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INLAND FISHERIES PROJECT

Philippines

PROGRESS REPORT FOR NSDB-ASSISTED PROJECT NO. 7103.1Ag

July 1, 1974 Through December 31, 1974

(Report No. 6)

INLAND FISHERIES PROJECT
Philippines

Participating Agencies

National Science Development Board
University of the Philippines
Central Luzon State University
National Food and Agriculture Council (Department of Agriculture and Natural Resources)
Bureau of Fisheries and Aquatic Resources
National Economic and Development Authority
Province of Iloilo
Municipality of Leganes, Iloilo
United States Agency for International Development

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FOREWORD

The research activities of the Inland Fisheries Project from its Brackishwater Aquaculture Center, Leganes, Iloilo, and Freshwater Aquaculture Center, CLSU, Muñoz, Nueva Ecija, in the first half of the Fiscal Year 1975 are embodied in this technical report. Foremost among the research activities during the six month period are bangus culture in brackish and freshwater ponds, carp polyculture, propagation and culture of *Clarias batrachus*, culture of monosex and sex-reversed *Tilapia mossambica*, rice-fish culture, and parasites and diseases of freshwater fishes. The pond and laboratory facilities of both centers have been utilized at their maximum capacities and in accordance with research programs and plans of the project. All research projects have been done through team efforts among the scientific and technical staff.

This Inland Fisheries Project Technical Report No. 6 has been written and put together by the scientific staff of both centers including group editing between centers. The time and effort put into this report by the staff and the diligence by which the Assistant Project Director put the manuscripts into its final form are gratefully acknowledged.

In behalf of the entire staff of the Inland Fisheries Project, the support of the National Science Development Board, National Economic and Development Authority, University of the Philippines System, Central Luzon State University, Bureau of Fisheries and Aquatic Resources, United States Agency for

International Development and other agencies in the project is acknowledged with many thanks.

We request from our readers comments and/or recommendations on our research activities and reporting system.

ROGELIO O. JULIANO
Project Director

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I. RESEARCH ACTIVITIES

A. Research Completed

BRACKISHWATER AQUACULTURE CENTER

1. Bangus Production in Newly Constructed Ponds with Plankton as a Food Base

Introduction

This experiment was originally designed to compare bangus production with plankton and lab-lab as food bases. However, the difficulty encountered in encouraging the growth of lab-lab in the newly constructed ponds of the BAC made it futile to conduct a comparative study. Nevertheless, additional information was gathered on the growth rate of bangus using plankton as a food source. Earlier results of similar field trials on the plankton method of culturing bangus were reported in IFP-TR 3 and 4.

Materials and Methods

The study was conducted in three earthen ponds (each approximately 4,000 m^2) at the BAC in Leganes, Iloilo. Construction of these ponds was completed between the months of May and June, 1974, hence, this experiment was the first one ever to be conducted in these units.

Pond preparation consisted of drying the ponds (June 15 - 20); filling to the desired water depths at 8 and 70 cm, respectively, for the lab-lab and plankton ponds (June 21-23); and an initial application of 16-20-0 fertilizer on platforms at the rate of 50 kg per hectare (June 24). All ponds received 14 applications of this inorganic fertilizer at two-week intervals during the culture period.

Ponds 3 and 4 which had been prepared as plankton ponds following standard procedures (IFP-TR 4) were stocked with bangus fingerlings (ave. wt. 2.6 g) at the rate of 3,000/ha on June 28. On July 3, pond 4 was utilized as a holding pond for fingerlings which were inventoried from another experiment and had to be excluded from this study. Ponds 1 and 2, in the meantime, had been prepared as lab-lab ponds according to standard procedures (IFP-TR 3) but when efforts to grow lab-lab failed they were converted to plankton ponds and stocked on July 23 (ave. weight 6.6 and 5.9 g for fish stocked in ponds 1 and 2, respectively).

The pond water was monitored for data on salinity, pH, dissolved oxygen and carbon dioxide at weekly intervals. Observations on pond water coloration and visibility were recorded to provide crude indices on the abundance of phytoplankton. Stock sampling was conducted every three weeks which consisted essentially of seining 30 fish from each pond and obtaining individual length and weight measurements.

Fish were harvested using the traditional "pasulang" method. Initially water level was brought down to about 20-25 cm. Bamboo traps, about 3 m high and provided with two flexible longitudinal slits were installed within the perimeter of the pond gate. At night, depending upon the tide conditions, water was allowed to enter the ponds. The fish responded by moving against the current and into the traps. Fish were then brought ashore using dip nets. The following day was usually spent draining the ponds at low tide and picking up the fish that escaped the trap.

Resultd and Discussion

Table 1.01 contains data on growth and survival of fish during the experiment. The average gain per fish amounted to 126 g which represents an average growth rate of 0.9 g/day. Fish in Pond 3 showed the best growth response with 446 kg/ha after 140 days of culture. Those in Pond 1, however, grew approximately half as much as those in the other two ponds (Tables 1.01 and 1.02) This may be attributed to overcrowding brought about by the reproduction of tilapia. Based on a final harvest of bangus and extraneous species in the three ponds (Table 1.03) the total yield of bangus was found to be lowest where the total weight of Tilapia was highest.

Ranges of limnological data are presented in Table 1.04. Weekly observations on water quality parameters did not indicate any trend that could help explain the unusually low growth response of fish in Pond 1 and in fact, in all ponds. Although pond coloration appeared very variable it perhaps gave some indications that the response of ponds to inorganic fertilizer was generally poor. Thus, a persistent greyish-pale-brown appearance of the pond water in spite of regular applications of fertilizer was notable. Since production records were essentially of ponds that did not receive organic fertilizer, it will be interesting to see the effect of this treatment in the next trial.

The initial failure to grow lab-lab in two ponds cannot be explained. Based on the preliminary results of this study another trial furnished with pertinent innovations, has been programmed sometime in February, 1975.

Table 1.01 - Weight gain and survival of bangus fingerlings reared for 140 days in plankton ponds at the BAC.

Pond No.	Stocking per ha		Harvest per ha		% Survival	Ave. gain per fish (g
	No.	Weight (kg)	No.	Weight (kg)		
1	3078	20.3	2813	266.3	94	87.9
2	3000	17.9	2538	374.6	84	141.6
3	3000	7.8	2943	446.0	98	148.9
Average	3026	15.3	2764	362.3	92	126.1

Table 1.02 - Mean weights of bangus fingerlings stocked in approximately 4,000 m^2 plankton ponds at the BAC at 3000/ha for 140 culture days.

Days in culture	Mean weight (g)		
	Pond 1	Pond 2	Pond 3
0	6.6	5.9	2.6
20	17.5	25.4	23.6
41	19.8	45.9	46.2
63	31.3	68.2	70.4
94	51.6	124.5	125.0
120	80.0	144.9	160.5
140	94.6	147.9	151.6

Table 1.03 - Actual yield of bangus and other species from approximately 4000 m^2 plankton ponds at BAC after 140 culture days.[1/]

SPECIES	Total yield (kg)		
	Pond		
	1	2	3
Bangus	108.68	168.3	186.8
Tilapia	72.67	6.9	26.2
Shrimp	1.5	1.6	3.7
Lates sp.	1.3	1.5	0.5
Elops sp.	0.5	0.2	
Threadfins	0.2	0.15	0.13
Megalops sp.		0.007	0.013
Goby		0.8	
Triacanthus sp.			0.017
Total	184.85	179.45	217.36

1/Figures include cumulative weights of foreign species obtained during previous sampling periods.

Table 1.04 - Ranges of limnological data in the BAC plankton ponds over 140 - day culture period (July - Nov. 1974).

D A T A	P O N D		
	1	2	3
Salinity, ‰	17.7-41.0	17.3-41.4	17.3-42.3
Surface temperature, °C	27 - 33	27 - 33	27 - 33
Dissolved oxygen, ppm	4.8-8.8	4,6-10.0	5.3-9.9
pH	5.2-8.1	5.4-8.8	5.8-8.5
Visibility, cm	35-75	27-75	30-75
Free CO_2, ppm	5-70	2-80	2-110

2. The Rate of Growth of Bangus Fry/Fingerlings in Newly Constructed Brackishwater Ponds

Introduction

Preliminary studies on the rate of growth of bangus fry in brackishwater ponds have been conducted by the IFP. One was carried out in three nursery ponds of the BFAR in Molo, Iloilo City using the lab-lab method of culture (IFP-TR 4). A second study was conducted in three newly constructed ponds of the BAC in Leganes, Iloilo comparing both the lab-lab and plankton methods of culture (IFP-TR 5). This work was a continuation of these studies but this time using a combination of lab-lab and plankton methods of culture as an additional treatment.

The primary objective of this study was to compare these three methods of culture in growing bangus fry to fingerlings in newly constructed brackishwater ponds.

Materials and Methods

Three newly constructed, 500 m^2 ponds (Ponds 43, 44, and 45 hereafter referred to as P43, P44, and P45, respectively) of the BAC at Leganes, Iloilo, were used in this experiment. This study was programmed to be replicated in time because of the limited number of available ponds. The present work therefore, is actually a second run of the same experiment reported in IFP-TR 5. The design however, was slightly modified by the addition of the combination lab-lab-plankton treatment. The treatments were then assigned as follows: lab-lab method, P43; combination lab-lab-plankton method, P44; and plankton method, P45.

The combination treatment started out as lab-lab method and later was shifted to plankton method. In the former, lab-lab was encouraged to grow by increasing the level of water very gradually from 3 cm to 20 cm after it had been drained, dried, and fertilized. By doing this, lab-lab can develop and stabilize to serve as food for the fry. Sixteen days after stocking, lab-lab was beginning to be depleted and so plankton method was started. This was done by increasing the mean water depth in the pond to 60 cm and applying inorganic fertilizer to foster the growth of plankton.

Draining and drying of the ponds started on July 22, 1974. Construction of acclimation ponds in P43 and P44 started as soon as the ponds were drained and dried. The said ponds were 2 m x 2 m in dimension constructed about 1 m away from one corner of each pond. Liming of the pond dikes and the pond bottoms followed on August 9 and August 10 respectively. The lime in the form of $Ca(OH)_2$ plus undetermined amount of $CACO_3$ was applied in both areas at the rate of 2.2 tons/ha. On August 24 chicken manure was applied on the pond bottoms at the rate of 2 tons/ha. Water was admitted into the lab-lab ponds (P43 and P44) to 3 cm and to 60 cm in the plankton pond (P45) on August 27. Unwanted species of fish such as tilapia, mosquito fish and gobies were observed in high number in P45. Consequently, this pond had to be drained to remove these wild fishes. This pond was refilled to 60 cm on September 3 and from then on its water was maintained at mean depths ranging from 50 to 65 cm. Water in P43 and P44 was gradually raised from 3 to 20 cm and depth was maintained within the range of 20 to 30 cm. At culture day 16, P44 was shifted to plankton method and water was maintained within 45 to 65 cm depth.

Inorganic fertilizer (16-20-0) was applied at the rate of 50 kg/ha per application from September 5 to October 24 at approximately 2-week intervals for a total of 6 applications.

The fry, approximately 3 to 5 days old were received at the BAC on the evening of September 18, 1974. They came in 12 oxygenated polyethylene bags estimated to contain approximately 5,000 fry each. The fry from Hamtic, Antique, arrived at the BAC after about 3 hours of travel over rough roads. Except for oxygenation, no special care was given the fry during transport. The fry were held overnight in the unopened bags.

The next morning, the fry were counted employing the conventional method of counting. This method utilizes basins, bowls or cups, 100 small stones, a number of bigger stones, and 2 men. The method may be described briefly as follows: One of the two men scoops out a number of fry from the basin (usually not greater than 6) and calls out the number scooped; the other man separates certain number of stones from the group of 100 corresponding to the number called. As soon as all 100 stones are counted, the process is repeated but each 100 stones is represented by one bigger stone. This is done over and over until all the fry have been counted. Each 4,000 fry counted were then held in approximately 50-liter polyethylene plastic bags 1/3 full of water. The fry in these bags had also been sorted out from other species. With this procedure 23,944 fry were counted on the first day. In the same bags acclimation was made while awaiting stocking. The uncounted fry were again held overnight in plastic bags but this time the water was freshened by changing approximately 2/3 of its volume with fresh, diluted seawater and the bags re-oxygenated with industrial oxygen. The following day, the activity resumed and an additional 21,947 fry were counted.

Attempt was made to acclimatize the fry gradually from an average salinity of 27.40 ppt and temperature of 26°C (transporting bags) to a salinity ranging from 61.50 to 68.22 ppt and temperature ranging from 29.00 to 31.80°C (experimental ponds). The process of acclimation was by water replacement which was done in the course of counting and sorting. The method can be described as follows: Water in the transporting bag with lower salinity was replaced with pond water of higher salinity at the rate of approximately 1 l/hr until the water approached the desired salinity. Due to the wide ranges of salinity and temperature, it was difficult to attain the desired conditions gradually. The fry were then brought near the ponds where acclimation continued. In the lab-lab ponds, the fry were to be stocked first in acclimation ponds. As a means to hasten the acclimation process, half of the water in the acclimation ponds were removed and replaced with freshwater from Jalaud River. This brought down the salinities in these ponds from 68.22 ppt to 31.80 ppt (P43) and from 61.50 ppt to 28.40 ppt (P44). Even with these lowered salinities the fry were gradually adjusted to the existing conditions by water replacement.

As soon as the desired conditions were attained the fry for P43 and P44 were stocked in the acclimation ponds while those for P45 were stocked directly into the pond proper. In the acclimation ponds, the fry had a density of 3,880 fry/m^2 while those in the pond proper of P45 had only about 28.75 fry/m^2. In both situations only naturally occurring food was available to the fry. At culture day 7 the fry in the acclimation ponds were released by making narrow breaks on the dikes. This allowed the gradual flow of water from the pond proper which encouraged the fry to swim out of the acclimation ponds.

Physical parameters such as depth, visibility and water color were monitored. Chemical analyses of water to determine dissolved oxygen, free carbon dioxide, salinity and pH were made. These physico-chemical data were collected at least once a week and on extraordinary conditions such as when fish were observed to be in stress, after heavy rains, and during fish kills.

The rate of growth of fry was determined by measuring the individual lengths and taking the mass weights of a sample of 20 fish collected every sampling period. Seven samplings were made at intervals of 4 to 11 days to be as close as possible to the sampling periods of the first run.

<u>Results and Discussion</u>

The rate of growth of bangus fry to fingerlings are presented in Figure 2.01 (see also Table 2.01). The fry in P45 (plankton method pond) grew better than the fry in P43 and P44 (lab-lab and combination lab-lab-plankton methods respectively) between day 0 and day 11. This difference in growth may have resulted because the fry in P43 and P44 were kept in acclimation ponds from day 0 to day 7. Between days 11 and 17, there was a sharp increase in the weight of fry in all treatments. By day 17, fry in the lab-lab pond (P43) were bigger than those in the other two treatments. At day 27, the fish in P43 and P44 had outgrown those in P45. This time the net gains in weights of fish in P43 and P44 were highest but low for those in P45. This coincided with poor phytoplankton growth, high water pH (pH 4.2 to pH 5.8), high amount of carbon dioxide (9 to 44 mg/l), and too much rainwater in the ponds (depth ranged from 35 to 58 cm in lab-lab pond and 56 to 89 cm in plankton ponds). During this period the salinity could not be read by the lowest range of the available hydrometer. At day 38 the net gain in weight of fish in P43 and P44 decreased but increased in P45. At this point the experiment was terminated because of the apparent crowding of fish and due to the fish kills that occurred on two occasions. The ponds apparently did not respond favorably to fertilization that attempts to grow natural food failed. In addition, there was a need for fingerlings in other experiments. After some fingerlings to be used in other experiments were removed, an additional sampling was made as supplementary growth data. The data showed that the average weight of fish in P43 decreased from 1830.0 mg (day 30 to 1780.0 mg (day 46). This indicated reduced growth but when lengths were examined it was found that the fish collected were smaller than those sampled at day 38. Obviously, there were more than one size groups in P43.

Table 2.01 shows part of the data from the first run and those obtained from the second run on the rates of growth of bangus fry under the different methods of culture. There was no combination treatment in the first run so that comparison may be made only between the other two treatments. There was a consistent increase in the growth of fry in all treatments of both runs from day 0 to about day 27, beyond which, the growth became erratic.

The efficiency of the three methods of culture in growing bangus fry can not be definitely evaluated at this stage although similar trend in the rates of growth of fry in each treatment of both runs was observed. In terms of net weight gained (daily average) the lab-lab method gave a better production record than the plankton method in both trials (see Table 2.02). When the ponds for the second run were inventoried for survival from December 16 to 27, the plankton pond gave a better survival record than the lab-lab and combination lab-lab-plankton ponds. Data for the first run showed a better survival in the lab-lab ponds.

