FURTHER OBSERVATIONS ON POLYCULTURE OF FINFISHES AND PRAWNS IN SALTWATER PONDS AND IN A NET-PEN AT MANDAPAM

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ABSTRACT

The paper deals with the results of polyculture experiments with milkfish, mullets, *Sillago* and prawns in salt water ponds and in a netpen in the coastal waters of Palk Bay at Mandapam, during the period 1979-82. The growth of mullet and *Sillago* was better in the netpen than in the pond, whereas milkfish showed better growth in the pond. Significant differences in production from fertilized and unfertilized ponds have not been noticed, the result of which is attributed to poor soil conditions of the farm. Mullets sharply reacted to low levels of oxygen in ponds. During 1979-80 period, in experiment I, the production per hectare was 671.1 kg for *Chanos chanos*, 68.9 kg for *Valamugil seheli*, 593. 3 kg for *Liza macrolepis* and 31.1 kg for *Penaeus indicus*, thereby recorded the total of 1364.4 kg. In experiment II, the production was 1286. 7 kg for *C. chanos*, 551.1 kg for *V. seheli* and 26.7 kg for *Sillago sihama* with the total of 1864.5 kg. In 1980-81 experiment, the total production was 1600 kg with the combination of 1266.7 kg *C. chanos* and 333.3 kg *V. seheli* in the fertilized pond and 1422.2 kg with the combination of 1205.5 kg of *C. chanos* and 216.7 kg of *V. seheli* in the unfertilized pond. During 1981-82 period, the total production was 1377.8 kg in which *C. chanos* showed 1288.9 kg and *V. seheli* 88.9 kg in the fertilized pond, and in the unfertilized pond it was 1469.9 kg with 1405.5 kg of *C. chanos* and 64.4 kg of *V. seheli*.

INTRODUCTION

Coastal aquaculture is an age-old industry in the Indo-Pacific region, it embracing a wide range of activities from extensive 'sea-ranching' and management activities in large bodies of water to intensive culture with fertilization and feeding of fish in small man-made ponds. Pond culture of fish, utilizing either freshwater, brackishwater, or marine situations, is the most widely practised type of operation in aquaculture. Polyculture of fish is an ancient technology and is most popular in Asia, especially in China and India. The first and most important consideration in polyculture is the probability of increasing production by better utilization of natural food. The selection of species also plays a role in this system that all the species should be benefitted by the available food such

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as plankton, detritus and others, without competing with each other. Different combinations of species of fish in polyculture are used in different regions according to specific conditions. Of all the species of fish, milkfish and mullets are the most acceptable food fish in many countries.

In many countries mullets are cultured in association with other fishes. Lin (1940) reported on the culture of carps together with mullets in brackish-water ponds in Hongkong. Jhingran et al (1972) indicated the possibility of introducing polyculture of Indian major carps together with mullets and species like milkfish and prawns in lower saline waters. The rearing of grey mullets in combination with milkfish, Indian major carps and prawns in the coastal tanks of West Bengal has been described by Pakrasi et al (1975). Results of preliminary experiments on the culture of grey mullets and milkfish in polyculture system in salt water ponds and a pen have been given by James et al (in press).

Further studies on the culture of finfishes in saltwater ponds and netpen were carried out at Mandapam during the period 1979-82. The results of these experiments are presented in this paper.

Material and Methods

The seed of milkfish, mullets, *Sillago* and prawn were collected from the tidal pools, creeks, lagoon and coastal waters at Pamban, Manauli Island, Pillaimadam and Thonithurai area. Fingerlings of the grey mullet *Valamugil seheli* appeared in coastal waters of Thonithurai during May to September. Milkfish fingerlings were available from April to July at Pamban creek, Pillaimadam lagoon and the tidal stream at Manauli Island. The seeds were collected by a drag net of 8 m in length and 2.5 m in breadth, with a bag-like portion measuring 3 m in length, made out of nylon mosquito cloth. The required species were sorted out immediately. The seed thus collected were transported by putting them in fibreglass tanks, plastic buckets and also in oxygenated bags filled with sea water. Prior to stocking them in the culture ponds, they were reared in 12'-dia polycraft pools for a few days, with artificial feed composed of groundnut oil cake, rice bran and fish meal in the form of pellets and paste. But in the pen the seeds were released directly.

During 1979, two ponds, each of size 0.045 ha, at the fish farm were drained completely to remove undesirable organisms such as *Tilapia* and other predatory fishes. The supply of water to the ponds was effected by direct pumping of sea water daily. The water depth was maintained at a level of 70-90 cm. To study the difference in growth in fertilized and unfertilized ponds, during the 1980-81 and 1981-82 experiments, one pond was fertilized with dry chicken manure at a dosage of 1000 kg/ha. The pond was allowed to remain as such for some days with little water. Good growth of filamentous green algae such

as *Chaetomorpha* spp., *Enteromorpha* spp. and *Cladophora* spp. was indicated by green colouration of water. Subsequent application of the same manure was continued at the rate of 500 kg/ha at three-month intervals.

