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The Intensive Farming of Striped Mullet, Mugil cephalus *Linnaeus, in the Polyethylene Film-lined Ponds Developed on the Sea Shore at Calicut, Kerala*

S. LAZARUS* and K. NANDAKUMARAN**

Introduction

Significant advances have been made in the mariculture fin fishes in many parts of the world. In India two major cultivable fin fishes, namely, mullets and milk fish, have been used in the traditional culture practices and also in the scientific culture of fin fishes in ponds and pens. Among mullets, the striped mullet *Mugil cephalus* is a fast growing species and is commonly available on the east and west coasts of India. It is also an important table fish and has a good market both in the coastal and interior regions of our country. When compared to the studies made on the milk fish the attention given to the scientific farming of this species seems to be meagre and only a few reports are available on the poly- and mixed culture of this species (Parkasi *et al.*, 1975; Anonymous, 1978; Marichamy and Rajapackiam, 1981 and Mohan and Nandakumaran, 1981). Under these circumstances, the studies made at Calicut on the growth survival and production of this species in the polyethylene film-lined ponds are reported here. The present paper highlights some of the observations

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made on the monoculture of *M. cephalus* during the period September 1983 to February 1985 with comments on the feasibility of using sandy beaches for mariculture purposes.

Material and method

Pond Preparation

Seven ponds (Plate 1) ranging in size from 200 to 750 m^2 water area were prepared as described by Mohan and Nandakumaran (1980) and Lazarus and Nandakumaran (1987). Sea water was pumped into the ponds with a 5 HP diesel pump by suspending the foot valve of the pump from a float anchored in the sea at a distance of about 90 m from the shore. Fresh water was pumped from a well by a 5 HP electrical pump. Water level around 1.5 m depth was maintained in the ponds throughout the period of experiment.

Plan of the Experiment

In a trial run in 1983 the fish were stocked in only one pond (A). The results obtained were encouraging and in the second year, the fish were stocked in six ponds (B—G) having different water areas (200-750 m^2) and under different stocking densities, (0.25 to 1.00/M^2). This was done mainly with the idea of finding out the optimum stocking density for better growth, survival and production of the striped mullet in this culture system. The stocking details are given in Table 1.

Monitoring of Environmental Parameters and Growth

Estimates of dissolved oxygen, salinity and pH of the culture medium were made twice a week and temperature noted twice daily at 10 a.m. and 2 p.m. Growth of fish in the ponds was recorded once in a fortnight from a random sample of fish taken with a cast net. Usually 20 to 30 fish were measured in live condition and were released back into the pond after the measurement. Organic waste and other detritus found on the bottom of the ponds were removed periodically by siphoning out the bottom water with a three inches flexible hose by a person getting into the pond and moving the inlet portion of the hose across the bottom area in a uniform manner. The water lost by this as well as by evaporation was compensated by pumping water up to the earlier level. This enabled the fish to get oxygen rich water throughout the period of culture.

Sources of Seed, Collection, Transportation and Stocking

The seed was found in plenty in the tidal pools and creeks of estuaries between Kadalundi and Thiruvangoor in the Calicut area during the