The lack of knowledge in the rhythmic behavior of lab-lab and plankton populations and their suitability as fish food created a problem in the evaluation of the efficiency of each method of culture. Aside from measuring the visibility of water and describing its color no other means was attempted to measure plankton density and to identify them. It was also difficult to determine exactly whether or not the main food of the fry was lab-lab or plankton since as early as the 8th day of culture a moderate amount of phytoplankton bloom was observed in P43 (lab-lab pond). At day 13, the fish in P45 (plankton pond) were observed feeding on lab-lab that covered about 1/16 of the surface of the pond.

Figure 2.01 - The rates of growth of bangus fry/fingerlings in the three methods of culture.

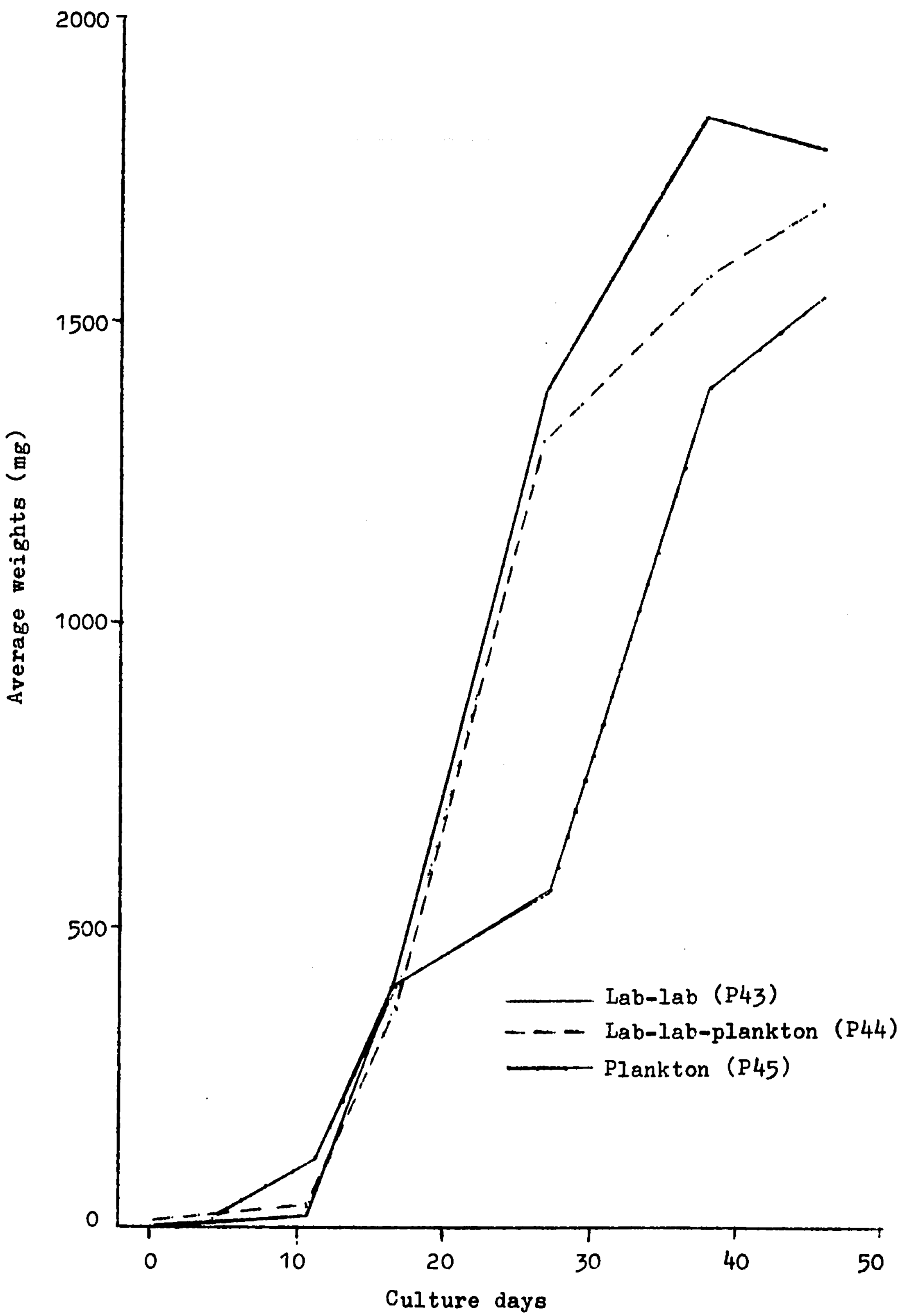


Table 2.01 - Some data from the first run and the data from the second run on the rates of growth of bangus fry and their weight increment under the different methods of culture.

Culture day	FIRST RUN				Culture day	SECOND RUN					
	Lab-lab (P43 P44)		Plankton (P45)			Lab-lab (P43)		Lab-lab-Plankton (P44)		Plankton (P45)	
	Averages		Averages			Averages		Averages		Averages	
	WEIGHT (mg)	NET GAIN (mg)	WEIGHT (mg)	NET GAIN (mg)		WEIGHT (mg)	NET GAIN (mg)	WEIGHT (mg)	NET GAIN (mg)	WEIGHT (mg)	NET GAIN (mg)
0	5	0	5	0.0	0	7	0	7	0	7	0
4	16.5	11.5	27.0	22.0	4	10.9	3.9	11.2	4.2	13.2	6.2
10	24.0	7.5	151.0	124.0	11	25.0	14.0	39.0	27.7	110.0	97.7
18	330.0	306.0	360.0	209.0	17	438.0	418.0	393.0	354.0	414.0	304.0
25	1050.0	720.0	900.0	540.0	27	1440.0	1002.0	1297.0	904.0	550.0	136.0
31	2450. 0	1400.0	700.0	-200.0	31						
38	1875. 0	-575.0	580.0	-120.0	38	1830.0	390.0	1560.0	263.0	1380.0	830.0
45			1600.00	1000.0	46	1780.0	-50.0	1690.0	130.0	1530.0	150.0

Table 2.02 - The average net weight gain per day of each fish in the different culture methods of two runs and the per cent survival after inventory.

	Net Wt. Gain daily (mg)		Survival (%)	
	1st Run	2nd Run	1st Run	2nd Run
Lab-lab method (P43)	*49.2	48.0	*80.2	65.4
Lab-lab plankton combination (P44)		40.8		75.9
Plankton method (P45)	25.6	36.1	75.7	80.1

*Average of two replicates

3. Monoculture and Polyculture of Bangus and Shrimp *Penaeus* sp. in Brackishwater Ponds

Introduction

A trial run on the mixed culture of bangus-shrimp utilizing a single pond was conducted by the IFP in 1973. The stock of 3,330 bangus/ha and 2,756 shrimps/ha yielded 510 kg bangus/ha and 109 kg shrimps/ha after approximately three months (IFP-TR 4). This result indicated greater production than those usually obtained with a monoculture of bangus. The present work was a follow-up of the previous study to compare the yields, growth rates and survivals between the monocultures and polyculture of bangus and shrimps.

Materials and Methods

This work utilized twelve 1,000 m^2 ponds for three treatments, namely bangus only, shrimp only and combination bangus-shrimp. Each treatment was replicated four times.

Drying of the ponds was started July 27, 1974. Lime at the rate of 1.8 ton/ha was applied on August 9, 1974, but due to heavy rains during the succeeding days, additional lime at the rate of 290 kg/ha was applied on August 14, 1974. The first application of inorganic fertilizer (16-20-0) at the rate of 10 kg P_2O_5/ha was made on the following day with the depth of water maintained at 3-5 cm to promote lab-lab growth. There were subsequent applications of fertilizer at the same rate on September 3 and September 18. Prior to stocking water level was increased to 10-15 cm.

Thirty thousand shrimps/ha and 3,000 bangus fingerlings/ha were needed for the experiment. This quantity of fry was not readily available and they had to come in batches over a period of four days from September 23 to September 26, 1974. Subsequently, stocking proceeded also at this interval.

The shrimps were transported to the BAC in polyethylene bags from Treasure Island, Balwarte, Iloilo City. Immediately upon arrival, these were counted and sorted; and unwanted species eliminated. The shrimps that were counted for individual ponds were freshened by placing them in separate polyethylene bags about 1/3 full of water having similar conditions to that of the transport bags.

Before stocking, the shrimp fry were acclimated to pond conditions. The salinity of which ranged from 42.3 ppt to 67.2 ppt and water temperature ranged from 29.4°C to 31.9°C. The salinity of the transport bags ranged from 33.2 ppt to 45.5 ppt and water temperature ranged from 25°C to 29.8°C. Acclimation to higher salinity was carried out as follows: At hourly intervals 0.44 l of water was removed from the bag and replaced with equal amount of pond water until the existing pond salinity was attained. This took approximately 5 hours. This method was unsatisfactory and it was necessary to resort to other means to increase survival. Other methods tried were: feeding with lab-lab during the slow process of acclimation; speeding up the acclimation by shortened intervals between successive exchanges of water while simultaneously aerating the shrimps; and stocking directly into acclimation ponds. These ponds were 1 m x 1 m in dimension, constructed about 1 m away from the corner of each pond. These were relatively small ponds whereby water with desired salinity and temperature could be attained easily. This was made possible by bailing out the water from these ponds and replacing them with water having salinity and temperature suitable to the shrimps. Coconut leaves were provided over the acclimation ponds in order to protect the shrimp from direct sunlight which could be detrimental to them. Two days after, the fry were released into the pond proper by making narrow breaks on the dikes of the acclimation ponds.

On October 3, bangus fingerlings were seined from the holding pond of the BAC and held in bitinan installed in the secondary supply canal adjacent to the ponds. Fingerlings required in each pond were removed from the bitinan by a dip net and placed in 60 L buckets full of water. These were carried to the ponds immediately and the fish were stocked directly.

Results and Discussion

Handling of the shrimp was a critical aspect of the work. The method of acclimation was not successful. It was observed that aeration seemed to decrease mortality, shortening acclimation process to 1.5 hr increased stress; feeding with lab-lab reduced cannibalism but did not help alleviate stress; acclimation ponds were found useful.

The shrimps stocked in the pond had an average weight of 10 mg and an average length of 13 mm from the tip of the rostrum to the end of the extended telson. As a result of mortality during handling and acclimation, approximately 2,000 shrimp fry/

ha were stocked. The actual number of successfully stocked fry is unknown because many were weak and dying when released in the pond.

Bangus fingerlings with an average length of 14.9 cm and an average weight of 23.2 g were stocked at the rate of 208/pond. A day after stocking about 37 to 88% dead bangus were recovered. Samples of dead fish showed typical signs of bacterial disease syndrome describe in IFP-TR 4. Perhaps, handling contributed to severe mortality.

As a result of bangus mortality and unknown survival of shrimp fry, the experiment was considered ruined. Owing to the non-availability of additional shrimp fry from commercial sources at that particular time, it was decided that the experiment be terminated. The ponds were drained October 25, 1974. A total of 510 bangus were recovered but only 31 shrimps were accounted. They were hardly recovered from the ponds, because of their tendency to burrow in the mud. Seven shrimps had an average length of 6.5 cm and an average weight of 1.5 g. An average size bangus weighed 104 g with a total length of 22.7 cm.

This experiment was terminated due to the inavailability of the shrimp fry, Penaeus sp. Future plans to repeat this experiment using Penaeus monodon have been considered, since the fry could be readily available from SEAFDEC. There is also a higher market value for P. monodon and a wide commercial interest in the culture of this species.

FRESHWATER AQUACULTURE CENTER

4.Carp Polyculture in Fertilized and Unfertilized Ponds

Introduction

The culture of different fish species with different food habits in a pond at the same time is one way to increase fish production through efficient use of the culture environment. Different species of carp, for example, show particular promise for use in such polyculture systems. This experiment in the newly constructed ponds at the FAC was designed to learn what production could be expected from combined carp culture in ponds with and without the use of fertilizer. Such information should be useful in predicting yields and guiding management practices like stocking rate, length of culture and effectiveness of fertilizers. This experiment combined the plankton-feeding silver carp, *Hypophthalmichtys molitrix*; the omnivorous and benthos feeding common carp, *Cyprinus carpio*; and the herbivorous rohu carp, *Labeo rohita*.

Materials and Methods

The eight rectangular ponds used in this experiment were built from heavy clay soil found in the previously existing rice field. This was the first experiment to be conducted in these ponds. Exact pond areas were not measured until after the experiment was underway so inputs were based on the estimated 0.1 and 0.05 ha sizes of the different ponds. Mean water depth of the ponds was approximately 75 cm.

Four of the ponds were fertilized 14 days prior to stocking.

The other four ponds were to serve as unfertilized control ponds. However, even after a few days it was apparent that the fish in the control ponds were not growing well, therefore fertilization was begun on culture day 70 in two of these ponds to learn if fish growth would improve. Fertilizer inputs into the various ponds are summarized in Table 4.01. Chicken manure was broadcast first in a single application at approximately 1100 kg/ha to provide an organic base to support productivity in the new ponds. Subsequently, inorganic fertilizers high in phosphate were applied using platforms to sustain plankton growth. The inorganic fertilizer, 16-20-0 or 0-20-0 with each application approximately 50 kg/ha, was given when water visibility as measured with a Secchi disk exceeded 45 cm. The same general fertilizer treatment was used in other experiments at the FAC so a comparison with results from these other experiments was possible.

Fish were stocked on November 14, 1973 (culture day 0), at the sizes and numbers given in Table 4.02. Fish were contributed by the BFAR from its Tanay Farm and had been treated with formalin (15 ppm for 36 hr) as prophylaxis against ectoparasites upon arrival at the FAC. The stocking rates for silver and rohu carps were determined by the number of these fish that were available. Prior to stocking fish were held in Pond 2I from which they were distributed without draining. The number of fish remaining in that pond was only estimated. A sample of fish was seined from each pond monthly to estimate the growth rate of the fish. After weighing, the sampled fish were returned to their ponds. Ponds were drained and fish harvested from August 26 to August 28, 1974. The fish were in the experiment for 285 to 287 days.

Table 4.01 - Fertilizer applied to ponds with mixed carps at the Freshwater Aquaculture Center October 31, 1973 to June 28, 1974.

Treatment	Pond no.	No. of fertilizer applications	Total fertilizer applied (kg/ha) Chicken manure	16-20-0	0-20-0
Fertilized	2H	17	1053	729.0	94.8
	3I	21	1071	934.2	96.4
	4J	19	1124	879.3	101.2
	5K	21	1152	1005.1	103.6
Delayed fertilization	3H	15	1086	684.0	0
	4K	12	1160	574.2	0

Table 4.02 - Stocking information for carps stocked in ponds at Freshwater Aquaculture Center on November 14, 1973.

Treatment	Pond no.	Pond area (m^2)	Carps stocked				
			type	no.	mean wt. (g)	no/ha	kg/ha
Fertilized	2H	950	Silver	25	14.5	263	3.82
			Rohu	80	5.8	842	4.88
			Common	40	4.6	421	1.94
	3I	934	Silver	25	14.5	268	3.88
			Rohu	80	5.8	857	4.97
			Common	40	4.6	428	1.97
	4J	445	Silver	10	14.5	225	3.26
			Rohu	45	5.8	1011	5.87
			Common	20	4.6	449	2.07
	5K	434	Silver	10	14.5	230	3.34
			Rohu	45	5.8	1037	6.01
			Common	20	4.6	461	2.12
	4K	431	Silver	10	14.5	232	3.36
			Rohu	45	5.8	1044	6.06
			Common	20	4.6	464	2.13
Delayed Fertilization	3H	921	Silver	25	14.5	271	3.94
			Rohu	80	5.8	869	5.04
			Common	40	4.6	434	1.99
No fertilizer	2I	962	Silver	42*	14.5	437*	6.33*
			Rohu	126*	5.8	1310*	7.60*
			Common	267*	4.6	2775*	12.77*
	5J	442	Silver	10	14.5	226	3.28
			Rohu	45	5.8	1018	5.90
			Common	20	4.6	452	2.08

*Estimate based on the 87% average survival from other ponds.

Results and Discussion

Growth curves for fish in each pond are presented in Figure 4.01. Fish grew most in the fertilized ponds and least in the unfertilized ponds. The addition of fertilizer to the two previously unfertilized ponds starting on culture day 70 resulted in accelerated fish growth. Common carp in the fertilized ponds appeared to have reached carrying capacity when fish reached a mean weight of 500 to 800 g.