A 3-m high net enclosure, covering an area of 100 m^2, was erected in the coastal waters of Palk Bay during 1980. The area selected was such that the water level maintained even at the lowest tide. The net for the pen was of 1 cm mesh, fabricated with 1 mm thick monofilament twine. The pen was erected with the help of palmyrah poles implanted in the sand at an interval of 2 m. About 50 cm of the net was buried in the sand. The depth of water inside the pen varied between 0.5 m, during the lowest low tide, and 1 m at peak high tide. Cleaning of the net was done daily to avoid any clogging.

During the culture period the stock in the ponds, as well as in the pen, were fed with supplementary feed composed of groundnut oil cake and rice bran in equal proportion, at a rate of 5-10% of the body weight of fish, in the form of dough. Hydrological conditions in the ponds and pen were monitored regularly.

Hydrological Conditions

In both the experiments I and II, during the period 1979-80, the water temperature ranged from 25.3°C to 33.2°C. The salinity values varied from 16.62 ppt during monsoon period to 38.75 ppt in summer months. The dissolved oxygen content was found to vary from 2.42 to 5.58 ml/l. The pH of the pond water ranged from 7.2 to 8.2. During the periods 1980-81 and 1981-82, the water temprature ranged from 26.2°C to 31.0°C; salinity varied from 25.58 to 41.44 ppt; dissolved oxygen content ranged between 1.59 and 6.65 ml/l and the pH from 7.6 to 8.4 in the fertilized pond. On the other hand, the ranges in the unfertilized pond were 26.2 to 31.2°C for water temperature, 24.12 to 41.72 ppt for salinity, 1.88 to 7.31 ml/l for dissolved oxygen and 7.7 to 8.4 for pH. In the pen the range in water temperature was from 28.5 to 30.2°C, salinity from 30.98 to 35.62 ppt and dissolved oxygen from 2.95 to 5.47 ml/l. A low level of 0.55 ml/l of oxygen was observed in the unfertilized pond during the end of May 82, when mortality of mullets occurred. But no mortality of milkfish was noticed. In the same month, the level of oxygen in the fertilized pond was 1.09 ml/l and no mortality of either species was noticed. The hydrological conditions in the culture sites are shown in Figs. 1 and 2.

Salt Water Ponds

1979-80 *Experiment*

During the year 1979, one pond was stocked with fingerlings of milkfish (*Chanos chanos*), the grey mullet (*Valamugil seheli* and *Liza macrolepis*) and the prawn seed (*Penaeus indicus*) (experiment I). In experiment II, the combination was *C. chanos, V. seheli* and *Sillago sihama*. Preliminary results up to the period October 1979 in both the experiments have already been presented by James et al (in press).

