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STUDIES ON THE MONOCULTURE OF MILKFISH IN ARTIFICIAL PONDS

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ABSTRACT

The results of two sets of milkfish culture experiments conducted in the polyethylene film-lined ponds at Calicut sea shore are given. Maximum instantaneous growth rate(1.8219-1.2155)was observed for fish which were stocked at a smaller size (16.3 mm - 53.6 mm) and minimum (0.5433-0.3727) for the fish which were stocked at a bigger size (104 mm and 107 mm). A maximum survival rate of 88.8% in 180 days was observed for the fish which were stocked at 16.3 mm size under 1/m² stocking density; whereas for fish which were stocked at a higher stocking size of 130.5 mm it was 99.0% for 107 days under the same stocking rate. Highest production of 1882 kg/ha/181 days under 2/m² stocking density and 1751 kg/ha/180 days under 1/m² stocking density were obtained. The economics of the culture operation has been worked out. Optimum stocking size, stocking density, pond size and culture period have been suggested. The earlier reports on the culture of milkfish are compared.

INTRODUCTION

THE MILKFISH *Chanos chanos* (Forskål), is widely distributed in the semitropical and tropical regions of the world. Apart from its quality as an important food fish; it is euryhaline, hardy and fast-growing and hence large scale culture of milkfish is undertaken both in brackish and sea water farms of Philippines, Indonesia and Taiwan. In India interest in the possibility of commercial farming of milkfish has grown apace in recent years following many successful experiments conducted in earthen ponds and coastal pens. Considering the importance of converting the barren sandy beaches for aquaculture purposes an attempt was made at Calicut to culture the milkfish in ponds lined with polyethylene film. Already some reports are available on the earlier results in the culture of milkfish in this culture system (Lal Mohan and Nandakumaran, 1980, 1981 a, b; Lazarus and Nandakumaran, 1987. The present report highlights some of the results obtained from two sets of experiments conducted during June, 1983 to January, 1984 and provides further information on the feasibility of using sandy beaches for mariculture purposes.

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MATERIAL AND METHODS

Preparation of ponds

The ponds were prepared as described by Lal Mohan and Nandakumaran (1980) and Lazarus and Nandakumaran (1987.) The ponds were got ready by April/May before the onset of southwest monsoon. This period because of its dry nature, facilitates quick drying of the ponds after dewaterisation. This in turn makes it easier for cleaning and repairing the lining and also, if needed, for relining the ponds. Sea water was pumped to the ponds with a 5 H. P. diesel pump by fixing the foot

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valve of the pump to a float anchored in the sea at a distance of about 90 m from the shore. Freshwater, when needed, was pumped from a well situated in the office campus by another 5 H. P. electrical pump. After filling the ponds with water the exposed part of the lining on the borders was covered with empty gunny bags and weighted down with laterite blocks. This afforded cover and increased the durability of the exposed lining. Water level around 1.5 m depth was maintained throughout the period of experiment.

Plan of experiments

In the first experiment, size of pond was kept as the variable by keeping other aspects such as stocking size, stocking density, height of water in the pond and rate of feeding at uniform levels. Apart from these, in the first experiment, the seed was stocked in the culture ponds A - D immediately after acclimatisation whereas in the second experiment the seed was reared in the nursery ponds for a period of about 3 months and then transferred to the culture ponds (E and F) by keeping the stocking density as the only variable. This was done, because the number of culture ponds available was not sufficent to stock all the seed immediately and also with an intention of allowing the fish to have a stunted growth and to know the performance of fish with higher stocking size in the ponds. A study of this kind may also give the necessary information to utilise maximum number of seed collected during the peak season and to continue the culture operation throughout the year. However, the present study was limited to know only the performance of fish with higher stocking size in the ponds and to compare that with that of the smaller sized ones. Stocking details are given in Table 1.

Monitoring of environmental parameters and growth

Organic waste and other detritus found on the bottom of the ponds were removed periodically by siphoning out the bottom water with the help of 3" flexible hose by a person getting into the pond and moving the inlet portion of the hose across the bottom area in an uniform manner. The water loss thus occurred and also due to evaporation was compensated by pumping sea water and freshwater in equal quantities into the ponds. Estimates of dissoved oxygen, salinity and pH were made twice a week and temperature noted twice daily at 1000 hrs and 1400 hrs. The growth of fish 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 to the pond after measurement.

