellow	–	–	10
Dicalcium phosphate	1	1	–
Oil: (vegetable:cod liver 1:1)	2	2	2
Starch	–	–	1
Vitamin mix, Afsillin	6	6	1.56
	100	100	100
Percentage			
Crude protein	38	38	35
lipid	8.66	8.69	8.12
Crude Fiber	5.76	5.13	5.95
Ash	6.21	10.26	8.25
NFE	29.22	25.49	34.67
D. E. (kcal/100g)	292	267	275

Bighead carp, *Aristichthys nobilis*

Determination of biochemical genetic variation in Asiatic carps

Samples of bighead and silver carps were analyzed by starch gel electrophoresis. Among 22 loci investigated, 14 were fixed and 8 indicated possible polymorphism for at least two alleles. Some other buffer systems and electrophoretic conditions will be tried to assess allelic and genotypic frequencies. Heterozygosity and degree of polymorphism will be determined when a larger number of fish samples has been analyzed.

Binangonan Research Station (BRS) is involved in freshwater aquaculture

Sampling of carp breeders to determine sexual maturity

SEED PRODUCTION

Development of mass production techniques for milkfish fry

More than 37 batches of milkfish eggs (stripped, induced, and naturally spawned) were collected from five different floating cages in Igang from April to October 1985. The eggs were brought to TRS for incubation hatching, and rearing. Each batch was reared up to fry stage (day 21 after hatching) in 20-1, 60-1, 1.5 t and 3 t tanks depending on the quantity of eggs collected. Rearing salinities were adjusted from 32 ppt to 24 and 16 ppt during rearing. For the April to June batches, hatching rates ranged from 7 to 94% and survival rates at day 21 ranged from 4 to 85%. For the July to September batches, survival rates were from 0.5 to 46%. A total of 473,000 day 21 fry were harvested from April to September. Of the 132,000 fry harvested from July to September, 45,000 were brought to LRS, 28,200 were used for various experiments, and the rest were retained in the canvas tanks.

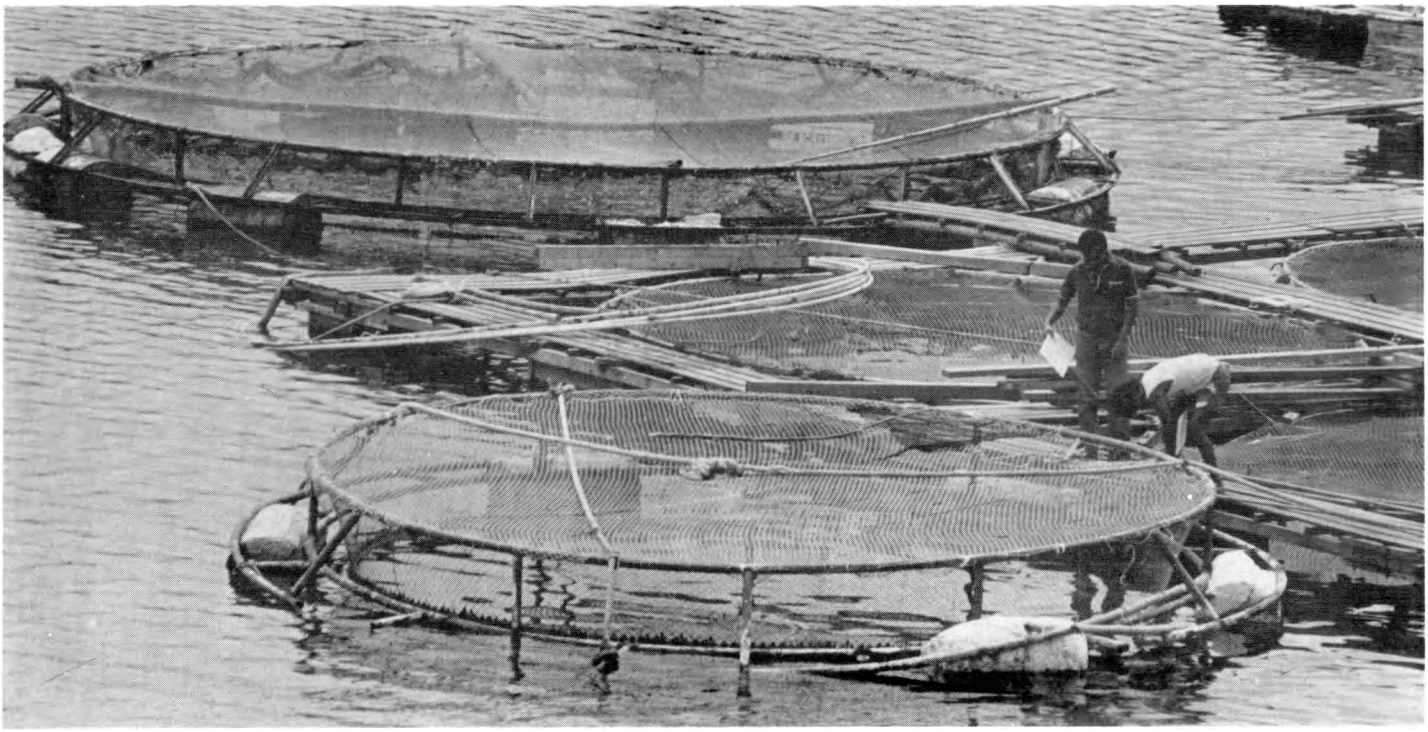
An experiment was conducted to determine, (1) the salinity that minimizes mortality during transfer, and (2) the larval age least sensitive to transfer stress. From day 0 to 21, groups of 20 larvae were transferred abruptly from 32 ppt to three transfer salinities: 16, 24, and 32 ppt. Mortalities of larvae were recorded at timed intervals during the 72 h exposure period.

A transfer salinity of 16 ppt reduced larval mortality during transfer in all ages tested, while a transfer salinity of 24 ppt gave better survival rates than 32 ppt. Day 3, 4, 5, and 6 larvae were most sensitive to transfer, their mortalities were more than 50% in all transfer salinities. However, 16 ppt gave the best survival for these ages. Sensitivity to transfer was reduced as larvae grew. By day 21, mortality was zero in 16 and 24 ppt, and 3% for 32 ppt. Day 0 and 1 larvae were also less sensitive to transfer compared to slightly older larvae.

Another experiment determined growth and survival of milkfish larvae reared in 16, 24 and 32 ppt. Higher survival rates were obtained in 16 and 24 ppt during the 28 day rearing period. Samples of larvae taken from different salinities at day 4, 8, 12, 16, 20, 24, and 28 show no significant difference in the total length.

The occurrence, abundance, and food and feeding habits of fish fry in Panay shore waters

Long term collections (1975-1977) of larval and juvenile fish were made onshore (a sandy beach flanked by a coral terrace and a river mouth) and 500 m offshore in 30 m deep water in Pandan Bay. About 70 species in 47 families were



Another type of milkfish floating cages in Igang

recorded offshore. Sixty species were common to both stations.

Metamorphic stage Mugilidae dominated the onshore catch (75% or 587 samples), followed by *Ambassis* spp. (55%), and *Chanos chanos* (48%). Predominant in the offshore station were larval *Stolephorus* spp. and *Sardinella* spp. in 79% and 62% of 345 samples, respectively. Apogonidae, Leiognathidae Gobiidae, Synodontidae, *Dussumieria* sp., *Caesio* spp., *Upeneus* spp. larvae, and the neotenic fish, *Schindleria praematura,* each occurred in 20-40% of the offshore samples. *Siganus* spp., *Lutjanus* spp., *Sphyraena* spp., and *Terapon* spp. were abundant onshore. The first two species were more abundant offshore than the latter two. Mugilidae and *Chanos chanos* were also less abundant offshore. Larvae of many inshore and pelagic fishery species like Carangidae, Scombridae, and Bothidae occurred at the offshore station together with larvae of coral reef species like *Pomacentrus* spp. and the mesopelagic species like *Benthosema* spp. and *Lestidiops* sp.

Seabass fry production

Seabass, *Lates calcarifer,* fry produced in the hatchery totalled 434,000. Table 3 shows the results of induced spawning using LHRH-A.

Table 3. Induced spawning of seabass using LHRH-A (TRS hatchery)

Date of injection	Date of spawning	No. of fish used M	F	No. of eggs produced (x 10^6)	Hatching rate (%)
May 15	May 17	4	2	2.5	40
July 4	July 6	8	6	10	55
Aug. 15	Aug. 17	6	5	8	50
Oct. 15	Oct. 17	6	4	6	20

Table 4 gives the percent survival of seabass larvae at different rearing periods. Bacterial disease caused mass mortality of day 22-25 larvae in July.

Production of seabass fry in hatcheries is commercially feasible. Fry must be transferred to, and reared in earthen nursery tanks to prevent bacterial disease and mass mortality. Better nursery procedures and techniques have to be developed.

Tigbauan Research Station (TRS)

Table 4. Survival of seabass larvae at different rearing periods.

Date of injection	Initial number of hatched larvae ($\times 10^6$)	Percentage survival from hatching to Day 10	Day 20	Day 30
May 15	1	80	65	9.9
Jul. 4	5.5	75	20	0
Aug. 15	4	80	60	6.1
Oct. 15	1.2	70	65	7.5

Siganid seed production

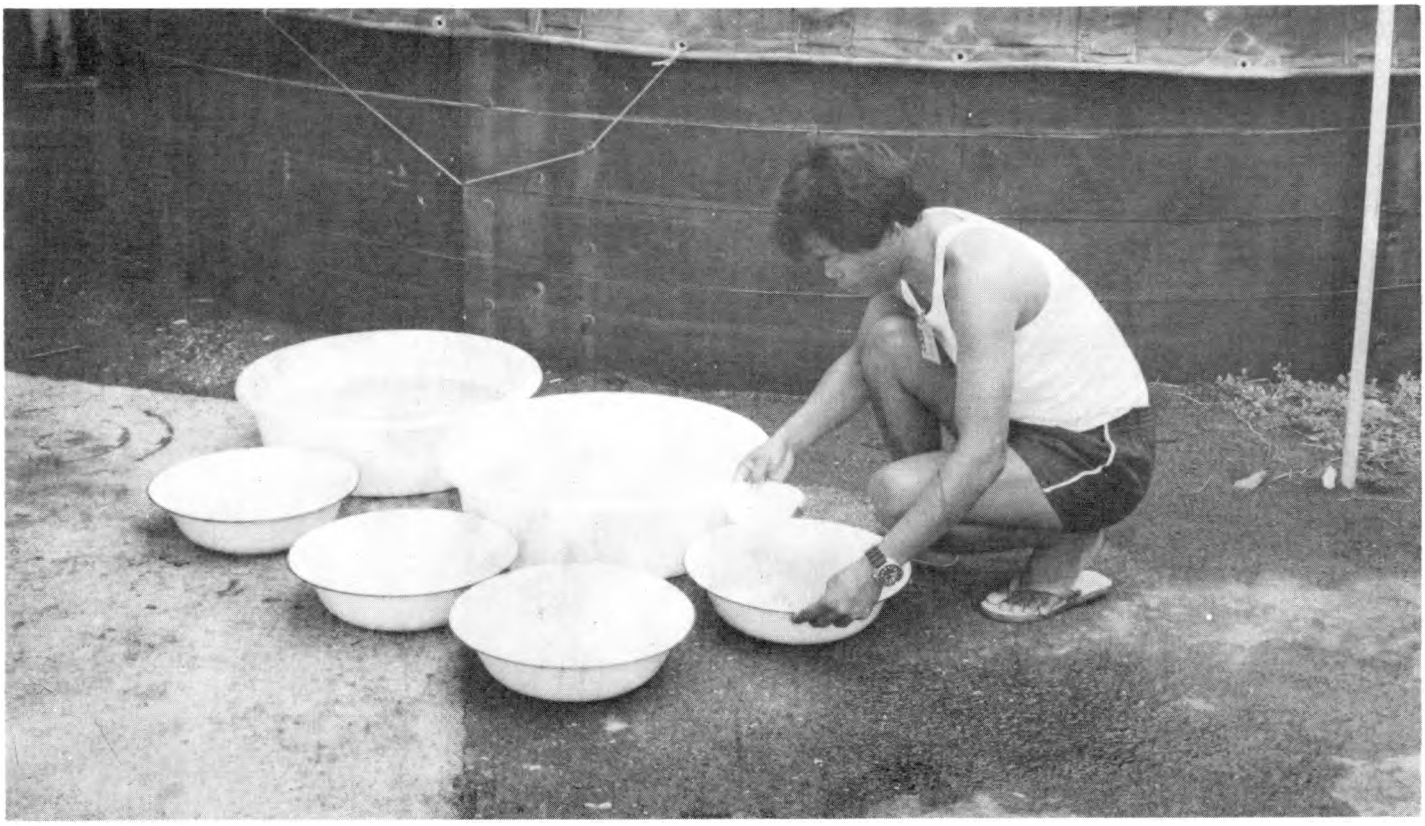
Spawning of the rabbitfish, *Siganus guttatus*, occurred every month throughout the year, between the first quarter and the full moon, without hormonal treatment. Gonadosomatic indices (GSI) of 400 specimens collected in Cebu showed a similar gonad cycle in wild fish. Lunar periodicity of siganid spawning was confirmed; fish spawn every first quarter period.

Females mated for the first time spawned without fail, and some females spawned repeatedly for four consecutive months. Females fed diets rich in cod liver oil, soybean oil, and lecithin spawned more often than those fed diets with little or no lipid source.

Sixteen spawnings produced an average of 570,000 eggs. Fertilization rates averaged 84%, hatching rates, 90%. Survival rates were 4.5-30% from hatching to day 21 and 44-92% between day 21 and day 45, with higher larval survival in 5-10 ton tanks than in 500-1 tanks.

Larvae were fed rotifers starting day 2. *Artemia* nauplii and artificial diets were readily accepted when first introduced on day 15 and 21, respectively. Higher preference for brine shrimp over rotifers occurred in larvae of 8-9 mm total length (TL). This and other changes in feeding habits coincided with the full osteological development of the feeding apparatus at 7-8 mm TL. A diurnal feeding pattern was observed, with the first morning feeding occurring earlier in the day (at lower illumination) as the larvae grew.

Larvae changed their swimming and feeding modes at 4 mm TL, improved rapidly in both abilities and attained full efficiency at 7-8 mm TL.



Counting of finfish fry

Seabass, *Lates calcarifer*

Rabbitfish, *Siganus guttatus*

Development and behavior of milkfish, seabass, and rabbitfish larvae

Egg size, larval size, amount of yolk and oil reserves, and mouth size were all greater in milkfish than in seabass, and greater in seabass than in rabbitfish. During the first 24 h after hatching, rabbitfish larvae grew much faster then milkfish and seabass larvae at ambient temperature of 26-30°C. The eyes became fully pigmented and mouths opened earlier in seabass and rabbitfish (32-36 h from hatching) than in milkfish (54 h). Yolk was completely resorbed 120 h after hatching in milkfish, yolk plus oil at 120 h in seabass, and 72 h in rabbitfish at 26-30°C.

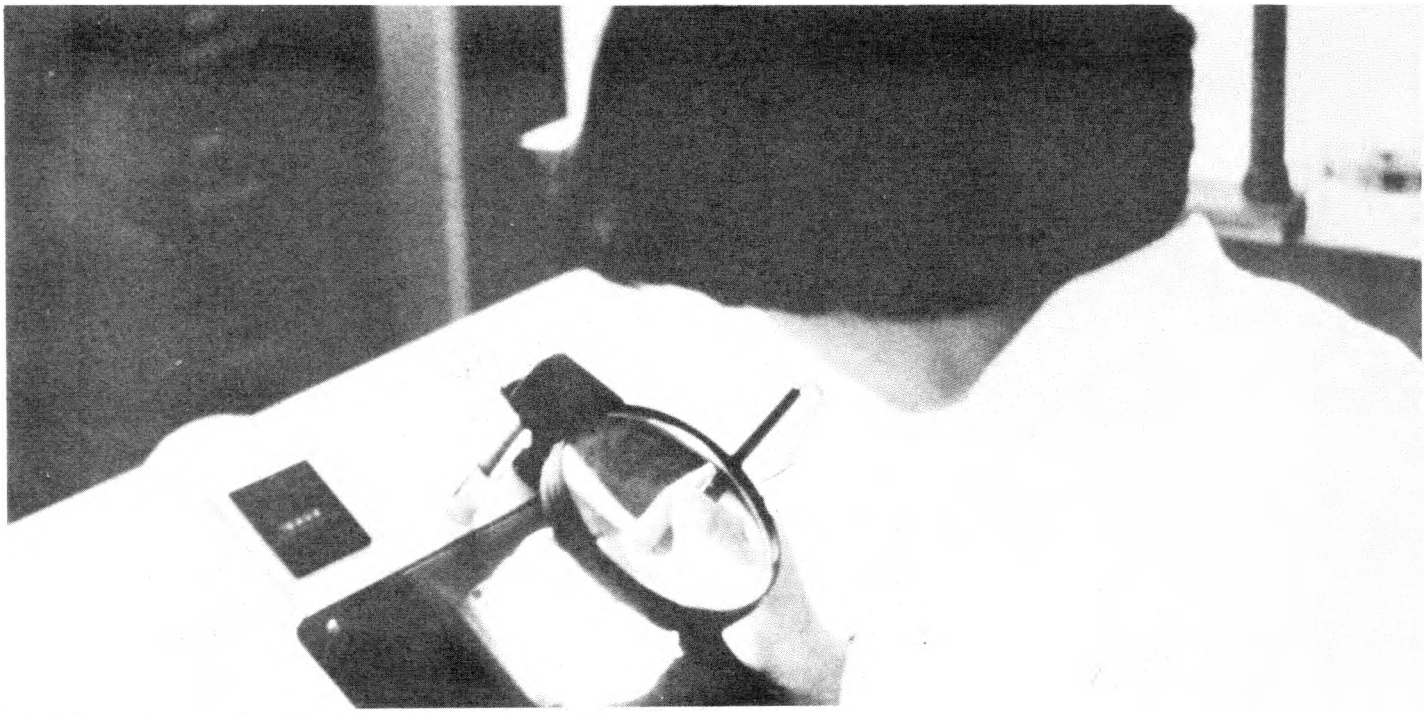
Delayed feeding experiments showed that 50% of unfed milkfish larvae died at 78 h and all died at 150 h after hatching. Larvae fed within 54-78 h had improved survival rates: 50% mortality occurred at 96-120 h; 10-13% survived beyond 150 h. Unfed seabass larvae all died at 144 h; 6-13% of larvae fed within 32-56 h after hatching survived beyond 144 h and well into the subsequent weeks. Unfed rabbitfish all died at 88 h, while 7-12% of those fed within 32-56 h survived beyond 88 h. Delay in initial feeding of more than 24 h after eye pigmentation and mouth opening may be fatal for all three species.