Harvest results are given in Table 4.03. Mean net production was 1080 kg/ha in ponds fertilized from the beginning, 841 kg/ha in ponds receiving delayed fertilization and 222 kg/ha in ponds without fertilization. The mean net productions in both treatments with fertilization were significantly higher (P .05) than that from unfertilized ponds. The amounts of fertilizer needed to produce one kilogram more fish compared with that in the unfertilized ponds were 1.3 kg chicken manure and 1.1 kg inorganic fertilizer in the ponds fertilized from the beginning and 1.8 kg chicken manure and 1.0 kg inorganic fertilizer in the ponds receiving delayed fertilization.

Data from similar experiments (IFP-TR 5) were used to make the comparison presented in Table 4.04. The validity of this comparison is limited because of different stocking rates, duration of the culture and amounts of fertilizer applied. The potential for high production and income using mixed carp species is still apparent. Further experiments are needed to establish the best stocking rates, species combinations and optimum returns from fertilizer inputs.

Table 4.03 - Harvest information for carps taken from pond at Freshwater Aquaculture Center August 26 to 28, 1974.

Treatment	Pond no.	Pond area (m^2)	Kind	no.	mean wt.	no/ha	kg/ha	net* kg/ha	survival %
Fertilized	2H	950	Silver	24	1931.1	253	487.86	484.04	96
			Rohu	70	818.5	737	603.11	598.22	88
			Common	40	604.4	421	254.48	252.55	100
	3I	934	Silver	25	1670.5	268	447.14	443.25	100
			Rohu	72	608.8	771	469.31	464.34	90
			Common	38	672.8	407	273.73	271.76	95
	4J	445	Silver	6	1900.9	139	256.30	253.04	60
			Rohu	42	463.3	944	437.27	431.41	93
			Common	17	504.6	382	192.77	190.70	85
	5K	434	Silver	10	1895.3	230	437.71	433.36	100
			Rohu	22	518.4	507	262.78	256.77	49
			Common	17	617.1	392	241.77	239.60	85
Fertilized (delayed)	3H	921	Silver	25	1547.8	271	420.14	416.21	100
			Rohu	79	432.4	858	370.90	365.86	99
			Common	34	404.8	369	149.44	147.44	85
	4K	431	Silver	7	1265.1	162	205.47	202.10	70
			Rohu	42	371.9	974	362.41	356.35	93
			Common	19	445.8	441	196.52	194.39	95
Unfertilized	2I	962	Silver	37	241.4	385	92.85	86.52	-
			Rohu	110	65.7	1143	72.12	67.52	-
			Common	232	16.4	2412	39.55	26.78	-
	5J	442	Silver	8	523.0	181	94.66	91.38	80
			Rohu	41	142.3	928	131.99	126.09	91
			Common	14	150.3	317	47.61	45.53	70

*Net production is harvest weigh minus stocking weight.

Table 4.04 - Mean net production of different fishes cultured in new ponds at the Freshwater Aquaculture Center using combined organic and inorganic fertilization.

	No. of ponds	Estimated net production (kg/ha/yr)	Estimated value (₱/kg)	Estimated Gross income (₱/ha/yr)	Fertilizer input (kg)*	
					organic	irorganic
Milkfish	2	1007	5	5035	5.4	1.2
Common carp	2	832	5	4160	3.1	1.4
Hito	2	209	8	1672	10.5	7.1
Mixed carps	4	1374	4	5496	1.3	1.1

*Amount of chicken manure (organic) and 16-20-0 or 0-20-0 NPK (inorganic) fertilizers applied for each kilogram of fish harvested more than in unfertilized control ponds.

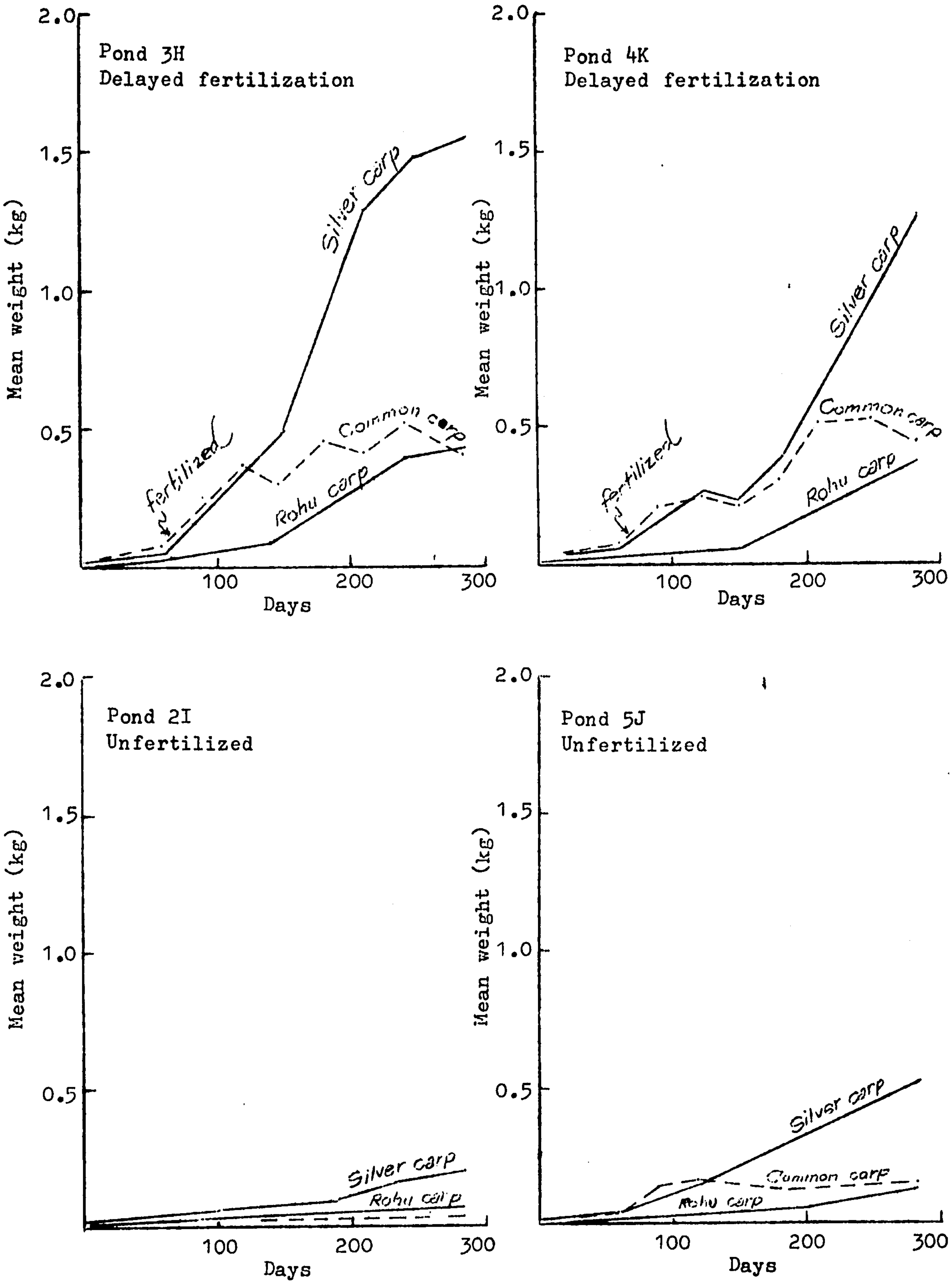


Figure 4.01 - Growth curves of carps in ponds at the Freshwater Aquaculture Center based on periodic sampling.

5. Rice-Fish Culture: Production of Rice IR-26 and Tilapia

Ten plots, each about 180 m^2, were constructed in riceland near the FAC ponds in which a trench 1.0 m across and 0.4 m deep was dug along the center of each plot. The trench permitted fish to move along the length of the plot and forage easily into the shallow water around the growing rice. Seedbed of IR-26 was started on February 22, transplanting took place March 22 to 25. The planting and fertilization system followed IRRI recommendations. Fish were stocked April 8 to 16 as given in Table 8.03 in TR-No. 5. The experiment was intended to evaluate tilapia and freshwater shrimp production in the rice plots.

Harvest of the palay and fish took place the first half of July. Palay and fish harvest results are presented in Tables 5.01 and 5.02. Both palay and fish yields were considered encouraging though most of the fish production was of small tilapia resulting from reproduction. It was also apparent that paddy dikes were not effective in retaining water well during the experiment. It is recommended that future rice-fish experiments build more substantial dikes and that water entering or leaving the plots be carefully screened to prevent loss of fish or contamination by unwanted fish. In retrospect we know that two species of tilapia, *Tilapia mossambica* and *T. zillii*, were stocked. Future experiments with tilapia should control the species used and seek ways to either limit fish reproduction or use rice fields as nurseries for fish seedling production.

Table 5.01 - Harvest information from ten plots in rice-fish culture experiment at FAC, July 1974.

Plot no.	Area (m^2)	No. hills	Tillers/hill[1]	No. white heads	No. missing hills	No. hills rat damaged	No. hills too green	Kg/palay	Kg/ha	Cavans/ha[2]
1	171	3,268	17.1	118	5	38	0	60.0	3509	79.7
2	171	3,120	15.9	118	7	46	0	54.5	3187	72.4
3	181	3,608	17.2	213	0	78	0	59.0	3260	74.1
4	180	3,010	14.5	236	0	47	0	43.0	2389	54.3
5	179	3,120	23.9	248	0	39	0	85.0	4749	107.9
6	177	3,157	16.9	323	0	84	0	48	2712	61.6
7	178	3,441	16.2	315	0	78	0	74	4157	94.5
8	175	3,219	20.6	323	0	153	0	47	2686	61.0
9	179	3,780	21.0	264	0	43	0	70.5	3939	89.5
10	180	3,360	17.5	336	0	63	0	45.5	2528	57.4
Mean	177	3,308	18.1	249	1	67	0	58.7	3312	75.2

1/Mean for sample of 20 hills

2/Cavan = 44 kg palay sun dried to about 13% moisture

Table 5.02 - Fish harvest from ten rice-fish culture plots at FAC, July 1974.

Plot no.	Tilapia				Shrimp		Total weight	
	Large*		Small*					
	no.	weight (g)	no.	weight (g)	no.	weight (g)	kg	kg/ha
1	36	1755.0	469	81.3	11	8.0	1.844	107.9
2	26	867.4	1900	2500.0	0	-	3.367	196.9
3	35	1216.2	1575	2000.0	245	162.5	3.379	186.7
4	1	19.4	173	170.6	0	-	0.190	10.6
5	32	1446.3	1200	2500.0	604	464.4	4.411	246.4
6	21	789.1	1810	2250.0	0	-	3.039	171.7
7	15	518.0	2570	4750.0	0	-	5.268	296.0
8	28	1590.2	1447	3000.0	0	-	4.590	262.3
9	33	1625.7	715	123.3	0	-	1.749	97.7
10	23	604.8	1115	2000.0	0	-	2.605	144.7
Mean of Stocked plots	28	1157	1422	2133.8	-	-	3.361	190.0

*Large fish were those + 15 g, small fish were 15 g or smaller.

6. Rearing of Milkfish Fry in Nylon Net Enclosures (Bitinan)

Introduction

The low survival of milkfish fry in nursery ponds is a major problem of fish farmers. The use of nylon net enclosures facilitates fry recapture, provides protection from predators and eliminates use of nursery ponds. This work was conducted to determine survival and growth of milkfish fry in nylon net enclosures at different densities.

Materials and Methods

Six enclosures were placed in a 0.1 ha pond, 6 m apart starting from the water supply pipe to the drainage pipe. There were two enclosure lengthwise alignment across the pond. The four corners of the top and bottom of each enclosure were tied to bamboo poles so the nets were suspended approximately 10 cm above the pond bottom. The fine mesh (13 meshes per cm^2) nylon net, were sewed on the seams and when hang look like an inverted mosquito net.

On June 10, milkfish fry purchased from Dagupan, Pangasinan were transported to the FAC in oxygenated plastic bags at 2,000 fry/bag containing about 10 liters of 15 ppt brackishwater. Upon arrival to the station, the fry were allowed to rest for 1 hr, then acclimatized to freshwater in concrete circular tanks for 1 day. During the acclimatization period the fry were fed with zooplankton (Cladocera) collected with a plankton net from the FAC ponds. After 24 hrs, the fry were counted and stocked in the net enclosures with two replicates for each of the following densities: 500, 1000 and 2000 per m^3 of water. Assignment of densities to individual net enclosure was done at random. The mean weight and length of fry was 0.005 g and 13 mm, respectively at stocking.

Results and Discussion

Milkfish fry recovery and production from June 11 to July 5, 1975 are presented in Table 6.01. From this table the following are apparent: (1) there was no growth difference at densities of 1,000 to 2000/m^3, although production at density 2,000/m^3 was higher than 1,000 m^3; (2) fish growth with plankton was good with fertilization, growth was on the average 9.5 g at 500/m^3 and 0.95 g at 1,000/m^3 and 2,000/m^3; (3) fingerlings raised in net enclosures had narrow size ranges; (4) fry recovery was 64 to 99%.

After July 5, the milkfish fingerlings were further held in net enclosures for 48 days without additional pond fertilization. This time, there was no definite fish density and net enclosures arrangement followed; pond water level fluctuated from 60-80 cm due to occasional heavy rain from July 5 to August 22. Though not in the experiment anymore, the following observation (Table 6.02) are worth mentioning: (1) recovery of fingerlings was poor, probably because of the presence of Tarpon, *Megalops cyprinoides* a predator accidentally stocked with the fingerlings and low net enclosure vertical clearance (21 to 25 cm) or height of enclosure outside water surface, (2) there was practically no fish mortality in transfer of fry from net enclosure to the production pond.

Results of this work seemed encouraging but to this point no conclusion can yet be made.

Recommendations

To maximize recovery of milkfish fingerlings reared in *bitinan*, the following are suggested:

1. *Bitinan* should be doubly-sewn at seams with nylon thread to make it more durable. Cotton thread deteriorates faster.

2. Predators should be eliminated from milkfish stocks before putting them in *bitinan*.

3. Nets with larger mesh size, depending on size of fish to be stocked, may provide better entrance of food organisms and better circulation of water in *bitinan*.

4. To prevent fish escape, the suggested *bitinan* vertical clearance from water surface should be not less than 30 and 50 cm for fish with size ranges of 13-37 mm and 38-60 mm, respectively.

5. Experiments to test effect of mesh size, pond fertilization, spacing between *bitinan* and density of plankton inside and outside the *bitinan* need to be carried out.

Table 6.01 - Recovery and Production of milkfish fry reared in bitinan from June 11 to July 5, 1974 after 23 culture days at the FAC.

Bitinan No.	No. fish stocked m^2	No. fish stocked m^3	No. of fish recovered m^2	No. of fish recovered m^3	% recovered	Mean length at harvest (mm)	Mean weight at harvest (g)	Length range (mm)	Production (g) m^2	Production (g) m^3
1	250	500	218	435	87*	49	1.0	42-55	218	435
2	500	1,000	481	961	96	36	0.5	38-56	241	481
3	1,000	2,000	638	1,275	64*	37	0.5	35-38	319	638
4	250	500	226	452	90	47	0.9	39-58	204	407
5	500	1,000	495	990	99	37	0.5	33-55	248	495
6	1,000	2,000	828	1,656	83*	38	0.5	35-42	414	828

*Net partially destroyed at harvest.

Table 6.02 - Milkfish recovered in bitinan after 48 days without additional fertilization from July 5 to August 22, 1974 at the FAC.

Bitinan no.	Bitinan Clearance (cm)	No/m^3	Stock $\bar{X}$ wt (g)	$\bar{X}$ l (mm)	No/m^3	% Harvest recovered	$\bar{X}$ wt (g)	$\bar{X}$ l (mm)	l (range)	Remarks
1	21	887	1.0	48	53	6	5.0	83	55 - 103	2 tarpons* present; net intact
2	24	961	0.5	36	279	29	1.7	57	50 - 63	one tarpon present; net intact
3	30	1,895	0.5	37	250	13	0.8	45	40 - 55	3 tarpons present; net intact
4	50	2,981	0.5	37	2,146.3	72	1.4	50.1	45 - 58	no tarpon, but net partially destroyed on one side

*Megalops cyprinoides with average weight of 27 g.

7. Clarias batrachus Natural Reproduction

Clarias batrachus fry imported from Thailand grew to breeder size in a FAC holding pond from November 11 to April 23, 1974. In an attempt to make the fish spawn in natural pond condition, a separate breeding pond was provided with variety of nest types. This work will test if the fish will use the nests or whether there is preference of one type over the other.