Sources of seed, collection, transportation and stocking

Seed was collected from the tidal pools from Korapuzha to Kadalundi during June and July by using an ordinary mosquito cloth net. The bulk of the collection was made from the water-logged areas between the road and the beach of West Hill, Calicut. A total of 4127 seeds ranging in size from 15 to 62 mm total length was collected during July '83 alone. This is the first time such a large number was collected from this area. Soon after the collection the seeds were brought to the fish farm in plastic bins and acclimatised for a while by keeping them in fibre glass tanks and plastic pools containing pond water. After acclimatisation the healthy ones were counted and stocked as per the details given in Table 1.

Feed and feeding method

The stocks were fed with an artificial feed made out of groundnut oil cake (30%), tapioca waste powder (30%), prawn head powder (25%) and rice bran (15%). The feed thus compounded contained 55.52 - 66.34% carbohydrate, 16.45 - 17.15% protein, 1.70 - 2.75% fat, 3.84 - 15.65% ash and 9.92 - 10.68% moisture. The feed ingredients were mixed up 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 requirments, the quantity of feed to be supplied to the ponds was regulated. It varied from 5 times the body weight in the beginning of the experiment to 1/50 of the body weight towards the end of the experiment in some of the ponds (B, C and D).

TABLE 1. *Details of stocking and harvest of* Chanos chanos *in* 1983

	Ponds					
	A	B	C	D	E	F
Area (m^2)	200	555	1000	220	300	135
Depth of water (m)	1.5	1.5	1.5	1.5	1.5	1.5
Number stocked	200	555	1000	440	300	34
Stocking density (No/m^2)	1.0	1.0	1.0	2.0	1.0	0.25
Mean length (mm) at stocking	53.6	16.3	16.3	27.8	130.5	175.3
Mean weight (g) at stocking	1.30	0.045	0.045	0.20	22.5	43.0
Duration of the experiment (days)	182	180	180	181	107	104
Date of stocking	2.7.'83	4.7.'83	4.7.'83	15.7.'83	27.9.'83	30.9.'83
Date of harvest	31.12.'83	31.12.'83	31.12.'83	12.1.'84	12.1.'84	12.1.'84
Mean length (mm) at harvest	332.7	280.3	321.6	259.6	289.4	297.4
Increase in length (mm) / day	1.53	1.47	1.70	1.28	1.49	1.17
Mean weight (g) at harvest	271.4	156.7	256.7	130.4	182.2	209.8
Increase in weight/day (g)	1.48	0.87	1.43	0.72	1.49	1.60
No. of fish harvested	93	493	682	371	297	32
Survival (%)	46.5	88.8	68.2	84.3	99.0	94.1
Quantity harvested (kg)	25.2	77.3	175.1	41.4	41.0	6.8
Production (Kg/ha)	1260	1392	1751	1882	1367	503
Extrapolated level of production (ka/ha/year)	2527	2823	3550	3795	4663	1765

In pond A it was 1/2 to 1/50 of body weight, in pond E it was 1/2 to 1/25 and in pond F it was 1/5 to 1/25 of the body weight.