Mass mortality occurred in two-week old seabass larvae reared in an outdoor hatchery tank with high ambient temperatures, salinity and illumination, and a dense diatom bloom. This was traced to swimbladder malfunction causing high positive buoyancy. The problem occurred soon after handling and partitioning of larvae by seine and bucket, and seemed to have been a case of swimbladder stress syndrome. The development of the swimbladder in seabass larvae was also studied.

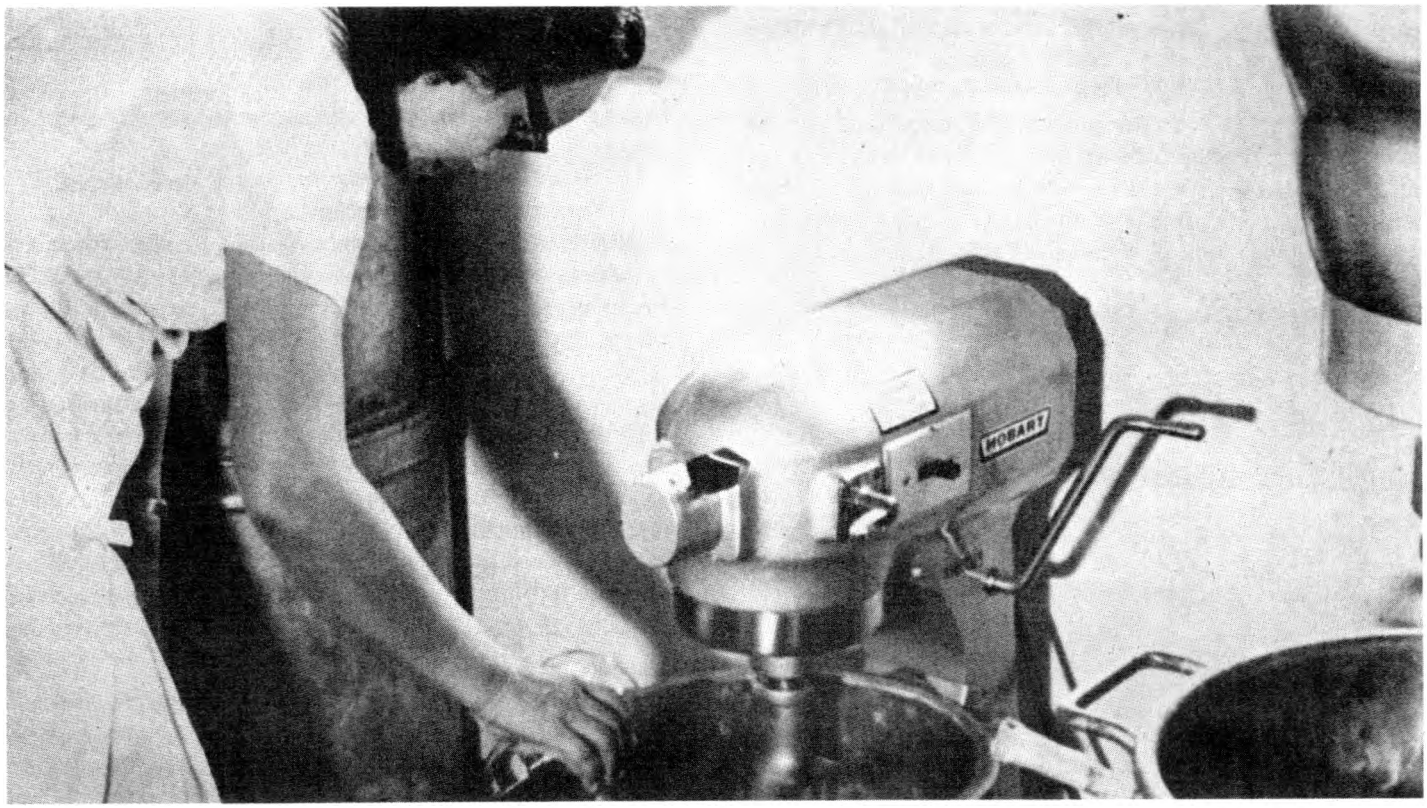
Investigation of transport-stress related infections of milkfish fingerlings

The sensitivity of the bacterial *Aeromonas hydrophila* and *Pseudomonas* spp. isolated from transport-stressed milkfish fingerlings to antimicrobial agents was tested. Results indicate that *A. hydrophila* is sensitive to Polymyxin B, Nitrofurazone, Triple Sulfa, Erythromycin, Sulfadiazine, Streptomycin, and Chlortetracycline but resistant to Novobiocin. On the other hand, *Pseudomonas* spp. reacted variably to the antimicrobials. One isolate was sensitive to Nitrofurazone, Erythromycin, Streptomycin, Chloramphenicol, Kanamycin, Nitrofurazone, and Chlortetracycline while resistant to the other test drugs. Another isolate was found sensitive to Sulfadiazine, Streptomycin, and Chlortetracycline but resistant to the other test drugs.

Preliminary temperature tolerance experiments showed that *A. hydrophila* thrives optimally at a temperature range of 17.5 to 40.5°C in 24-48 hr. Extreme test temperatures of 5.5 and 49.5°C reduce growth rate but do not kill the bacteria.



Counting of bacterial colonies isolated from diseased fish



Mixing of feed ingredients in a Hobart mixer is one of the steps in the preparation of artificial diets for prawn and milkfish

NUTRITION AND DIET DEVELOPMENT

Amino acid composition of feedstuffs used as protein sources in aquaculture feeds

Samples were hydrolyzed using either 6N hydrochloric acid (HCl), or 4N methanesulfonic acid (MSA), or both. Results showed that squid meals are good source of the amino acid arginine.

Among the plant protein sources, defatted mungbean is slightly poorer than soybean meal, with methionine being higher in the former. In leaf meals, the leguminous sesbanias and crotolaria appear to be promising plant protein sources (about 30% crude protein). The essential amino acid found in highest proportion is leucine followed by phenylalanine, while the lowest is cysteine, then methionine. Total amino acid is around 70 g/100 g protein.

Amino acid values are generally higher in the MSA than in the HCl hydrolysates, except in albumin and the amino acid arginine in gelatin. The slightly higher values in the HCl hydrolysates in gelatin and prawn ovary are not significant.

Among protein concentrates, casein contains all the essential amino acid but has slightly lower cysteine and tryptophan. Albumin has a relatively high cysteine but is deficient in tryptophan. A rich source of leucine is zein but it is deficient in tryptophan, lysine, and cysteine. Gelatin is also deficient in tryptophan and cysteine, and a poor source of tyrosine and methionine. It has a comparatively lower essential amino acid among the four concentrates analyzed, but it is a good source of arginine.

Lipid nutrition and fatty acid metabolism in milkfish

The essential fatty acid requirement of milkfish in seawater was determined through a feeding trial using purified diets. Six groups of fishes were fed diets with well-defined fatty acid types including: (1) a fully saturated fatty acid, (2) n-3 fatty acid, (3) n-6 fatty acid, and (4) n-3 + n-6 fatty acid. Two control diets were also tested: a "lipid-free" diet (0.05% lipid) and a diet with complete fish oil.

Milkfish fed the control diet with complete fish oil gave the highest growth rate. However, milkfish fed a "lipid-free" diet grew just as well as fish fed with 10% fish oil. The ability of milkfish to survive and grow for about 12 weeks even at an extremely low lipid level suggests that essential fatty acids are well conserved.

Lipid deposition in milkfish fed "lipid-free" diet was comparable with fish fed diet with 10% fish oil. This may indicate a high metabolic rate for *de novo* synthesis of fatty

acids from carbohydrates and proteins. It also suggests a highly efficient enzyme system for lipid biosynthesis.

Based on growth response at the end of 12 weeks it was not possible to make an unequivocal conclusion regarding the essentiality of medium chain (n-3) or (n-6) fatty acid for milkfish. A growth depression was however noted in fish fed diets with 1:1 ratio of (n-3) to (n-6) fatty acids suggesting that certain combinations of these acids may inhibit growth in milkfish.

Milkfish fingerling production in freshwater ponds using artificial and natural feeds

Acclimated milkfish fry (4.7 mg initial mean body weight) stocked at 90/m^2 in 12 ponds were given either of the following feed for six weeks: *Oscillatoria; Oscillatoria* plus artificial diet; or artificial diet alone. Cultures of *Oscillatoria* were concentrated and supplied weekly (at 1 x 10^6 cells/ml) to the fry in ponds. The artificial diet was given daily at 15 to 5% of fish biomass for the combination feeding and 30 to 10% for artificial diet alone.

Fry given the artificial diet alone had the highest final mean weight (1,319 mg) and total length (50.4 mm). Growth was slower (887 mg and 45.3 mm) when the combination of *Oscillatoria* and artificial diet was used. With *Oscillatoria* alone, growth of fry was low (621 mg and 39.6 mm). Survival rates ranged from 53 to 86% but were not significantly different among treatments.

A similar feeding experiment was conducted for eight weeks under laboratory conditions with *Spirulina* alone as an additional treatment. Fry fed with the artificial diet had highest growth and survival rates (483 mg and 73%), followed by fry fed with *Oscillatoria* and artificial feed combination (464 mg and 55%). Growth and survival rate of fry fed with *Oscillatoria* alone (52 mg and 27%) and *Spirulina* alone (59 mg and 53%) were much lower.

Results demonstrate the effectiveness of the artificial diet alone or in combination with *Oscillatoria* and the indigenous natural food in freshwater ponds in rearing milkfish fry to fingerling.

Rearing milkfish larvae to metamorphosis using practical diets

Hatchery-bred milkfish larvae (mean initial weight, 0.8 mg) were reared to metamorphosis using practical diets. The larvae were first introduced to the diets at 10 days after hatching, while being fed with rotifers. The rotifer density was gradually reduced and was completely withdrawn on the third day when the larvae were 13 days old. The live food control group was fed with rotifers until the larvae were 13 days old and then with brine shrimp nauplii. Time to metamorphosis was influenced by the feeding regime and by dietary quality. Larvae fed to satiation with practical diets metamorphosed earlier (90% metamorphosed on Day 40) than those on a restricted feeding regime (50% metamorphosed on Day 45). The larvae fed live food matamorphosed earlier (Day 30) than those reared on practical diets (Day 40 to 45). Larval survival was dependent on salinity. With practical diets or with live food, higher survival was observed for larvae reared at 16 ppt than at 32 ppt. A biphasic growth was observed for larvae fed on practical diets. This was characterized by an initial slow growth followed by a phase of rapid growth rate which was comparable with that observed for larvae reared on live food. The initial slow growth is probably associated with a phase in which the larvae learned to ingest non-live food.

Algal cultures in carbouys

FINFISH CULTURE

Primary productivity in brackishwater ponds

On the evaluation of inorganic fertilizers for milkfish culture in brackishwater ponds, no significant differences in weight increments and production were observed among the four treatments, in a three-month culture period. The four treatments were:

Treatment I : Traditional method – 50 kg/ha of 16-20-0 + 15 kg/ha of 45-0-0;

Treatment II: Half-dosages of the traditional method;

Treatment III: 22 kg/ha of 18-46-0; and

Treatment IV: 26 kg/ha of 18-46-0.

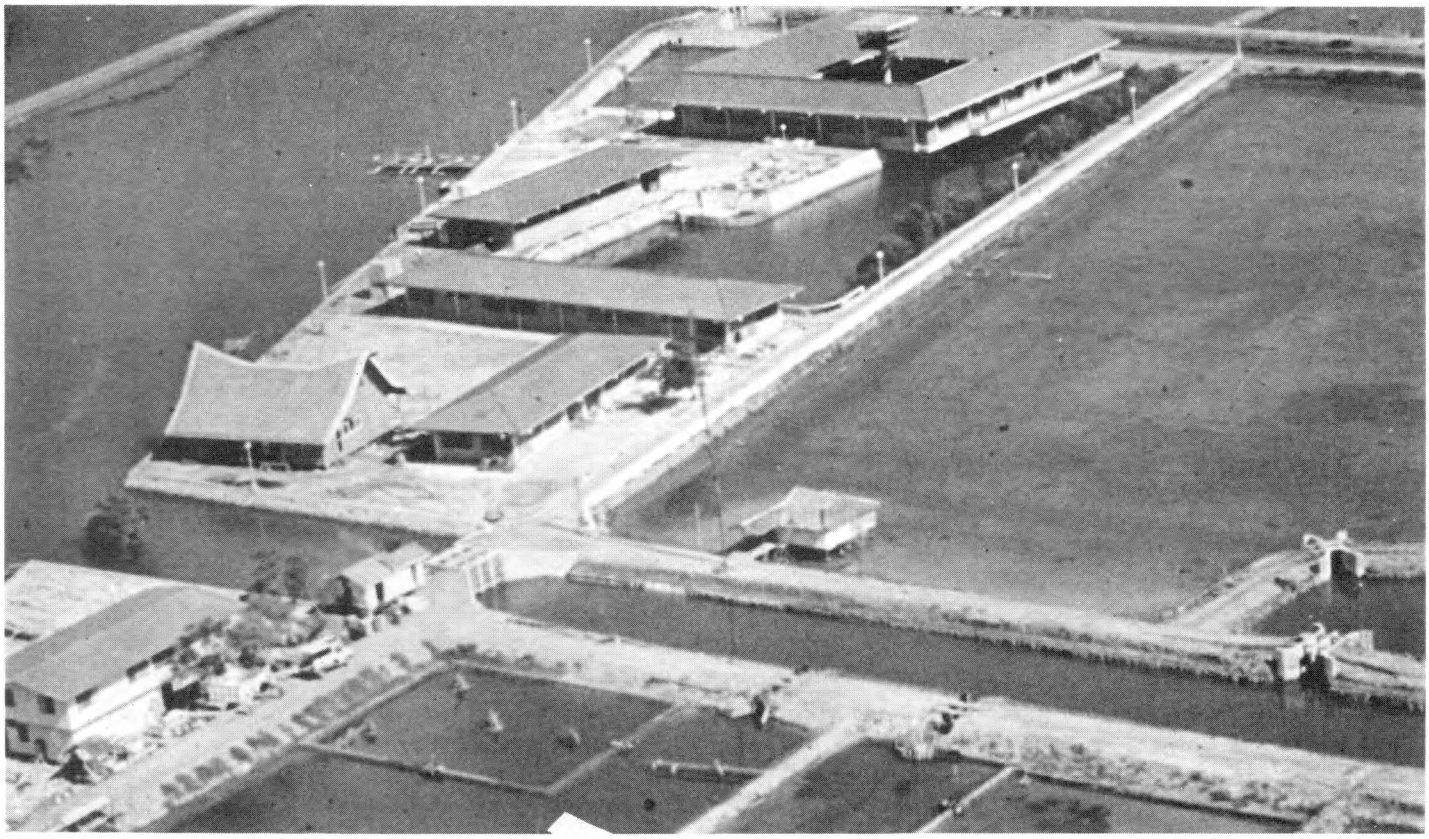
Results confirm that traditional method of fertilization is not significantly better than the half-dosage rate in terms of milkfish growth and production.

Growth performance of different ages and sizes (3-7 g) of milkfish in grow-out ponds showed that weight increments in a three-month culture period, did not differ significantly among the treatments.

In studies with different water replenishment and fertilization schemes in grow-out ponds, average weights were highest for the treatment(s) with biweekly water replenishments, and fertilization from the second month of culture until harvest. (Treatment I: weekly replenishment + biweekly fertilization; Treatment II: weekly replenishment + weekly fertilization; Treatment III: biweekly replenishment + biweekly fertilization; and Treatment IV: biweekly replenishment + weekly fertilization.) This confirms the good result obtained from half-dosage rates of the traditional fertilization method given every two weeks after water replenishment.

Stunting milkfish fingerlings in brackishwater ponds

The study was conducted in 12 earthen stunting ponds (144 m^2) with three treatments (6, 9, and 12) culture period). Milkfish with an average body weight of 3 g were stocked at a density of 20/m^2. The ponds were prepared using the lab-lab method. Feeding started after 60-day culture period, giving trash fish mixed with fine rice bran at a ratio of 1:10, twice a week at 2% of body weight. Results show that milkfish gained an average weight of 12.4 g and 81% survival after a 6 month culture period; 13.1 g and 80% after 9 month; and 14.2 g and 52% after 12 month.



Leganes Research Stations (LRS)

The effect of supplemental feeding and stock manipulation on the growth, survival and production of milkfish using the lab-lab and plankton methods

Milkfish (3.5 g average body weight) were cultured in twelve 950 m^2 compartments at a density of 4,000/ha using the lab-lab method for 120 days. Six compartments were provided supplemental feeds of rice bran, trash fish, and rice bran plus trash fish; the other six were not.

Mean growth of milkfish cultured for 120 days with, and without supplemental feeding, ranged from 119 to 160 g, and 144 to 156 g, respectively. Fish fed a mixture of trash fish and rice bran grew best at an average rate of 1.4 g/day. Low growth rates were obtained in two compartments, probably due to snails competing with milkfish for the natural food.

In a related experiment, the blue-green alga *Anacystis* was observed in ponds with the poorest milkfish growth, while *Brachionus* occurred in ponds with the best growth. Analysis of physico-chemical parameters showed that DO, total alkalinity, nitrates and phosphates are slightly higher when blue-green algae are present in the ponds. All other physico-chemical parameters were within the same range in all the ponds. The digestibility and possible toxicity of many blue-green algae to milkfish should be studied.

Mono and polyculture of prawn in a modular pond system

Polyculture. The study started with the extensive repair, renovation, and conditioning of the pond bottom. Modular ponds were prepared following the lab-lab method. Catwalks and feeding trays were provided, and mangrove *(Avicennia* spp.) twigs were placed in all modules. Chopped trash fish at 5% body weight was given twice a week. Prawn juveniles were stocked at 5,000 pcs/ha, and milkfish at 2,500 fingerlings/ha. The study is on-going.

Prawn monoculture. Four sets of existing modular ponds with a ratio of 1:2:4 and with a corresponding area of 550, 1100, and 2200 m^2 were used. These were stocked with prawn juveniles at 5,000/ha and 10,000/ha. The lab-lab method was used and chopped trash fish was given twice a week at 5% BW. The study is on-going.

An economics/verification study of milkfish production in a modular pond system has been conducted at a private cooperator's 7.9 ha pond in Carcar, Cebu. The area has a corresponding pond ratio of 2.2:2.7:3.0 ha. Milkfish was grown using the lab-lab method. In the first run, 13,200 milkfish fingerlings were stocked in the first module, then transferred to the second and third modules every 30 days thereafter. Milkfish production from the first run was 2.11 t, or 260 kg/ha in 3 months.

Another verification site has been started in Lala, Lanao del Norte.

Experimental ponds in LRS

Siganid production in brackishwater nursery and grow-out ponds

The study was conducted in nine 300 m^2 earthen ponds using three stocking densities, 3 fry/m^2, 5 fry/m^2, and 7 fry/m^2 Siganid fry, weighing 118 mg, were grown for 45 days only on lab-lab and lumut. Fry stocked at 7/m^2 had the highest survival of 39% and an average body weight of 2.3 g. Fry stocked at 3/m^2 had survival of 35% and body weight of 1.5 g, while those stocked at 5/m^2 had a 30% survival and 2.1 g.