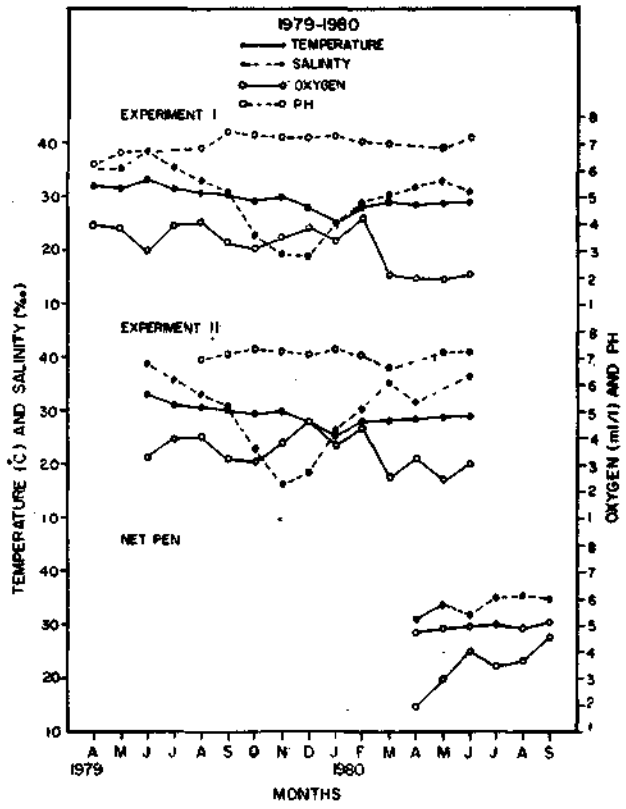

FIG. 1. Hydrological conditions in the culture sites

Further studies revealed that, in experiment I, the average sizes attained by *C. chanos, V. seheli, L. macrolepis* and *P. indicus* were 342.5 mm (221.6 g), 223.2 mm (120.0 g), 210.5 mm (95.0 g) and 180.9 mm (32.0 g), respectively, at a harvest after 14 months. The monthly average growth increments were 20.1 mm (15.6 g) for *C. chanos,* 13.6 mm (8.6 g) for *V. seheli,* 10. 7 mm (6.4 g) for *L. macrolepis* and 10.5 mm (2.3 g) for *P. indicus.* The yields per hectare were 671.1 kg, 68.9 kg, 593.3 kg and 31.1 kg, with a survival of 13.8%, 26.0%, 49.7% and 14.3% respectively for *C. chanos, V. seheli, L. macrolepis* and *P. indicus.* Similarly, in experiment II after a rearing period of 12 months, at harvest, *C. chanos* grew to a size of 253.7 mm (115.1 g), *V. seheli* to 142.3 mm (23.6 g) and *S. sihama* to 156.0 mm 51.8 g). The respective growth rates recorded by these species were 17.3 mm (9.5 g), 10.2 mm (4.3 g) and 9.2 mm (2.0 g). The yields per hectare, as well as the rate of survival, were 1286.7 kg (67.7%) for *C. chanos,* 551.1 kg (64.4%) for *V. seheli* and 26.7 kg (6.7%) for *S. sihama* (Table 1).

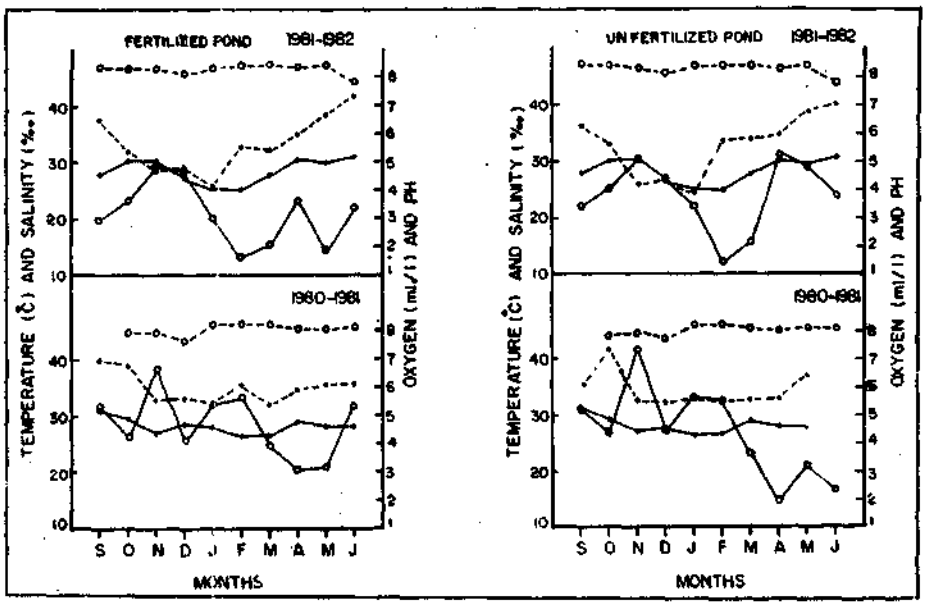

FIG. 2 Hydrological conditions in the culture sites

The growth of *C. chanos* and *V. seheli* appeared to be better in experiment I. Though the recovery of *C. chanos* was poor, the production was good as a result of increase in body weight. On the other hand, in experiment II, the survival as well as the production was higher for *C. chanos* than in experiment I.

1980-81 *Experiment*

During September 80, both the fertilized and unfertilized ponds were stocked with *C. chanos* at the rate of 8333 nos./ha. In October *V. seheli* was added to the stock in each pond at the rate of 7777 nos./ha.

In the fertilized pond *C. chanos* grew to a size of 174.7 mm (47.7 g) in 3 months, 215.4 mm (80.6 g) in 6 months and 360.0 mm (270.0 g) in 10 months, at harvest in July 81, from the initial average size of 91.6 mm (10.6 g). In the unfertilized pond, this species attained the average size of 160.3 mm (35.1 g), 240.2 mm (113.6 g) and 343.3 mm (249.0 g) in 3, 6 and 10 months, respectively, from the initial size of 65.9 mm in length and 2.5 g in body weight (Fig. 3). Therefore the monthly growth rate observed was 26.8 mm(25.9 g) in the fertilized pond and 27.7 mm (24.6 g) in the unfertilized pond.

The grey mullet, *V. seheli*, was in sizes of 86.7 mm (9.4 g), 121.9 mm (25.3 g) and 190.1 mm (75.0 g) at harvest in the 3rd, 6th and 9th month, respectively, from the stocking size of 50.6 mm in length and 2.0 g in body weight, in the fertilized pond. In the unfertilized pond, they progressed to 115.1

TABLE 1. *Polyculture experiments in saltwater ponds at Mandapam during* 1979-80. (0.045-ha pond)