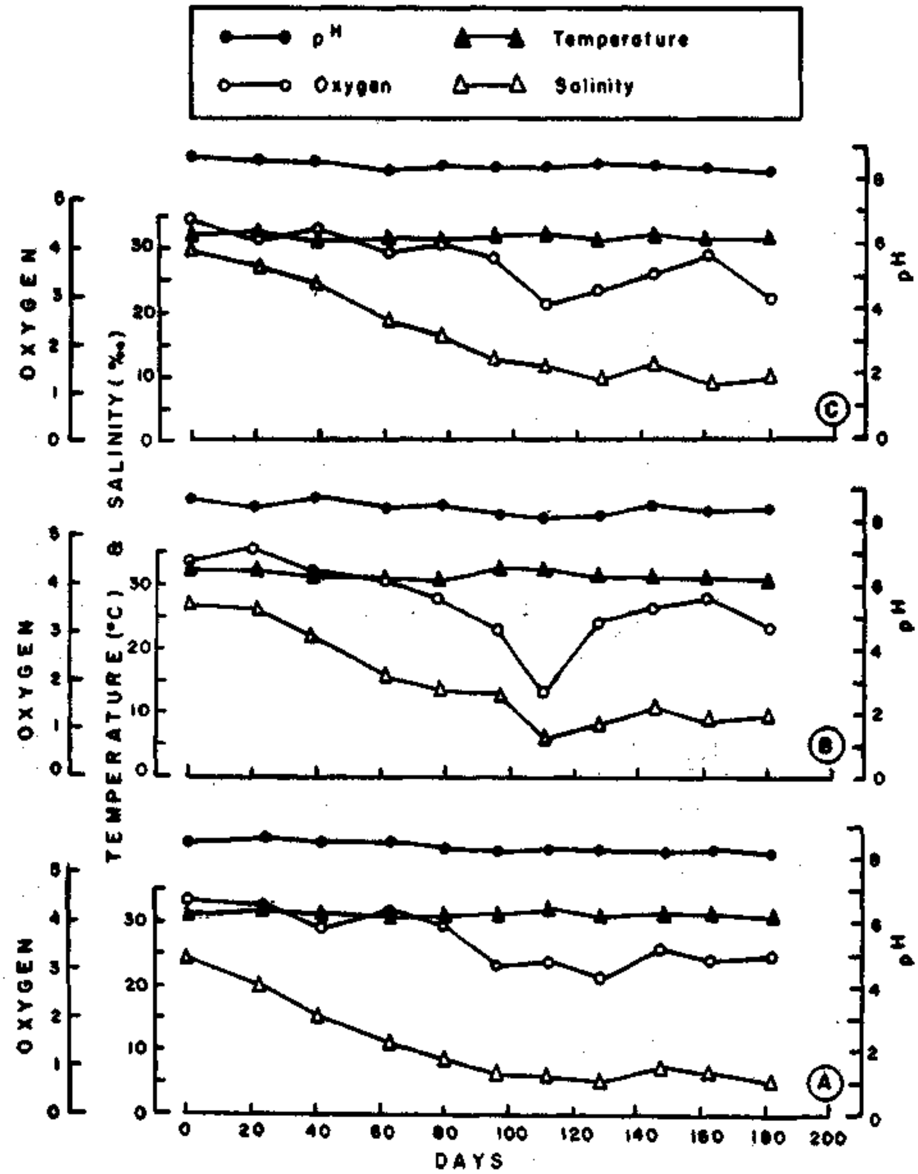

Fig. 1. Fluctuations in the environmental parameters recorded in ponds (A - C) during the period of experiment.

RESULTS

Environmental conditions

Temperature fluctuated within a narrow range of 31.0 - 32.5°C in the ponds throughout the experiment. Salinity was at its maximum in ponds A - C at the beginning of the experiment. A maximum of 24.2‰, 27.3‰ and 29.2‰ was observed respectively in ponds A, B and C at the beginning of the experiment and a minumum of 5‰, 9.1‰ and 6.1‰ respectively in the above three ponds towards the end of the experiment. This decrease in salinity was evaporation when the sea water pumping system fails. In the other three ponds, how-