Fingerlings weighing 4.80 g and measuring 6.24 cm were later grown in the same ponds. After 60 days, fish stocked at 0.25/m^2 grew to 41 g and 12 cm; those stocked at 0.5/m^2, 38 g and 12 cm; and those at 0.75/m^2, 20 g and 9 cm.

Culture of siganids in cages

Hatchery produced siganid fry (average total length, 2 cm; average weight, 0.119) were stocked in 1 x 1 x 1 m floating cages using three stocking densities:

I – 20 fry/cage; II – 50 fry/ cage; and III – 100 fry/cage.

Fish were fed with green algae, mostly *Enteromorpha* sp., gathered from nearby areas. Supplemental fish pellets were given during the second month of rearing. Results after a 70 day culture period are given in Table 5.

Daily growth increments of 0.13, 0.10, and 0.08 g were obtained for Treatments I, II, and III, respectively. Survival rate was highest at 20 fry/cage and lowest at 100 fry/cage. Temperature ranged from 29 to 31°C, while salinity ranged from 24 to 33 ppt during the culture period.

In another development, siganids were also cultured in three floating cages measuring 2 x 3 x 2.5 m. Each cage was stocked with 240 juveniles averaging 60 g each. The fish were given filamentous algae at the rate of 50% of the total biomass. On the third month of culture, fish weighed an average of 107.6 g. It is expected that by the fourth month selective harvesting could be done.

Table 5. Growth and survival of siganids after 70 days

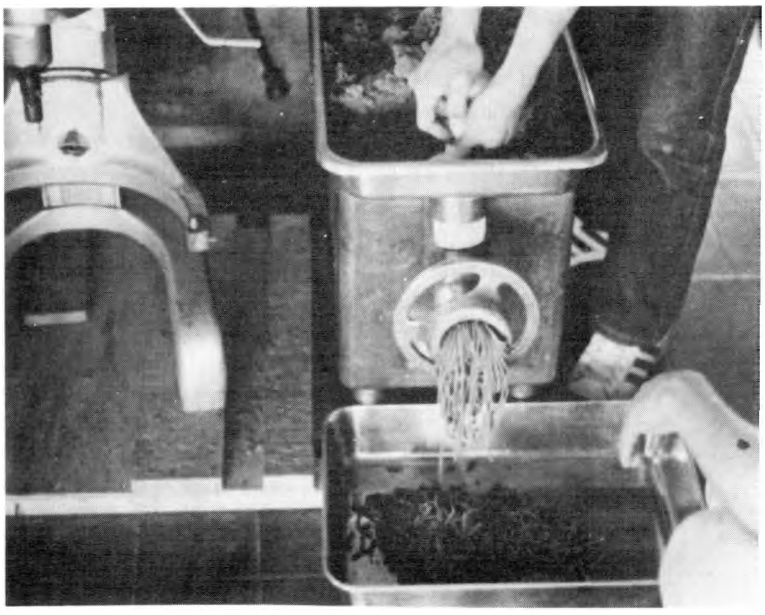
Treatment (fry/cage)	Final average TL (cm)	BW (mg)	Survival rate (%)
20	7.6	10,150	70
50	6.3	7,430	52
100	5.8	6,020	47

Growth and survival of carp fry reared to fingerling at various stocking densities and fertilizers

Three-day old bighead carp fry were stocked in aquaria at 5/1 and were given ad libitum, the following feed combinations: (1) *Brachionus-Moina-Oscillatoria.* (2) Artificial feed-*Moina-Oscillatoria,* and (3) Artificial feed-*Moina.* The artificial feed was prepared by the Nutrition Laboratory of BRS.

The different feed combinations were modified based on the results of the earlier experiment, as follows: (1) Artificial feed-*Moina,* (2) *Moina-Oscillatoria,* and (3) Artificial feed-*Moina-Oscillatoria.* The range of concentration of natural food for both experiments were: a) *Brachionus,* 2 x 10^6 to 80 x 10^6 cells/ml; b) *Moina,* 5 x 10^5 to 20 x 10^5 cells/ml; and c) *Oscillatoria,* 2.7 x 10^6 to 5.4 x 10^6 cells/ml.

Fry grew best when given a combination of artificial feed *Moina-Oscillatoria,* while the combination of artificial feed and *Oscillatoria* alone was inadequate for fry growth. This indicates the necessity of zooplankton in the diet. Using artificial feed instead of *Brachionus* and *Oscillatoria* enhanced growth. Survival of the larvae increased when *Oscillatoria* was added to the rearing medium. Mean survival among the different treatments did not vary significantly.



Production of artificial feeds for finfish nutrition

In a separate experiment, 6-day old silver carp fry with an average weight of 3 mg stocked at 5/1 in aquaria. The fish were fed with: a) *Anabaena* (7 x 10^4-26 x 10^6 cells/ ml); b) *Oscillatoria* (7 x 10^4 -2.8 x 10^6 cells/ml); and c) *Spirulina* (1.25 x 10^3 -5 x 10^4 cells/ml). The blue-green alga *Spirulina* was found to be the best natural food of silver carp larvae. Highest weight increase of 358 mg was obtained with *Spirulina* compared to 59 mg with *Anabaena* and 120 mg for *Oscillatoria*. Fry survival was highest when fed with *Oscillatoria*. Results differed significantly among the treatments.

In another development, twelve nursery ponds (5 x 10 x 2 m) were prepared and stocked with 12-day old silver carp fry at 100/m^2, and 200/m^2. Two types of fertilizers were used: 1) organic fertilization using chicken manure and *Azolla*, and 2) inorganic fertilization using ammonium sulfate (21-0-0) at 375 g/pond. Organic fertilizers were added initially at 10 kg/pond (5 kg chicken manure, 5 kg *Azolla)*. After two weeks *Azolla* was added at 2 kg/day.

Highest growth rate of silver carp fry in ponds was at a stocking density of 100/m^2 and using *Azolla* and chicken manure as fertilizer (Fig. 1).

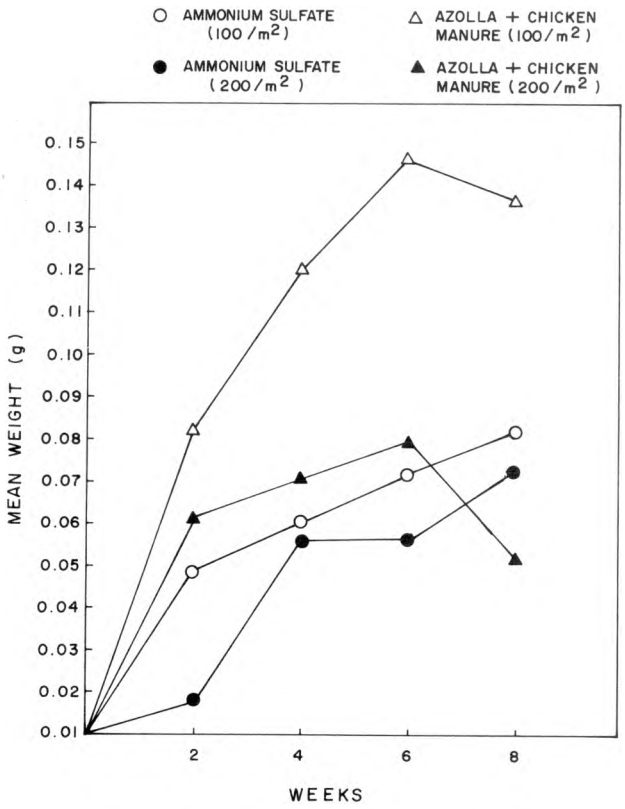


Fig. 1. Growth of silver carp fry reared at two stocking densities and two fertilization types.

Effects of organic and inorganic fertilizers on the growth of plankton and fish production in newly constructed ponds

Bighead carp (ave. wt., 1.91 g) and Nile tilapia (ave. wt., 0.17 g) fingerlings were stocked in ponds at 2.1/m^2 and 2.5/m^2, respectively. Four fertilization treatments were used, Treatment I: 100% phosphate fertilizer (0-18-0); Treatment II: phosphate + nitrogen (0-18-0-+ 21-0-0); Treatment III: 100% nitrogen fertilizer (21-0-0); and Treatment IV: 100% chicken manure alone. The ponds (4 ponds, 500 m^2 each) fertilized with chicken manure alone showed fastest growth (weight 81 g, length = 214 cm) in six months for bighead carp. This was followed by those grown in ponds fertilized wih 0-18-0. Carp fingerlings reared in ponds with 21-0-0 exhibited slowest growth 37.0 g and 175.0 cm. Results showed a steady increase of carp growth up to the 14th week in all treatments. Growth in ponds fertilized with chicken manure alone, and in ponds fertilized with mixed 0.18-0 + 21-0-0, levelled off after the 18th week of culture. While growth was highest in ponds fertilized with chicken manure alone, the lowest recovery rate of 69% was obtained. Relatively high survival rates (96-99%) were obtained in ponds with either 21-0-0, 0-18-0, 0-18-0 + 21-0-0 (Table 6).

Newly-constructed ponds in Bay, Laguna

Table 6. Data on stocking and production of silver carp *(Aristichthys nobilis)* and tilapia *(O. niloticus)*

Treatment	Stocking Rate	Recovery (%)	Yield (kg/pond)
For silver carp			
0-18-0	1050	99.0	57.3
0-18-0 + 21-0-0	1050	97.6	49.3
21-0-0	1050	95.6	18.5
Chicken manure	1050	69.0	59.0
For Nile tilapia			
0-18-0	1250	59.6	70.7
0-18-0 + 21-0-0	1250	49.0	43.1
21-0-0	1250	47.8	49.8
Chicken manure	1250	85.0	78.0

For Nile tilapia, the highest weight gain of 83 g was obtained in ponds fertilized with chicken manure alone. Highest length and weight gains were obtained in ponds with 0-18-0. Growth did not vary significantly from ponds applied with 21-0-0 and 0-18-0 + 21-0-0. Highest recovery of tilapia was obtained in ponds, fertilized with chicken manure alone (85%) and lowest (49%) with 0-18-0 + 21-0-0 (Table 6).

The results demonstrate the importance of phosphorus as fertilizers in the ponds used. Good fish yields may be attributed to the increased organic matter content in the soil resulting from manuring, and to the availability of desirable food organisms. Average phytoplankton cell count showed the dominance of green and blue-green algae in ponds fertilized with 0.18-0. In ponds fertilized with chicken manure alone, a dominance of diatoms was observed, followed by blue-green algae.

The effect of various feeding levels of trash fish on the growth and survival of seabass

The study determined the effect of various trash fish rations on the growth and survival of seabass juveniles and assessed the economics of the different rations. The experiment was carried out in 1.5 t oval fiberglass tanks for four months. Four feeding levels were tested: 10%, 20%, 30%, and 40% dry fish biomass.

Results revealed increase in growth rate with increase in feeding level. However, there was no significant difference in mean weight gain, condition factors, food conversion, and percentage survival of fish among treatments at 95% confidence level.

The amount of food consumed increased with increasing fish weight up to a certain limit then decreased with further increase in weight, and with time. The results showed that the maximum amount of food consumed by the fish were much lower than the given rations.

Analysis of input and output indicated that profit is maximized at input levels below the 10% feeding level. Based on the highest yield, least cost, and least net loss the 10% ration make it the best among the treatments tested.

Polyculture of carp, tilapia, and seabass in cages in ponds

Polyculture of tilapia, carp, and seabass has the highest average fish production of 2.0 kg/m^3, as compared to culture of tilapia with carp (1.9, kg/m^3), monoculture of tilapia (1.5 kg/m^3), monoculture of seabass (0.5 kg/m^3), and monoculture of carp (0.2 kg/m^3) over a six month growout period.

The study also showed that seabass can efficiently control tilapia population in cages. However, its effectiveness depends upon the proper stocking ratio of tilapia and seabass, as well as the prey fish preference of seabass.

Economic feasibility of milkfish fingerling production in freshwater ponds

Financial performance of three milkfish nursery operations using 1) 100% natural food, 2) 50% natural food and 50% artificial diet and 3) 100% artificial diet was studied. Return on investment (ROI) was highest (39%) for treatment 2. Treatment 1 gave ROI of 8.5%; treatment 2, 26.2%.

Comparative economic analysis of milkfish and tilapia pen industry at Laguna de Bay

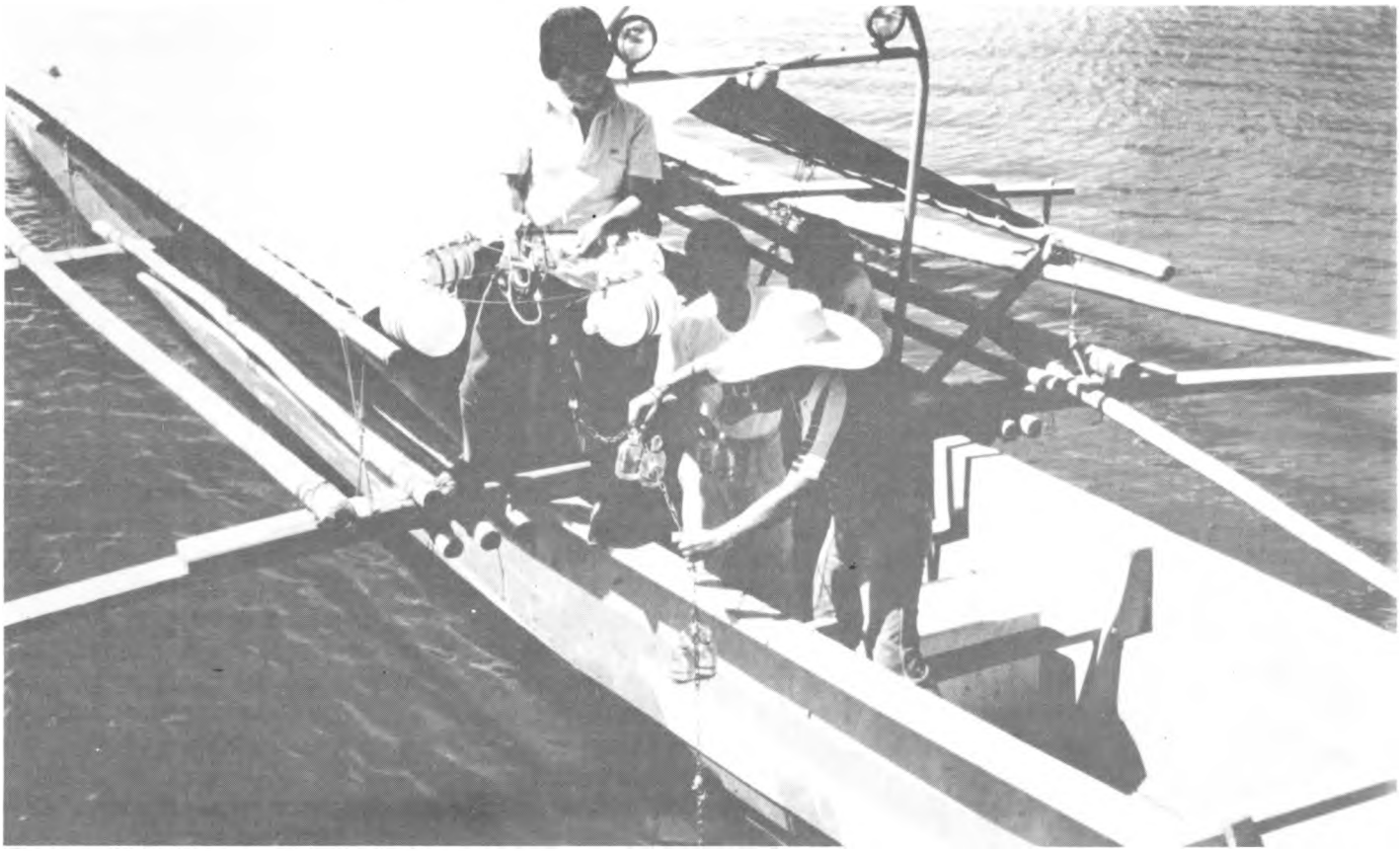
A financial study verified that tilapia culture in pens is more lucrative than the traditional milkfish pen culture. The return on investment (ROI) on tilapia pen culture is 155%, while that of milkfish pen culture declined from 142% in 1984 to 85% in 1985. Polyculture of tilapia and milkfish in pens is most lucrative, with an ROI of 476%.

Limnological study of West Cove, Laguna de Bay

Selected physico-chemical and biological parameters were monitored. These include depth, transparency, turbidity, and total filterable solids for physical parameters; and pH, dissolved oxygen, conductivity, total hardness, total alkalinity, calcium hardness, chloride, ammonia, nitrite, and phosphate for chemical parameters. The biological parameters were gross primary production, phytoplankton and zooplankton biomass, and zoobenthos population density.

Results showed that physico-chemical parameters exhibited patterns but did not reach the critical levels. Gross primary productivity varied between 2.28 g/m^2 in early June, and 0.05 g/m^2 /d in mid-October. Phytoplankton standing crop was highest at 129.2 g/m^2 in mid-May and lowest at 0.27 g/m^2 in mid-October. Zooplankton standing crop ranged from 2.43 g/m^2 to 20.70 g/m^2 in April and late May, respectively. Zoobenthos had the highest density in March (2493 g/m^2) lowest in December (277 g/m^2).

Data indicate that the most productive period in West Cove is from April to October.



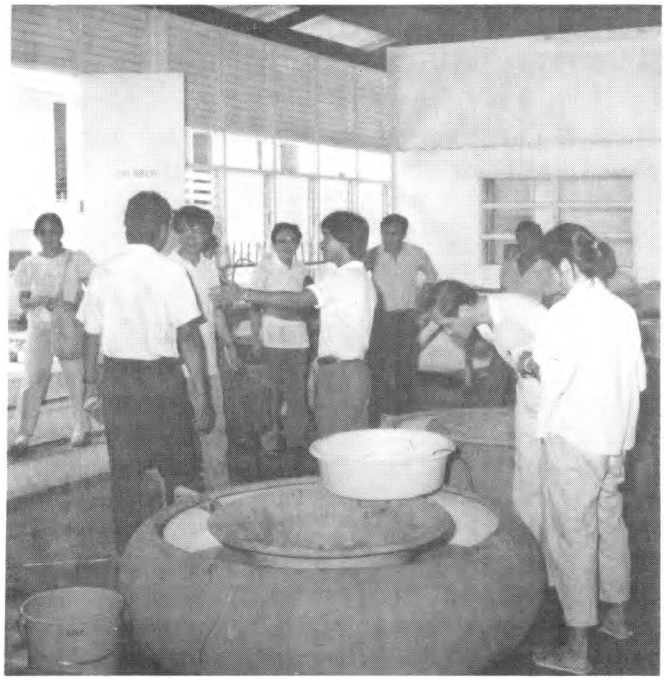
Monitoring of limnological parameters in Laguna de Bay

Experimental culture of milkfish fry to fingerlings in different types of tanks

The hydraulic characteristics of the four types of culture tanks (circular, Raceway, David's Tank, and Vertical Tank) were evaluated using the step-response method of tracer experimentation. Results showed that there is no significant difference among the different types of tanks in terms of mean residence time and dead volume. The vertical tank is significantly different from the other three types in terms of variance. Although the data (Table 7) implied that the vertical tank typifies a plug-flow type of ideal tank, it is believed that the difference in density between the tracer (saltwater) and the original water in the tank (freshwater) acting in combination with the upwelling movement of the water led to the results.