Plate IA. A general view of the fish farm

IB. A pond being harvested by a drag net after reducing the water level

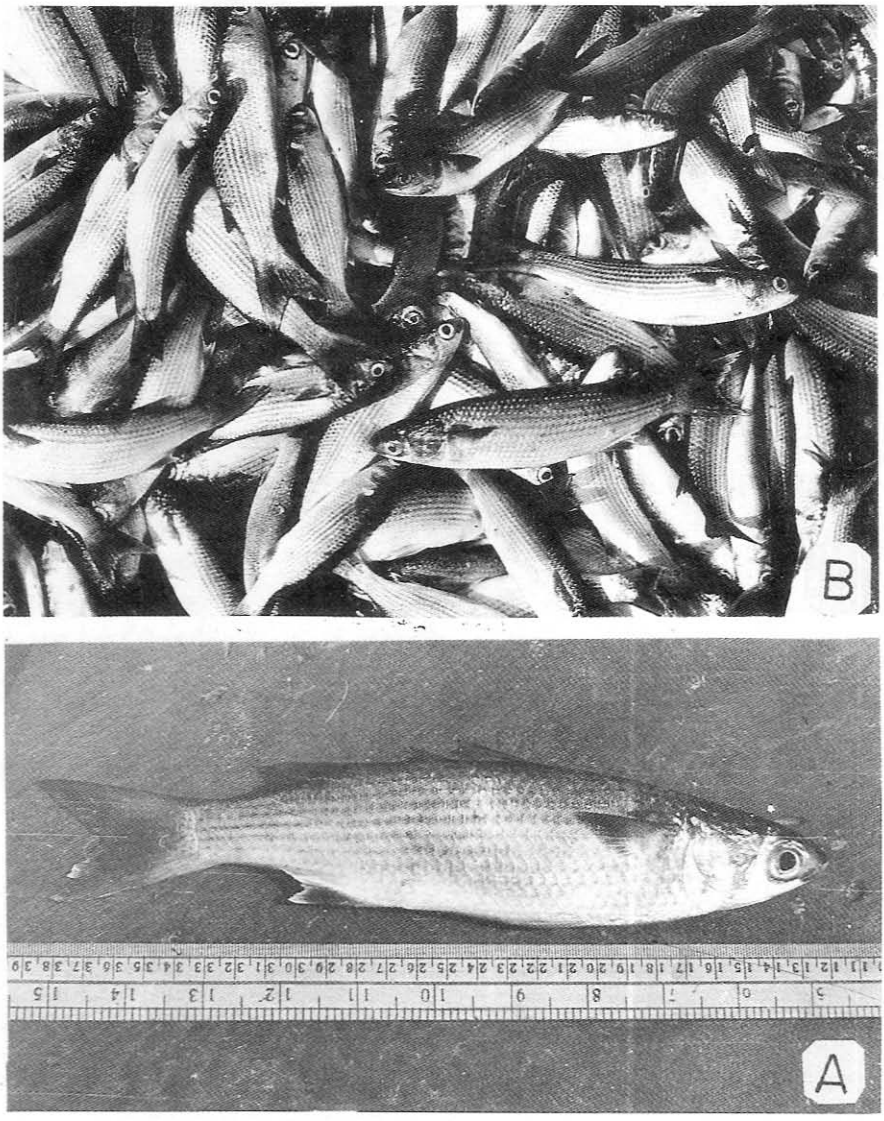

Plate IIA. Size of *Mugil cephalus* at the time of harvest
IIB. A protection of the harvested *M. cephalus*

Table 1. Stocking and harvest details of *Mugil cephalus*

	Ponds						
	A	B	C	D	E	F	G
Area of the pond (m^2)	300	400	750	200	300	200	300
Date of stocking	20-9-83	2-8-84	2-8-84	2-8-84	2-8-84	23-7-84	6-7-84
Number of fish stocked	154	100	375	200	300	200	300
Mean size at stocking (mm)	107	75.3	28.8	25.8	36.8	60.5	22.1
Mean weight at stocking (g)	15.9	6.2	0.18	0.18	0.9	5.2	0.15
Stocking density (no/m^2)	0.50	0.25	0.50	1.00	1.00	1.00	1.00
Date of harvest	9-2-84	22-2-85	22-2-85	22-2-85	22-2-85	29-1-85	7-12-84
Duration of the experiment (days)	142	204	204	204	204	190	154
Mean length at harvest (mm)	218.1	240.8	192.1	211.4	218.2	216.9	193.3
Length increment per day (mm)	0.78	0.81	0.81	0.91	0.89	0.82	1.1
Mean weight at harvest (g)	113.9	142.2	71.1	104.4	114.1	101.3	82.4
Weight increment per day (g)	0.69	0.67	0.35	0.51	0.55	0.51	0.53
Number of fish harvested	74	91	269	125	298	124	220
Survival rate (%)	48.1	91.0	71.7	62.5	99.3	62.0	73.3
Quality harvested (kg)	8.4	13.0	26.9	13.0	33.0	12.5	18.2
Production rate (kg/ha)	280	325	255	650	1100	625	607