	EXPERIMENT I			
	C. chanos	*V. seheli*	*L. macrolepis*	*P. indicus*
Total (No.) seed released	1000	100	600	300
Rate of stocking (No./ha)	22000	2000	13000	7000
Size at stocking				
Average length (mm)	61.4	32.6	60.5	34.0
Average body wt. (g)	2.6	1.0	5.4	0.3
Culture period (months)	14	14	14	14
Size at harvest				
Average length (mm)	342.5	223.2	210.5	180.9
Average body wt. (g)	221.6	121.0	95.0	32.0
Rate of growth per month				
Length (mm)	20.1	13.6	10.7	10.5
Weight (g)	15.6	8.6	6.4	2.3
Total Nos. recovered	138	26	298	43
Survival rate (%)	13.8	26.0	49.7	14.3
Production (kg/ha)	671.1	68.9	593.3	31.1
	EXPERIMENT II			
	C. chanos		*V. seheli*	*S. sihama*
Total No. of seeds released	750		750	750
Rate of stocking (No./ha)	17000		17000	17000
Size at stocking				
Average length (mm)	45.6		33.9	31.0
Average body wt. (g)	1.1		0.4	0.2
Culture period (months)	12		12	12
Size at harvest				
Average length (mm)	253.7		156.0	141.3
Average body wt. (g)	115.1		51.8	23.6
Rate of growth per month				
Length (mm)	17.3		10.2	9.2
Weight (g)	9.5		4.3	2.0
Total Nos. recovered	508		483	50
Survival rate (%)	67.7		64.4	6.7
Production (kg/ha)	1286.7		551.1	26.7

mm (20.6 g) in 3 months, to 168.1 mm (57.0 g) in 6 months and to 190.9 mm (65.0 g) in 9 months, as against the initial length and body weight of 57.0 mm and 3.0 g, respectively (Fig. 4). The monthly average growth increase was 15.5 mm (8.1 g) in the fertilized pond and 14.9 mm (6.9 g) in the unfertilized pond.

The yield per hectare and survival rate recorded for *C. chanos* at harvest were 1266.7 kg and 60.8%, respectively, in the fertilized pond and 1205.5 kg and 65.1% in the unfertilized pond. The yields and survival rates of *V. seheli* in the fertilized and unfertilized ponds were 333.3 kg 57.0% and 216.7 kg and 42.9%, respectively (Table 2).

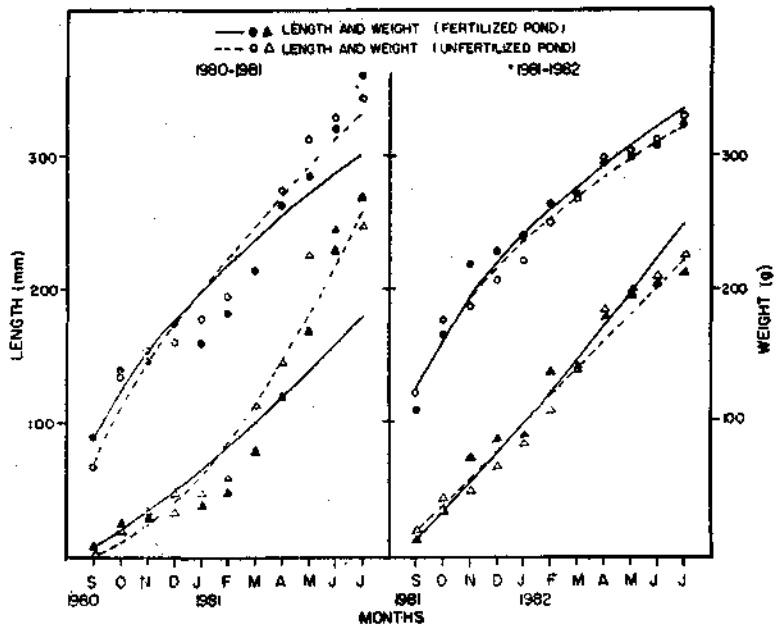

FIG. 3. Growth curves for *Chanos chanos*

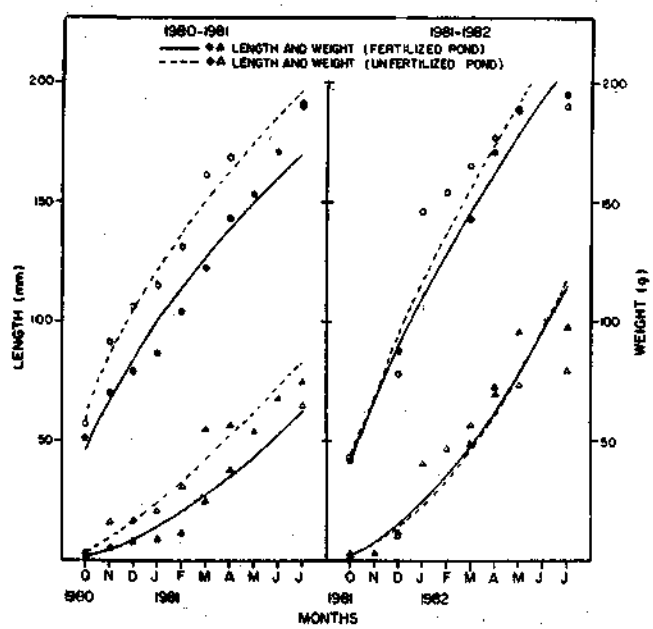

FIG. 4. Growth curves for *Valamugil seheli*

TABLE 2. *Polyculture experiments in saltwater ponds at Mandapam during* 1980-81.