Table 7. Hydraulic characteristics of the different types of culture tanks

	Circular Tank	Raceway	David's Tank	Vertical Tank
1. Mean Residence Time (min.)				
Trial 1	35.9	39.7	39.2	37.3
2	38.9	37.6	38.8	36.9
3	39.3	38.1	35.2	39.4
4	37.7	39.5	33.4	35.1
Mean	38.0	38.7	36.6	37.2
II. Dead Volume (% of total water volume)				
Trial 1	10	1	2	7
2	3	6	3	8
3	2	5	12	1
4	6	1	17	12
Mean	5.25	3.25	8.50	7.00
II. Variance (min. ^{2})				
Trial 1	1026	977	1180	13
2	938	869	1194	12
3	943	1189	1147	16
4	994	1297	1071	11
Mean	975	1083	1148	12



Types of culture tanks

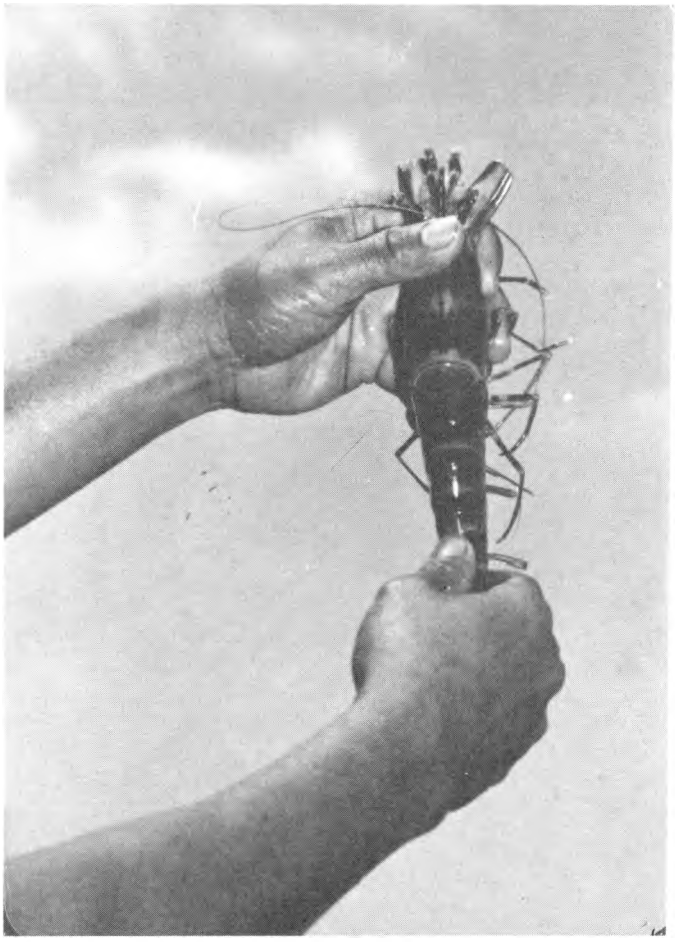
Crustacean Program

BROODSTOCK DEVELOPMENT AND SEED PRODUCTION

Monitoring of *P. monodon* wild spawners and their environmental conditions

Field surveys at Roxas, Batan, and Tigbauan areas were conducted to evaluate the different environmental conditions of the spawning grounds of the giant tiger prawn, *P.monodon.*

Preliminary results show that maturation of female *P. monodon* is mainly affected by water temperature and available food. A strong correlation was found between ratio of spawners over total females and water temperature, and between ratio of matured females over total females and benthos.



Jumbo tiger prawn, *Penaeus monodon*

Development and evaluation of prawn broodstock diets

Lipid requirement. The effects of three formulated diets on the reproductive performance and survival of pond-reared tiger prawn broodstock were tested. Diets A, B and C were formulated to contain the same 50% crude protein, but supplemented with different sources of lipids, either cod liver oil (Diet A), soybean lecithin (Diet C), or their combination (Diet B). An all-natural diet consisting of squid, mussel meat, and marine annelids served as control.

Pond-reared tiger prawn were stocked in four 12 m^3 flow-through maturation tanks at 28 females and 21 males/tank, with the females unilaterally ablated. Reproductive performance in terms of total number of spawnings, egg and nauplii production, and average hatching rate of eggs was best for Diet A, followed by Diet C (Table 8). Diet B gave the poorest over-all performance among the formulated diets, but

Table 8. Reproductive performance of pond-reared *P. monodon*

Treatment	Diet A	Diet B	Diet C	Control
Total no. of spawning	34	20	29	15
with hatching	23	8	13	5
without hatching	11	12	16	10
Nature of spawning:				
PS	20.59%	30.00%	27.59%	26.67%
CS	79.41%	70.00%	72.41%	73.33%
Total no. of eggs*	6,967,000	3,853,000	6,410,000	2,724,000
Total no. of nauplii**	2,555,000	1,068,000	1,252,000	609,000
Average hatching rate	32.69%	23.53%	27.41%	18.94%
Average no. eggs/sp	204,912	192,650	221,034	181.600
Average no. nauplii/sp	75,147	53,400	43,172	40,000
Survival rate				
Males	85.71%	85.71%	100%	47.62%
Females	60.71%	57.14%	47.14%	42.86%
Total No. of Eggs		– 19,954,000		
Total No. of Nauplii		– 5,484,000		
Average Hatching Rate		– 27.48%		

was better than the control. In the control, most of the mature females resorbed their ovaries and failed to spawn. Survival rate of control females was also lowest. These indicate the importance of lipid supplementation in formulated diets for successful reproduction of pond-reared tiger prawn broodstock.

Protein requirement. Three experiments were conducted in 1.5 t fiberglass tanks with six-month old all-female ablated tiger prawn broodstock fed artificial diets containing *Artemia* biomass, squid, and mussel meat as major protein sources. *Artemia* and mussel diets promoted spawnings of Stage II females although the eggs were unfertilized.

In the second experiment, four 8-month old unablated females and three males in a 1.5 t tank were fed diets with 20, 40, and 60% squid or shrimp meal or *Artemia* biomass as major protein sources. No spawning was obtained although gonadal maturation occurred more in the higher protein diets regardless of the source. The *Artemia* diet with 45% protein promoted growth rates comparable to the other diets with higher protein levels.

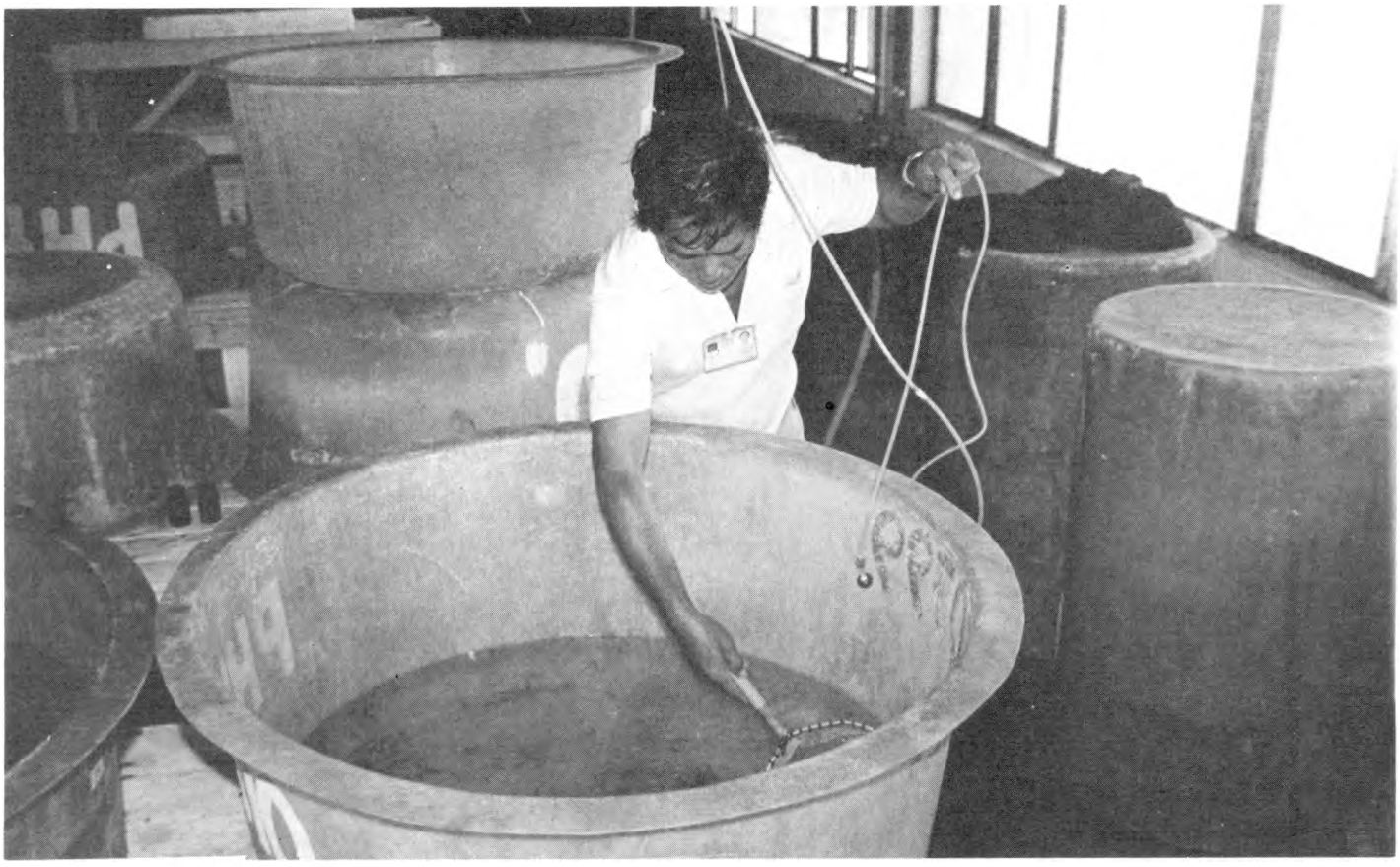
In the third experiment, the same diets were fed to six 5-month old six ablated females and three males in 1.5 t tank. Diets with at least 45% protein enhanced Stage III and Stage IV maturation. More spawnings occurred in the batch given 63% protein diet with squid as the major protein source. However, the eggs were not viable.

Evaluation of K-Carrageenan Micro-Binding Diet (C-MBD) for prawn larvae

The possibility of adopting a new feeding system using C-MBD on tiger prawn larvae was assessed. Results showed that this diet can be successfully used as long as proper environmental factors such as temperature, water quality, and salinity are maintained.

Survival rates of the larvae were not significantly affected by feeding level, feeding frequency, and particle size of the diet. Highest survival was with larvae fed four times daily at 0.64 mg/larvae/day. There was no significant difference, in growth indices among treatments.

Several types of microparticulate diets were tested and evaluated. Natural foods such as *Skeletonema* and *Artemia* served as control. Survival rates of the prawn larvae were significantly affected by the diet given. Larvae fed with natural



Prawn nurseries, TRS

food had the highest survival from Z_1 to PL_5 followed by the C-MBD diet. Larvae given a Japanese formulated diet (BP) and micro-encapsulated diet (MED) had much lower survival rates. Larvae fed locally formulated diets had survival rates ranging from 45 to 92%. The dietary value of the C-MBD diet was almost comparable to those of live feeds, *Skeletonema* and *Artemia*. Larvae fed these diets grew from Z_1 to PL_5 in 13 days.

Evaluation of micro-encapsulated diets for larval penaeids

Experimental runs using purified M-carrageenan micro-binding diets were conducted in 30-l polycarbonate tanks with temperature maintained at 29-30°C to test the effects of feeding level, feeding frequency, and particle size of feed on morphological growth and survival of tiger prawn larvae.

Results showed that survival rate of the prawn larvae was significantly affected by the size of feed particle as well as the feeding levels. No significant difference was detected on the growth and survival of the larvae fed either three or four times daily. Feeding the larvae four times daily at 0.64 mg/larvae/d showed highest survival and the shortest interval from zoea to postlarval stage. Feed acceptance seemed to be very dependent on size (53 µm) during the early zoeal stage until the mysis stage and subsequently tend to shift to bigger particles (125 and 250 µm) in the postlarval stage.

Determination of stages in molting cycle of *P. monodon*

Tiger prawn sub-adults (30-40 g) were stocked in fiber-glass aquaria. Based on the molt stages, the following molting patterns were observed:

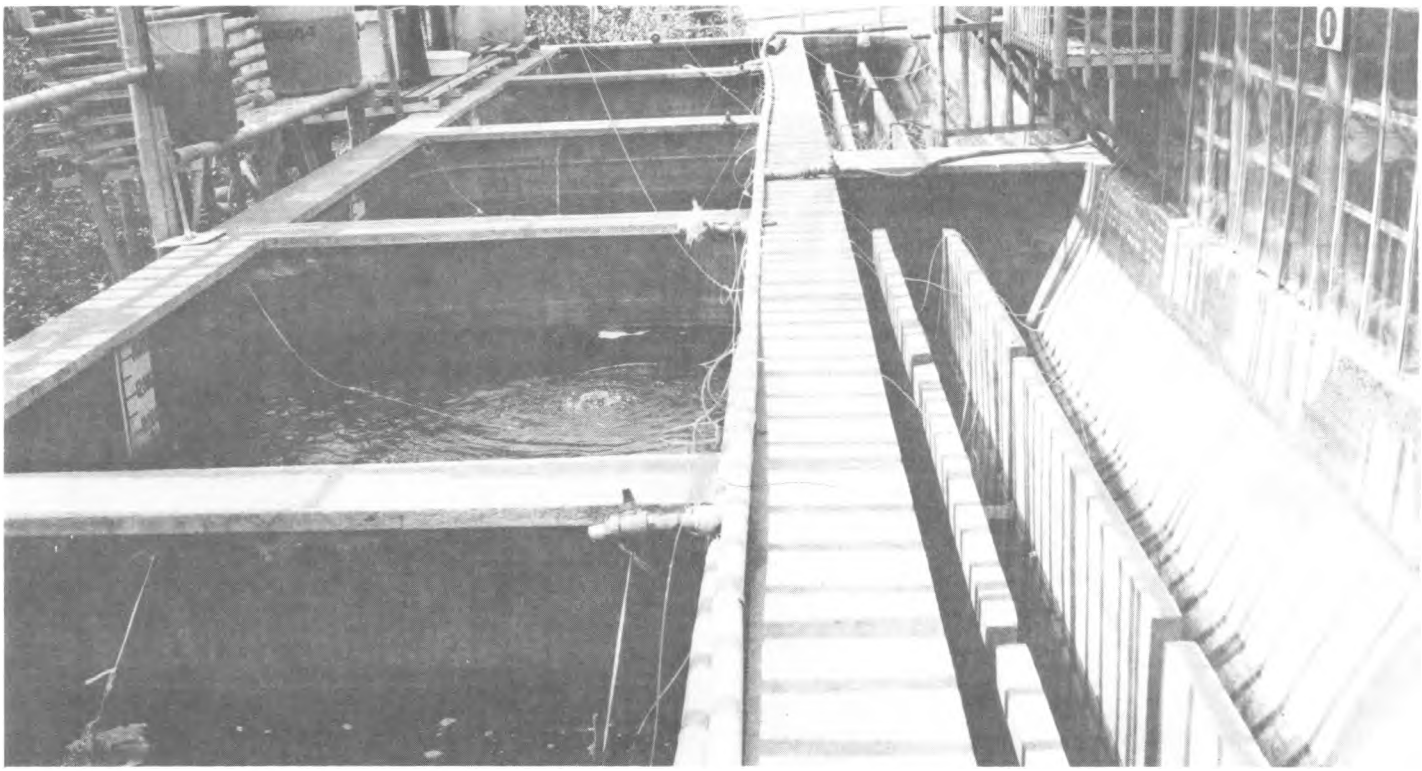
Stage	Duration	Stage	Duration
A1	0-2 h	DO′	5-7 d
A2	2-6 h	DO″	7-15 d
B1	3 h-1 d	D1′	9-17 d
C1	1.5-3 d	D2	14-17 d
C2	3-4 d	Second molting	12-18 d

Prawn fry production

About 755,000 tiger prawn fry were produced from 438 spawners at the TRS hatchery. Of these 152 were wild spawners and 286 were from broodstock maturation tanks. Average nauplii per spawner, monthly nauplii production, and survival rates are shown in Table 9. Mean survival from nauplius stage to P_{16-60} was 2.1%. This could have been higher if fry were disposed of as soon as they reach P_{15-25}.

Table 9. Nauplii production and survival rates

Month	WILD No. of spawner	WILD Ave. nauplii per spawner	BROODSTOCK No. of spawner	BROODSTOCK Ave. nauplii per spawner	Total nauplii/ month	% Survival (N^1-P_{15-60}
January	26	69 192			1 799 000	7
February	17	167 353	27	91 111	5 305 000	4
March	20	133 200	15	289 933	7 013 000	1
April	8	64 625	23	135 522	3 634 000	0
May	1	488 000	52	150 288	8 303 000	0
June	31	181 097	34	160 852	11 083 000	1
July	12	183 750	30	81 067	4 637 000	2
August	5	192 220	65	112 544	8 277 000	1
September	3	54 333	40	39 125	1 758 000	0
October	5	343000			1 715 000	0
November	7	287 857			2 015 000	4
December	18	190 055			3 421 000	4
Total	153		286		58 960 000	



One of the Department's prawn hatcheries

CRUSTACEAN CULTURE

Development and evaluation of grow-out diets for prawn

Vitamin requirements. The study determined which of the 18 diets are needed in practical diets for tiger prawn. Postlarvae weighing 2.69 g/6 pcs. were fed diets with or without vitamins, or with one vitamin excluded from the diet, for eight weeks.

Highest percentage weight gains were in those fed nicotinic acid-free diet (420%) followed by biotin-free (392%), and thiamine-free diets (Table 10). Survival rates were higher in those fed biotin-free (83.3%), para-aminobenzoic acid-free, and alpha tocopherol-free diets. Juveniles given the complete vitamin diet had only 50% survival and 177% weight gain. Those given a diet without vitamins had 50% survival and 141% weight gain. These suggest some imbalance in the amount of vitamins given as higher weight gain and survival rates were observed in some diets lacking some vitamins. Feed conversion was better in diets which were thiamine free, niacin free, biotin free than those with no vitamins or complete vitamin diets.