months June and July 1983 and June to August 1984. A dragnet made of ordinary cotton mosquito netting was used for the collection. In the first year 450 fry ranging in size from 22 to 40 mm were collected, reared in a nursery pond for about three months and then stocked in the culture pond (A) when they reached a size of 107 mm. This initially helped in the correct identification and separation of this species from others of similar sized seed stage. However, this difficulty was overcome by experience in the second year and the seeds numbering about 1,475 ranging from 20 to 87 mm were stocked directly in the culture ponds, B-G, as detailed in Table 1, after acclimatisation. Four of the ponds (B-E) were harvested on the 204th day after stocking. Ponds A, F and G were harvested on the 142nd day, 190th day and 154th day of stocking respectively (Table 1).

Feed and Method of Feeding

The stocks were fed with an artificial feed made of groundnut oil cake (30 per cent), waste tapioca powder (30 per cent), prawn head powder (25 per cent) and rice bran (20 per cent). The feed thus compounded contained 49.37 to 53.15 per cent carbohydrate, 15.45 to 20.65 per cent protein, 3.45 to 5.86 per cent fat, 14.04 to 18 per cent ash and 9.03 to 12.05 per cent moisture. The feed ingredients were mixed thoroughly, cooked well and allowed to cool down before serving in a dough form in trays kept at the corners of the pond. Depending upon the size of the fish and feed requirement the quantity of feed supplied in the ponds was regulated. It varied from one-third of body weight in the beginning of the experiment to one-fiftieth of body weight towards the end of the experiment.

Results

Environmental Conditions of the Culture Systems

The fluctuations in the values of environmental parameters recorded in the ponds are given in Figs. 1 a and 2. The water temperature varied between a minimum of 29.5°C in July in pond E and to a maximum of 32°C in February in pond D. The dissolved oxygen values were highest in August, the month in which the fish was stocked. This might be due to the low water temperature and low rate of consumption by the seed. Extreme levels of salinity were found in pond F among the ponds which were stocked during 1984 with a minimum of 11.1 ppt in September and a maximum of 28.2 ppt in December. In pond A, however, it was very low and it ranged between 7.2 ppt in December and 14.1 ppt in October. The range in pH was from 8.1 to 8.4 in pond A and was observed in the months October and December respectively. In the other ponds it ranged between 8.3 and 8.8 pH and both the extremes were found in pond B during September to December months.