While drained, a 500 m^2 pond was prepared by providing it with different types of spawning nest such as tin cans, wooden boxes, clay pots and horizontal holes on the perimeter dikes. The earthen holes were 10-20 cm above the pond bottom. All the nest types, had basic dimensions of 20 cm opening and 25 cm deep. There were six of each kind and about 3.5 m apart. Each nest site was marked with stakes for easy identification. Pond water was maintained at a mean water level of 70 cm and fertilized every two weeks with chicken manure at 500 kg/ha dry weight basis.

On April 24, 1974, Clarias batrachus raised for 164 days at the station from fry (0.7 g) to breeders size and from some donated by Mr. A. Nava, a commercial fishpond manager, from Nampicuan, Nueva Ecija were stocked in the prepared breeding pond. The fish from the latter source were of unknown age. There were 18 females and 32 males stocked with a mean weight of 217 g and 262 g respectively. Identification of sex was done by examination of the genital papilla, rounded for the female and pointed for the male. Beginning the second week, the nest were inspected daily for possible spawning and nest preference. A fine mesh seine (7 meshes per cm) was dragged across the pond every week to ckeck presence of fry.

Results and Discussion

On June 15, the earthen nest had increased in number from original 6 to 14 and all had smooth slimmy inner surface, while the other nest types were filled with a handful of mud. The man-made earthen nest did not increase in depth but its opening had widen from 20 to 25 and 35 cm, probably due to erosion. However, the fish-built nest had a 15-25 cm opening, were 20 to 50 cm deep and were 30 to 40 cm below the water surface or 30 to 40 cm above the pond bottom. All the fish built nest holes, were horizontally located along the perimeter dike, and had narrow opening but deeper than the man-made nest.

On July 3, ten female breeders were captured and examined externally. Though all females were distinctly gravid, only five females had pinkish genital pores. No fry was collected when a fine mesh seine was dragged across the pond.

On July 15, with use of a seine net, Clarias batrachus fry were collected, an evidence of spawning. Results of fry recovered alive are given in Table 7.01. On October 24, pond was completely drained. Only 6 females with a mean weight of 327 g and 6 males with mean weight of 352 g were recovered out of 18 females and 22 males initially stocked. Egg samples from 6 females were collected and preserved in Bouins solution for histological sectioning. The six pairs were transferred to a holding pond for future brood stock.

Considering weather conditions, there was heavy rainfall from July 6 to 8 at FAC. Rainfall record at CLSU Weather Laboratory was on the average 55 mm. Rainfall is mentioned here because it might be an stimulus to spawning.

Clarias batrachus fingerlings were recovered in neighboring ponds. In one adjacent pond where no breeders were stocked, 3,064 fingerlings were caught. The breeders which produced this fingerlings certainly had been a part of the 12 females and 16 males missing in the hito breeding pond and had migrated to the neighbor ponds.

Conclusion

Clarias batrachus at about 6 months, attained maturity and can easily reproduce in the FAC from June to October. It seemed that earthen nest are preferred over other nests and fish make their own nests. Egg masses were not collected possibly because of lack of proper timing or skill in searching for it. Escape of fish breeders were apparent.

Recommendation

Further work on means of preventing brood fish escape, account for fry recovery per pair, ration of male to female breeder, proper timing to expect cluster of fry, brooder stocking density are suggested.

Table 1 - Summary of *Clarias batrachus* fingerlings and post fingerlings recovery as a result of reproduction in a pond from July 15 to October 24, 1974, at the FAC.

Date	No.	Mean wt. (g)
July 15	2,151	2.1
22	885	2.4
29	628	-
Aug. 1	570	0.2
16	1,007	-
Oct. 24	1,331	40

8. Pond Culture of Sex-Reversed *Tilapia mossambica* and *Tilapia zillii* Treated with Ethynyltestosterone

Introduction

Sex reversal is one method that has been applied for the control of over reproduction in tilapia. The production of all-male tilapia through sex reversal utilizing synthetic hormones such as methyltestosterone and ethynyltestosterone has been achieved in *T. mossambica* and *T. aurea*, respectively. The method has the advantages of being less laborious and more effective than the manual sexing method. In the absence of suitable species of *Tilapia* for hybridization (e.g. *T. hornorum*) to produce all-male hybrids, sex reversal may be practical for commercial culture of tilapia. This work was conducted to determine effectiveness of sex reversal treatment using ethynyltestosterone on *T. mossambica* and *T. zillii*.

Materials and Methods

Fry of *T. mossambica* and *T. zillii* were collected with a dip net from breeding ponds of the FAC containing the two species. The fry, measuring 9-11 mm total length were transferred into 260-liter circular concrete tanks with 500 fry per tank and acclimated for 24 hours before feeding.

Treated feed contained 50 mg ethynyltestosterone per kilogram of feed (30% fish meal, 40% rice bran and 30% of brewer's yeast). Fry were fed 12% of body weight divided into three portions and fed three times daily, six days a week for the first two weeks and 10% of body weight for the rest of the treatment period using four styrofoam feeding rings per tank. When fry measured 19 mm total length, treatment was ended.

Following treatment, fry were stocked in three approximately 500-m^2 earthen ponds at the rate of 5,000/ha for two ponds (4G, 5G) and 7,000/ha in one (5H). Two other 500-m^2 ponds (4H, 6H) were stocked with control fry at 5,000/ha. Control fry were held in concrete tanks and fed with untreated feed at the same rate and duration as treated fry.

Fish were harvested after a 120-day culture period in the ponds fertilized biweekly with 16-20-0 at 50 kg/ha using fertilizer platforms. Fifty fish per pond were randomly selected, sexed by means of the genital papilla and weighed. Reproduction recovered from each pond was evaluated for total weight.

Results and Discussion

Fry of *T. mossambica* and *T. zillii* were inadvertently mixed in one control pond (4H) and in one pond (5G) stocked with treated fish. In the collection of fry from breeding ponds, no distinction was possible between *T. mossambica* and *T. zillii* fry. The two species were mixed when transferred into the concrete tanks. No difference in the fry of the two species was recognized upon stocking in ponds.

Treatment of fry in tanks lasted for 40 days. Total length of fry averaged 20.9 mm after treatment. Based on sex ratios and reproduction, sex reversal for all-male fish was apparently induced in *T. mossambica* but not in *T. zillii* (Table 8.01). Growth of treated *T. mossambica* was greater than that for untreated fish (Table 8.02). Survival of fish in ponds ranged from 75-96%. Fish in pond 5H stocked at 7,000/ha had the lowest mean weight and survival.

Table 8.01 - Sex ratios and reproduction of *T. mossambica* and *T. zillii* cultured in ponds for 120 days.

Pond	Treatment	Species	Sex ratio (Female:male)	Reproduction (kg)
4H	Control	*T. mossambica*	1:1.3	0
		T. zillii	1:1.8	0.249
6H	Control	*T. zillii*	1:2.1	0.021
4G	Sex reversal	*T. zillii*	1:1.1	0.244
5G	Sex reversal	*T. mossambica*	0.:50	0
		T. zillii	1:2.1	1.208
5H	Sex reversal	*T. zillii*	1:4.1	0

Table 8.02 - Pond stocking, recovery and mean weights of *T. mossambica* and *T. zillii*.

Treatment	No. fry stocked	Species	No. fish recovered	Mean weight (g)
Control	245	*T. mossambica*	30	84.5
		T. zillii	170	52.8
Control	248	*T. zillii*	215	66.3
Sex reversal	249	*T. zillii*	195	61.4
Sex reversal	248	*T. mossambica*	181	148.9
		T. zillii	60	101.0
Sex reversal	344	*T. zillii*	258	34.8

Treated *T. mossambica* fry resulted in 100% males while 15 of the 30 untreated *T. mossambica* recovered were females. There was no reproduction of *T. mossambica* in ponds stocked with the species. There seemed to be no difference between the sex ratios of treated and untreated *T. zillii*. Mean weight for *T. zillii* was highest in pond 5G. This increase in weight is probably because of the low number of *T. zillii* in the pond and not as a result of sex reversal.

Reproduction of *T. zillii* was found in four of the five ponds. No reproduction was found in Pond 5H apparently because of stunted growth with high fish density. However, no reason is evident for the absence of *T. mossambica* reproduction in pond 4H where large size fish of both sexes were recovered.

A study to confirm achievement of sex reversal in *T. mossambica* is needed. Mating of a sex reversed male with a normal female should produce all-female progenies. Treatment of *T. zillii* was probably ineffective because of a possible difference in fry development compared to *T. mossambica*. Future experiments on sex reversal should ensure identity of fish species for treatment.

9. Bangus Length-Weight Study

Analysis of bangus length-weight data has been completed. A manuscript covering the analysis has been circulated to 5 American fishery scientists for their comments. The manuscript is now being revised and will soon be submitted for publication. The overall regression equation for 6,304 fish was $\log W = -5.0463 + 2.98895 \log L$. A table giving calculated weights at different lengths was already presented in TR-4.

10. Cage Culture of Male and Female *Tilapia mossambica* with and without Supplementary Feeding in a Fertilized Pond

Introduction

Culture of fish in cages has value in flowing water systems and large bodies of water such as lakes and reservoirs where construction of fishponds is not practical. Fishes such as tilapia and common carp have been cultured in cages with high production.

Cage culture of fish has the advantages of economy of cage construction, easy recovery and inventory of fish, and portability of cages. The disadvantages are susceptibility of fish to disease because of crowding and the need for artificial feeding.

Studies on the culture of tilapia in cages have not considered differences in growth of the sexes. In *T. mossambica* the males are faster growing than the females. Culture of males only in ponds has resulted in higher production compared with females only and mixed sexes.

The use of high-protein complete feeds for tilapia in cages is costly. Supplementary feeding of T. mossambica with a low-protein, economical feed to augment natural food in a fertilized pond could increase yield and lower feeding cost.

This experiment was conducted to compare the growth of males and females of T. mossambica in cages with and without supplementary feeding in a fertilized pond.

Materials and Methods

Eight cages measuring 1 m^3 each and with ¼ in mesh wire screen were placed in a 1000 m^2 pond with a distance of 5 m between cages. The cages were set on hollow blocks which were approximately 10 cm high to prevent the cages from touching the pond bottom. Average depth of the pond was 60 cm.

Four cages were each stocked with 100 male T. mossambica, measuring 8-10 cm total length and with mean weight of 10.4 g. The other four cages were each stocked with 100 female T. mossambica, 8-10 cm total length and mean weight of 10.6 g.

Two cages for each of the following treatments were used: males with supplementary feeding, males without supplementary feeding, females with supplementary feeding and females without supplementary feeding. Fed fish were given bulgur wheat (13% protein) at 5% of body weight daily divided into two portions given in the morning and afternoon, 6 days a week. Cages with fed fish were provided with feeding trays. Feeding rates were adjusted every two weeks based on sampling of 20% of total fish per cage.

The pond with mixed sex T. mossambica outside the cages was fertilized biweekly with 16-20-0 at the rate of 50 kg/ha using a fertilizer platform. Fish were cultured for 2 months, October - November, 1974. Lengths, weights and survival of fish in each cage were evaluated at termination of the study.

Results and Discussion

Mean net weights of male T. mossambica given supplementary feed and without were higher than those of females with and without supplementary feeding (Table 10.01). Males and females given supplementary feed had slightly higher mean net weights compared with corresponding sexes without feeding. These suggest the benefit of supplementary feeding of T. mossambica in fertilized ponds provided cost is not prohibitive. Survival of both sexes in cages after two months in all treatments was generally high (92-100%).

Table 10.01 - Summary of T. mossambica production in cages.

Treatment	mean length (cm)	mean net weight (g)	net production g/cage/day
Males with feeding	11.5	25.0	41.6
Males without feeding	11.3	21.7	33.3
Females with feeding	10.3	9.7	16.0
Females without* feeding	10.0	6.3	10.3

*Data from one cage only.

Unfed T. mossambica males had a mean net weight of 21.7 g after the 60-day culture period. With a survival of 92% this meant a total net gain of about 2 kg/cage for two months or an average of 33.3 g/cage/day. Since no supplementary feed was given, increase in fish weight is attributable alone to food sources in the pond water.

Faster growth of males compared to females is attributed to inherent factors, i.e. genetic, rather than environmental conditions. Results of this study indicated that males of T. mossambica apparently utilized planktonic food in the pond and probably bulgur wheat better than females.

A female T. mossambica, 10.0 cm total length, with sac fry in its mouth was found in one of the cages stocked with only males. This female was inadvertently stocked in the cage. Another female mouthbrooding eggs was recovered in a cage with only females. It is believed that males outside the cage probably spawned with this female. These strongly T. mossambica demonstrated that T. mossambica is capable of breeding in cages at a density of 100 fish/m^2. One cage stocked with females was overturned by strong winds during a typhoon after 45 days of culture.

11. Monosex Culture of Male and Female *Tilapia mossambica* in Ponds at Three Densities

Introduction

The cichlid, *Tilapia mossambica* is one of the important fishes for pond culture in many parts of the world. Mainly feeding on plankton, *T. mossambica* grows fast, matures early and breeds frequently. A major obstacle in tilapia culture is overpopulation which results in stunted growth and low yields of harvestable-sized fish.

Several methods have been applied to control unwanted reproduction of tilapia in ponds. One method is monosex culture of the species involving the growing of only one sex. Production of all-male tilapia can be achieved by manual sexing, hybridization or sex reversal.

Sexual dimorphism in size among *Tilapia* species is well known. Males of *T. mossambica* grow faster than females. Culture of *T. mossambica* males only instead of mixed sex populations for obtaining harvestable-sized fish has been suggested.

Few studies on monosex culture of tilapia have been conducted. This experiment compared the monosex culture of male and female T. mossambica in fertilized ponds at three stocking rates.

Materials and Methods

Six earthen ponds approximately 500-m^2 each were used. Fish from the FAC breeding ponds used for stocking measured 11-13 cm total length, with weight of 11.9-13.0 g for males and 11.0-12.0 g for females. Sexing was done manually by examination of the genital papilla.

Three ponds were stocked with *T. mossambica* males in July, 1974 at rates of 2,000/ha, 7,000/ha and 10,000/ha with one rate per pond. Females were stocked at the same rates in the other three ponds.

All ponds were fertilized weekly with 16-20-0 at 45 kg/ha using fertilizer platforms. Twenty fish were sampled per pond by means of a ¼-in (stretched mesh) seine 30 days after stocking. Fish were harvested after 60 days and measured for total length and body weight. Survival, sex ratio, and reproduction of experimental fish in each pond were also evaluated.

Results and Discussion

Growth of *T. mossambica* males was greater than that of females at all stocking rates after two months (Table 11.01). Males reached harvestable size (50 g or heavier) after 30 days at 2,000/ha and 10,000/ha. Growth of males was lower than that of females at 7,000/ha after 30 days.

Table 11.01 - Mean weights (g) of male and female of *Tilapia mossambica* grown in separate ponds at three stocking rates for 60 days.

No. of days from stocking	Stocking rate 2,000/ha		7,000/ha		10,000/ha	
	male	female	male	female	male	female
0	11.9	11.6	13.0	12.2	12.1	11.0
30	100.0	27.3	30.0	52.5	57.5	37.5
60	121.1	26.9	83.1	50.3	83.4	31.5

The pond where males were stocked at 7,000/ha was observed to be turbid and had an abundance of Elodea sp. When drained at termination of the study, it was found to contain four *Cyprinus carpio*. These factors probably contributed to the slower growth of males in this pond during the first 30 days. Growth of males in the same pond, however, exceeded that of females after the next 30 days.

Growth of females decreased slightly after 30 days of culture at all stocking rates. The sharpest decline in growth was in the pond stocked at 10,000/ha.

Contamination with the opposite sex occurred in all ponds. This was attributed primarily to human error in stocking of either males or females.

Survival of males was lower at all stocking rates compared to females (Tables 11.02 and 11.03). Survival rate of males was highest at 10,000/ha (78%) and lowest at 7,000/ha (39%). These indicate that an increase in density may not be the cause of low survival. Handling stress is probably one cause of mortality in males stocked at 2,000/ha and 7,000/ha in our study.

The highest net production of harvestable-sized fish (530 kg/ha) was attained with males at 10,000/ha (Table 11.02). A sex ratio of one female to seven males was found in the fish population of this pond at harvest and weight of reproduction, 3-12 cm total length, was the least (1.1 kg) compared to the other five ponds.

The highest amount of reproduction was found in the pond stocked with females at 2,000/ha (Table 11.03). Net production of 12 kg/ha harvestable size fish in this pond was lowest of all treatments. The sex ratio of fish at harvest was nine females to one male. Reproduction in the ponds was observed to be light up to 30 days after stocking and heavy thereafter.