	Fertilized pond (.045 ha)		*Unfertilized pond (.045 ha)*	
	C. chanos	*V. seheli*	*C. chanos*	*V. seheli*
Total (No.) seed released	375	350	375	350
Rate of stocking (No./ha)	8333	7777	8333	7777
Size at stocking				
Average length (mm)	91.6	50.6	65.9	57.0
Average body wt. (g)	10.6	2.0	2.5	3.0
Culture period (months)	10	9	10	9
Size at harvest				
Average length (mm)	360.0	190.1	343.3	190.9
Average body wt. (g)	270.0	75.0	249.0	65.0
Rate of growth per month				
Length (mm)	26.8	15.5	27.7	14.9
Weight (g)	25.9	8.1	24.6	6.9
Total Nos. recovered	228	200	244	150
Survival rate (%)	60.5	57.0	65.1	42.9
Production (kg/ha)	1226.7	333.3	1250.5	216.7

The size of *C. chanos* at harvest ranged from 272 mm (200 g) to 480 mm (500 g) in the fertilized pond and from 284 mm (160 g) to 430 mm (520 g) in the unfertilized pond, with about 49% of fish grown above average size in both the ponds (Fig. 5). The size range of *V. seheli* varied from 168 mm (50 g) to 220 mm (120 g) and from 167 mm (30 g) to 228 mm (100 g) in the fertilized and unfertilizsed ponds, respectively, about 62% in the fertilized and 57% of fish in the unfertilized pond having grown beyond the average size (Fig. 6).

1981-82 *Experiment*

The same experiment was repeated during 1981-82.

In the fertilized pond, *C. chanos*, having the average stocking size of 109.9 mm (12.8 g) in September 81 progressed to 229.5 mm (83.6 g), 271.5 mm (143.4 g) and 322.7 mm (213.0 g) in 3, 6 and 10 months respectively. On the other hand, in the unfertilized pond the same species attained a growth of 206.5 mm (68.3 g) in 3 months, 267.2 mm (143.2 g) in 6 months and 329.1 mm (227.2 g) in 10 months, from the initial average size of 121.9 mm in length and 21.2 g in body weight (Fig. 3). The rate of growth per month was 21.3 mm (20.0 g) in the fertilized and 20.7 mm (20.6 g) in the unfertilized pond.

In the fertilized pond, *V. seheli* progressed to 88.8 mm (11.7 g) in 2 months, 170.6 mm (73.7 g) in 6 months and 195.0 mm (67.6 g) in 9 months

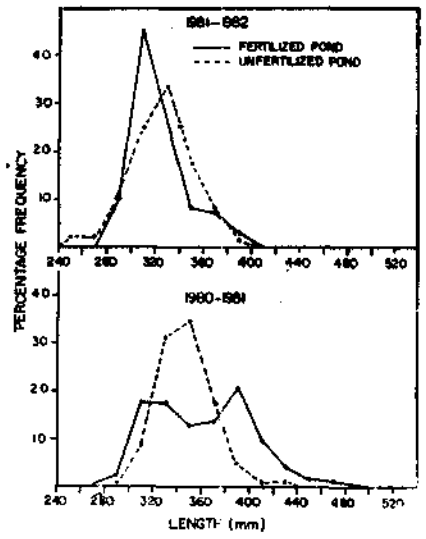

FIG. 5. Length-frequency curve of harvested *Chanos chanos*

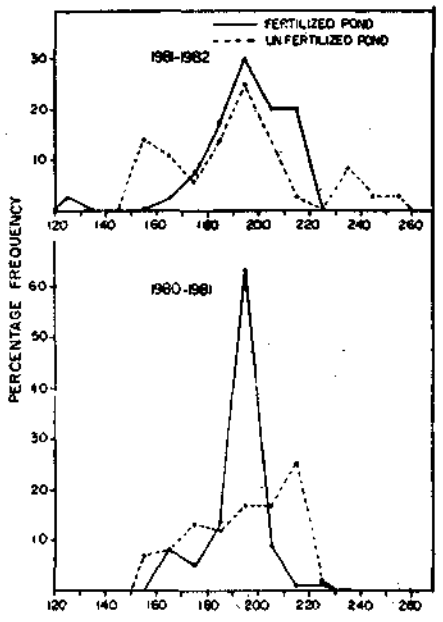

FIG. 6. Length-frequency curve of harvested *Valamugil seheli*.

respectively, from the stocking length and body weight of 42.5 mm and 2.5 g. In the unfertilized pond this species, having the same stocking size, attained the size of 146.3 mm (48.1 g) in 3 months, 177.2 mm (70. g) in 6 months and 190.0 mm (80.0 g) in 9 months (Fig. 4). The monthly growth rate was 16.9 mm (10.6 g) in the fertilized and 16.4 mm (8.6 g) in the unfertilized pond.