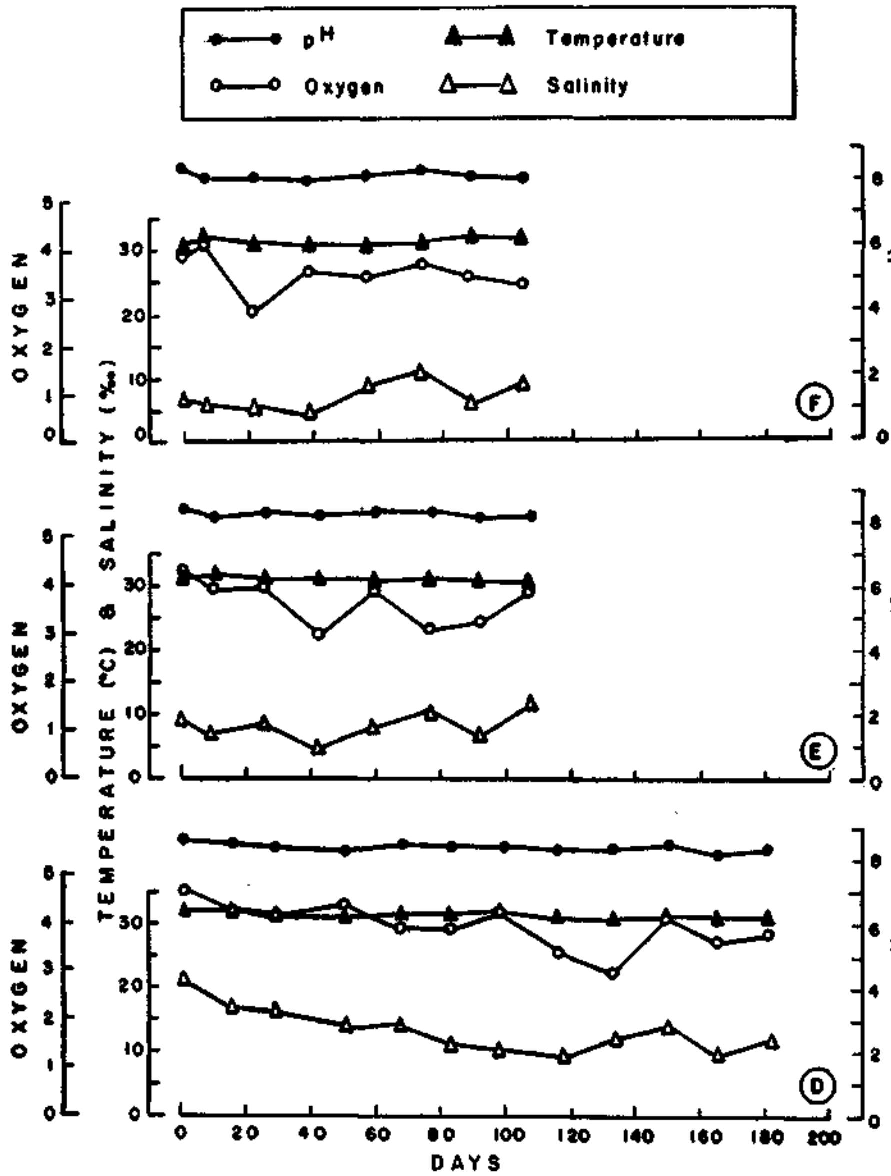

Fig. 2. Fluctuations in the enviromental parameters recorded in ponds (D - F) during the period of experiment.

due to the rain fall and pumping in of fresh water to compensate the water loss due to ever, this difference was not found much. Dissolved oxygen values ranged between 2.6