Results of this study demonstrate the faster growth of male *T. mossambica* over the female. Although monosex culture of either sex was not achieved because of human error in manual separation of the sexes and other possible sources of contamination, reasonably high yields of harvestable size fish were attained with males at all stocking rates.

The probability of obtaining higher reproduction in a predominantly female *T. mossambica* population is greater than in a predominantly male one. This study also suggests the detrimental effect of reproduction on growth of females.

Table 11.02 - Summary of production in ponds stocked with male *T. mossambica* after 60 culture days.

Item	Stocking rate		
	2,000/ha	7,000/ha	10,000/ha
No. of fish stocked	102	350	500
Percent survival	61	39	78
Mean length (cm)	19.1	16.4	16.6
Net production (kg/ha) of harvestable size fish	108	126	530
Sex ratio (female: male) of population at harvest	1:6	1:22	1:7
Weight of reproduction (kg)	19.0	1.4	1.1

Table 11.03 - Summary of production in ponds stocked with female *T. mossambica* after 60 culture days.

Item	Stocking rate		
	2,000/ha	7,000/ha	10,000/ha
No. of fish stocked	102	350	500
Percent survival	77	63	93
Mean length (cm)	11.7	14.8	12.4
Net production (kg/ha of harvestable size fish	12	108	166
Sex ratio (female: male) of population at harvest	9:1	30:1	18:1
Weight of reproduction (kg)	31.9	12.9	17.5

12. Culture of Male *Tilapia mossambica* with Rice IR-26

Introduction

A trial on rice-fish culture was conducted at the FAC during the rainy season to obtain more information on the following:

1. If increased trenching would result in increased fish yield.
2. If male *Tilapia mossambica* would reach a marketable size (50 g) in rice plots during a single culture period.
3. If a higher stocking rate would result in the same fish growth and higher production.

Materials and Methods:

Twelve test plots each about 200 m^2 were reformed from the previous rice-fish trial. A trench 1 m wide by 0.4 m deep was constructed along the periphery of 6 plots. A single trench across the middle was constructed in each of the remaining 6 plots. The area occupied by trench and not planted to rice was 23% with the peripheral trench and 10% with the center trench of the total plot area.

Seedlings of IR-26 were grown in a rice paddy and transplanted on August 15 through August 18, 1974, after 22 to 25 days from seeding. Before transplanting fertilizer was broadcast at the rate of 150 kg/ha 16-20-0 (ammonium phosphate) and 75 kg/ha 45-0-0 (urea) in each of the plots. Two or 3 seedlings per hill were planted with a distance of 20 cm between hills and 25 cm between rows. All plots received herbicide treatment of granular 2,4-D at the rate of 25 kg/ha five days after transplanting. Wild fish such as dalag and tilapia were eliminated with the application of Gusathion at the rate of 24 ppb active ingredient in each of the plot on September 2, 1974.

The fish used in the experiment were male Tilapia mossambica, with an average length and weight of 8 cm and 15 g, respectively. Sexing was done by hand sorting and visual inspection of genital papillae. Fish were stocked on September 10, 1974. Stocking rate was 33 fish in each of 6 plots. (3 plots with peripheral trench and 3 plots with a center trench design) and 66 fish in each of the remaining 6 plots. A screen was provided in the water inlet-outlet of each plot to prevent the entry or exit of fish.

Missing rice hills were replaced during the first two weeks of culture. Water level in the rice plots was maintained at 3 to 6 cm throughout the culture period. At booting stage, (45 to 60 days after transplanting), 45-0-0 (urea) was applied at the rate of 75 kg/ha as top dressing. Rat bait with poison was maintained at strategic points in the experimental area from the rice tillering stage to harvest. Fish were harvested in all plots on December 3 and 4, 1974, after 84-85 days of culture. Rice was harvested on December 11 through 17, 1974, or 125 to 130 days after seeding.

Results and Discussion

The results of rice harvest are presented in Table 12.01.

The average yield per plot was 31.6 kg (36.0 cav/ha) clean palay. The yield is based on total area and would be greater if corrected for area not planted in trenches or paddy dikes. Palay harvest averaged 298 kg/ha (17%) less in the plots with a peripheral trench than those with a center trench. During the tillering stage whorl maggot infestation was apparent in 5, 6, 7 & 8 but damage was minimal. Plants were able to recover. Brown plant hoppers and green leafhoppers caused some dead hearts among the tillers. Stemborer damage resulted in some unfilled white heads in all plots. However, overall damage of insects was considered minimal compared to damage in the surrounding areas planted to rice. During the culture period a series of seven typhoons caused overflooding in Plot 11 which may have resulted in the mixing or loss of stocked fish.

Fish stocking and harvest data are presented in Table 12.02. Many small tilapia occurred in 7 of the 12 plots indicating that hand sorting was not completely effective in identifying female fish and stopping reproduction. Besides giving lower palay yields, the peripheral trench system failed to produce fish as well the center trench system. Mean total fish production was 78.4 kg/ha in the plots with center trench and 59.8 kg/ha in the plots with a peripheral trench. This was in spite of the unusually low return in Plot 11 which had a center trench. Further experiments are needed to learn if even smaller amounts of trenching than the 10% area taken in the center trench design would be advantageous.

The mean total yield was 94 kg/ha in plots at the higher stocking rate and 44 kg/ha in plots at the lower stocking rate. However, stocking higher numbers resulted in a greater chance of introducing a female and having reproduction. Five of the 6 plots at the higher rate had reproduction while only 2 of the 6 plots stocked at the lower rate had reproduction. Also, stocked fish had an unweighted average of only 33.7 g at harvest in the plots at the higher stocking rate and 39.9 g in the plots stocked at the lower rate. In neither case did the fish grow to a size that would be good for marketing as fresh fish. The best use of rice fields for tilapia production probably lies in finding a way to utilize many small fish rather than attempting to produce a few large fish.

Table 12.01 - Rice harvest results from 12 plots grown at the Freshwater Aquaculture Center from August to December 11, 1974.

Plot no.	Area (m^2)	Area planted to rice m^2	No. hills	Tillers per hill	No. Whitehead	No. Missing hills	No. hills rat damage	No. hill too green	Dry wt. palay kg	kg/ha	cav*/ha
1	204	129	2774	21	1442	2	0	0	36.1	1770	40.2
2	205	131	2759	20	2074	0	0	5	28.0	1366	31.0
3	201	151	3282	23	1599	1	0	4	39.4	1960	44.5
4	204	164	3360	17	2076	7	0	3	29.7	1456	33.1
5	205	128	2728	23	1778	3	0	0	29.7	1449	32.9
6	197	133	2697	20	1324	9	0	43	22.0	1117	25.4
7	206	164	3474	24	2223	7	0	264	33.2	1612	36.6
8	197	167	3533	22	1437	5	0	0	33.8	1716	39.0
9	201	126	2728	24	1222	0	0	33	29.0	1443	33.0
10	196	131	1610	22	848	2	0	0	29.0	1479	33.6
11	188	176	3471	21	1482	0	2	10	36.1	1920	43.6
12	192	158	3324	22	1640	2	1	0	33.6	1750	39.7
mean	199	147	3061	21	1595	3	.25	30	31.6	1587	36.0

*Computation of yield/ha based from the area of entire plot.
One cavan weighs 44 kg (dry) palay.

Table 12.02 - Stocking and harvest data of fish grown in 12 rice plots at the Freshwater Aquaculture Center from September 10 to December 3, 1974.

Plot no.	Trench constructed*	Area m^2	No. stocked	Ave. size of stocked fish at harvest (g)	% Survival	Total wt. fish recovered (g)	Reproduction wt. (g)	Other Species** wt. (g)	Total wt. (g) all fish	Yield kg/ha
1	P	204	67	27.5	88	1622.9	148.2	0	1771.1	86.8
2	P	205	33	34.6	73	829.9	0	40.3	870.2	42.4
3	C	202	33	42.5	73	1019.8	0	0	1019.8	50.5
4	C	204	67	36.8	90	2210.5	45.7	0	2256.2	110.6
5	P	203	33	39.0	52	663.3	233.8	0	897.1	44.2
6	P	197	67	27.3	78	1418.8	100.3	0	1519.1	77.1
7	C	206	67	31.8	84	1780.8	254.2	85.2	2120.2	109.9
8	C	197	33	42.7	85	1195.7	0	0	1195.7	60.7
9	P	201	67	42.0	40	1132.7	0	0	1132.7	56.6
10	P	196	33	28.8	85	806.8	210.2	0	1017.0	51.9
11	C	188	33	51.9	15	259.5	0	0	283.3	15.1
12	C	192	67	36.6	88	2158.4	213.1	23.8	2371.5	123.5
mean	-	199	-	36.8	70.9	2158.4	-	-	1371.2	68.8

*Trench constructed of 2 types: C for the center trench and P for peripheral trench.
**One dalag each recovered in plots nos. 2, 7 & 12 and one gouramy in plot no. 7.

13. Parasites and Diseases of Freshwater Fishes

Common Carp Fingerlings

Common carp fingerlings (total length 30-43 mm) were obtained from the BFAR fingerling production station at Bay, Laguna, for use in experiments at the FAC. Examination revealed the presence of *Argulus* ("fish louse"), *Lernaea* ("anchor worm") and *Trichodina* on the skin; and *Trichodina*, *Dactylogyrus* and *Gyrodactylus* on the gills. The incidence and load of all parasites were light, with the exception of gill trematodes, which were moderate in number with 100% incidence.

Before stocking in ponds, treatment of the fish was attempted. One ppm potassium permanganate in concrete tanks overnight eliminated most *Dactylogyrus* and *Gyrodactylus* from the gills. One ppm (active) Masoten (trichlorophon) for 48 hr in concrete tanks did not kill adult anchor worms. Twenty g/l Masoten as a 5 min dip was tried, as recommended by the manufacturer, but was not tolerated well by the fish. Sufficient numbers of infected fish were not available for further treatment trials.

After 28 days in a pond four of the above carp were examined for parasites. Two fish had light infections of *Dactylogyrus* on the gills, suggesting possible reinfection in the pond, or incompletely effective from treatment. Four days later two carp fingerlings from the same pond which just had a serious kill of *C. macrocephalus* because of myxobacterial infection were recovered. The fingerlings had bloody, crater-like lesions in the muscle of the flank containing typical myxobacteria (long, slender rods with a flexing, gliding motility). The caudal fin of one fish was completely eroded. Large numbers of myxobacteria were present on the gills, but no lesions were observed. A light *Trichodinella* infection was also present on the gills. All carp fingerlings from this pond were given prophylactic treatment with 0.8 ppm (active) Furanace (nifurpirinol) for 1 hr before returning to another pond. No further problems were apparent. It was not possible to evaluate the effectiveness of the treatment.

Bangus Fingerlings

Bangus fingerlings (total length 53-108 mm) were routinely examined for parasitism. Light *Trichodina* infections were present on the gills, fins and skin, and moderate to heavy *Trichodinella* and *Cryptobia* infections on the gills, all of which are a potential source of respiratory stress. A common problem encountered at the FAC is erosion and inflammation of fins with the presence of large numbers of bacteria, with mortalities occurring in ponds. It is our general impression that bangus in freshwater culture are more sensitive to stressful conditions than in brackishwater, and thus disease prevention and control will probably play an important role in their management.

Native and Thai Hito

Clarias macrocephalus at the FAC is parasitized by nematodes (*Procamalanus* sp.) in the stomach, digenetic trematodes in the intestine, and *Gyrodactylus* on the fins and skin. No mortalities attributable to parasitism alone were experienced

In one case, fish averaging about 100 mm total length exhibited inflammation and sloughing of the skin and inflammation of the fins, swollen abdomen filled with watery, bloody fluid; and swollen, blood-filled kidneys. Fresh and stained smears from skin, abdominal fluid and kidneys were negative for bacteria and parasites. In another case 300 fingerlings, 78-98 mm total length, were seined from a pond and held in plastic pails. All fingerlings appeared normal immediately after recovery from the pond, but within 1 hr, 50% of the fish died after developing edema of the skin characterized by white, opaque blotches on the belly and side, petechial hemorrhages in the skin, and a firm, stiff body. Examinations for bacteria were negative.

A fish kill occurred in one pond in which 90% of 119 C. macrocephalus (aver. 40 gms) died within 48 hr after stocking. The infected fish had "saddle-back" lesions on their bodies with gray, necrotic centers and inflamed borders; necrosis and erosion of skin with crater-like excavations into inflamed muscle tissue; and partial to complete erosion of fins and caudal peduncle. Surviving fish recovered from the pond had similar lesions. Smears taken from lesions revealed the presence of typical myxobacteria. It is suspected that the bacterium is Chondrococcus columnaris, the agent of "columnaris" disease, which has a cosmopolitan distribution, but which has not previously been reported from the Philippines. Kidney smears revealed concurrent septicemia due to a large, flagellated bacillus. The infected fish had a recent history of stress due to excessive handling, crowding in cages, and were in poor nutritional condition. Other *C. macrocephalus* in the pond at the time of stocking, in good nutritional condition and with no recent history of stress, did not become infected. Experiments treating the surviving infected fish with Furanace were inconclusive. Fingerlings (total length 40-60 mm) held in a *bitinan*, developed myxobacterial infections 24 hr after being transferred to a new *bitinan*. The skin on the posterior one-third of the body, on the head and around the mouth, had a grayish discoloration.

C. macrocephalus post-fry produced at the IFDR hatchery became diseased and the FAC staff was called for consultation. Twenty to 30% of a population of approximately 300 fish developed distended abdomens on the assumption that it was a bacterial infection, treatment with furanace was recommended. All fish recovered after 2 treatments 24 hr apart, at 0.2 ppm active ingredient. These fish also had a high incidence of *Gyrodactylus* on the skin and fins. Preliminary trials indicated that 100 ppm formalin bath for 3 hours removed the parasites, and that the fish tolerated this concentration well.

Clarias batrachus fingerlings at FAC are heavily parasitized. *Gyrodactylus* and an unidentified monogenetic trematode are found on the gills. *Myxosporidian* cysts are also found on the gills. From one fish 16 spherical myxosporidian cyst (0.2 - 0.5 mm dia) were recovered from pigmented connective tissue at the base of the gill arch. Fresh specimens treated with Lugol's solution exhibited iodinophilic vacuoles identifying the genus as *Myxobolus* sp. Myxosporidia identified as

Myxosoma sp. were found in white, flat, amorphous cysts in the mesenteries just below the kidneys. The myxosporidian, *Henneguya* sp., was found in white cysts, 0.5 - 1.0 mm dia., on the dorsal and ventral fins. A very high incidence and parasite load of non-segmented cestodes were found in the intestines, with some fingerlings harboring in excess of 200 worms. Worm burdens of this magnitude are undoubtedly detrimental, and in this case may affect growth by interference with utilization of consumed food. A means of controlling this infection should be sought.

Typical myxobacterial infections of *C. batrachus* have been observed, complicated by severe systemic infections have usually occurred after stress from handling or transport. It appears that myxobacterial disease will be an important limiting factor in pond culture of hito. Even minimal and unavoidable handling will potentially induce the disease. Attempts to control the disease should be aimed at prevention by eliminating or minimizing handling, and chemical prophylaxis and treatment. Furanace has been used successfully in the U.S. for controlling "columnaris" disease of channel catfish. This drug is available in the Philippines (Abbott Laboratories), and its effectiveness for prophylaxis and treatment of myxobacterial disease of hito should be investigated.

An unusually thin *C. batrachus* was recovered from an FAC pond. Upon autopsy, a yellow, spongy, tumorous growth was found in the visceral cavity closely associated with the stomach wall. This tissue was preserved for histological examination.

Tilapia

Tilapia mossambica and *T. zillii* are parasitized by monogenetic trematodes on the gills, fins and skin, and *Trichodinella* on the gills. Fish held in tanks at FAC experienced fraying of fins and mortalities because of heavy *Trichodina* infections. Particularly heavy *Trichodinella* infections were present on the gills of *T. zillii*, but without apparent pathological effects. Hemoflagellates were present in the blood of *T. zillii*. Bacterial infection is common in fish held in tanks, and is usually characterized by petechial hemorrhages and heavy pigmentation of the skin, erosion of skin and fins, and abnormal swimming behavior. Numerous gram negative motile bacilli were observed in smears from the skin and fins. On one occasion nearly 100% of 200 *T. zillii* (aver. 34 g) crowded in a cage suspended in a pond, exhibited bacterial disease characterized by moderate to severe erosion of fins. Smears revealed the presence of many small, short gram-negative bacilli. Smears from the kidney revealed many refractile rods with a regular geometric shape the size of large bacilli, and refractive to staining. The identity of these structures is not known.