TABLE 3. *Polyculture experiments in saltwater ponds at Mandapam during* 1981-82.

	Fertilized pond (.045 ha)		*Unfertilized pond (.045 ha)*	
	C. chanos	*V. seheli*	*C. chanos*	*V. seheli*
Total (No.) seed released	375	350	375	350
Rate of stocking (No./ha)	8333	7777	8333	7777
Size at stocking				
Average length (mm)	109.9	42.5	121.9	42.5
Average body wt. (g)	12.8	2.5	21.2	2.5
Culture period (months)	10	9	10	9
Size at harvest				
Average length (mm)	322.7	195.0	329.1	190.0
Average body wt. (g)	213.0	97.6	227.2	80.0
Rate of growth per month				
Length (mm)	21.3	16.9	20.7	16.4
Weight (g)	20.0	10.6	20.6	8.6
Total Nos. recovered	305	40	321	36
Survival rate (%)	81.2	11.4	86.7	10.3
Production (kg/ha)	1288.9	88.9	1405.5	64.4

At harvest the yields (as well as the rates of survival) for *C. chanos* were 1288.9 kg|ha (81.2%) and 1405.5 kg|ha (86.6%) in the fertilized and unfertilized ponds, respectively. Similarly, the yield and survival rates for *V. seheli* were 88.9 kg|ha (11.4%) in the fertilized pond and 64.4 kg|ha (10.3%) in the unfertilized pond (Table 3).

The size range of *C. chanos* at harvest varied from 283 mm (120 g) to 397 mm (300 g) in the fertilized pond and 245 mm (100 g) to 398 mm (340 g) in the unfertilized pond. About 49% and 42% of fish have grown above the average size in the fertilized and unfertilized ponds respectively (Fig. 5). The range in size of *V. seheli* varied between 120 mm (40 g) and 218 mm (120 g) in the fertilized pond and 150 mm (40 g) and 250 mm (120 g) in the unfertilized pond. About 57% in the fertilized and 53% in the unfertilized pond attained sizes above the average (Fig. 6).

The Net Enclosure

The net enclosure was stocked with the fingerlings of *S. sihama* in April, *C. chanos* in May and *V. seheli* in June 1980, at the rates of 6000, 30000 and 14000 nos.|ha, respectively. The average size at stocking was 119.0 mm (13.0 g) for *S. sihama*, 63.7 mm (1.9 g) for *C. chanos* and 38.3 mm (0.7 g) for *V. seheli*. The periods of growth observed for these species varied between 4 to 6 months due to non-occurrence of the seed of all these species at the same time for stocking. Among these three species, *S. sihama* attained the average size of 221.0 mm (61.8 g) in 6 months. In 5 months period, *C. chanos* progressed to 177.3 mm (53.3 g). On the other hand, in 4 months, *V. seheli* increased to a size of 145.9 mm (42.8 g). The monthly average growth rates observed were 16.8 mm (8.1 g) for *S. sihama*, 22.7 mm (10.3 g) for *C. chanos* and 26.9 mm (10.5 g) for *V. seheli* (Table 4).

The growth of *S. sihama* and *V. seheli* was better in in the net enclosure than in the pond, whereas *C. chanos* showed better growth increment in the pond than in the net enclosure. The sudden roughness of the sea after the sixth month of this experiment lifted off the net trenched in the sand and most of the stock escaped. Hence the production and survival rates were not calculated.

Behaviour of the Fish in the Culture Ponds

It was observed that mullet could not tolerate the low oxygen level. When there was oxygen depletion the entire stock of mullets came to the surface and gasped for air by opening and closing the mouth. During 1981-82 experiment, the oxygen level in the unfertilized pond decreased to 0.55 ml|l in the end of May 82 due to non-replenishment of water by pumping. As a result mortality of mullets occurred though there was no mortality of milkfish. When fresh sea

TABLE 4. *Polyculture experiments in the next pen in Palk Bay at Mandapam during* 1980. (0.01-ha).

	C. chanos	*V. seheli*	*S. sihama*
Total No. of seed released*	300	140	60
Rate of stocking (No./ha)	30000	14000	6000
Size at stocking			
Average length (mm)	63.7	38.3	119.0
Average body wt. (g)	1.9	0.7	13.0
Culture period (months)	5	4	6
Size on completion of the experiment			
Average length (mm)	177.3	145.9	221.0
Average body wt. (g)	53.3	42.8	61.8
Rate of growth per month			
Length (mm)	22.7	26.9	16.8
Weight (g)	10.3	10.5	8.1

* The survival and production rates could not be determined since the experiment was discontinued due to roughness of the sea.

water was pumped into the ponds, mullets were found to congregate in the place where the water fell evidently because of the better oxygenation and favourable water temperature.

At the harvest milkfish were captured first because of its quick agitation, whereas in the case of mullets, *Sillago* and prawns, it was difficult to catch them till the pond was dewatered.