Lipid requirement. Eighteen semi-purified diets containing either of the six lipid sources (CLO, SBO, BT, CCO, CO and PL) at 4%, 8%, or 12% level, and a control diet (without lipid) were fed to *P. monodon* juvenile with weights ranging from 0.24 to 1.00 g. Feed was given twice daily at 10% to 16% of the body weight and adjusted after sampling on day 14. Feed period was 28 days. Best growth rate was obtained in the treatment containing cod liver oil (CLO) at 12%. The second best sources were soybean oil (SBO), pork lard (PL) and corn oil (CO) at higher levels. The poorest sources were coconut oil (CCO) and beef tallow (BT). The n-3 fatty acid rich lipid source indicated to be better in promoting growth than those containing 6 n-6 fatty acid lipid sources.

Amino acid patterns and requirements of *P. monodon*

Tiger prawn postlarvae weighing around 120 mg were reared in one-liter jars (10 jars in 60-1 water bath) for 28 d and given semi-purified moist diets. Salinity and temperature ranged from 27 to 32 ppt and 26 to 28.9^{o}C, respectively.

Percentage mean weight gain and survival were not significantly different. However, trends indicate that some amino acids are more critical in the diets than others. Animals given phynylalanine-free, leucine-free, and methionine-free diets gained more weight in four weeks than those fed the complete amino acid diets. Those fed the diet containing all the amino acids gained by 340%.

Table 10. Percentage survival, weight gain, and feed conversion of *P. monodon* juveniles fed various kinds of diets, with or without vitamins

Treatments No./ Diets	% Survival	% Wt. Gain	Feed Conversion
Thiamine free	67	321.2	10.0
Riboflavin free	55	284.0	13.5
Pyridoxine free	67	178.4	17.8
Nicotinic acid free	45	420.1	8.4
Pantothenic acid free	50	254.2	18.4
Inositol free	78	235.4	12.2
Biotin free	83	392.6	8.2
Folic acid free	72	277.0	10.8
Para aminobenzoic acid free	83	251.2	18.9
Choline achloride free	50	203.0	18.8
Ascorbic acid free	61	180.8	16.0
α-tocopherol free	83	241.4	10.9
Menadione free	50	197.5	16.0
Carotene free	56	268.4	11.0
Ergosterol free	67	167.1	14.2
Cyanocobalamine free	67	203.6	16.2
No vitamins	50	141.1	18.6
Complete vitamins	50	177.8	15.6

Postlarvae fed isoleucine-free and tryptophan-free diets also gained weight. A low weight gain of 289% was observed in animals fed arginine-free diet, followed by those free of histidine, lysine, threonine, and valine.

Survival rates were 60% for prawns given threonine-free and isoleucine-free diet, and 70% for histidine-free and complete amino acid diets. This close similarity suggests that if amino acids were not present in the diet, they may have been obtained from other sources.

Improvement of the nutritional values of various phytoplankton species by media enrichment

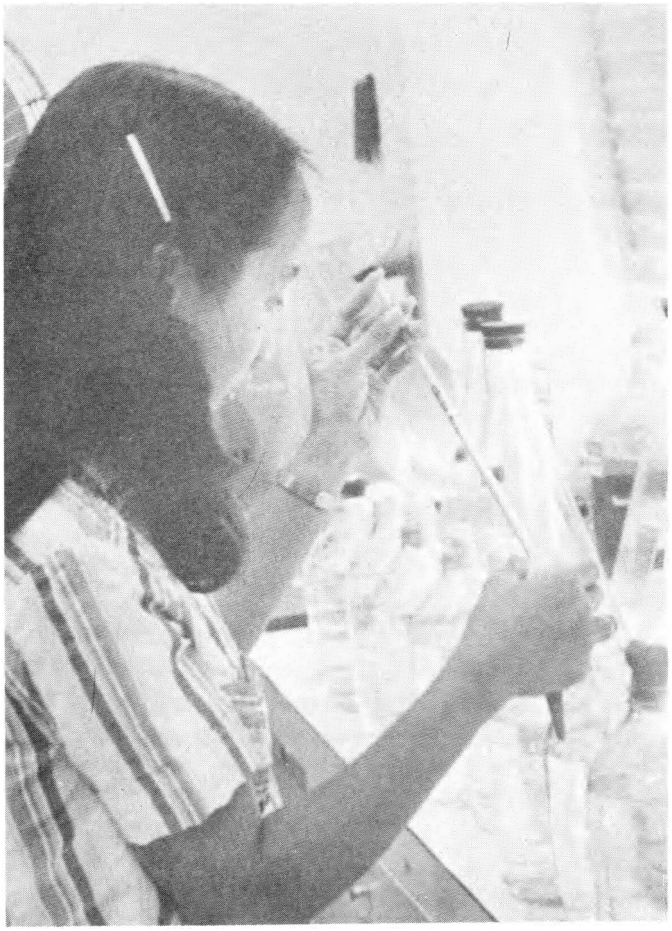
Various inorganic media formulations used for stock and mass production of algae were tested for their effects on the growth and nutrient composition of *Chaetoceros calcitrans, Skeletonema costatum, Tetraselmis chuii, Isochrysis galbana, Chlorella vulgaria,* and *C. vulgaris,* Results indicate that the media components affect growth in terms of cell count and chemical composition of the resulting algal cells.

Assimilation rates of the various phytoplankton species by tiger prawn zoea were determined using ^{14}C. *I. galbana* gave the highest rate followed by the diatoms *C. calcitrans* and *S. costatum,* and by *T. chuii.* Lowest rates were those for *C. virginica* and *C. vulgaris.*

The effects of these phytoplankton on the growth and survival of tiger prawn larvae, zoea, and mysis stages were compared. Nauplii (N_6) were fed the six algal diets singly. Results showed that only *C. calcitrans, S. costatum, I. galbana,* and *T. chuii* could support development up to mysis stage M_1. When the same test was done on M_1 larvae, results show that all six species could support growth to postlarval stage P_1.

Zoea fed *C. calcitrans* had a survival rate of 75%, followed by those given *T. chuii* (51%), *I. galbana* (49%), and *S. costatum* (23%); lowest rates were for *C. vulgaris* (3%) and *C. virginica* (1%).

Mysis fed *S. costatum* and *T. chuii* developed into P_1 one day earlier than those fed other algal species. There was no significant difference in the survival rates among treatments although *T. chuii, S. costatum,* and *C. calcitrans,* gave higher survival rates of 72, 66, and 65%, respectively.



Preparation and fertilization of sea water for phytoplankton cultures.

Investigation of soft-shelling among penaeids from grow-out ponds

Normal hard-shelled prawns (*P. monodon*) were individually exposed to various concentrations of Gusathion A in 8-1 aquaria in a static bioassay procedure. Shell quality and survival were monitored for 96 h. Prawns were preserved for possible pesticide residue analysis. The same procedure was applied to Brestan.

Histochemical analysis showed a significantly higher calcium content in the hepatopancreas of hard-shelled prawns than in soft-shelled prawns. The calcium content in the exoskeleton of hard-shelled prawns was likewise slightly but not significantly higher.

Histological examination of the exoskeleton revealed significantly thicker exocuticular and endocuticular layers in the hard shell, while the epicuticle and the epidermis of the hard and soft shell did not vary significantly.

Experimental feeding runs to study the role of various calcium and phosphorus ratios were conducted. Analysis of the data is in progress.

Extensive prawn culture

Two stocking densities of tiger prawn were tested in twelve 1000 m^2 earthen ponds with different fertilizer combinations: I – 3500 pcs with 1-t chicken manure + chemical fertilizer I (30 kg N + 15 kg P); II – 700 pcs with 1-t chicken manure + fertilizer (1) III – 3500 pcs with 1-t chicken manure + chemical fertilizer 2 (15 kg N + 30 kg P); and IV – 7000 pcs with 1-t chicken manure + chemical fertilizer 2.

Survival among treatments did not differ significantly. Highest mean survival was in treatment III with 97% followed by IV 96%, I with 89%, and II with 75%. Results showed that stocking density and fertilizers affected growth and gross production. Highest mean body weight was in treatment II (35.3 g), followed by I (30.5 g), IV (28.6 g), and lowest in II (16.1 g).

Highest mean gross production was in treatment IV (193 g kg/ha), followed by III (119 kg/ha), I (98 kg/ha), and II (82 kg/ha).

Sampling of prawns from ponds

ARTEMIA

Pilot scale production of Artemia cysts and biomass in ponds

Locally produced cysts harvested in 1983 were stored in the refrigerator at -4°C and the quality evaluated using the standard hatching efficiency criteria. Results showed a decrease in quality with refrigeration (Table 11), which nevertheless is still higher compared to most commercially available *Artemia* cysts.

A trial run feeding pre-adult and adult *Artemia* (1-5 mm) to 1-2 cm seabass fry was successful. Further trials will be conducted on size preference and feeding levels.

Integration of *Artemia* and salt production with milkfish/ prawn culture

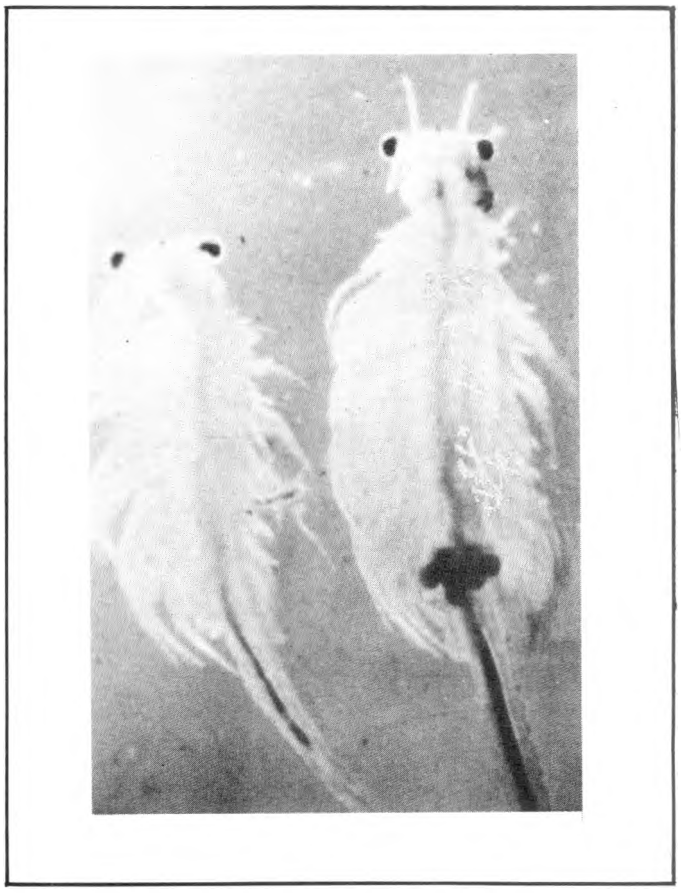
Artemia and salt production was undertaken from January to June (dry season), and milkfish culture from July to December (rainy season). A total of 142.3 kg (wet weight) of *Artemia* biomass was harvested and used as feed for seabass and prawn. Cysts were found floating in the *Artemia* ponds during the later weeks of June.However, foam formed at the windward corner of the pond, and the cysts were accummulated and trapped there. Strong winds blew the foam with the cysts of the pond, making collection impossible. About 202 sacks of salt (weighing 50 kg each) were harvested from a 1.9 ha pond. Total milkfish harvested from 3.9 ha of grow-out ponds after 90-day culture period was 1.3 t.

In a related verification study, a new commercial system integrating *Artemia*-salt-finfish-prawn-shrimp production with existing agriculture activities was developed at the Sycip Plantation saltfarm in Manjuyod, Negros Oriental. Use of costly, imported inorganic fertilizers was eliminated by connecting the pond system to poultry and cattle-fattening sheds, and by culture of seabass in reservoirs and canals supplying the *Artemia* ponds.

Whole-year *Artemia* pond production was made possible with the use of overflow devices for freshwater runoff. During summer, blooms of *Tetraselmis* in highly saline evaporation ponds was enhanced by operation of the flow-through system. After the salt season, a combined *lab-lab-Artemia* kitchen pond allowed daily harvests of 0.5-3.0 t wet *lab-lab* and 0.2-20.0 kg wet *Artemia*. Harvested lab-lab and *Artemia* also provided nutritious food sources for poultry, prawns, and milkfish.

Table 11. Quality evaluation of locally produced *Artemia* cysts.

Date of harvest	Hatching Efficiency (H. E.) 1985 24 Hrs.	1985 48 Hrs.	1984 24 Hrs.	1984 48 Hrs.
21-27 Apr 1983	5.71	6.58	3.41	3.34
05-11 May 1983	9.80	16.26	3.61	3.78
17 Aug 1983	5.43	9.71	4.37	4.59
25 Jun-01 Jul 1983	5.40	8.89	3.26	
11 May 1983	3.44	3.32	2.98	3.32
20 July-04 Aug 1983	4.18	3.65	4.70	3.38
20 Mar-08 Apr 1983	12.27	12.82	5.26	4.19
01-23 Jul 1983	3.68	5.65	4.14	4.98
19-31 Jul 1983	5.73	11.05	3.83	3.54
15 Aug 1983	5.25	8.89	4.21	4.35
15 Aug 1983	5.37	8.89	3.72	3.68
26 Feb 1983				
23 Apr-26 May 1983	7.14	6.41	4.76	4.92
17 Aug 1983	5.17	7.04	4.08	4.32
18-24 Jun 1983	7.63	24.69	5.25	7.18
10 Aug 1983	5.33	4.57	3.39	1.10
07-20 May 1983	9.23	32.26	11.79	8.90
08 May 1983	5.97	8.93	3.09	3.10
09 Aug 1983	5.88	9.22	3.57	3.90
01-31 Jul 1983	9.30	14.70	4.91	4.92
05-31 Jul 1983	6.78	10.58	5.19	5.34
25-27 Apr 1983	4.67	14.60	3.41	3.34
12-25 Mar 1983	4.60	17.39	5.60	7.08
22 Mar-06 May 1983	4.53	5.10	4.45	4.02



Male (left) and female cyst-bearing *Artemia* produced in earthen ponds.

Molluscs and Seaweed Program

Pathogenic bacteria authochthonous on three phytoplankton species used as feed for shrimp and oyster larvae

Potentially pathogenic and pathogenic bacteria associated with *Spirulina platensis, Tetraselmis chuii,* and *Isochrysis galbana* were identified.

The 48 bacterial strains isolated from growing cultures of *Spirulina* were fully characterized physiologically, biochemically, and morphologically. A total of 251 tests were completed. Strains will be clustered for further analysis.

Thirty-three strains were isolated and characterized from growing cultures of *Tetraselmis:* 263 tests were completed. Bacterial load associated with *Spirulina* cultures over a 7 day period was quantified. The growth curve of the developing bacterial population will be correlated with that of the alga.

The association between the bacterial and the three algal species were examined by electron microscopy. Bacteria attached to the walls of *Spirulina* and on the pellicle of *Tetraselmis,* but not on the pellicle of *Isochrysis.*

Preliminary pathogenecity tests on 25 isolates, mostly *Vibrio,* showed that seven isolates effected killing rates ranging from 28 to 100%. When subjected to further tests, seven isolates were pathogenic under high density. Four isolates were non-pathogenic in salinities of 28-31 ppt. TC-15, a true *Vibrio,* was most pathogenic at salinities of 15-25 ppt.

Detection and quantification of pathogenic bacteria in oysters before and after depuration

A grossly contaminated batch of oysters was depurated to an acceptable level within 48 h in all portions of the 4 x 8 m tank used, except at an area near the center. The FC level of MPN 490/100 g meat near the tank center suggests a dead or indifferent spot or volume. After 72 hr, the residual MPN ranged from 78-92/100 g meat, and 18-45/100 g meat after 96 h. Maximum reduction of the coliform load occurred during the first 24 h, where 99-100% of the total initial microbial load was depurated. Removal at 25-48 h ranged from 69% at the center to 93% at the outflow area.

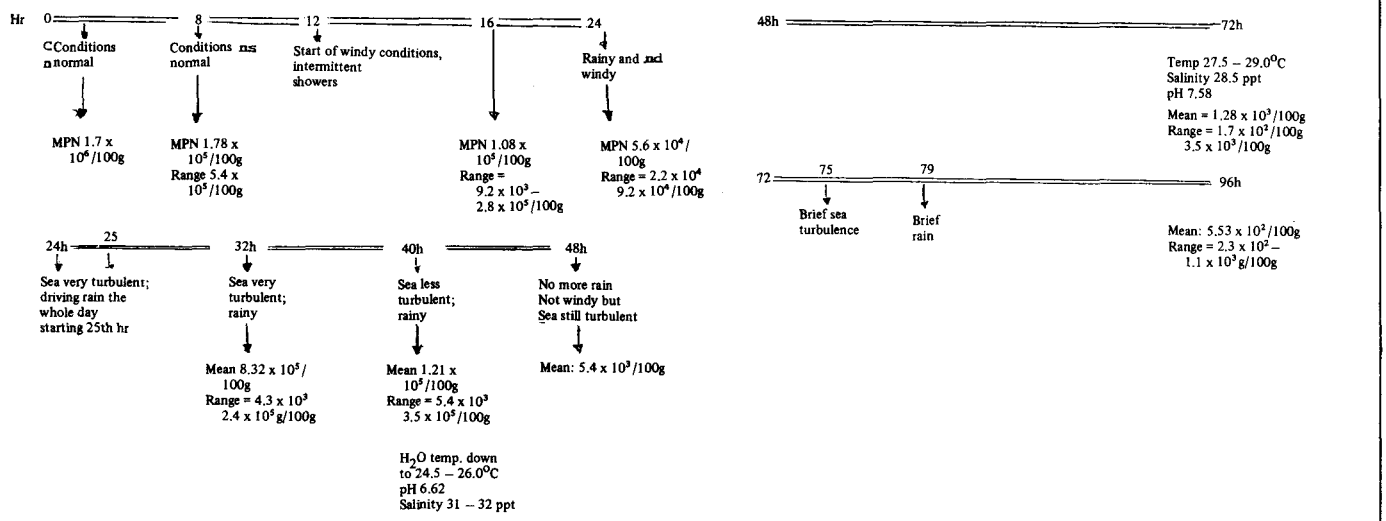
Another depuration run was made to coincide with the arrival of a typhoon in Iloilo and adjacent areas. The following sequence characterized the cleansing action on the oysters (Fig. 2).

The quantity and variability of *Vibrio* in the initial bacteriological flora of undepurated oysters was investigated. Of 100 strains of presumptive *Vibrio* picked during the second run, only 13 turned out to be true *Vibrio.* The *Vibrio*, load after depuration was studied. Out of 57 strains, only one was a true *Vibrio.*

Four attempts were also made to isolate *Salmonella.* However, no strain was observed even though well-known and effective methods were used.

Depuration of oysters, TRS

Fig. 2. Cleansing action on oysters.



Microbiology of spoilage in cold-stored oysters and mussels

Change in the microbial load of oysters, *Crassostrea iredalei,* during cold storage was determined. Oysters on shellstock were stored at room temperature (24°C), chilled (4.°C), under blanket of ice (4°C), and frozen (-25°C) up to time of spoilage. Processed (shucked and chlorinated at 150 ppm for 5 min, then packed in sterile glass jars) oysters were also stored at the same temperature as oysters on shellstock, except the frozen samples which were stored at -15°C.