Mudfish

Dalag (*Ophicephalus striatus*) fingerlings were collected from FAC drainage canals and held in aquaria for experiments. A high incidence of *Gyrodactylus* was present on the skin and fins, and a high incidence of moderate to heavy infections of *Apiosoma* on the gill filament tips and pharyngeal surface of the gill arch was observed. Nematodes were present in the intestine.

14. Production of Bangus in Combination with Common Carp and Thai Hito in Fertilized Freshwater Ponds

Introduction

Our first tests with bangus culture in fertilized freshwater ponds produced net productions averaging 447 kg/ha in 165 culture days. The present experiment was to determine if the previous results could be repeated using the most productive organic-inorganic fertilization program. Another more economical fertilization program using phosphate only was also followed in some of the ponds. The previous experiment was in newly constructed ponds and took place during the hot season. This experiment was repeated in the same ponds but during the wet season. Common carp and Thai hito, Clarias batrachus, were added to some of the ponds to determine if total production would be higher than when bangus was stocked alone.

Materials and Methods

Eighteen 0.1 ha ponds at the FAC were used. Half of the ponds were fertilized with chicken manure broadcast on August 15 at the rate of 1000 kg/ha. These 9 ponds subsequently received 16-20-0 NPK fertilizer on platform in the usual plankton production system (IFP-TR 4). The other 9 ponds received only 0-20-0 NPK fertilizer on platforms starting on August 16. The ponds that received P-only fertilizer were selected from those that had a history of no fertilizetion or P-only fertilization. The other ponds previously had received N and P fertilization or N and P plus organic fertilization.

All ponds were stocked with bangus fingerling averaging

2 g each on August 21-22 at the rate of 3000/ha. Dead bangus recovered after stocking were replaced on September 3. Six of the ponds, 3 in each of the fertilizer treatments, were stocked with hito fingerlings averaging 2.4 g each on August 22 at the rate of 1000/ha. Another 6 ponds, again with 3 in each fertilizer treatment, were stocked with carp fingerlings averaging 0.3 g on August 26 at the rate of 1000/ha.

Water levels were maintained in the ponds to give them depths estimated at 0.7 to 0.8 m. Secchi visibilities and other field observations were noted weekly. Dense growths of submerged weeds (Chara and Elodea) in the ponds were cleared by hand when they developed.

On October 30 a single seine haul was made in each pond to observe fish and evaluate their growth.

Wild tilapia were observed in several ponds shortly after the experiment began. Data from the BAC indicated that tilapia were more susceptible to Gusathion than bangus so one attempt was made to tilapia poison selectively. Pond 3C was treated with 8 ppb active ingredients Gusathion A on August 27 which resulted in only a partial kill of tilapia.

Harvest began on December 18. Ponds were first seined and later drained to give a complete inventory of all fish in the ponds. Draining of the last pond was completed on January 27, 1975. Culture period averaged 125 days.

Two bangus from each pond where the first were potentially large enough for marketing, about 100 g or larger, were taste tested for possible off flavors. Bangus with off flavors and those too small for marketing were transferred to a separate holding pond. For fish that were retained, a sample of at least 20 fish from each pond was measured for lengths and then weights were estimated based on a length-weight table (TR-4).

Results and Discussion

The amounts of fertilizer applied and field observations are summarized in Table 14.01. Secchi visibilities during the experiment averaged 36 cm. Submerged plants were abundant in 7 of the 18 ponds.

Harvest results are presented in Table 14.02 to 14.04. Mean net production for all ponds was 245 kg/ha. Bangus net production in the 3 ponds with bangus only treated with combined fertilizer was 285.2 kg/ha or 833 kg/ha/yr. This is less than that in the previous dry season trial with the same fertilization system where a net production of 454.8 kg/ha in 165 days equivalent to 1006 kg/ha/yr was achieved. The difference between yields with combined fertilizer and P-only fertilizer is obscured by the presence of many wild tilapia in 6 of the P-only treated ponds. It is unclear if the low yields in these ponds with tilapia resulted from the tilapia or the fertilizer treatment or a combination of the two. On the average, bangus ponds stocked with carp gave higher net production than ponds with bangus and hito or hito alone.

Tilapia less than 6 cm in length and *Macrobrachium* sp. shrimp were not included in the harvest figures because of the difficulty in picking up and sorting the many small individuals.

Shrimps were found in all ponds and contributed approximately 2 kg additional harvest per pond (21 kg/ha).

In the 8 days following seining of the ponds on October 30, a total of 71 dead bangus were recovered from 8 different ponds. This confirms our earlier experience that bangus in freshwater are particularly susceptible to handling stress. Starting on November 29 until harvest time chronic mortalities of bangus occurred at various times in 5 of the ponds. Dead fish were recovered each day over a several day period. Microscopic examination revealed no bacterial or parasitic infection on dying fish. Dissolved oxygen and CO_2 levels in the ponds with dying fish were + 5 ppm and 0 when measured in the mid-afternoon. Phytoplankton abundance did not appear excessive although dead fish had an odor reminiscent of Anabaena blooms. No satisfactory explanation for the mortalities has been found. The addition of freshwater may have helped reduce the amount of mortality.

Overall survival of bangus was 57%, carp 59% and hito 62%. A few additional hito were recovered from ponds in which they were not stocked. These fish may have "walked" away from their original ponds. Small hito resulting from recent reproduction were collected in 5 ponds and were not included as part of the harvest. The number of these young fish in a single pond ranged from 2 to 138. Apparently *C. batrachus* will reproduce in at least limited numbers during November or December.

At harvest bangus from 11 ponds were taste tested by FAC staff. Fish from 8 ponds (1H, 1I, 2B, 2G, 3D, 3E, 3F, 3G) were considered of good flavor. Bangus from 3 ponds (1E, 2D, 2F) had an off flavor.

Table 14.01 - Amount of fertilizer applied and field observations in bangus experimental ponds at FAC August 15 to December 18, 1974.

Pond no.	Fertilizer type	No. of applications	Total kg/ha	Mean Secchi visibility (cm)	Notes
1C	Chicken manure 16-20-0	1 4	1000 201	46	*Elodea* abundant
1I	Chicken manure 16-20-0	1 4	1000 201	39	
3G	Chicken manure 16-20-0	1 4	1000 199	32	
1G	0-20-0	5	249	43	*Chara* & *Elodea* abundant
2C	0-20-0	4	201	33	
3D	0-20-0	6	298	46	*Elodea* abundant
2B	Chicken manure 16-20-0	1 3	1000 149	24	
2G	Chicken manure 16-20-0	1 4	1000 201	25	
3F	Chicken manure 16-20-0	1 5	1000 249	39	partial fish kill
1E	0-20-0	5	250	37	*Elodea*, abundant
2F	0-20-0	5	253	31	partial fish kill
3C	0-20-0	5	251	35	Gusathion treated
1F	Chicken manure 16-20-0	1 5	1000 252	35	partial fish kill, Nov. 5
2D	Chicken manure 16-20-0	1 4	1000 201	28	
3E	Chicken manure 16-20-0	1 4	1000 198	40	*Elodea*, abundant partial fish kill
1B	0-20-0	5	251	45	
1D	0-20-0	6	300	33	*Chara*, abundant
1H	020-0	6	303	36	*Elodea* & *Chara* abundant, partial fish kill

Table 14.02 - Harvest results for six ponds stocked with bangus at 3000/ha at FAC August 21 to December 24, 1974

Treatment	Pond no.	Area (m^2)	Type of fish	No.	Mean wt. (g)	No./ha	kg/ha	net kg/ ha	Survival %
Combined fertilizer	1C	955	bangus	244	115.4	2555	294.8	291.4	85
			tilapia	1	129.0	10	1.4	1.4	-
			Total	-	-	-	296.2	292.8	-
	1I	917	bangus	160	99.8	1745	174.1	170.0	58
	3G	906	bangus	230	157.3	2539	399.4	391.5	85
			hito	1	114.5	11	1.3	1.3	-
			Total	-	-	-	400.7	392.8	-
Treatment mean			-	-	-	-	290.3	285.2	-
P-only fertilizer	1C	922	bangus	85	11.9	922	10.9	6.8	31
			tilapia	1632	9.5	17,701	168.1	168.1	-
			hito	4	71.3	43	3.1	3.1	-
			Total	-	-	-	182.1	178.0	-
	2C	916	bangus	139	15.5	1517	23.5	19.4	51
			tilapia	614	15.4	6703	103.0	103.0	-
			hito	2	135.5	22	1.5	1.5	-
			Total	-	-	-	128.0	123.9	-
	3D	906	bangus	142	92.4	1567	144.8	136.9	52
			hito	3	197.8	33	6.6	6.6	-
			-	-	-	-	151.4	143.5	-
Treatment mean			-	-	-	-	153.8	148.5	-
Mean			-	-	-	-	222.1	216.9	-

Table 14.03 - Harvest results for six ponds stocked with bangus at 3000/ha and carp at 1000/ha at FAC August 21 to December 24, 1974

Treatment	Pond no.	Area (m^2)	Type of fish	No.	Mean wt. (g)	No./ha	kg/ha	net kg/ha	Survival %
Combined fertilizer	2B	866	bangus	239	78.0	2760	210.5	206.4	90
			carp	75	114.2	866	96.7	96.4	84
			hito	4	57.9	46	2.6	2.6	-
			Total	-	-	-	309.8	305.4	-
	2G	896	bangus	185	118.3	2065	244.2	236.3	69
			carp	57	244.7	636	155.7	155.4	63
			Total	-	-	-	399.9	391.7	-
	3F	909	bangus	104	97.9	1144	112.0	104.1	38
			carp	40	237.5	440	104.5	104.5	44
			Total	-	-	-	216.5	208.4	-
Treatment mean			-	-	-	-	308.7	301.8	-
P-only fertilizer	1E	919	bangus	285	113.9	1301	353.1	347.7	103
			carp	69	298.3	751	224.0	223.7	75
			hito	2	92.3	22	2.1	2.1	-
			dalag	1	60.3	11	.7	0.7	-
			Total	-	-	-	579.9	574.2	-
	2F	891	bangus	39	94.6	438	41.4	37.3	15
			carp	53	182.5	595	108.5	108.2	60
			Total	-	-	-	149.9	145.5	-
			bangus	32	30.0	365	11.0	3.1	12
			carp	24	203.7	274	55.8	55.5	27
			tilapia	92	40.3	1050	42.3	42.3	-
			Total	-	-	-	109.1	100.9	-
Treatment mean			-	-	-	-	279.6	273.5	-
Mean			-	-	-	-	294.2	287.7	-

Table 14.04 - Harvest results for six ponds stocked with bangus at 3000/ha hito at 1000/ha at FAC August 21 to December 24, 1974

Treatment	Pond no.	Area (m^2)	Type of fish	No.	Mean wt. (g)	No./ha	kg/ha	net kg/ha	Survival %
Combined fertilizer	1F	913	bangus	264	137.4	2892	397.4	393.3	96
			hito	69	118.1	756	89.3	86.9	76
			Total	-	-	-	486.7	480.2	-
	2D	922	bangus	175	128.1	1898	243.1	235.2	63
			hito	84	129.1	911	117.6	115.2	91
			tilapia	1	177.8	11	1.9	1.9	-
			dalag	1	22.8	11	.2	0.2	-
			Total	-	-	-	362.8	352.5	-
	3E	848	bangus	87	113.4	1026	116.3	108.4	34
			hito	43	151.8	507	77.0	74.6	51
			Total	-	-	-	193.3	183.0	-
Treatment mean			-	-	-	-	347.6	338.6	-
P-only fertilizer	1B	896	bangus	225	66.5	2511	167.0	161.7	84
			hito	68	54.0	759	41.0	38.6	76
			tilapia	20	122.6		27.4	27.4	-
			Total	-	-	-	235.4	227.7	-
	1D	959	bangus	129	17.0	1345	10.4	5.9	45
			hito	43	38.8	448	17.9	15.5	45
			tilapia	362	13.3	3775	50.3	50.3	-
			dalag	2	473.8	21	9.9	9.9	-
			Total	-	-	-	88.5	81.6	-
	1H	911	bangus	21	55.6	231	12.8	14.6	8
			hito	32	65.0	351	22.8	20.4	35
			tilapia	32	37.9	351	13.3	13.3	-
			Total	-	-	-	48.9	48.3	-
Treatment mean			-	-	-	-	124.3	119.2	-
Mean			-	-	-	-	235.9	228.9	-

B. Research in Progress

1. Bangus Production in Newly Constructed Ponds on Plankton and Lab-lab for Three Consecutive Cultures Using Various Single and Combination Fertilizers

The objective of this study is to find answers to the following fundamental questions regarding culture of bangus in brackishwater fishponds:

1. Is the traditional lab-lab method of culture superior to the plankton method? In the lab-lab method water less than 40 cm deep is used to encourage the growth of benthic algae and associated organisms to provide food for the fish, whereas in the plankton method water deeper than 70 cm is used to encourage the development of a planktonic community for a food source.
2. Is fertilization superior to non-fertilization?
3. If fertilization is superior, what is the effectiveness of organic fertilizer (chicken manure) compared with inorganic fertilizers (nitrogen and phosphorous), and with various combinations of organic plus inorganic fertilizers?
4. Is phosphorous fertilizer alone more effective than nitrogen fertilizer alone in ponds already having sufficient organic matter to provide nitrogen through natural mineralization processes?

Forty-six ponds (each approximately 500 m^2 in surface area), comprising three blocks of 14, 14 and 18 ponds, respectively, are being used for the study. There are 16 treatments in the experiment. These were assigned in such a way that the ponds of each block contained one replicate of each treatment, except that two treatments had to be omitted in each of the first two blocks whereas block three contained two extra control ponds (IFP-TR 5) contains details of the experimental design).

The first of three planned trials of this experiment has been completed. Table 1.01 contains a summary of data obtained. Several factors make these data of questionable usefulness. Mortality of fish during the experiment was very heavy, especially in block I. In five of the seven lab-lab ponds of this block no fish survived until the termination of the experiment. Mortality in this block and the others has now been attributed to highly acidic conditions that developed in the ponds dwing to the formation of sulfuric acid from the abundant sulfur compounds in the pond soils (see IFP-TR 5 for a discussion of this problem). In addition to the confounding influence of poor survival, there were differences among blocks with regard to the number of culture days. This situation resulted from terminating the experiment in a block when growth of fish, as determined by periodic sampling, stopped in that block. Another confusing factor was that the mean individual weights of fish at stocking differed substantially from block to block. Also, wild fishes invaded most of the ponds; in some cases the standing crop of these fishes far exceeded that of bangus. As a result of these factors it is intended to conduct three more trials of this experiment.

The second trial of this experiment is now in progress following the same design as the previous one. Bangus were stocked on November 20 and 27, and December 4 in Blocks II, I and III, respectively. Because further problems with pH levels are expected, they are being monitored frequently to detect acidic conditions. As soon as low pH levels are detected, the situation is corrected by applying lime ($Ca(OH)_2$ + $CaCO_3$) as necessary to neutralize the acid. Since stocking it has become necessary on several occasions to lime one or more ponds. This was accomplished by broadcasting a water solution of lime over the pond surface at rates of 25 to 100 ppm (weight of lime to weight of water) to achieve neutral or slightly basic conditions. The method appears to be effective based on the fact that observed mortalities have been below 10 per cent. Results of the present trial will be reported in subsequent technical reports.

Table 1.01 - A summary of data on bangus production obtained using two methods of culture and various fertilization treatments.

Block I

<u>Stocking date</u>: April 3, 1974
<u>Harvest date</u> : July 11, 1974
<u>No. culture days</u>: 99

<u>Stocking rate</u>: 3000/ha
<u>Mean individual</u>
<u>Weight at stocking</u>: 6.8 g

Treatment 1/	Culture method 2/	Total weight stocked (kg/ha)	Survival (%)	Net production of bangus (kg/ha)	Total weight of wild species harvested 3/ (kg/ha)
U	LL	17.0	20.8	160.8	0
U	PL	20.0	60.3	176.0	27.8
CNP	LL	19.3	0	0	0
CNP	PL	21.1	18.0	46.8	15.0
CP	LL	20.6	0	0	0
CP	PL	20.5	41.7	81.0	5.2
CN	LL	20.6	0	0	0
CN	PL	20.7	64.5	234.4	0
C	LL	20.0	34.6	213.9	0
C	PL	22.2	32.1	67.2	63.6
NP	LL	19.4	0	0	0
NP	PL	20.6	47.9	127.2	74.2
N	LL	Missing treatment		-	-
N	PL	Missing treatment		-	-
P	LL	20.2	0	0	0
P	PL	19.4	61.0	202.6	0.2

1/U = control, unfertilized
C = chicken manure
N = nitrogen (46-0-0)
P = phosphorous (0-20-0)
NP = nitrogen-phosphorous (16-20-0)

2/LL = lab-lab
PL = plankton

3/Wild fishes were almost entirely *Tilapia* although *Poecilia*, *Megalops* (tarpon), *Lates* (seabass), and shrimp were present.