At the time of stocking there was no *Tilapia* in the pond. But, after three or four months, young ones of this fish were found in large quantities; and at the time of harvest most of them were in the breeding condition. Evidently, the entry of *Tilapia* into the pond was through the water supply in egg or larval stages, which could not be filtered out efficiently.

DISCUSSION

Devenesan and Chacko (1944) reported the growth rate of *Chanos* as 28 mm per month in the marine fishponds of Krusadai Island, in monoculture system. Chacko and Mahadevan (1956) found that the average length of *Chanos* was 235-240 mm in 12 months from the initial size of 50-85 mm at the same place. Tampi (1960) reported that the growth of *Chanos* was rapid during 3-4 months. He has also mentioned that the fingerlings of 80 mm in size grew to 300 mm in one year period in the salt water ponds at CMFRI fish farm. The findings of the present authors indicated that *Chanos* in polyculture system attained the length of 253.7 mm in one year and 342.5 mm in 14 months during 1979-80 experiment and 322.7-360.0 mm in the fertilized and 329.1-343.3 mm in the unfertilized ponds after 10 months, during 1980-82 period.

The growth rate per month (26.9 and 27.7 mm) shown by this species in the fertilized and unfertilized pond during 1980-81 period is more or less similar in some extent with the observation of Devenesan and Chacko (1944).

Yashouv (1968) reported that mullet, when weighing 30-70 g in their second year, stocked in carp ponds at the density of 500-800 nos./ha in Isreal, increased to 400-700 g after a period of 120-150 days. The average daily increment of 50-60 g fingerlings of *Mugil cephalus* in the biannual culture introduced into the ponds in Israel together with carp, *Tilapia* and silver carp, was 3.2 g and the growth was also same for lower ranges of population densities ranging from 750-1200 fish/ha (Pruginin et al 1975). Liao (1981) stated that, in a mixed culture of milkfish, mullet and grass prawn in a milkfish pond at Taiwan, the growth of mullet was better than the growth of milkfish. In the present study, *V. seheli*, when stocked with milkfish, showed an average growth rate of 10.2-13.6 mm in 1979-80 period, 15.5 mm and 14.9 mm in the fertilized and unfertilized ponds, respectively, during the 1981-82 period. In 1979-80 experiment, *L. macrolepis* indicated the monthly growth rate of 10.7 mm.

The long period of tillage heavy application of chicken manure and higher stocking rates resulted in 1388 kg/ha of milkfish in Taiwan (Jium-Kuo Liang and Chin-Yun Huang 1972). The annual average production of milkfish was 1000 kg/ha by improved methods in Philippines and 1600-1800 kg/ha in Taiwan, where ponds were heavily manured and provided with supplementary feed (Ling 1972). Elaborate preparation of pond, heavy fertilization, feeding and stock manipulation gave a higher production of 1500-2500 kg/ha/year in Philippines (Blanco 1972) and 2500 kg/ha in Taiwan (Tang 1972). In the marine fish farm of CMFRI, Tampi (1960) stated, that the production of *Chanos* was 212-455 kg/ha in monoculture system. An yield of 1088 kg/ha of *Chanos* with supplementary feed and 705 kg/ha without feed was reported by Sundarajan et al (1979) in the brackishwater fish farm at Adyar. The production of 318 kg/ha/11 months and 857 kg/ha/14 months was recorded in the saltpan of Veppalodai at Tuticorin (Bensam and Marichamy 1981). The present investigation showed a maximum yield of 1405.5 kg/ha of *Chanos* in 10 months' period.

With regard to culture of *M. cephalus*, the results of experiments in Egypt (Zarka and Fahmy 1968) indicated a production of 192-350 kg/ha in the fertilized ponds as against 131 kg/ha in the unfertilized ponds. In Taiwan mullet, when cultured with milkfish and carps, gave a production of 1000 kg/ha (Rabanal 1968). Polyculture experiments in brackishwater ponds in Lagos (Sivalingam 1975) indicated that the natural entry of mullet fry with the tide resulted in a production of 239 kg/ha in addition to other species without feed or fertilizer. He has also stated that the pond in which mullet fry were stocked yielded 220 kg/ha with fertilizer or supplementary feed. A net production of 199.6 kg/ha/11 months and 139.84 kg/ha/8 months was obtained in polyculture

system in the coastal tanks of West Bengal (Pakrasi et al 1975). In the present study the production of mullet *V. seheli* was 68.9 kg|ha|14 months and 551.1 kg|ha|12 months and of *L. macrolepis* was 593.3 kg|ha|14 months in 1979-80 and 333.3 kg|ha|10 months in the fertilized and 216.7 kg|ha|10 months in the unfertilized ponds during 1980-81 period. In 1981-82 the recovery of mullet was very poor and hence the production also decreased in both the ponds.