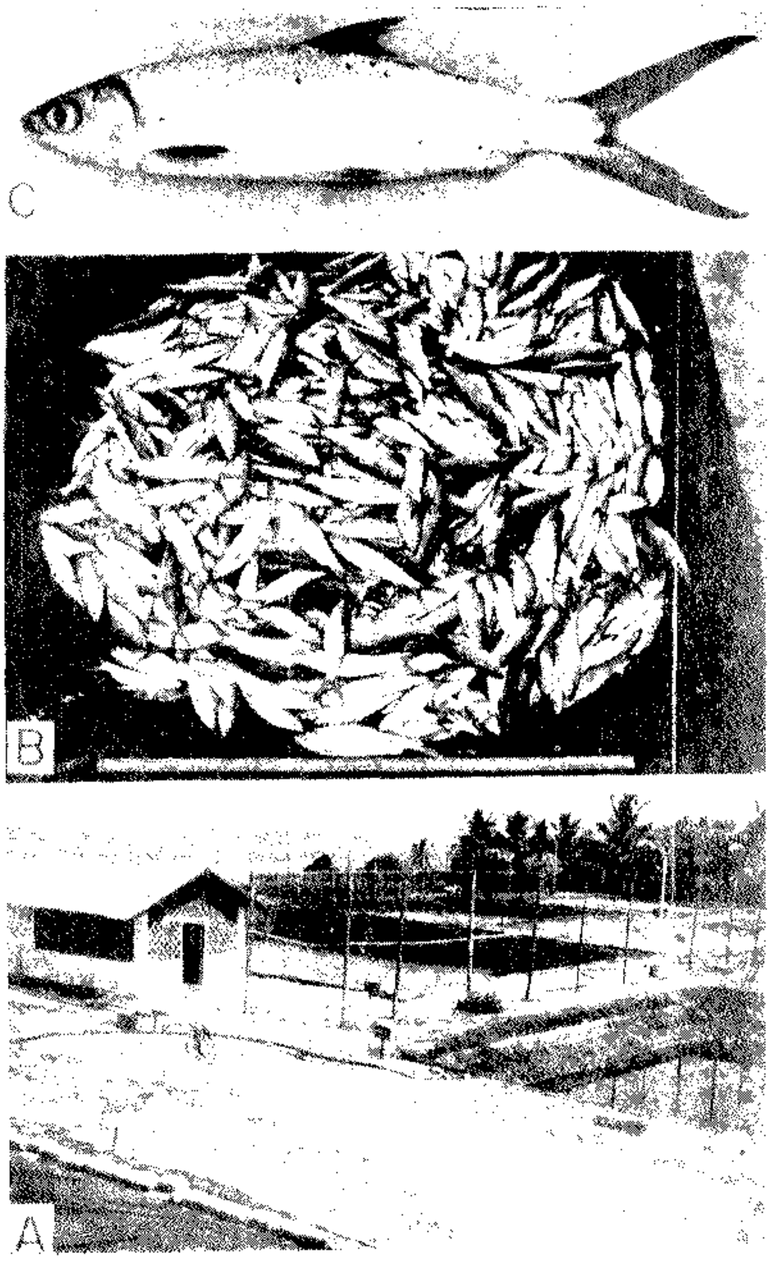

PLATE I. A. General view of the fish farm showing the polyethylene film-lined ponds and the field laboratory, B. a portion of the harvested milkfish and C. size of milkfish at harvest.

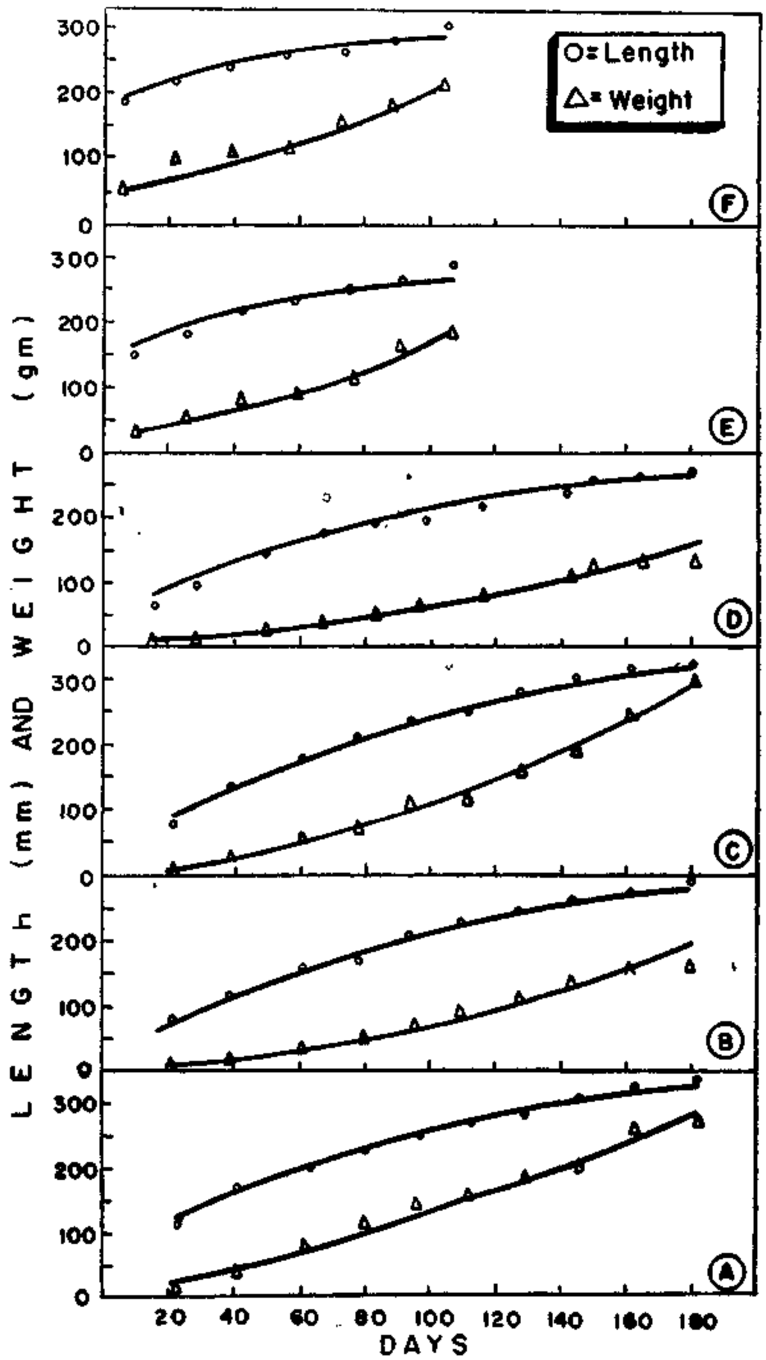

Fig. 3. Growth of milkfish in the different ponds (A - F).