Table 1.01 (cont'd)

Block II

Stocking date: May 8, 1974
Harvest date : August 21, 1974
No. culture days: 105

Stocking rate: 3000/ha
Mean individual
Weight at stocking: 1.9 g

Treatment[1/]	Culture method[2/]	Total weight stocked (kg/ha)	Survival (%)	Net production of bangus (kg/ha)	Total weight of wild species harvested[3/] (kg/ha)
U	LL	5.2	93.7	300.4	36.1
U	PL	6.6	50.0	38.7	22.8
CNP	OO	5.5	0	0	0
CNP	PL	5.3	91.5	224.9	16.5
CP	LL	5.4	34.9	112.5	0
CP	PL	5.4	99.4	245.6	0.9
CN	LL	5.1	0	0	0
CN	PL	5.6	83.2	221.8	42.8
C	LL	5.5	53.6	167.1	0.2
C	PL	5.7	93.6	185.1	7.3
NP	LL	5.7	87.1	425.0	9.7
NP	PL	5.5	26.2	30.2	0
N	LL	5.4	98.0	535.2	21.2
N	PL	6.2	69.2	108.9	3.3
P	LL	Missing treatment		-	-
P	PL	Missing treatment		-	-

Table 1.01 (cont'd)

Block III

Stocking date: June 28, 1974
Harvest date : August 29, 1974
No. culture days: 62

Stocking rate: 3000/ha
Mean individual
Weight at stocking: 2.6 g

Treatment[1]	Culture method[2]	Total weight stocked (kg/ha)	Survival (%)	Net production of bangus (kg/ha)	Total weight of wild species harvested[3] (kg/ha)
U	LL	7.8	59.0	1.3	53.4
U	LL	7.5	0	0	0
U	PL	6.9	55.5	2.8	9.6
U	PL	7.0	27.5	0.5	69.8
CNP	LL	8.4	76.5	4.6	492.4
CNP	PL	7.6	28.0	0.9	103.0
CP	LL	7.8	8.3	0.1	17.4
CP	PL	7.5	44.7	1.6	35.5
CN	LL	8.4	73.7	3.7	543.9
CN	PL	7.8	37.7	1.6	59.6
C	LL	7.7	69.4	3.7	0
C	PL	7.1	83.1	4.6	7.4
NP	LL	7.3	81.5	4.4	85.2
NP	PL	7.2	77.3	6.5	0.5
N	LL	7.3	0	0	0
N	PL	7.0	27.5	0.5	69.8
P	LL	7.7	0	0	0
P	PL	7.6	61.1	1.6	2.0

2. Simultaneous Culture of Bangus Fry Inside Happas and Bangus Fingerlings at Large in Same Ponds

The objective of this study is to explore the possibility of rearing bangus fry within net enclosures (happas) suspended in a plankton pond stocked simultaneously with bangus fingerlings. This set-up if proven feasible may entirely eliminate the need for a nursery pond in rearing the fry prior to stocking in production ponds. The use of happas, moreover could facilitate the harvest of the resulting fingerlings. It is also anticipated that fry mortality on account of predation by various species of fish will be significantly reduced.

On a per pond basis, performance of the fry will be evaluated in terms of growth rate and survival under two stocking rates, namely, at 60,000 fry/ha and at 100,000 fry/ha, using a single happa for both cases. At the lower stocking rate, the fry are assigned to three happas to test whether the use of more than one unit has an advantage in minimizing the possible effects of overcrowding and related density dependent factors. The experiment design also calls for a treatment in which no fingerlings are released in the ponds to have some measure on the degree of competition that this set-up will impose upon the usual stocking of fingerlings at 3,000/ha. The following table summarizes the four treatments in duplicate, utilizing 0.1 ha ponds of the BAC:

Pond nos.	No. fry per happa	No. happas[1/]	Fingerlings stocked
17, 13	6,000	1	3,000/ha
14, 18	10,000	1	3,000/ha
15, 20	1,000	1	3,000/ha
	2,000	1	
	3,000	1	
19, 16	6,000	1	0

[1/]Surface area of happas was 1 m^2; volume was approximately 1 m^3 but varied owing to pond depth.

Lime in the form of $Ca(OH)_2$ was initially applied on August 14 which on a per pond basis amounted to 133 kg for the slopes of the dikes and 230 kg for the pond bottom. On September 21 - October 5, the ponds were filled with water to an average depth of 70 cm using combined gravity flow and portable diesel pumps. Heavy rains prevailed in the locality during the month of October and subsequent pH checks indicated a need for extra liming which was applied to all ponds on two occasions (October 22 and October 25) at 45 kg/pond or the equivalent of 50 ppm per application. Ponds 17, 18 and 19 which had persistent low water pH received an additional dose of 50 ppm immediately prior to stocking. Meanwhile, prior to stocking three applications of inorganic fertilizer (16-20-0) at 50 kg/ha per applications were given each pond.

On November 4 a total of 31,500 fry were assigned to 10 happas at rates ranging from 1000-6750 per happa because the design of the experiment had to be slightly altered as follows:

Pond no.	No. fry per happa	No. happas used	Fingerlings stocked
17, 13	3,000	1	3,000/ha
14, 18	6,750	1	3,000/ha
15, 20	1,000	1	3,000/ha
	2,000	1	
19, 16	3,000	1	0

The total number stocked, thus represented only 55% of the original requirements. The reduction came about following a heavy mortality which occurred during the process of counting and sorting the fry. Mortality was attributed to poor water quality in the plastic bags used to transport the fry. The fry had been fed boiled egg yolk before transport and the remains of still unconsumed feed were found in the water. There was, in addition, an error committed when the oxygen in these plastic bags was released inadvertently without placing the fry in wider containers where they could obtain oxygen from natural sources.

On November 6, bangus fingerlings, with an average total length of 57 mm and an average weight of 1.5 grams, were stocked in six 0.1 ha ponds.

It was soon discovered that most of the happas were falling apart at the seams which were sewed using cotton thread. At that time, the units had been immersed in pond water for a period of 28 days. Fouling, consisting of brown, filmy growths of algae appeared to have blocked the meshes of the net and to have increased the load on the net considerably. Although a new set of nets, reinforced at the sides by nylon thread, was immediately installed, it was too late to prevent the escape of fry into the pond proper and the intrusion of wild, predatory fishes into the damaged happas.

The happa phase of the experiment was terminated on December 5 after a culture period of 30 days. Recovery of fry ranged from 0 - 36% (except a single case with 76%). Consequently no information could be derived to account for any treatment differences. No single factor could be isolated to account for the severe loss of fry. Survival was lowest in Ponds 18 and 19 (1.2% and 0%, respectively) which had consistent records of low water pH, ranging from 4.6 - 6.0. The influx of predatory fish, notably *Elops sp.* and *Megalops sp.* when the happas were damaged, appeared to have contributed significantly to fry attrition, as revealed by stomach analyses of some of these predators. The fry usually swim at the surface where they were vulnerable to predation by birds. Frequently, the top framework of the happas bore traces of bird feces. Furthermore, some losses of fry were brought about by strong wave action that got them entangled against the net above water. Escape of fry from happas into the pond proper, another factor to account for in connection with the low recovery of the fry, will be evaluated at the end of the experiment.

After inventory, some of the fry were reapportioned into four *happas* to obtain supplementary growth data at stocking rates of 500 and 1,000 per happa. Only one pond was used for this set-up. The rest of the fry are currently being held in two other *happas* for future research assignment. The whole group cannot be programmed into a single experiment due to two size-groups that resulted from the previous trial.

The fingerlings stocked in the pond at 3,000 per hectare are being sampled at three-week intervals. As of last sampling (65th culture day), they are growing at an average rate of 0.54 g/day. Meanwhile, data on salinity, dissolved oxygen, carbon dioxide, visibility, pH and temperature are being monitored on a weekly basis.

3. Competition and Comparative Growth Rates Between *Clarias macrocephalus* and *Clarias batrachus*

In a previous experiment at FAC, comparison were made of yields of *Clarias macrocephalus* in ponds, using chicken manure, 16-20-0 and chicken manure, and 16-20-0 only. At stocking, density of 1,800 fingerlings/ha the net production was 298 kg, 132 kg and 129 kg/ha in 230 culture days at the different respective treatments. The chicken manure fertilizer gave higher fish yields over other fertilizer application. Native hito production were quite low, maybe because of low stocking density so another follow-up experiment is being done with three objectives: first to test the effect of density on growth of the two Asiatic catfish species with organic fertilization, and second to evaluate growth rates between native hito, *Clarias macrocephalus* and Thai hito *Clarias batrachus*; third; to check if there is food competition between the two species, when raised together. Results may help fish farmers manage hito production ponds using supplemental organic enrichment.

A total of six 500-m^2 ponds were used in this experiment, four of which were divided into two parts lengthwise by a bamboo screen to separate the two species. Thai and native hito postfingerlings were stocked separately within a pond in two replicates per treatment at density 5,000/ha and 10,000/ha. In two other ponds with no bamboo screen partition two different hito species at 1:1 ratio were stocked together at 5,000/ha.

Ponds are receiving manure enrichment at 25 kg/ha every week at dry weight basis. Fish are being sampled monthly to determine weight. The experiment will terminate after 6 months culture period.

4. Freshwater Shrimp Culture

Freshwater shrimps tentatively identified by the National Museum as *Macrobrachium lanceifrons* var. *montalbanensis* and *Macrobrachium lanchesteri* from Pond 6I were collected and placed in aquaria on 14 August 1974. Berried females were placed in separate aquaria.

In an aquarium where two berried females were placed, egg samples were taken and observed for development in petri dishes. In the same aquarium, iodized salt was added for a 0.1% salt solution. Within 24 hours larval stages of shrimps were observed in the aquaria. These larvae (3rd stage) remained alive in the aquarium for six days without feeding.

Continuing studies on the spawning habits of the freshwater shrimps in aquaria and then production in ponds are being done in the FAC.

5. Pond Culture of Sex-Reversed *Tilapia mossambica* Treated with Methyltestosterone and Estrone

The sex reversal method of controlling tilapia overpopulation is less laborious and more effective than the manual sorting of sexes method. Production of all-male *T. mossambica* using ethynyltestosterone at 50 ug/g diet for induced sex reversal was achieved in an earlier study of the FAC.

In sex reversal using male sex hormones such as methyltestosterone treated genotypic females are converted into phenotypic males. Growth superiority of males is believed to be genetic. Nest-building activity and probably display of spawning coloration are carried out by males even without the presence of females.

Sex reversal of tilapia using female sex hormones such as estrone has not been achieved to date. If attainable, sex reversed males may probably retain their growth superiority but lose their male spawning characteristics.

The objectives of this study were: (1) to determine the effectiveness of methyltestosterone and estrone for sex reversal of *T. mossambica* fry; (2) to compare the growth of methyltestosterone-treated and estrone-treated *T. mossambica* in fertilized ponds; and (3) to determine spawning characteristics of hormone-treated fish.

Fry of *T. mossambica*, 9-11 mm total length, obtained from the buccal cavities of females and reared in *hapas* were used. Treatment of fry for sex reversal was done in 260-liter circular concrete tanks with 600 fry per tank.

Fry given the medicated feed (methyltestosterone at 30 ug/g diet and estrone at 100 ug/g diet) by means of styrofoam feeding rings were fed at the rate of 12-10% of body weight divided into three portions and fed three times daily, six days a week. Water in the tanks was replaced every two days using a siphon.

Hormone treatment lasted for 39 days in the case of estrogen-treated fry and 37 days for methyltestosterone-treated ones. Total lengths of treated fish averaged 19 and 18 mm with estrone and methyltestosterone, respectively, following treatment.

The treated fry were stocked in four approximately 500-m^2 earthen ponds of the FAC at the rate of 5,000/ha on 11 December 1974. Two ponds per hormone treatment were used. One pond stocked with estrone-treated fish was stocked at 2,639/ha only because of poor survival during treatment. Ponds were fertilized biweekly with 16-20-0 at 50 kg/ha.

Sampling of fish will be done after 60 days of culture. The study will terminate after 120 days. Growth, sex ratio, survival, reproduction and nesting activity of experimental fish shall be evaluated.

6. Polyculture of *Ophicephalus striatus* and Male *Tilapia mossambica* with supplementary feeding in fertilized ponds

A previous study of the FAC has shown that monosex culture of male *T. mossambica* postfingerlings stocked at 10,000/ha can yield harvestable size fish in two months. One major drawback of the monosex culture method, however, is contamination of ponds with females because of human error in manual sexing of fish or entry of wild fish. Use of a predator like *O. striatus* which commands a high price in the market could reduce reproduction of tilapia resulting from such contamination.

With monosex male culture of tilapia providing harvestable size fish in two months, it would be possible to restock ponds after harvest without draining the pond for a maximum of six crops a year. In this system, pond drying and preparation is minimized and water fertility is conserved. As long as reproduction of tilapia females that accidentally get stocked is kept to a minimum, a regular put-and-take process of fish production can be maintained.

This study has two objectives: (1) to determine if *O. striatus* stocked at a ratio of one mudfish to 25 monosex male *T. mossambica* would be effective in reducing tilapia reproduction as a result of accidental stocking; and (2) to determine the optimum time for harvesting monosex male *T. mossambica*.

Two approximately 500-m^2 earthen ponds of the FAC were stocked with male *T. mossambica* postfingerlings and *O. stria-*

tus at rates of 10,000/ha and 400/ha, respectively on 2 October 1974. Prior to stocking, 25 ppb of Gusathion A was applied in the ponds to eliminate wild fish. Fertilization of ponds with 0-20-0 at 50 kg/ha biweekly is presently being done and water depth in the ponds maintained at 80 cm.

Manually sexed *T. mossambica* males had mean total length of 9.6 cm and mean weight of 14 g. Fingerlings of *O. striatus* used had a mean total length of 2.4 cm and mean weight of 0.15 g.

To supplement natural food sources *T. mossambica* were fed with bulgur wheat (13% protein) at 5% of fish body weight divided into two portions and given daily in the morning and afternoon, six days a week. Feeding rate was adjusted once a month based on monthly sampling of 5% of the total fish.

After 120-day culture period, ponds will be drained and fishes harvested. Length-weight data, reproduction and survival of fishes shall be evaluated.

7. Tilapia Fry Rearing in Nylon Net Enclosures (Bitinan)

The practical use of the sex-reversal technique for monosex tilapia fry production requires a large and continuous supply of fry from 9 to 11 mm in total length. At this size the fry are not yet sexually differentiated and are suitable for hormone treatment through feeding. However, under pond conditions the fry are difficult to collect in quantity because they return to the female brooder's mouth for parental care or disperse when frightened. This work is evaluating the use of a rectangular suspended nylon net enclosure to hold incubated eggs and parent fish; and facilitate fry recovery.

Two systems are being attempted. The first is testing fry survival when period of oral incubation is shortened. This method uses bitinan, 0.6 x 0.3 x 0.5, to incubate larvae of *Tilapia mossambica* which have been prematurely removed from the female brooder's mouth. The larval stage and number per female was determined prior to stocking. Fry development and survival rate is being observed and recorded every 3 days until the fry attain the desired size.

The second system is evaluating the number of *Tilapia mossambica* fry recovered by placing females with incubated eggs of known age into the bitinan and manually releasing the fry when they are capable of swimming.

This experiment started on December 28, 1974. Results will be evaluated by the end of the experiment on February.

8. Polyculture Systems Utilizing Common Carp, Thai Catfish, Mudfish and Male Tilapia

One of the problems in fish polyculture is determining what combinations of species will be most effective in utilizing available natural food. Two or more species can be cultured together to utilize the available food even if they compete for certain types to some extent. Thus overall fish production in such a polyculture system is considerably high compared to a monoculture system.

The objectives of the study in culturing combined species of common carp (*Cyprinus carpio*), a benthos feeder; Thai hito (*Clarias batrachus*), an insectivore; dalag (*Ophicephalus striatus*, a carnivore; and male Java Tilapia (*Tilapia mossambica* an omnivore are to determine optimum stocking combinations and stocking rates, competition and growth patterns between species and to determine the percentage of harvestable-sized fish that can be produced in five to six months.

Eight ponds: four of 0.1 ha and four of 0.05 ha were used in these trials. Four treatments with two stocking combinations each were made. Two replicates per treatment were used.