Total aerobic plate counts (in CFU/g=colony forming units/g) for oysters stored at room temperature, chilled, or iced increased by 2-3 log cycles during storage. Counts for frozen oysters increased by 1 log (processed) or decreased by 2 logs (on shellstock). Mold and yeast counts (CFU/g) or all treatments decreased during cold storage. The predominant organism isolated at the end of the storage period was yeast.

Total and fecal coliform counts (in MPN/g = most probable number/g) decreased progressively for almost all treatments. Presumption counts for *Staphylococcus aureus* either decreased, for frozen samples, or increased by 1-3 log cycles. Confirmation of typical *S. aureus* isolates by the coagulase test showed that the organisms are not pathogenic.

Analyses for the presence of other organisms revealed that *Shigella, Salmonella, Vibrio cholerae, Vibrio parahemolyticus,* and Lactose + vibrios were present in very low undetectable levels. Hazards or risks associated with these organisms may be considered minimal.

Bacterial typing of randomly picked colonies were made every four days. *Coryneforms, Pseudomonas,* and *Enterobacteria* were predominantly identified. Other organisms were *Aeromonas, Bacillus, Micrococcus, Staphylococcus, Vibrio, Acinetobacter/Moraxella,* and *Flavobacterium.*

Total volatile nitrogen and trimethylamine, both chemical indicators for freshness or spoilage, were also determined during each sampling.

Shelf life of oysters was only 2 d when stored at room temperature 12-14 d for iced, 26-28 d for chilled and up to 64 d for frozen samples.

Mass production and on-site settlement of hatchery-reared molluscs

The Asian moon scallop *Amusium pleuronectes* was successfully spawned and the eggs reared through all larval stages to settlement.

Ripe scallops obtained from a local trawler were kept in cold seawater for 2-3 d before they were induced to spawn. The scallops were subjected to the following stimuli: temperature and salinity fluctuations, irradiated seawater, algal concentrations of 1 million cells/ml, and hydrogen peroxide. Hydrogen peroxide effectively induced spawning.

Fertilized eggs were stocked in a 750-l tank to develop into shelled larvae. After 48 h, D-veliger larvae were recovered and stocked at 5/ml in 320-l cylindrical fiberglass tanks. Larvae were fed *Isochrysis* during the first week, and a mixture of *Isochrysis* and *Chaetoceros* later.

Amusium eggs averaged 60 μm in diameter, while newly-developed D-veligers were typically 107 μm long and 83 μm high. At lengths of 145 μm and beyond, larvae were mostly at the umbo-veliger stage. The umbo of *Amusium* larvae was low, broad, and not prominent with the larval shell equivalve. Pediveliger stage larvae averaged 170 μm in length and alternate between swimming and crawling. Starting on the 13th d after spawning, pediveliger larvae attached byssally to sides and bottom of glass, plexiglass, and fiberglass containers.

Scallop spats remained byssally attached until they reached an average shell diameter of 5 mm. Juvenile scallops exhibited characteristic jet-propulsion movements as early as 1 mm size.

More trials will be conducted to develop more reliable methods of induced spawning. Although hydrogen peroxide was relatively effective in eliciting spawning response, latency period of up to 8 h was generally too long. Hydrogen peroxide is also harmful to both eggs and adults. Serotonin, a substance increasingly used for prawn, bivalve as well as univalve molluscs, will be tested.

Development of culture techniques of Porphyra marcosii

Adult laver, *Porphyra thalli* were collected from Burgos, Ilocos Norte in January and brought to TRS. All thalli were kept at the Phycology Laboratory in slightly aerated culture flasks. The following week, liberation of monospores from the tips of the mature thalli was induced by providing strong aeration to the culture vessels.

The liberated monospores were kept in a free-living state and later developed into free-living conchocelis. The free-living conchocelis have been propagated.

Research Seminars

Date	Title	Speaker
March 3	Sperm preservation of Tilapia, *Oreochromis mossambicus* (cryopreservation and chilling)	C. Duenas
March 7	State-of-the-art of feed development	A. Tacon*
March 7-8	Fish farming in Singapore	L. Landesman*
March 10	Interaction between dietary electrolyte and basic amino acid in rainbow trout	Y. Chiu*
March 21	The use of conventional and unconventional protein sources in practical fish diets.	A. Tacon*
March 27	Design in fish cages	V. Traviña
April 17	Testing linear relation among treatment means in multiple analysis of dovariance	M. de Ramos
April 25	Culture of *Porphyra yezoensis* in Ariake Kai, Sega Prefecture, Japan	L. Ver

April 26	Fish production: evolution of LHRH	N. Sherwood*
May 15	Biology and culture of seabass, *Lates calcarifer*	P. Kungvankij
May 24	Finfish seedling mass production, centers in Japan: the flatfish *hirame (Paralichtys olivaceus)* and microcapsulated diets for fish larvae	H. Gigaroff*
May 29	ASEAN workshop on red tide and mussel toxicity	A. Llobrera R. Gacutan
June 5	The role of iron in *Vibrio anguillarum* infection	E. Cruz
June 19	Scale-up studies on the culture of brine shrimp *(Artemia)* fed with rice bran	R. Platon
July 3	Experimental designs and their analysis	M. de Ramos
July 24	In-vitro study of the mechanism of estradiol-17B production in the ovarian follicle of goldfish	J. Tan
August 15	Involvement of the urea cycle in arginine formation in rainbow trout	Y. Chiu*
August 28	Training experience	R. Duramdez
October 16	The use of osmotic pump in the induced spawning of seabass, *Lates calcarifer*	J. Nacario
November 6	Larval fish morphology and identification The larval and juvenile fish community in Pandan Bay, a milkfish fry collection ground	T. Bagarinao
November 20	Single fat sources for *Chanos chanos* fingerlings	V. Alava
November 27	Bacteria associated with infection at hormone implantation sites among *Chanos chanos* adults Immuno-response in tilapia, *Sarotherodon niloticus,* vaccinated with *Edwardsiella tarda* by hyper-osmotic infiltration method	G. Lio-Po
November 28-29	Advances in *Artemia* culture: Belgium experience	J. Canto, Jr.
December 4	Genetic analysis of induced gynogetic diploids and triploids in tilapia, *Oreochromis niloticus* and *O. aureus*	R. Romana

* Department guests

TRAINING AND EXTENSION

The year saw continued advancements in AQD's various training and extension activities. Funding support from some international agencies, notably IDRC and FAO/UNDP, indicated continuing trust in the Department's research and training capabilities.

A total of 643.7 man-months training was offered by the Department, involving 1,013 individuals from the Philippines and 19 other countries. AQD also continued to undertake technology verification projects on some technologies identified for packaging and dissemination. Information dissemination programs were expanded to involve not only the print media, but broadcast media as well.

Training

A total of 274.5 man-months training involving ten short-term technician courses, one long-term training course, an in-house training program for the government and the private sector, and practicum training program for graduating students were conducted during the year. A total of 261 individuals from 19 countries attended the various courses.

Trainees sampling prawn fry

Small-scale Prawn Hatchery Management/Operations

This eight-week training course on seed production of prawn was conducted on 11 March-3 May with 19 trainees coming from six regions in the Philippines and one coming from Nigeria. Another session was conducted for 20 participants coming from 10 countries, namely, Ecuador, Nigeria, Belize, China, Saudi Arabia, Palau, Malaysia, Thailand, Indonesia, and the Philippines last 3 September-25 October.

Marine Finfish Hatchery

This first international course on hatchery operations for marine finfishes was conducted on 6 May-28 June at TRS and Igang Substation. Of the 12 participants, 7 were from the Bureau of Fisheries and Aquatic Resources – National Bangus Breeding Project (BFAR-NBBP) stations, 2 from Iloilo State College of Fisheries and Pasacao School of Fisheries, and 3 from Saudi Arabia, Malaysia, and Brunei. The course taught techniques in seed production for milkfish, siganids, and seabass.

Brackishwater Pond Culture

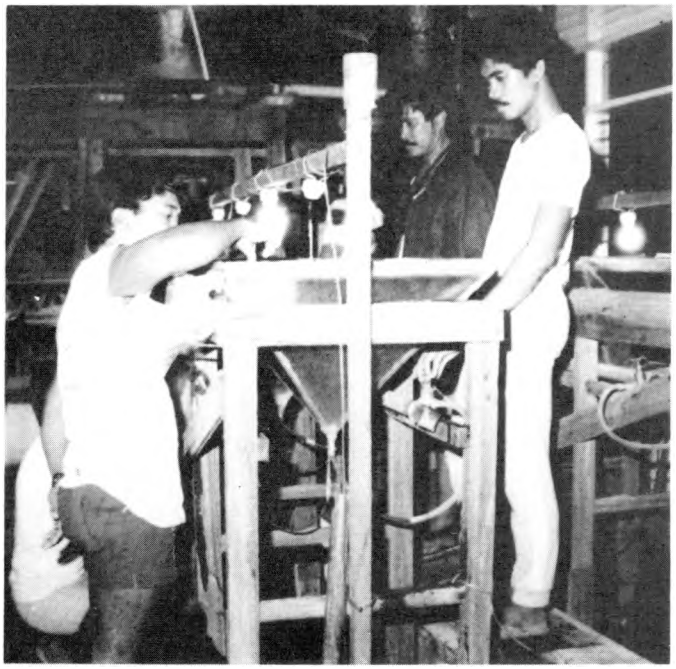
The national level course for 11 trainees was conducted from 6 May to 11 June. Eighteen trainees from Sri Lanka, Saudi Arabia, Kiribati, Belize, India, Malaysia, Indonesia, and the Philippines attended the international session held on 6 August-14 September at LRS.

A post-training tour was conducted to give opportunities to trainees to observe operations at a *Caulerpa* pond and a *Eucheuma* processing plant in Cebu City, the Siliman University, Marine Laboratory in Dumaguete City, and the Integrated Artemia Project in Manjuyod, Negros Oriental. The trainees also visited BRS and the International Center for Living Aquatic Resources Management (ICLARM).

Freshwater Aquaculture

Thirteen participants completed this international course held on 2-27 September at BRS. The participants were from Sri Lanka, Nigeria, Sweden, Indonesia, Thailand, and the Philippines. The course covered basic techniques and skills in freshwater fish production, operation, and management.

Participants in 1985 AQUAFRESH training.



Trainees observing newly-hatched carp eggs

Fishfarm Engineering

Twenty-four BFAR extension workers involved in the BFAR-ADB Aquaculture Development Project joined the third session held at LRS on 14 October-14 November. The course aims to apply basic concepts, principles, and procedures of engineering to fish development and operation.

Induced Spawning and Seed Production of Carps

Nine fishfarmers from Rizal and Laguna Province attended the nine day training on induced spawing and seed production of carps at BRS on 13-22 November. The trainees conducted two spawning runs and practical exercises on larval rearing, live feed production, artificial feed preparation, and transport of fingerlings.

Depuration and Hatchery Techniques for Tropical Bivalves

Five trainees sponsored by IDRC completed the course which ran from 4 November to 13 December at TRS. The participants were from Thailand, Sri Lanka, Malaysia, and the Philippines. Topics discussed were hatchery, depuration, transport and marketing of mussels, oysters, and other shellfish.

A post-training tour was held in selected mollusc farms in Cebu and Samar, and the PHDRC depuration plant in Dagupan City.

Aquaculture Course for Social Scientists

This first training course for social scientists, specially economists, appraised the participants of the basic principles, concepts, and practices in aquaculture. Fourteen trainees from Thailand, Indonesia, Malaysia, and the Philippines completed the one-month course held from 20 November to 19 December. A post-training tour was conducted at ICLARM, University of the Philippines at Los Banos (UPLB), Central Luzon State University (CLSU) and BRS.

Trainees constructing ponds

Training Course for Senior Aquaculturists in Asia and the Pacific Region

This one-year training course was conducted by the Network of Aquaculture Centres in Asia (NACA), the University of the Philippines in the Visayas (UPV) and SEAFDEC AQD. The 22 participants of the fifth session (March 1985-1986) underwent an intensive series of lectures and practical work on various aquaculture activities. The trainees also went on a study tour to observe and participate in various aquaculture practices involving different aquatic species at NACA lead centers in Thailand, India, and China on 12 July-18 September. During the last quarter, they also visited aquaculture and hatchery farms in Panay Island, and observed post-harvest and seaweed culture systems in Cebu and Bohol.

In-house Training Program

A total of 36 private individuals and government employees from the Philippines, Saudi Arabia, India, Japan, Sri Lanka, and the USA availed of various short-term special training offered by the Department in its various stations and substations. The training which lasted from one week to five months, dealt with prawn broodstock development and maturation, prawn/finfish hatchery, nutrition, natural food and pond culture.

Student Practicum

Seventy-nine graduating college students from various fishery schools in the country worked in different research projects at the Department's three main stations. Participating schools were Mindanao State University, Agro-Industrial Foundation College of the Philippines, Daniel Z. Romualdez Memorial School, Tario-Lim Memorial School, Don Mariano Marcos Memorial State University, Cagayan State University, CLSU, Pasacao School of Fisheries, UPV, Bicol University, and Negros Occidental School of Fisheries.

NACA 1985-1986 Trainees

Technology Verification

The Department continued its Technology Verification program in collaboration with various government institutions and the private sector.

Field-testing of modified extensive prawn culture and seabass/tilapia polyculture was conducted at the four BFAR Demonstration and Training Centers (DTC's) in Pagbilao, Quezon: Paombong/Hagonoy, Bulacan; Calape, Bohol; and Lala, Lanao del Norte. In April-May, some 15,000 prawn fry were transported to each DTC. Another shipment of 10,000 to 18,000 was done during the last quarter. Minimal mortality was observed in this shipment.

Verification projects on extensive prawn culture were also done in selected BFAR regional demonstration farms in Sorsogon, Leyte, Antique, Iloilo, Ozamis City, and Butuan. Some 3,020 prawn fry were stocked at the Sorgoson farm site in April. Total harvest in early September was 86.38 kg. Of some 2,000 fry stocked in March at the BFAR Masao farm site in Butuan, 60 kg or 1,934 pcs. were recovered in June. In Ozamis City, out of 1,625 fry stocked in March, 926 pcs were harvested in June with an average weight of 41.79 g and an average length of 28.2 cm.

Another SEAFDEC-BFAR project on seed banking (nursery) of prawn, siganid, seabass, and grouper was implemented at the Molo, Iloilo City demonstration farm. During the last quarter, some 8,000 prawn fry were stocked in a 0.55 ha pond.

Verification studies on freshwater species were also conducted as a follow-up of the 1984 field testing of carp with tilapia culture. The project, which included polyculture of bighead carp, common carp, and tilapia in selected cages in Laguna Lake, was undertaken by the Laguna Lake Development Authority (LLDA), Farm Systems Development Corporation (FSDC), BFAR, and SEAFDEC AQD. Eight private cooperators from Laguna Bay, who participated in the project, provided the specified culture cages and purchased bighead carp fingerlings from BRS and tilapia fingerlings from the Bay Freshwater Project at reduced prices. Stocking density was 16 fish/m^2 ; for polyculture – 10 tilapia:6 carp. After a six-month culture period, bighead carps showed a wide range of growth increment at the different farm sites ranging from 187 to 1,015 g, while tilapia showed low weight gains in both polyculture and monoculture systems.

Phase 2 of the polyculture demonstration project under the United Neighborhood for Livelihood and Development (UNLAD) Program undertaken by LLDA/FSDC, BFAR, and SEAFDEC AQD was started with 10 cooperators from the Bay area in Laguna. The project, terminated in November, showed promising growth increment of bighead carp and common carps in polyculture with tilapia. However, common carp was not suitable for culture in net cages that do not touch the lake bottom.

The verification project on *Artemia* production, started in 1983, at the 18.8 ha salt ponds at Sycip Plantation, Inc. in Manjuyod, Negros Oriental was completed during the year. Techniques in brine shrimp culture including processing, utilization, pond inoculation, and packaging of *Artemia* cysts and biomass harvest were developed.

Extension

Ten in-situ seminars were conducted in Metro Manila and various regions of the country in collaboration with BFAR, local fishfarmers associations, and the private sector.

Agri-business Opportunities in Freshwater Aquaculture
Manila Mandarin Hotel, Makati
25-27 January

Sixteen participants, mostly from the business community, were appraised of the current advances in freshwater aquaculture and were encouraged to expand culture techniques for freshwater species in the country. Field trips were also conducted to selected farms and hatcheries in Rizal and BRS.

Brackishwater and Freshwater Aquaculture
San Fernando, Pampanga
28-29 March

The 22 participants were co-sponsored by the Pampanga Fishpond Operators Association, BFAR Region III, and SEAFDEC AQD. Topics focused on general principles of aquaculture, prawn and milkfish culture, tilapia production in cages and pens, gourami farming, artificial propagation of Chinese carps, and integrated agriculture-aquaculture systems.

Freshwater Aquaculture
Bay, Laguna
3 May

Fifty fishfarmers attended this one-day seminar conducted by BRS for tilapia fishpond operators.

Brackishwater Pond Culture
Leyte and Cebu
22-24 August and 12-14 September

Twenty-five participants attended the seminar held in Tacloban City, Leyte, 22-24 August, in collaboration with BFAR Region IV and the Leyte Fishpond Operators Association. Two other seminars on the same topic were held in Cebu City, 12-14 September with 38 participants sponsored by the Cebu Fish Producers Association, and at the Sycip Plantation in Manjuyod, Negros Oriental, 14-16 October with 50 fishfarmers.

Available Aquaculture Technologies
PHILCITE, Manila
10-14 April

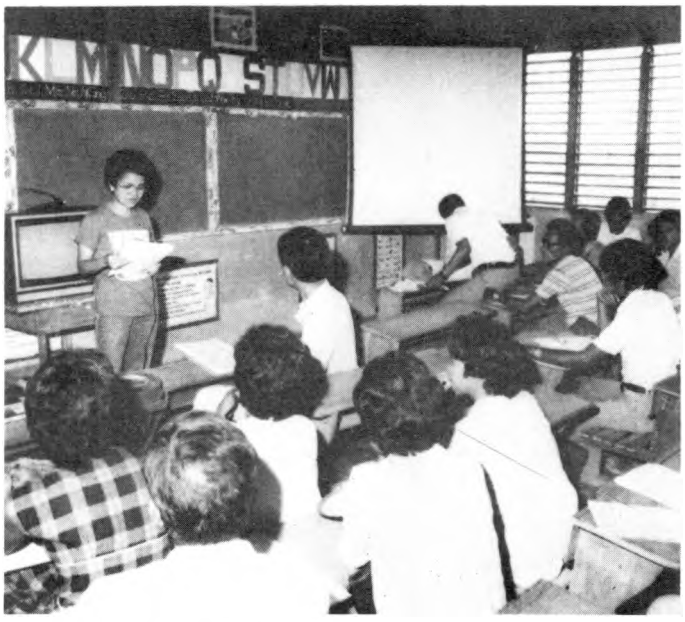
Conducted as a feature of AQUATECH '85 Exhibits, 250 participants attended the different sessions which also served as aquaculture clinics.