Regarding the survival rate, *Chanos* showed better survival in 1981-82 period in both the fertilized and unfertilized ponds than during 1980-81 period. In these two experiments it was noticed that the lower the growth rate compensated, the higher the survival, and vice-versa. Tampi (1960) reported 9-11% survival for *Chanos* at Mandapam. In the brakishwater fish farm at Adyar. the survival rate of *Chanos* was found to be 89.2-99.04% (Sundarajan et al 1979). Bensam and Marichamy (1981) recorded a survival of 44.04% in higher stocking and 85.53% in lower stocking density in the saltpans of Veppalodai at Tuticorin. The survival of 81.2% in the fertilized and 86.6% in the unfertilized pond shown by *Chanos* in the present experiment of 1981-82 is in agreement with Bensam and Marichamy in the experiment of lower stocking rate.

As far as the survival of *V. seheli* is concerned, it was very poor during the period 1981-82, compared to the results of previous experiments. The lower survival in the unfertilized pond was due to mortality resulted from oxygen difficiency in the 8th month of the culture period. Nair (1974) stated that *Mugil parsia* and *Mugil tade* are intolerent of sewage pollution, death being due to difficiency of oxygen. Kutty and Mohamed (1975) reported that *Rhinomugil corsula* lose equilibrium at 0.8 mg 02|l in freshwater at 30°C. In the present study mortality of *V. seheli* occurred in the unfertilized pond at 0.56 ml 02|l. The oxygen depleation may be due to non-pumping of sea water for a week. However, *Chanos* were found to tolerate this oxygen level. On the other hand, the poor survival of mullets in the fertilized pond might be due to mortality of seed at the time of stocking.

Results of the present study also indicate that there was not much variation in growth and yield of species in the fertilized and unfertilized ponds. This might be due to the inadequacy of the quantity of the fertilizer used as well as its frequency of application. Hay (1952) recommended the use of 500-1000 kg|ha of poultry manure in the Cape Province of South Africa. An application of 2000 kg|ha chicken manure plus 500 kg|ha rice bran or other organic fertilizer is sufficient for the growth of algae in the first year and it can be gradually reduced, depending on the condition of algal pasture in the following years (Jium-Kuo Liang and Chin-Yun Huang 1972). Rappaport and Sarig (1978) mentioned that chicken droppings at a rate of 25 kg dry wt./week (5 kg dry wt.|day, 5 days in a week) showed an advantage in increasing the yield by reducing the feed conversion ratio in Israel, Joseph (1981) pointed out that a

yield of 800 kg|ha of mullet was obtained in polyculture system with *Tilapia* and silver carp in Israel when dry chicken droppings were used at a rate of 250 kg|ha. A compost prepared out of seaweeds and cowdung was used as organic manure at a rate of 500 lb (570 kg|ha) in the salt water ponds at Mandapam (Tampi 1960). In the present study, chicken manure at a rate of 1000 kg|ha initially and 500 kg|ha subsequently at an interval of every three months was practised. Eventhough it produced the filamentouss algae, they did not grow further. Tang and Chen (1867) indicated that the best texture soil for the growth of benthic algae in Taiwan ponds is silty loam which consists of silt, sand and clay. Djajadiredja and Poernomo (1972) reported that the productivity of the salt water ponds directly depends on the fertility of the bottom soil and water. Tampi (1960) stated that the poor and porous soil is largely responsible for inhibiting the fertility of the ponds. One reason of the ineffectiveness of the fertilizer in the present study might be also due to soil texture as mentioned above.

According to Felix (1975), *Chanos* which attained the size of 30-49 cm long in three months in pen in Philippines measured 65-80 cm in length and 2-3.5 kg in weight after eight months. At Mandapam, the growth rate per month observed in the pen made out of palmyrah leaf stalk, was 30.1 mm for *Chanos* and 24.6 mm for mullet (James et al, in press) and at Tuticorin it was 27.0-51.0 mm for *Chanos* and 23.0-29.0 mm for *Mugil* species in the pen made of split bamboo screens (Shanmugam and Bensam 1982). In the present investigation, the rate of growth per month shown by mullet (26.9 mm) in the net pen is more or less similar to the findings of the above authors. Milne (1970) stated that the substratum of locality selected should be of firm clay or mud, so that the poles driven for the support of pens can withstand strong winds, waves and currents. In the present experiment, the site selected was sandy bottom. Erection of pens in sheltered areas like lagoons, saline swamps and bays will be of great advantage both from production point of view and protection of structures from adverse conditions of the sea.

Constraints and Difficulties

Certain constraints and difficulties were identified during the present experiments. The major problem was the entry of Tilapia into experimental ponds and their competition for food with species under culture. Complete eradication was difficult even by repeated nettings. Sampling of mullet, prawns and *Sillago* was found to be difficult since they remain mostly at the bottom. Disruption in daily fresh seawater supply to the ponds affected the oxygen levels resulting mortality, primarily of mullets. Erection and maintenance of net pens in the open sea was found difficult and expensive. The period of experiment also gets restricted depending on the roughness of the sea.

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