All ponds were fertilized with 2,000 kg/ha of chicken manure each before stocking to promote plankton growth. After stocking, 500 kg/ha of chicken manure and 45 kg/ha of 16-20-0 were applied alternately at biweekly intervals. Later applications will be made depending upon the transparency of the water. Male tilapia, common carp, Thai hito, and mudfish fingerlings averaging 9.6, 1.2, 3.6 and 0.2 g, respectively, were stocked on October 18 through 21.

Bi-monthly sampling of each pond is being made. Data from the first sampling was done on December 20. Based on sampling data, combination of tilapia, Thai hito and mudfish with stocking rates/ha of 7,000, 1,000 and 500, respectively, appears to give the highest production compared to the other three treatments.

II. TRAINING AND EXTENSION ACTIVITIES

A. BRACKISHWATER AQUACULTURE CENTER

Consultations - The Center provided free consultation to various groups and individuals on subjects related to bangus culture and related fields. These services were given at the station by members of the research staff.

Lectures and seminars - Briefings were given a number of groups from both private and government sectors, local and international, on the general activities and operation of the Center. About 20 of these sessions were held from July to December, 1974.

Prof. Melchor M. Lijauco and Dr. Arsenio S. Camacho represented the BAC during the NSDB evaluation seminar held in Manila on October, 1974.

Training activities - The UPCF graduate course leading to the degree of Master of Science (Aquaculture) officially started in November with classes held at BAC. Teaching staff consist of Dr. Arsenio S. Camacho, Dr. Daniel F. Leary, Prof. Romeo D. Fortes and Prof. Norma R. Fortes. The BAC also assists the University of the Philippines at Iloilo in offering a bachelor course in Fisheries. Prof. Melchor M. Lijauco teaches the subject General Fisheries.

B. FRESHWATER AQUACULTURE CENTER

Consultations - Number of guests increased from 250 for the period January 1 to June 30, 1974 to more than 400. The technical staff gave suggestions or recommendations to individuals, government and private agencies regarding their problems in fish culture. In some occasions, staff were invited by owners to inspect existing and proposed fishpond sites.

Demonstrations - The Center participated during the NSDB Symposium held at San Fernando, Pampanga on July 18 to 19. Some exhibits were displayed for fish farmers such as plankton as seen through a microscope. At the Center, actual sexing and species identification were demonstrated to guests.

Lectures and Seminars - Briefings about the different activities of the Center were given to a number of guests. Seminars were also given by the Staff. Dr. Guerrero read a paper entitled "New directions in inland fisheries" during the NSDB Symposium at San Fernando. On August 28, he also gave a lecture on "Sex reversal of tilapia" at UPCF. He and Dr. C. dela Cruz presented the achievements and activities of the Center during the IFP Evaluation Series held in Manila on October 17.

Training Activities - Mr. Antonio Hugo, fisheries extension specialist of the Central Bank of the Philippines, spent two days (August 14 to 15) at the Center observing the on-going research activities. In addition, he was briefed or given special lectures by the technical staff regarding their research activities or field of specialization. Miss Cynthia Querubin, a UPCF student ended her four months training on October 25. Another batch of students Misses Marilou Tagle and Jacinta Diaz, also from UPCF reported for training about the middle part of November.

III. STATUS OF CONSTRUCTION

A. Brackishwater Aquaculture Center

As of December 31, 1974, the following accounts on the BAC construction are given :

1. Of the 2-ha-pond series, Pond 1 is finished; Pond 3 is due for completion by the end of February 1975, while Pond 2 maybe completed within 1 to 1½ months if construction is mechanized. Recomendations to their effect is being prepared.

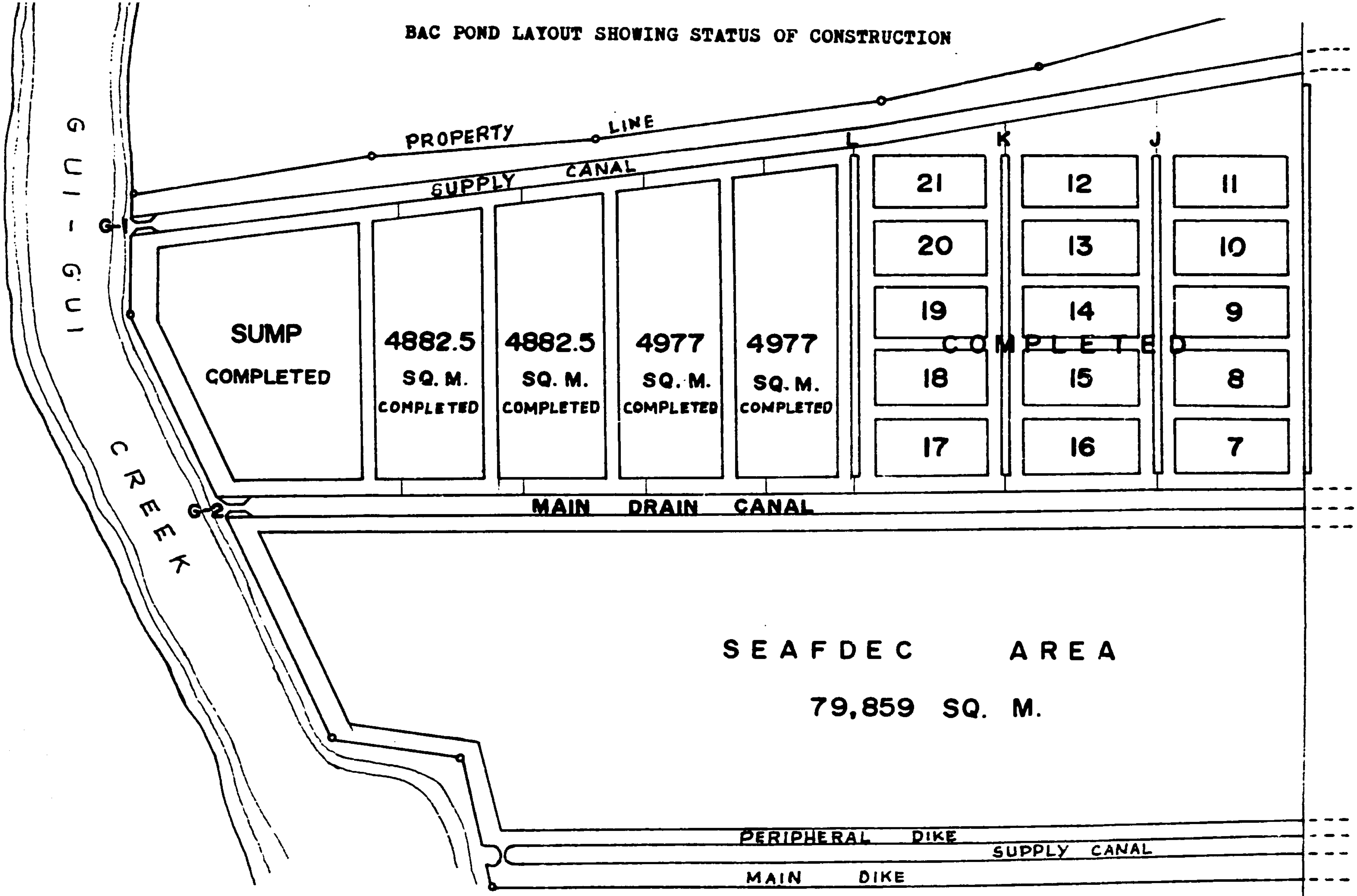
2. Deepening of main drain canal is found necessary, and the supply canal still remains to be done. "Takay" contracts on these construction work are already prepared and submitted for approval.

3. The 1-ha pond series that was phased out during the just 3 years of the IFP constructions should be worked on during this dry season. Additional funding for this is necessary and the source still remains to be identified.

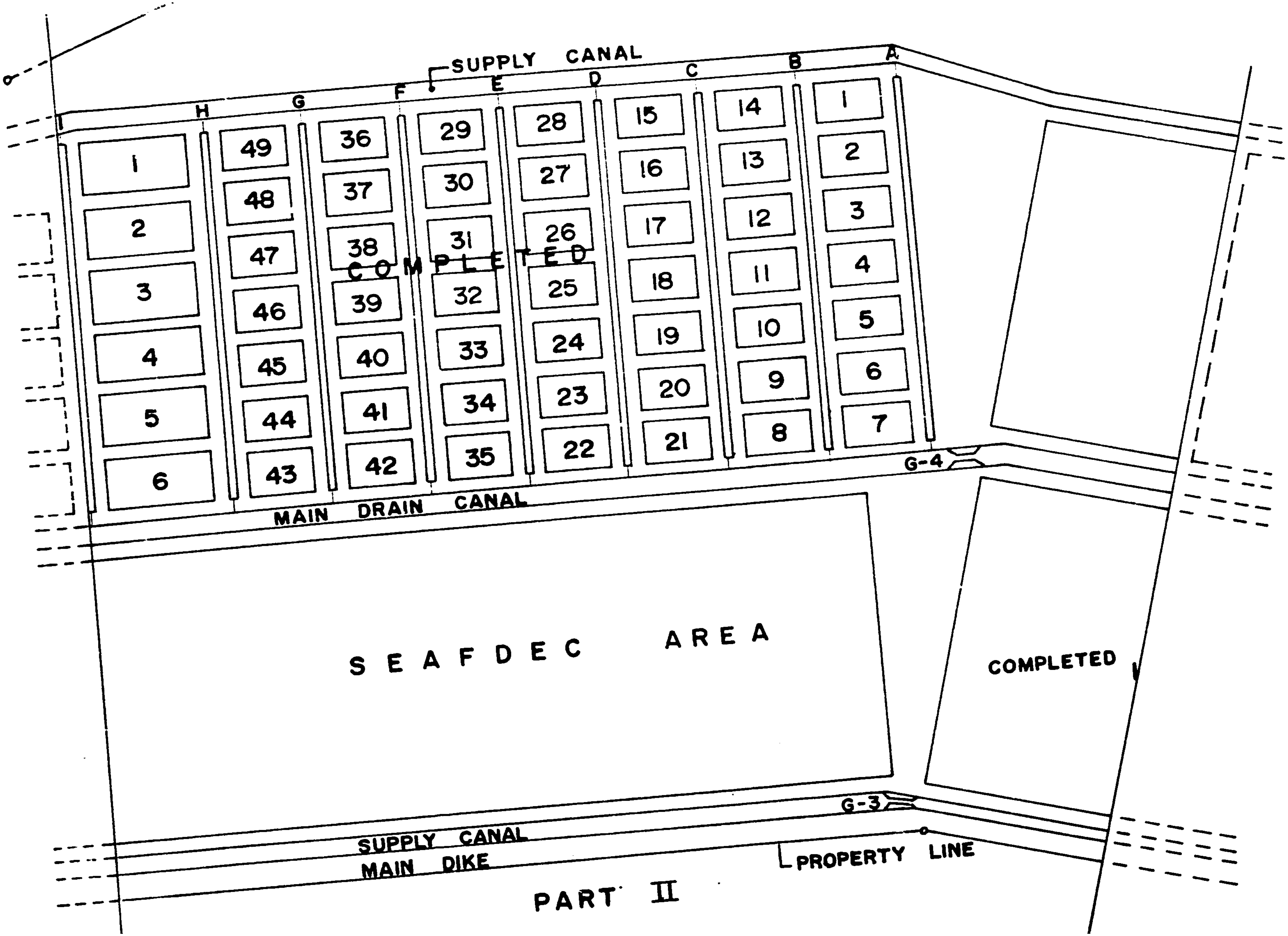
For other pertinent details and for better picture on the status of BAC Construction, please refer to the BAC Pond Layout Showing Status of Construction immediately following.

B. Freshwater Aquaculture Center Construction Completed.

BAC POND LAYOUT SHOWING STATUS OF CONSTRUCTION



PART I



SUPPLY CANAL
A
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C
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F
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H
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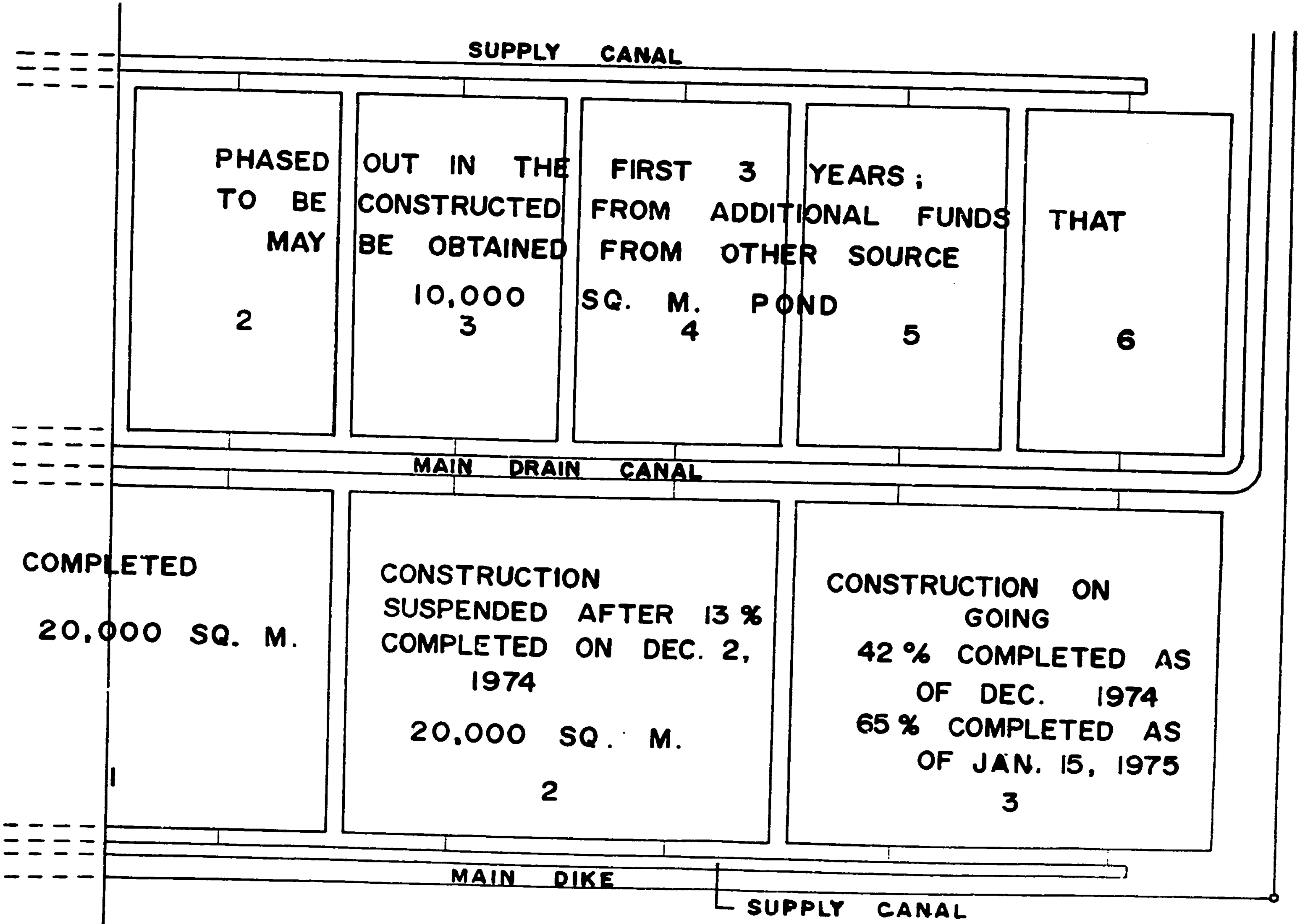
48
49
1
2
3
4
5
6
COMPLETED
G-4
MAIN DRAIN CANAL
SEAFDEC AREA
COMPLETED
G-3
SUPPLY CANAL
MAIN DIKE
PROPERTY LINE
PART II


SUPPLY CANAL
PHASED OUT IN THE FIRST 3 YEARS;
TO BE CONSTRUCTED FROM ADDITIONAL FUNDS THAT
MAY BE OBTAINED FROM OTHER SOURCE
10,000 SQ. M. POND
2
3
4
5
6
MAIN DRAIN CANAL
COMPLETED
20,000 SQ. M.
1
CONSTRUCTION
SUSPENDED AFTER 13 %
COMPLETED ON DEC. 2,
1974
20,000 SQ. M.
2
CONSTRUCTION ON
GOING
42 % COMPLETED AS
OF DEC. 1974
65 % COMPLETED AS
OF JAN. 15, 1975
3
MAIN DIKE
SUPPLY CANAL

PART III