Prawn Culture in Ponds
Manila Garden Hotel, Makati
19-20 August

Twenty seven participants, mostly from the business community, attended the two-day seminar on prawn culture systems and operations.

Freshwater Aquaculture
Natividad, Pangasinan
6-7 November

Attended by 50 participants, the seminar focused on tilapia, carp, and snail culture systems. This was conducted in collaboration with the BFAR regional office and the local fishfarmers association.



In-situ **training in Bay, Laguna**

Trainees in pond culture

Prawn and Milkfish Fishpond Management
Dagupan City
7-8 December

Conducted upon the request of the Dagupan Jaycees, the seminar touched on the potentials of the prawn and the milkfish industry, and the various aspects of milkfish and prawn monoculture and polyculture systems. Twenty-four fishfarmers joined the sessions.

Consultative Meetings

Four quarterly consultative meetings were held between SEAFDEC AQD, the Iloilo Fish Producers Association, and BFAR with a total of 151 participants. As an offshort of meetings, a collaborative verification project on extensive and semi-intensive prawn culture was conducted in selected grow-out ponds at LRS. SEAFDEC and BFAR experts undertook pond preparation, stocking, soil and water analyses, natural food production, feeds and feeding system, and monitoring of growth rates.

After a four-month culture period, harvest from the semi-intensive prawn culture was 843.35 kg/ha. This demonstrated the technical and financial viability of prawn culture at a nominal (+10%) stocking rate of 25,000 fry/ha with supplemental feeding of commercial pellet and trash fish added to the natural food in the pond. Average weight was 31.42 g (32 pcs/kilo) with an estimated survival of 97.6%. The overall results indicate that 2.1 tons can be realized from one hectare with 2.5 croppings/year.

Assessment

Social Laboratory

Early in 1985 a baseline study was conducted on the feasibility of aquaculture as a viable economic entry point for rural development. A social laboratory of tilapia/carp pen culture in irrigation canals was established in June in Barrio Cauayan, Pototan, Iloilo. Undertaken by SEAFDEC AQD, Ministry of Human Settlements, and the National Irrigation Authority (NIA), this joint project had 21 cooperators. Envisioned to serve as a model in rural development and to teach tilapia and carp culture in irrigation canals, the project was discontinued during the last quarter as NIA could not assure a continued water supply for a one-year culture period.

The establishment of another social laboratory in two small freshwater ponds in Barangay Namocon, Tigbauan was proposed in November, as a joint project of SEAFDEC AQD, the Barangay Council of Namocon, and the pond owner. A survey was conducted last December and a seminar was later held for the prospective cooperators.

Post-Training Survey

Started in 1984, this post-training survey was conducted to determine and assess the performance of the training graduates and to gauge the effectiveness and applicability of the Department's manpower development program. Some 368 local graduates and 261 foreign participants were selected as respondents.

Partial survey reports showed that the overall rating of the past trainees in all the courses was very satisfactory. Many participants attributed the change in their professional status to the knowledge and skills they have acquired from the training courses.

Information Dissemination

LIBRARY AND DOCUMENTATION SERVICES

The Library collection now stood at 7795 monograph volumes, 7370 reprints, 2803 pamphlets, 2823 bound journal volumes, 1519 SEAFDEC publications, 492 microfiches titles, and 27 rolls of microfilms.

Collection and documentation activities are being implemented through the Brackishwater Aquaculture Information System (BRAIS) and the Aquaculture Information System (AQUIS) Projects. There are 764 brackishwater aquaculture information entries in the BRAIS data base and 1114 data units in the AQUIS data base, including those on temperate cultivable species production studies. Some 136 monographs, 71 journal issues, and 412 articles were acquired from the literature survey and acquisition done in the Greater Manila area.

Three issues of the Brackishwater Aquaculture Abstracts were published together with the Mudcrab Bibliography. Abstract bibliographies on mussel and seabass are being prepared.

Various library materials like monographs, journals, reprints, and theses were receive and organized through gifts and exchange agreements with 93 foreign and 16 local partners.

A training on ASFIS Methodologies (30 September-11 October) was attended by 12 library and information specialists from various parts of the country. Ten participants also availed of IDRC-MINISIS package system training held last 25 November-11 December.

COMPUTER OPERATIONS

The Computer Unit was organized early this year to assist in implementing the AQUIS and BRAIS Projects. It also assists in providing an effective management information system to facilitate the operational activities of the Department for system and control, particularly for research. A data base was also created to provide on-line information on the training courses conducted by AQD. The establishment of the Mail-list Information System improved the mailing and subscription system of AQD publications. The Development Payroll System Package Program was made operational.

AQD Library facilities

PUBLICATIONS

Aquaculture publications completed during the year included:

1. Aquaculture Technology Module 2 – *How to Transport and Acclimate Prawn Fry* – by R. A. Tenedero and A.C. Villaluz, 500 copies
2. Aquaculture Technology Module 3 – *Floating Cage Nursery for Tiger Prawn* by D. de la Pena, O. Prospero and A.T.G. Young, 500 copies.
3. Aquaculture Poster No. 4 – *Life Cycle of Prawn (P. monodon)* illustrated by J. Legaspi, 500 copies.
4. *SEAFDEC Asian Aquaculture,* Vol. VII, Nos. 1-11, a widely circulated outreach newsletter containing aquaculture research and development notes and relevant news on aquaculture developments in Asia.
5. *Aqua Farm News,* Vol. III, Nos. 1-11, a monthly production guide for fishfarmers and extension workers.
6. *AQD Bulletin,* 38 issues, an in-house publication for Department officials and staff.

Three Technology Verification Projects (TVP) methodologies on extensive and semi-intensive prawn culture systems, and on seabass and tilapia polyculture were packaged during the year. Manuscripts completed during the year were on fish/shrimp fry collection, identification and handling; pond production and use of brine shrimp; and natural food organisms for freshwater and marine species.

The Department entered into an agreement with Goodwill Trading Company, Inc. for the latter to reprint selected AQD publications and make these available through bookstore outlets nationwide. Among the first group of publications reprinted at 2,000 copies each were: *Farming of Prawns and Shrimps; Broodstock of Sugpo; A Guide to Prawn Hatchery Design and Operation; Tilapia Cage Farming in Lakes; How to Transport and Acclimate Prawn Fry;* and *Sugpo and Other Penaeids (Bibliography).*

SPECIAL PUBLICATION PROJECTS

SAFIS Manual No. 11 – *Culture of Seabass,* 500 copies were reprinted by AQD at TRS with permission of the Southeast Asian Fisheries Information Service (SAFIS) in Bangkok, Thailand.

SAFIS Manual No. 22 – *Nakakaing Krustasyo sa Pilipinas* by H. Motoh. SAFIS requested some AQD staff to review and improve the translation in Pilipino of the book *Edible Crustacea of the Philippines,* in cooperation with the Association for Science Cooperation in Asia with main office located at NSTA, Taguig, Rizal and the Institute of National Language in Manila. The Department also assisted in the production of this publication.

BROADCAST MATERIALS

In May, the Broadcast Project was initiated in cooperation with IBC Channel 12 of Iloilo City (Panay Region as pilot area) for television, then later with other television stations in Metro Manila, and with the Philippine Federation of Rural Broadcasters for radio. The Project involved one-minute development plugs on aquaculture technologies and news releases aired regularly through radio and television. During the period, nine plugs were produced in both English and Hiligaynon for television. About 60 interviews with various SEAFDEC research staff were packaged in Pilipino for airing in more than 100 radio stations nationwide.

VTR production of institutional and instructional materials was continued. A sound-slide production on *Eleven Years of Aquaculture Research and Development* was completed in June.

Papers Published In Scientific Journals

Benitez, L.V. and Gorriceta, I.R. 1985. Lipid composition of milkfish grown in ponds by traditional aquaculture. In: Finfish Nutrition in Asia: Methodological Approaches to Research and Development, pp. 145-152. C.Y. Cho, C.B. Cowey and T. Watanabe. Ottawa, Ontario, Canada.

Cruz, E.R. and Muroga, K. 1985, Studies on the tolerance of Japanese eel *(Anguilla japonica)* to zinc sulfate. Fish Pathol. 20:459-461.

Duremdez, R. and Po, G. 1985. Studies on the causative organism of *Sarotherodon niloticus* (Linnaeus) fry mortalities. 2. Identification and characterization of the physiological properties of *Pseudomonas flourescens.* Fish Pathol. 20:115-123.115-123.

Gacutan, R., Tabbu, M., and Icatlo, F. Jr. 1985, Paralytic shellfish poisoning due to *Pyrodinium bahamense* var *compressa* in Mati, Davao Oriental, Philippines, Mar. Biol. 75.

Harvey, B., Nacario, J., Crim., L.W., Juario, J.V. and Marte C.L. 1985. Induced spawning of seabass *Lates calcarifer* and rabbitfish, *Siganus guttatus* after implantation of pelleted LHRH analogue. Aquaculture 47:53-59.

Juario, J.V., Duray, M.N., Nacario, J.F., and Almendras, J.M.E., 1985. Breeding and larval rearing of the rabbitfish *Siganus guttatus* (Bloch). Aquaculture 44:91-101.

Kumagai, S., Bagarinao, T. and Unggui, A. 1985. Growth of juvenile milkfish, *Chanos chanos* (Forsskal) in a natural habitat. Mar. Ecol. 22:1-6

Ledger, O., Sorgeloos, P., Millamena, O.M. and Simpson, K.L. 1985. Factors determining the nutritional effectiveness of *Artemia.* The relative impact of chlorinated hydrocarbon and essential fatty acid in San Francisco Bay and San Pablo Bay *Artemia.* J. Mar. Biol. Ecol. 93:71-82.

Pantastico, J.B., Baldia, J.P. and Reyes, D. 1985. Acceptability of five species of freshwater algae to tilapia (*Oreochromis niloticus*) fry. In: C.V. Cho, C.B. Cowey and T. Watanabe (eds.) Finfish nutrition in Asia; Methodological approaches to Research and Development, Ottawa, Ontario, Canada, IDRC. pp. 135-144.

Po. G., Baticados, M., Lavilla, C. and Sanvictores, E. 1985. In-vitro effects of fungicides on the fungus, *Halipthoros philippinensis.* J. Fish. Dis. 8:359-365.

Santiago, C.B., Aldaba, M.B., Abuan, E., and Laron, M.A. 1985. The effects of artificial diets on fry production and growth of *Oreochromis niloticus* breeders. Aquaculture 47:193-203.

Segner, H., Acosta, B.O. and Juario, J.V. 1985. The dietary value of *Brachionus plicatilis* grown on three different species of phytoplankton as feed for *Chanos chanos* (Forsskal) fry. Aquaculture 42:109-115.

Tan, J.D. 1985. A histological study of the hypophysial-gonadal system during sexual maturation and spawning in the milkfish *Chanos chanos* (Forsskal). J. Fish Biol. 26(6):657-662.

Vogt, G., Storch, V., Quinitio, E. and Pascual, F. 1985. Hepatopancreas as monitor organ for the nutritional value of prawn diets in aquaculture-investigations on *Penaeus monodon* (Decapoda). Aquaculture 48:1-12.

Villegas, C. and Doyle, R. Aspects of feeding, behavior correlated with growth rate in *Oreochromis mossambicus:* possibilities of indirect selection. Second International Symposium on Genetics in Aquaculture, University of California, Davis, California, U. S. A., June 23-28, 1985.

Papers presented at the National Consultative Meeting on Aquaculture Engineering, Tigbauan, Iloilo, October 2-5, 1985.

1. Gavieta, P. Aeration system of Tigbauan Research Station.
2. Platon, R. Application of engineering scale-up principles in aquaculture.
3. Subosa, P. Pond liming and liming materials for brackishwater ponds.
4. Tillo, S. Saltwater system of Tigbauan Research Station.
5. Torres, P., Jaspe, S., Oniate, L., and Silomenio, L. Comparative performance of three propeller blades used for push pumps.
6. Traviña, V. The construction of an aquaculture based Social Laboratory in Brgy. Cauayan, Pototan, Iloilo.
7. Vizcarra, A. Evaluation of hydraulic characteristics of some fish culture tanks.
8. Yu, O. Layout and design of aquaculture projects: pen and cage systems.

Papers Presented in Workshops and Conferences

Bagarinao, T. and Taki, Y. The larval and juvenile fish community in Pandan Bay, Panay Island, Philippines. Second International Conference on Indo-Pacific Fishes, Tokyo, Japan, 28 July-10 August 1985.

Benitez, L.V., Milkfish nutrition: a review. First International Fish and Crustacean Feed and Nutrition Seminar Workshop, Iloilo City, 1985.

Coloso, R.M., Benitez, L.V., and Tiro, L.B. An amino acid test diet for milkfish (*Chanos chanos* Forsskal) juveniles. Second International Conference on Warmwater Aquaculture: Finfish. Laie, Hawaii, 1985.

Gacutan, R.Q. Effects of coconut milk and brown sugar on the crude toxin from *Perna viridis* made toxic by *Phyrodinium bahamense* var *compressa.* Third International Congress on Toxic Dinoflagellate Blooms, St. Andrews, New Brunswick, Canada, June 8-12, 1985.

Millamena, O.N., Bombeo, R.F., Jumalon, N.A. and Simpson, K.L. The effects of various diets on the nutritional value of *Artemia* as feed for *Penaeus monodon* postlarvae. Abstract of the World Mariculture Society, 16th Annual Meeting, Orlando, Florida, January 13-17, 1985.

ADMINISTRATION

During the year, activities were coordinated to provide efficient support services to the research, training, and extension programs of AQD. Systems and procedures were modified to meet budgetary constraints

The Division worked on increasing funding support: new tie-ups were pursued and pending grants and donations were followed up. Cost cutting measures and a more effective financial programming were implemented. Administrative support towards the information and technology dissemination program of the Department at the local, national, and regional levels was strengthened.

PERSONNEL

As of 31 December 1985, personnel complement totalled 669 employees, with 379 in Research, 235 in Administration, and 55 in Training and Extension Divisions. Fifty one employees availed of the voluntary Resignation Scheme implemented duing the second quarter. Implementation of the scheme meant an estimated annual reduction of ₱2.16 M from the annual mandatory expenses of the Department, cutting down on excess manpower and overhead expenses.

STAFF MOVEMENT

Major designations made for the Research Division (RD) include: **Renato Agbayani**, Acting Head of Batan Substation, effective 2 January; **Jose Llobrera**, International Development Research Centre of Canada (IDRC) Project Coordinator, 2 January and Physiology Discipline Team Leader, 7 January; **Cesar Villegas**, Finfish Program Officer, 7 January; **Pastor Torres, Jr.**, Coordinator of the National Bangus Breeding Program (NBBP), 7 January; and **Jose Llobrera**, Crustacean, and Molluscs and Seaweeds Program Officer, 17 January.

Jonathan Nacario, Finfish Fingerling Production Project Leader, effective 7 January; **Josefa Tan**, Head of the Micro-technique Laboratory, 7 January; **Relicardo Coloso**, Discipline Team Leader of Nutrition and Feed Development; 16 January; **Melchor Lijauco**, Acting Administrative Officer, BRS, 31 January; **Candelaria Casalmir**, Computer Officer, 13 February; and **Felicitas Pascual**, Radiation Health and Safety Officer, 26 February.

Danilo Israel, OIC of the Economics/Statistics Section, effective 1 March; **Julia Pantastico**, OIC of Bay Fishfarm Project, 3 April; **Julius Gonzales**, Administrative Assistant of Batan Substation, 7 March; **Salvador Pamplona**, Administrative Assistant of Naujan Substation, 28 May; and **Melchor Lijauco**, acting Head of BRS, 1 August.

Rolando Platon was designated Chairman of the Staff Development Committee and Publications Review Committee. **Rufil Cuevas** and **Percival Gavieta** represented RD in the Department's Safety Committee.

The scalar chain of command for RD and TRS was established as follows: **Jose Llobrera, Cesar Villegas** and **Rufil Cuevas.**

Under the Finfish Program, project leaders were identified: **Jonathan Nacario**, Finfish Seed Production; **Clarissa Marte**, Finfish Broodstock Development and Gonadal Maturation; **Dan Baliao**, Finfish Pond/Cage Culture; **Lita Benitez**, Finfish Nutrition and Diet Development; **Antonio Bautista**, Tilapia Project; **Corazon Santiago**, Milkfish Project; **Socorro Castro**, Carp Project; **Asuncion An Lim**, Limnology; **Antonio Villaluz**, Finfish Special Project (Production) Tigbauan; **Melchor Lijauco**, Finfish Special Project (Production) Binangonan; **Rodrigo Lacierda**, Coordinator of Carp Fingerlings Production; **Nilda Tabbu**, Tilapia Fingerlings Production at Bay, Laguna; and **Dante Gerochi**, Study Leader of Siganid Pond Production.

Project leaders under the Crustacean Program were: **Rosario Pudadera**, Crustacean Broodstock Development and Gonadal Maturation; **Felicitas Pascual**, Prawn Diet Developmet and Evaluation; **Antonio Villaluz**, Prawn Larval and Postlarval Rearing; **Beato Pudadera, Jr.** Prawn Pond/Cage Culture; **Nepheronia Jumalon**, *Artemia* Project; **Kaylin Corre**, Crustacean Special Project-Leganes; and **Dioscoro de la Pena**, Crustacean Special Project – Batan.

The following personnel were reassigned from one unit/station to another: **Einstein Laviña** from Igang to the *Artemia* Production study in the LRS; **Leonardo Tiro, Jr.**, from LRS to Finfish Broodstock Development and Larval Rearing in Igang; **Nilo Franco** from Economics/Statistics Office to the Office of the Director, Administrative Division as Staff Assistant; **Ernesto Balangue** from Training and Extension Division to the Socio-Economics Section; **Maximiano M. Rivera, Jr.**, from

LRS to Igang Substation Finfish Broodstock Development and Hatchery Operation; **Selwyn Clyde Alojipan** from Research Management Service Office to the Computer Unit; **Marlo Tabbu** from Naujan Substation to BRS to conduct verification studies on tilapia and carp culture, and **Corazon Espegadera** from LRS to Bay Fishfarm Project.

The services of the following JICA experts were availed of: **Dr. Yasuhiko Taki**, Deputy Chief, June 1983-June 1985; **Mr. Mitzuru Yamasaki**, JICA Coordinator, May 1981 to May 1985; **Dr. Hiroshi Kohno**, two year assignment in finfish culture, beginning in February; **Mr. Shiro Hara**, fish seed production expert; and **Mr. Goro Nezaki**, prawn expert.

STAFF DEVELOPMENT

Rolando Platon defended his Ph.D dissertation on the *Scale-up Considerations in the Culture of Brine Shrimp* at the University of British Columbia, Canada in May.

Corazon Santiago defended her Ph.D dissertation on the *Amino Acid Requirement of Nile Tilapia* at Auburn University in Alabama, U.S.A. in October.