and 4.7 ml/l in all the ponds except pond B in which it touched a lower value of 1.8 ml/l around 110th day of stocking. The pH value ranged between 8.1 and 8.9. The fluctuations in the environmental conditions observed in the ponds are given in Figs. 1 and 2.

Growth of fish

Growth of fish in different ponds is shown in Fig. 3. Though the number of pond in which the experiments were conducted are insufficient for statistically treating the data an attempt has been made to study the growth rate in order to know its variation from pond to pond. Accordingly the instantaneous growth rates of length and weight of fish were studied using the following model: $Yt = at^{b}$, where Yt is length (mm)/weight (gm) at time t and a and b are constants. The estimated parameter values obtained for the different ponds are given in Table 2. The instantaneous growth rate was the highest in pond C followed by ponds B, D and A. In pond C it was 1.8219 and other three ponds they were respectively 1.6438, 1.4116 and 1.2155. In ponds E and F the fishes had a low instantaneous growth rate and it was 0.5433 and 0.3727 respectively.

Survival of fish

A maximum survival of 99.0% was observed in pond E having $1.0/m^2$ stocking density and 130.5 mm stocking size after 107 days of stocking which is followed by pond F having $0.25/m^2$ stocking density and 175.3 mm stocking size after 104 days of stocking. Pond D with a higher stocking of $2.0/m^2$ and stocking size of 27.8 mm gave 84.3% survival rate after 181 days of stocking. In pond B and C the survival rates were found at 88.8% and 68.2% respectively. These two ponds had uniform stocking density ($1.0/m^2$), stocking size (16.3 mm) and period (180 days) of experiment.

TABLE 2. *The estimated parameter values obtained for the different ponds*

Pond	Character	Parameters a	Parameters b	Correlation r	No. of animals stocked	Harvested after (days)	Instantaneous mortality rate
A	Length	34.5221	0.4330	0.993	200	182	.0042
	Weight	0.5001	1.2155	0.995			
B	Length	14.0230	0.5806	0.999	555	180	.0007
	Weight	0.0362	1.6438	0.999			
C	Length	12.5322	0.6351	0.999	1000	180	.0021
	Weight	0.0233	1.8219	0.999			
D	Length	20.5138	0.4956	0.999	440	181	.0009
	Weight	0.0996	1.4116	0.999			
E	Length	101.3318	0.2033	0.983	300	107	.0001
	Weight	10.7370	0.5433	0.972			
F	Length	149.7849	0.1332	0.985	34	104	.0006
	Weight	29.6867	0.3727	0.975			

Pond A gave a survival of only 46.5% eventhough the stocking density was at $1/m^2$ and stocking size 53.6 mm.

Production of fish

Actual quantity harvested, production rate and extrapolated level of production for the year in different ponds are given in Table 1. In general the production was extremely good in all the ponds except pond F in which it was 503 kg/ha/104 days. Pond D with $2/m^2$ stocking density gave the highest production of 1882 kg/ha/181 days, which is followed by pond C with $1/m^2$ stocking density (1751 kg/ha/180 days). In ponds B, E and A the production rates were estimated as 1392 kg/ha/180 days, 1367 kg/ha/107 days and 1260 kg/ha/182 days respectively. These ponds had the uniform stocking density of $1.0/m^2$ even though they differed in the stocking size and period of experiment. The size at harvest (Pl. I B, C) was also remarkable in ponds A (271.4 g), C (256.7 g) and F (209.8 g). In the other three ponds the mean weight at harvest ranged between 130.4 g and 1822 g.

Economics of the culture operation

The details about the cost and returns of milkfish culture experiment are presented in Table 3. It is seen from the Table that a good sum has been spent on feed and labour under operational cost. Even after spending around Rs. 6000/- under operational cost a net return of Rs. 611 has been obtained from 0.24 ha area within a period of 6 months. If the operational costs can be minimised the profit can be increased considerably.