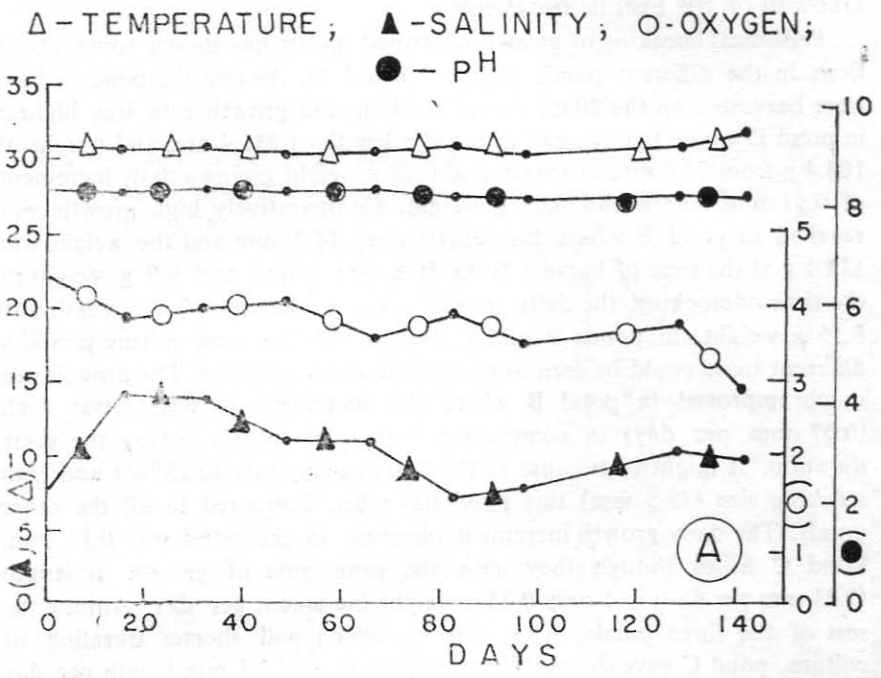

Fig. 1a. Fluctuations in the values of environmental parameters recorded in Pond A.

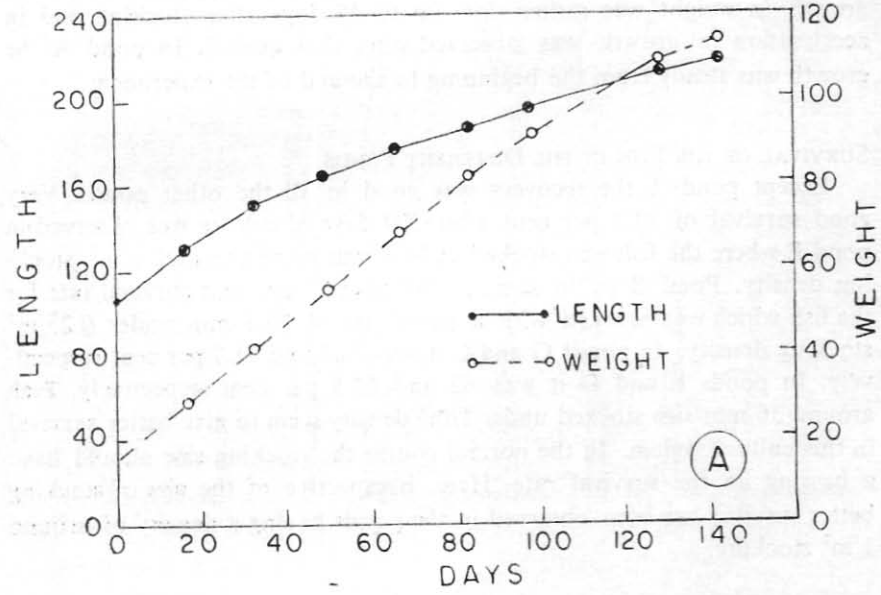

Fig. 1b. Growth of *Mugil cephalus* in pond A.

GROWTH OF THE FISH IN THE PONDS

Periodical checking of growth of striped mullet has shown some variations in the different ponds (Figs. 1 b and 3). Among the ponds which were harvested on the 204th day of stocking the growth rate was highest in pond D where the fish had attained a length of 211.4 mm and weight of 104.4 g from 25.8 mm in length and 0.18 g weight giving a daily increment of 0.91 mm length and 0.51 g weight. Comparatively high growth was reached in pond E where the length was 218.2 mm and the weight was 114.1 g at the time of harvest from 36.8 mm length and 0.9 g weight at the time of stocking, the daily growth increment being 0.89 mm length and 0.55 g weight. In ponds B and C though with the same culture period a different trend could be seen in the growth characteristics. The growth was much improved in pond B where the increment in weight was high (0.67 mm per day) in comparison with other ponds having the same duration. It might be because of the low stocking rate ($0.25/m^2$) and high stocking size (75.3 mm) this pond has when compared to all the other ponds. The daily growth increment observed in the pond was 0.81 mm. Pond C fishes though they gave the same rate of growth in length (0.81 mm per day) had only 0.35 g weight increment per day. Among the rest of the three ponds, A, F and G, which had shorter duration of culture, pond C gave the maximum growth rate of 1.1 mm length per day and 0.53 g weight per day, in pond F they were 0.82 mm and 0.51 g and in pond A they were 0.78 mm and 0.69 g respectively. In ponds B, C and D the growth was very fast up to about 60 days. In ponds E and F the growth in weight was rather slow up to 45 days after stocking and in acceleration in growth was observed after that period. In pond A the growth was steady from the beginning to the end of the experiment.