Armando Fermin and **Manuel Carlos** earned their M.S. in Aquaculture from the Central Luzon State University (CLSU) in Nueva Ecija. **Fermin's** thesis was on *Growth and Survival of Bighead Carp Fed with Different Types of Feed and their Combinations.* **Carlos** worked on *Response of Bighead Carp (A. nobilis Richardson) Fry to Different Feeding Levels and Frequencies.*

Maria Rowena R. Romana earned an MSc. in *Genetics and its Application* from the University of Wales (Swansea, U.K.) in October. Rowena's thesis was on *Electrophoretic Studies on Induced Gynogenetic Diploids and Triploids* in *Tilapia (Oreochromis niloticus* and *O. aureus).* The grant was sponsored by IDRC.

Nelson Golez was awarded a two-year Mombusho Scholarship Grant for an M.S. program in Soil Science at Kyoto University.

Nieves Aquino also received a two-year Mombusho Scholarship Grant for an M.S. program in Reproductive Physiology of Crustacean at Kagoshima University.

Maximiano M. Rivera Jr., and **James N. Paw** completed on March 22, 1985 the Fourth NACA-SEAFDEC-UPV Training Course for Senior Aquaculturists in Asia and the Pacific Region;

Thomas Young participated in the fifth Training Course, 1985-1986 session.

Corazon Duenas underwent an IDRC-sponsored training on sperm preservation, LHRH radioimmunoassay and HPLC in the University of Victoria, B.C. Canada from September 1984-January 14, 1985.

Oseni Millamena presented two papers on *Artemia* feeding scheme and on Prawn Maturation, at the World Mariculture Society Meeting in Orlando, Florida, 13-16, January.

Roselyn Duremdez underwent a six-month training program in fish pathology at the University of Oregon, U.S.A. from February to July, sponsored by IDRC.

Josefa Tan joined the four-month training course on the Reproductive Physiology of Fish at the National Institute for Basic Biology at Okazaki, Japan, 8 February to 8 June.

Mario Dimaano, **Demetrio Estenor** and **Noel Solis** participated in the seminar-workshop on Improving the Format and Content of Training Manuals, 19-27 February, sponsored by IDRC.

Rufino Ignacio attended a five-month training on Freshwater Aquaculture in Japan, 28 February to August, sponsored by JICA.

Rose Marie Caballero underwent a 4-month (21 March-6 August) training program in Prawn Hatchery Systems at Japan, sponsored by JICA.

Emiliano Aralar and **Renato Arcilla** joined the four-month training program on Integrated Fish Farming, from 14 April, at the FAO/NACA Regional Lead Centre in Wuxi, China.

Cesar Villegas and **Zubaida Basiao** attended the IDRC-sponsored Fish Genetics Training held in Singapore, 15-26 April.

Cesar Villegas attended the Second International Symposium of Genetics in Aquaculture held at the University of California at Davis, 23-28 June.

Jesus Almendras underwent an IDRC-sponsored training on Fish Physiology at the University of Florida, U.S.A., from 20 May to 20 November.

Jose Canto, Jr. attended the Fourth International Training Course on the Biology and Practical Use of Brine Shrimp *(Artemia)* in Aquaculture at Ghent, Belgium, 15 July to 7 September.

Teodora Bagarinao participated in the Second International Conference on Indo-Pacific Fishes held in Tokyo, Japan, 23 July to 10 August.

Nepheronia Jumalon attended the Fourth International *Artemia* Symposium in Belgium, 1-5 September.

Socorro Castro attended the International Conference on the Aquaculture of Carps and Related Species in Paris, France, 2-5 September.

Gilda Lio-Po attended the International Meeting on Fish Immunology in New Jersey, U.S.A., 8-12 September.

Adam Young joined the Study Tour of Mariculture in France (Oyster and Mussel Culture) sponsored by the United Nations and the Government of France, 9-27 September.

Alcestis Llobrera and **Nicanor Primavera** attended a meeting at the International Center for Living Aquatic Resources Management (ICLARM) held 8 October in Metro Manila to discuss editorial styles in Philippine Life Sciences Research Publications.

Melchor Lijauco and **Julia Pantastico** attended the Asian Symposium on Freshwater Fish Culture in Beijing, China, 10-15 October.

Joselyn Antiporda left in October for Thailand for a one-year FAO-sponsored secondment program of young scientists to participate in *Macrobrachium* research.

Alexandrina Dormitorio attended the First Editing and Publication Training Course sponsored by IDRC and the International Rice Research Institute in collaboration with the University of Toronto Press, held at IRRI Los Banos, 12 August to 29 November.

Pablito Ynot, Bienvenida Benedicto, Romulo Samson and Reuel Tumaliuan attended the Aquaculture Course for Social Scientists at AQD, 19 November to 10 December.

Reuel Tumaliuan trained on fisheries economics at the University of Pertanian Malaysia sponsored by IDRC, 16 December to 30 April 1986.

PERSONNEL MANAGEMENT AND EMPLOYEES BENEFITS

A Department-wide salary increase of P100.00 in basic pay, as provided in the Collective Bargaining Agreement, was given in January and July. An additional P20.00 longevity pay was also given in July.

The 1985 Ad Hoc Compensation Review Committee worked on the corrective salary adjustments of some personnel. The Committee also worked on the adoption of the revised basic salary ranges for the different positions. Adjustments were made in view of the additional wages prescribed under Wage Order No. 5 and the escalating market value of certain jobs/or expertise.

A performance appraisal, covering January to June, was done. Sessions were also conducted to improve and strengthen communication between and among top management, the supervisors, and the rank and file.

Group term insurance with accident and dismemberment benefits for 678 qualified employees was effected with the Philippine Asia Life Assurance Corporation. Medical and dental services were extended to all Department personnel and their dependents, trainees, and pupils of the WVSC Laboratory School.

Security measures in all stations were improved with the change in security agency. Better procedures on gate passes, wearing of ID's and recording of employees' attendance were implemented. The First-Aid Training Seminar was attended by 37 employees from the various stations and substations.

The Personnel Management Section established linkages with the Personnel Management Association of the Philippines local and national chapters, to conduct in-house seminars for first line supervisors and for advanced supervisory management training courses. The Section also monitored and assisted management in solving some labor-related problems encountered during the year.

PHYSICAL PLANT SERVICES

On top of undertaking routinary repair and maintenance of buildings, transport facilities, equipment, and life support systems, activities were focused on the cost reduction program started early in the year.

Airconditioning and refrigeration units unnecessary to program operations were pulled-out from various offices. This reduced the power expenditure of the Department by 50%. Shuttle service trips for employees and for supply procurement were scheduled so as to eliminate unnecessary transport costs. Unserviceable vehicles and equipment were disposed thru public bidding.

PROPERTY AND SUPPLY MANAGEMENT

Purchasing of supplies and materials required by the Research Division were further streamlined with leadtime scheduling of serving requisitions and deliveries.

In line with the cost-cutting measures adopted by the Department, acquisition and recording of equipment was done in close coordination with property custodians in all stations. An inventory of unutilized and unserviceable equipment was undertaken and recommended for consequent disposal.

PRODUCTION AND MARKETING COORDINATION

The creation of a Production and Marketing Coordinating Office and its corollary Marketing Committee in July reestablished a more policy-guided and systematic sale of aquaculture products incidental to the research and technology verification activities in all stations. The office strengthened the report and documentation system of research production income.

AUXILIARY SERVICES

Housing accommodations were provided for employees, trainees, and guests of the Department. Routine messengerial, printing, mailing, and visitor's services were done in support of the overall operations of the Department.

WVSC LABORATORY SCHOOL

The enrolment at the WVSC Laboratory School from Kindergarten I to Grade IV totalled 238 pupils. During the period, school facilities were improved; rooms were expanded or partitioned and a reading center was constructed. Community outreach activities were undertaken by WVSC-SEAFDEC teachers and pupils with the neighboring municipalities of Tigbauan and Guimbal.

Visitors

During the year, the following dignitaries visited the Department:

Hon. Ramesh Mulye
Indian Ambassador to the Philippines

Hon. Chen Sung Lu
Ambassador to the Philippines, PROC

Hon. Gaston Jenebelly
Belgian Ambassador to the Philippines

Mr. Sugiyanto Hadi Pronoto
Indonesian Embassy
Manila

Dr. Kazuo Inoue
Deputy Secretary General
SEAFDEC, Thailand

Mr. Angel Concepcion
Deputy Minister of Agriculture and Food
Philippines

Dir. Felix Gonzales
Bureau of Fisheries & Aquatic Resources
Philippines

Mr. Tito Primicias, Jr.
Deputy Minister of Local Government
Philippines

Dir. Jassim Al-Qaseer
Directorate Of Fisheries
Bahrain

Dr. Brian Davy
IDRC, Singapore

Dr. Allan Rex
IDRC, Singapore

Dr. James Ching Ming Kuo
ICLARM, Philippines

Mr. Louis Landesman
University of Singapore

Dr. Khoo Hong Woo
Kent Ridge, Singapore

Dr. Donald MacIntosh
ASEAN Food Handling Bureau
Malaysia

Dr. Brian Harvey
University of Victoria
Canada

Dr. William Vanstone
Resource Management International, Inc.
Singaraja, Bali, Indonesia

Mr. Henry Hsu
Ministry of Foreign Affairs
ROC

Mr. Chen Shan-Lin
Ministry of Foreign Affairs
ROC

Mr. Tsai Chauk
Commission on Audit
ROC

Mr. Chau Chih Kang
Council of Agriculture
Taiwan, ROC

Mr. Chang Yung Sing
Council of Agriculture
Taiwan, ROC

Dr. Yung Shang
University of Hawaii

Dr. John Williams
UNESCAP
Philippines

Mr. Christopher Robertson
SEAFARM, Australia

Dir. Peter Pownall
SCP Fisheries Consultation
Australia

Ms. Terry Commins
Australian Development Assistance
Australia

Mr. Marc Le Vernoy
Prawn Culture Management Research Division
France

Mr. Philippe Chua
Aqua Service Far East Group
France

Mr. Ronald Needham
SEAFIS, Thailand

Ms. Ana Guerrelhas
Mariculture de Bahia
Cuba

Mr. Sidarto
Asian Development Bank

Mr. Higochi
Asian Development Bank

Dr. Howard Pawles
Agriculture and Sciences Division
Senegal

Mr. Jesus Abrugar
Principal
Matarinao School of Fisheries
Eastern Samar, Philippines

Mr. Ali Ahmed Aziz
General Authority for Fish Resources Developmen
Egypt

Mr. Magdy Nassif Awad
Egypt

Mr. Mohamed Abdel Sinnawi
Egypt

Mr. Mohamed Al-Razik
Egypt

Mr. Andrew Shen
Ministry of Foreign Affairs
Republic of China (ROC)

Mr. Gilad Issar
Oceanographic and Limnological Research
Israel

Institutional Linkages

The SEAFDEC AQD's collaborative projects and activities undertaken in 1985 with regional and international institutions as well as with national agencies, were almost all a continuation of common endeavors started and implemented in the previous years. Collaborative activities in the fields of research and technology cooperation were improved and strengthened in order to help accelerate the development of the aquaculture industry in the country and the region. In the national scene, a working agreement was made with Goodwill Bookstore in Metro Manila, to produce and mass distribute AQD technology publications in behalf of the Department.

For 1985, the AQD's activities with and in cooperation with outside institutions and agencies are as follows:

International

NACA-SEAFDEC-UPV Training Course

The fifth training course was conducted at the AQD for senior aquaculturists in Asia and the Pacific Region. Twenty-one participants underwent an intensive series of lectures and practical work in at least five major aquaculture courses during the period covered by the training. The participants went on study tour of other regional lead centers of NACA to observe various aquaculture practices involving different aquatic species in different regions.

SEAFDEC-IDRC

SEAFDEC AQD's collaboration with the International Development Research Center (IDRC) of Canada has been a success all throughout 1985. Phase III of the Milkfish Project was completed with gratifying results. Success in spawning not only milkfish, but also, seabass and siganids were reported.

The operation of the Brackishwater Aquaculture Information System (BRAIS) was continued with the financial support of IDRC. BRAIS is being implemented in response to the need for better management and control of the exponentially increasing information and literatures on aquaculture.

In 1985, two issues of BRAIS bibliography were generated. Index format for authors and descriptions and data base design for library application was refined.

IDRC also sponsored a 6-month training in fish pathology of **Roselyn Duremdez** in February, the participation as trainor of **Cesar Villegas** to IDRC's short-term training on fish genetics held in Singapore from 15 to 26 April, 1985, and the short-term training in fish physiology of Jesus Manolo Almendras at the University of Florida from 20 May to 30 November.

JICA-NACA-SEAFDEC Audio-Visual Production

The Audio-Visual Production Unit (AVPU) continued to undertake video-tape production in collaboration with NACA and JICA. Among the significant outputs of the AVPU included:

- A 10-minute sound-slide tape production titled, "Available Technologies in Aquaculture" shown at AQUATECH '85 Exhibits held April 10 to 14 at PHILCITE Manila.

- A 20-minute sound-slide production of an AQD briefing titled. "Eleven Years of Aquaculture Research and Development, completed 3 June 1985.

- DEVPLUGS Production. The AVPU also undertook the production of 30 to 60 second spot plugs for television and radio broadcast.

SEAFDEC-JICA

The book, *Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps* was published through a grant from the Government of Japan and with the assistance of JICA. JICA also sponsored the five-month special training on freshwater aquaculture in Japan of **Mr. Rufino S. Ignacio.**

SEAFDEC-OI-USAID

The milkfish cooperative research project of SEAFDEC AQD and the Oceanic Institute (OI) of Hawaii, with the financial support of the US Agency for International Development (USAID) was implemented at AQD's Naujan sub-station in Mindoro. Phase I of the project will be completed in June 1986.

Phase II of the project has been recommended for funding also from USAID. Under the terms of agreement between SEAFDEC AQD and OI, Mr. Jessie Banno was also granted a study grant on "Advanced Maturation and Spawning Techniques" at the Oceanic Institute, Hawaii.

National

BFAR-FSDC-LLDA-SEAFDEC Technology Verification Projects

The verification study on the polyculture of bighead carp, common carp, and tilapia in cages was undertaken jointly with the Laguna Lake Development Authority (LLDA), Farm Systems Development Corporation, the Bureau of Fisheries and Aquatic Resources (BFAR) and SEAFDEC AQD. A follow-up of the year-long field testing of the potential of raising carps with tilapia, the project was based on the successful run involving carps conducted in 1984.

BFAR-SEAFDEC

Field-testing of the modified extensive culture of *P. monodon* was continued in collaboration with selected demonstration and training centers of BFAR.

Private Sector

SEAFDEC AQD – Goodwill Book Store

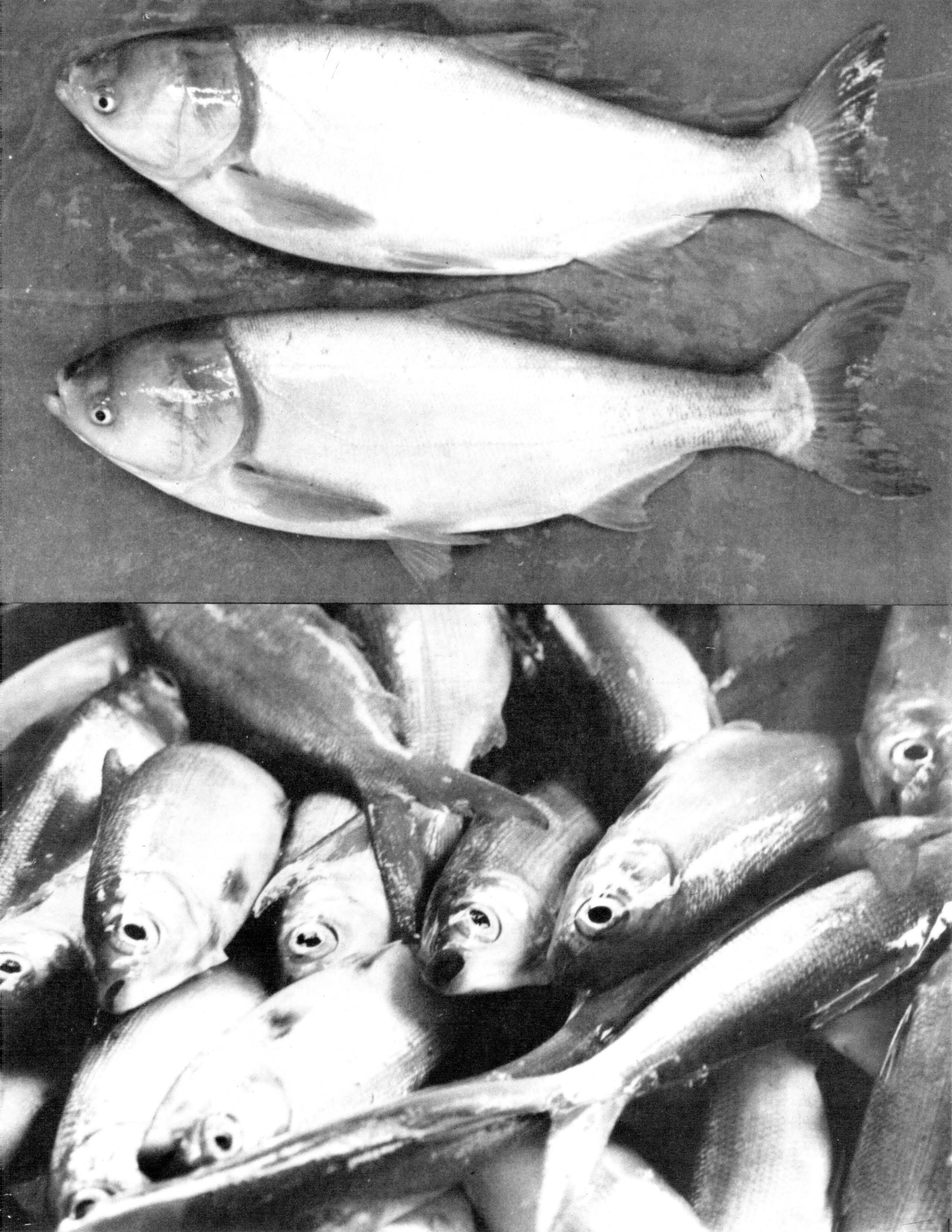
Pursuant to the instruction of the National Board on SEAFDEC AQD during its Twelfth Meeting on 6 September 1985, the Aquaculture Department updated its extension publications for wider circulation in the country and abroad.

Goodwill Trading, Inc. had been chosen to underwrite the reprinting of the technology manuals because of favorable terms it offered over other publishing houses and companies. GBS initially reprinted 2,000 copies each of the following titles:

1. Broodstock of Sugpo, *Penaeus monodon* Fabricius
2. Farming of Prawns and Shrimps
3. Prawn Hatchery Design and Operation
4. Tilapia Cage Farming in Lakes
5. How to Transport and Acclimate Prawn Fry
6. Sugpo Bibliography

SEAFDEC-PFRB

A radio broadcast project with emphasis on technology transfer was launched in collaboration with the Philippine Federation of Rural Broadcasters (PFRB).



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