DISCUSSION

It is seen from Table 1 that ponds A and C, though have the same rate of stocking and harvesting period, differ in size at stocking. Size at stocking in pond A was 53.6 mm against 16.3 mm in pond C. Inspite of the higher size at stocking in pond A a high mortality rate and a low instantaneous growth rate (1.2155) were observed. This may probably be due to

TABLE 3. *Economics of milkfish culture experiments conducted at Calicut during the year 1983-84 [For six ponds (0.24 ha) for six months]*

			Cost Rs.
1.	Initial investment:		
	Pond construction		1446
	Pump sets		10000
	Hose		2955
	Sheet and lining		8746
		Total	23,147
2.	Operational cost:		
	Feed		3379
	Seed		253
	Diesel and oil		786
	Kerosene		190
	Labour		1383
		Total	5,991
3.	Depreciation:		
	Pump sets		603
	Hose		369
	Sheet and lining		1,093
		Total	2,065
4.	Total cost:		
	Operational cost		5,991
	Depreciation cost		2,506
		Total	8,056
5.	Returns:		366.8 kg
6.	Value:	@ Rs. 6602	(Rs. 18 per kg)

Net returns without considering depreciation and interest for the initial investment for an area of 0.24 ha for 6 months Rs. 611.

competition. At the same stocking density ($1/m^2$) the larger ones would have greater competition for survival and food leading to less growth and survival rates.

Maximum survival rate of 94.1 and 99.0% were recorded for the fishes which were stocked in ponds F and E with 175.3 mm and 130.5 mm mean size respectively. The reason for high survival in these two ponds might be attributed to the fact that they were well acclimatised in the nursery pond for about three months before starting the experiment and then released into the ponds without giving much stress to the individuals. In ponds B and C though the seed was collected from the nearby grounds and stocked immediately to the ponds the survival rates are not found to be so good as those of pond E and F, the ponds stocked with well acclimatised fish. This proves beyond doubt that the seeds should be well acclimatised to the new environment before stocking them to the culture ponds.

A maximum instantaneous growth rate of 1.8219 is seen in pond C which is followed by 1.6438 in pond B and 1.4116 in pond D (Table 2). It is seen that among the three ponds, in C and B the fishes were stocked with a mean size of 16.3 mm and in D it was 27.8 mm. Among the other three ponds in pond A it was 1.2155 in which the stocking size was 53.6 mm. Pond F gave an instantaneous growth of 0.3727 with 175.3 mm stocking size and in pond E the growth rate was 0.5433 with 130.5 mm stocking size. As such there exists a co-relation between the stocking size and the growth rate of fish. As the stocking size increases the growth rate decreases. So, in order to get maximum growth and production rates it is better to stock the milkfish at a size ranging from 15 to 25 mm.

Though pond B had the same feeding rate, stocking rate, size at stocking and period of harvesting as that of pond C it differed from that pond only in the size of the fish at the time of harvest. In pond C the fishes had a mean weight of 256.7 g at the time of harvest whereas in pond B it was only 156.7 g. The results also show that in pond B when compared with pond C the survival rate was high, but the growth rate was less. Less growth rate inspite of the feeding rate remaining the same may be due to the high survival rate and due to inadequate feeding in that pond. Like all the other ponds in pond C also the feeding was done based on the original number stocked. No attempt was made to assess the mortality rate in the course of the experiment. The high mortality in pond C when compared to pond B would have enabled the remaining stock to get more food and space for faster growth after the period. So in order to ensure proper rate of supplementary feeding to the cultured fish periodical assessment of existing stock becomes necessary. This also shows that for getting better growth the production rates, the feeding rates may have to be increased slightly.

While comparing the ponds with different stocking densities it looks as if the one with a density of $2/m^2$ water area (Pond D) giving better result. But the size of fish at the time of harvest under such density falls far small than the one which was produced by a pond having $1/m^2$ density (pond C). So it is advisable to have a stocking density around $1/m^2$ for getting the best commercial size on a shorter duration.