SURVIVAL OF THE FISH IN THE DIFFERENT PONDS

Except pond A the recovery was good in all the other ponds. Very good survival of 99.3 per cent after 204 days of culture was observed in pond E where the fish was stocked at 36.8 mm mean size and $1/m^2$ stocking density. Pond B in the same period gave 91 per cent survival rate for the fish which was stocked with a mean size of 75.3 mm under $0.25/m^2$ stocking density. In ponds G and C it was 73.3 and 71.7 per cent respectively. In ponds F and D it was 62 and 62.5 per cent respectively. Fish around 36 mm size stocked under $1/m^2$ density seem to give better survival in this culture system. In the normal course the stocking size should have a bearing on the survival rate. Here, irrespective of the size of stocking better survival has been observed in the ponds having a density of around $1/m^2$ stocking.

PRODUCTION OF FISH FROM THE DIFFERENT PONDS

A total of 125 kg of fish was harvested from water area of 2,450 m^2 in

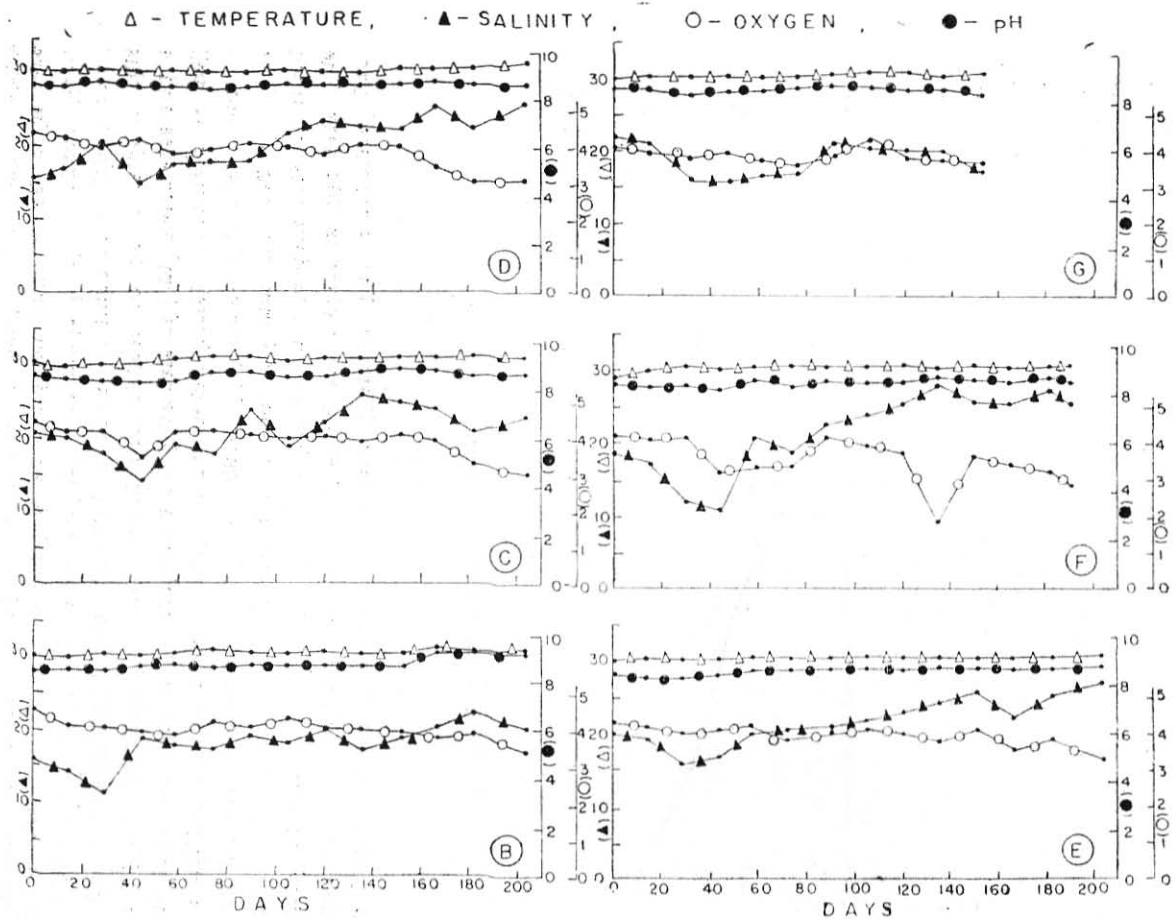

Fig. 2. Fluctuations in the values of environmental parameters recorded in ponds B-G.

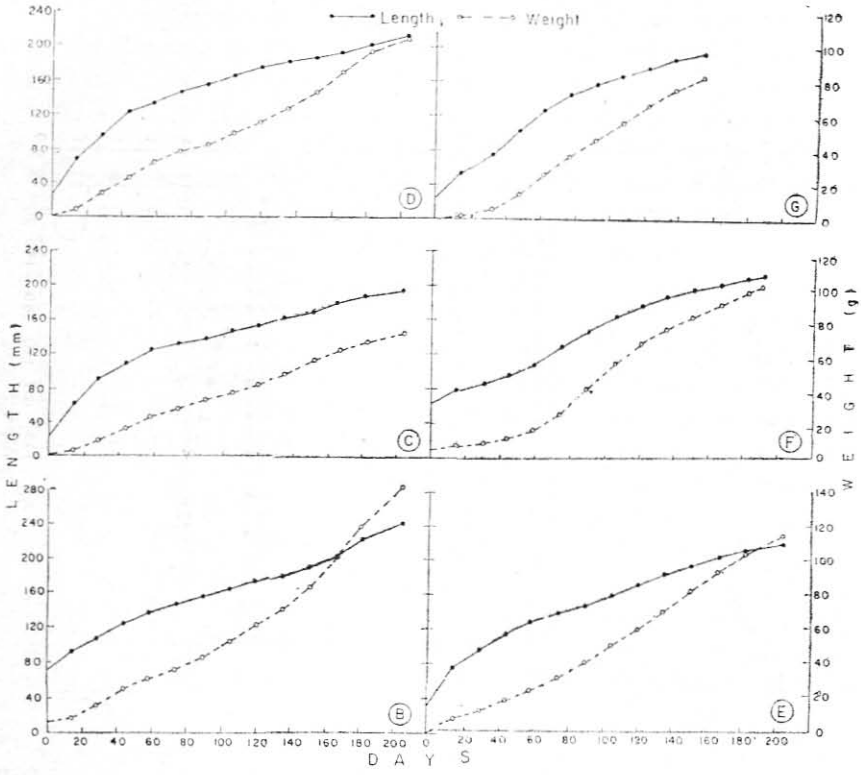

Fig. 3. Growth of *Mugil cephalus* in ponds B-G.

a period ranging from 142 to 204 days (Plate 2). The extrapolated production level varied from 255 to 1,100 kg per hectare in 204 days. The maximum production of 1,100 kg per hectare in 204 days was obtained from pond E with 1/m² stocking rate and 36.8 mm stocking size. The survival rate observed was also the highest (99.3 per cent) in that pond. It is inferred from these experiments that to obtain better production as well as better survival of *M. cephalus* a stocking rate of 1/m² water area and a stocking size around 36 mm (mean size) appear to be suitable in this culture system. The poor production rates obtained in ponds A to C appear to be due to the low rates of stocking made in these ponds. Even at 91 per cent survival in pond B we could get only 325 kg per hectare production under 0.25/m² stocking density. Similarly in pond C which gave 71.7 per cent survival the production was only 255 kg per hectare. This was also due to the low stocking rate (0.5/m²) this pond had. In ponds F and G with a short duration of culture we could get somewhat better

production around 600 per hectare. This might be due to the high stocking rate ($1/m^2$) these ponds had in this experiment.