When compared to ponds B and C, pond D having lesser area and twice the stocking rate has shown lesser growth rate, almost half than that of pond C. Ponds B and C bigger in size, 555 and 1000 m^2 respectively. Whereas pond D had only 220 m^2 water area. So it is presumed that the smaller size of the pond would have limited the growth rate of fish in that pond. Further the high survival rate in that pond would have also limited the growth rate of the fish to some extent. A similar condition

TABLE 4. *A comparison of the results of some of the earlier experiments on milkfish culture in India with the present one (Ponds with the highest production only are given for the earlier works)*

Author	Year	Culture system	Type of culture	Stocking size (mm)	Length at harvest (mm)	Weight at harvest (g)	Stocking density (No/ha)	Duration of culture	Production rate (kg/ha/year)	Survival rate %	Supplementary feed given or not
Tampi	1960	Saltwater pond	–	–	220	–	–	1 year	212–455	9–11	–
Evangeline	1967	Brackishwater pond	Monoculture	40–125	430–465	640–1000	3750	21 months	1125	60	No
Ramamurti *et al.*	1978	Brackishwater	–	40	249	–	1000	111 days	–	–	–
Anon.	1978	Earthen Pond	Monoculture	–	–	–	–	7 months	1714	–	–
Marichamy and Rajapackiam	1981	Earthen Pond	Polyculture	29	215	68.3	–	7.5 months	192	50.3	Yes
Shanmugham and Bensam	1981	Coastal pen	Monoculture	44.0	301	240	10000	–	–	–	–
Lal Mohan and Nandakumaran	1981 a	Polyethyleane filmlined pond	Monoculture	10–12	357	453	1300	234 days	920	96	Yes
James *et al.*	1984	Saltwater pond	Mixed culture	121.9	329.1	227.2	8333	10 months	1405.5	86.7	No
Lazarus and Nandakumaran	1987	Polyethylene filmlined Pond	Monoculture	18	305.7	208.8	5000	169 days	3927	87.1	Yes
Present Experiments	–	"	"	53.6	332.7	271.4	10000	182	2527	46.5	Yes
		"	"	16.3	280.3	156.7	10000	180	2823	88.8	"
		"	"	16.3	321.6	256.7	10000	180	3550	68.2	"
		"	"	27.8	259.6	130.4	20000	181	3795	84.3	"
		"	"	130.5	289.4	182.2	10000	107	4663	99.0	"
		"	"	175.3	297.4	209.8	2500	104	1765	84.1	"

was observed in pond E also even at a stocking density of $1/m^2$ water area.

Ponds A, B, C and D were harvested around 180 days of stocking. The other two ponds were harvested around 100 days of its stocking. A comparison of the results shows that a harvesting period around 180 days of stocking can give the maximum returns in this culture system for *Chanos*.

Many of the above findings of the present experiments are in conformity with the results obtained from this culture system on milkfish by the authors (Lazarus and Nandakumaran, 1987). So for proper planning and execution of milkfish culture in this culture system, the above aspects such as the optimum stocking size, stocking density, pond size and harvesting period, should be borne in mind. Table 4 gives a comparison of the results of some of the earlier experiments on milkfish culture in India with the present one. It is observed from the Table that the present method of culturing milkfish in polyethylene film-lined ponds gives better results than any other methods developed elswhere in India.

With all its merits, however, milkfish culture in polyethylene film-lined ponds seems to be a labour-intensive and highly expensive operation. Although high production and survival rates were obtained, because of high operational cost the profit seems to be negligible. Cost of labour accounts for about 23% of total operating expenses. Apart from this the cost of artificial feed accounts for about 56% of total expenditure. If suitable methods are introduced to reduce the above two expenses then milkfish culture in polyethylene film-lined ponds can be run profitably.

A major part of the labour was spent on pumping sea water and this operation tend to be disrupted very often due to the roughness of the sea. Erection of a permanent structure in the sea can avoid this problem. This problem can also be avoided by selecting the farm site in places where the sea is always calm. Expenditure towards artificial feeding can be avoided by promoting the growth of natural feed in the ponds by way of fertilisation. Schuster (1960) indicated that milkfish are facultative feeders, devouring other kinds of food, natural as well as artificial when the food of preference (e. g. *lab-lab*) has been exhausted. In an experiment in the Philippines by the Inland Fisheries Project (1972) it was reported that supplementary feeding did not appear to be advantageous where *lab-lab* was abundant. Similar results were obtained by Otubusin and Lim (1985) also. The above findings clearly indicate that the milkfish can grow well in ponds with natural feed than artificial feed.

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