Discussion

The results of the *Mugil cephalus* culture experiments in the polyethylene film-lined ponds are encouraging and the yield better than what was obtaining from some other culture systems elsewhere: for example, 336 kg per hectare from pond culture in Philippines (Carbine, 1948); from 131.7 to 143.4 kg per hectare from fertilised ponds and 111.6 kg per hectare from unfertilised pond in the U.SA. (Johnson, 1954); 350 kg per hectare in the fertilised brackish water ponds in the U.A.R. (El-Zarka and Fahmy, 1967). Under Indian condition the Vytila Fish Farm of the Kerala Agricultural University. Cochin has recorded a gross production of 494.18 kg per hectare of fish including *Etroplus suratensis*, *Chanos chanos* and *Mugil cephalus* stocked with a ratio of 16:4:1 at the rate of 5,250 per hectare in 15 months period (Anonymous, 1978). The quantity of *M. cephalus* harvested has not been given in the report separately. Pakrasi *et al.* (1975) have reported 100 per cent survival for *M. cephalus* in a polyculture experiment in an excavated coastal rain-fed reservoir tank in West Bengal for 23 fish with 252.6 mm mean length and 236.1 g mean weight. The average length and weight of fish after 11 months of culture were reported to be 426.6 mm and 873.8 g respectively with 217.74 kg per hectare per year production including *M. tade* and *M. parsia*. In the second experiment the above authors have reported 75.86 per cent survival for *M. cephalus* numbering 29 with 110.5 mm length and 17.5 g weight and the net production was given as 209.76 kg per hectare per year including the other two species of mullet also. Marichamy and Rajapackiam (1981) have also reported, based on three polyculture experiments with *Chanos chanos* and *P. indicus* at the Veppalodai Fish Farm at Tuticorin, a maximum production of 361.8 kg per hectare per year with 19.5 per cent survival and maximum survival of 85.7 per cent with 353.1 kg per hectare per year production for *M. cephalus* which was stocked with a model size of 35 to 45 mm and 65 to 70 mm respectively. Mohan and Nandakumaran (1981) have reared 2 *M. cephalus* specimens along with *Liza subviridis* from 10 to 12 mm size to 376 mm size within a period of 182 days by feeding them with the peeled prawns in one of the polyethylene film-lined ponds.

The culture *M. cephalus*, in ponds receiving heated effluents from a power plant at Texas the U.S.A. gave 50 to 85 per cent survival and 293 to 804 kg per hectare production rates within a period of 166 to 293 to 804 kg per hectare production rates within a period of 166 to 293 days with commercially prepared feeds (Linder *et al.*, 1975). Yashoua (1972) reported that striped mullet in monoculture ponds stocked at 183 per 0.1 hectare grew from an initial size of 30 g to a size of 553 g in 197 days.

In the present experiments the fish did not grow to this size probably because they were stocked at a smaller size pond under greater stocking density.

The results of the present experiments are thus better than those discussed here. In the range of values covered in the experiments a stocking density around $1/m^2$ water area has given the best survival and production. El-Zarka and Fahmy (1968) have found the ponds to be overcrowded when they stocked *M. cephalus* with $2/m^2$ density. The high production in these ponds may also be due to the artificial feed given. Being a phytobenthic and epiphytic feeder the mullet might have found it easier to consume the feed supplied here. Linder *et al.* (1975) have also observed better production and survival of this fish with commercially prepared feeds. In conclusion it may be emphasised that the present results give a better picture on the possible yield of mullet if cultured in ponds in India. The optimum parameters suggested here can be applied to the natural ponds also for getting better yield and survival. Since the polyethylene film-lined ponds are free from predators and other problems of natural ponds these can be used well for areas where natural ponds are not available.

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