Feasibility of Mariculture in the Polyethylene Filmlined Ponds

S.Lazarus
and
K.Nandakumaran
Calicut Research Centre
of Central Marine Fisheries
Research Institute,
Calicut.

Preparation and management of polyethylene film-lined ponds for mariculture purposes and the environmental conditions of the culture system are given in this paper along with the results of milkfish culture experiments conducted in eight ponds.

These experiments, according to the authors, gave a maximum production of 1819 kg/ha/169 days in a monoculture pond, 1303 kg/ha/169 days in a polyculture pond with Penaeus indicus and 1007.4 kg/ha/211 days in a mixed culture pond with P. indicus and Etroplus suratensis. The maximum survival rate was at 87.1%, 74.4% and 48.9% respectively in the mono, poly and mixed culture ponds.

Ever since the pressing need was felt to adopt mariculture methods with the double objective of augmenting food production and providing self-employment to the coastal rural population, the Central Marine Fisheries Research Institute has been investigating the possibilities of utilising the different marine ecosystems for culture. Diverse methods have since been developed with varying degree of success by Mahadevan (1985) for culturing suitable organisms in different marine systems, starting from protected lagoons and shallow waters to open seas exposed to severe conditions of wind and tide. Seasonal and perennial cultures have also been attempted even in man-made enclosures such as saltpans to produce fish as a bye product. In the course of examining the various waste-water resources for utilisation, the question has occurred why the large areas of barren sandy shores, too, should not be utilised for the purpose of mariculture, by converting them into seasonal or perennial ponds especially when we have hardy species of fish that can easily thrive in conditions of highly varying salinity and temperature. Induced by thoughts on these lines experiments were started by the authors on mariculture by excavating ponds on the sandy shore at West Hill, Calicut opposite to the CMFRI Research Centre.

Results of some preliminary experiments conducted in these ponds on fish and prawn have been briefly reported by Mohan and Nandakumaran (1980, 1981 a and b). The present study has been taken up in 1982 to understand in detail the feasibility of mariculture in these ponds using selected species of fishes and prawns giving emphasis on the management of mariculture. The study has led to identification of simpler methods, based on inexpensive technology, to maintain a high standard of water quality and increased production. As first in the series of results obained by the above study, the outcome of the experiments conducted using **Chanos chanos** under various culture combinations and stocking densities with reference to depth of water, the feeding efficiency and hydrographical features of the ponds etc, taking into account the details of the character of Calicut sea shore and preparation and management of the ponds, are presented in this paper. The results of the studies using other species of fishes and prawns will be presented subsequently.

Fig.1. **Calicut beach with a portion of fish farm fencing (pumped out water from one of the ponds is seen near the fence).**

Fig.2. **Location of the fish farm showing West Hill beach road.**

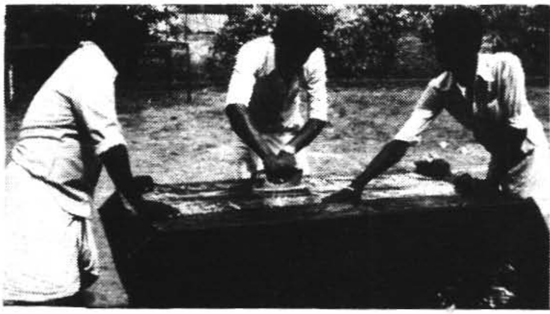

Fig.5. **Fusing the polyethylene film with a hot iron to increase the breadth.**

Fig.6. **Lining the pond with the fused up polyethylene film.**

Table-I
Ponds with stocking and harvest details of **Chanos chanos** stocked on 7.7.1982

Ponds	A	B	C	D	E	F	G	H
Area (m^2)	165	78	100	135	78	714	420	246
Depth of water (cm)	70	125	85	120	75	100	125	125
Number stocked	160	78	203	135	78	357	420	246
Stocked density (no/m^2)	1.0	1.0	2.0	1.0	1.0	0.5	1.0	1.0
Mean length (mm) at stocking	53	53	18	33	18	18	18	33
Mean wt (g) at stocking	0.665	0.665	0.046	0.150	0.046	0.046	0.046	0.150
Feeding intervals/day	once	once	once	once	once	twice	twice	once
Type of culture	Mixed culture with **E.suratensis**	Mjxed culture with **E.suratensis**	Monoculture	Poly culture with **E.suratensis & P.indicus**	Mono culture	Mono culture	Mono culture	Polyculture with **P.indicus**
Duration (days) of experiments	106	106	106	211	169	169	169	169
Mean weight (gm) at harvest	114.5	135.6	82.5	206.1	272.5	208.8	208.8	175.7
Mean length (mm) at harvest	250.6	262.5	219.4	300.5	305.7	305.7	274.3	
No. of fish harvested	79	28	91	66	20	298	266	183
Survival (%)	49.3	35.8	44.8	48.9	25.6	83.5	87.1	74.4
Quantity harvested (kg)	9.0	3.8	7.5	13.6	5.5	62.2	76.4	32.2
Production rate (kg/ha)	546	487	750	1007	705	871	1819	1309
Extrapolated level of production (kg/h (kg/ha/year)	1876	1675	2581	1741	1522	1880	3927	2825
Quantity of feed supplied (kg)	29.5	19.6	28.7	101.4	50.6	189.5	224.2	148.2
Apparent feed efficiency	3.2722	5.1440	3.8270	7.4516	9.1911	3.0469	2.9342	4.6083

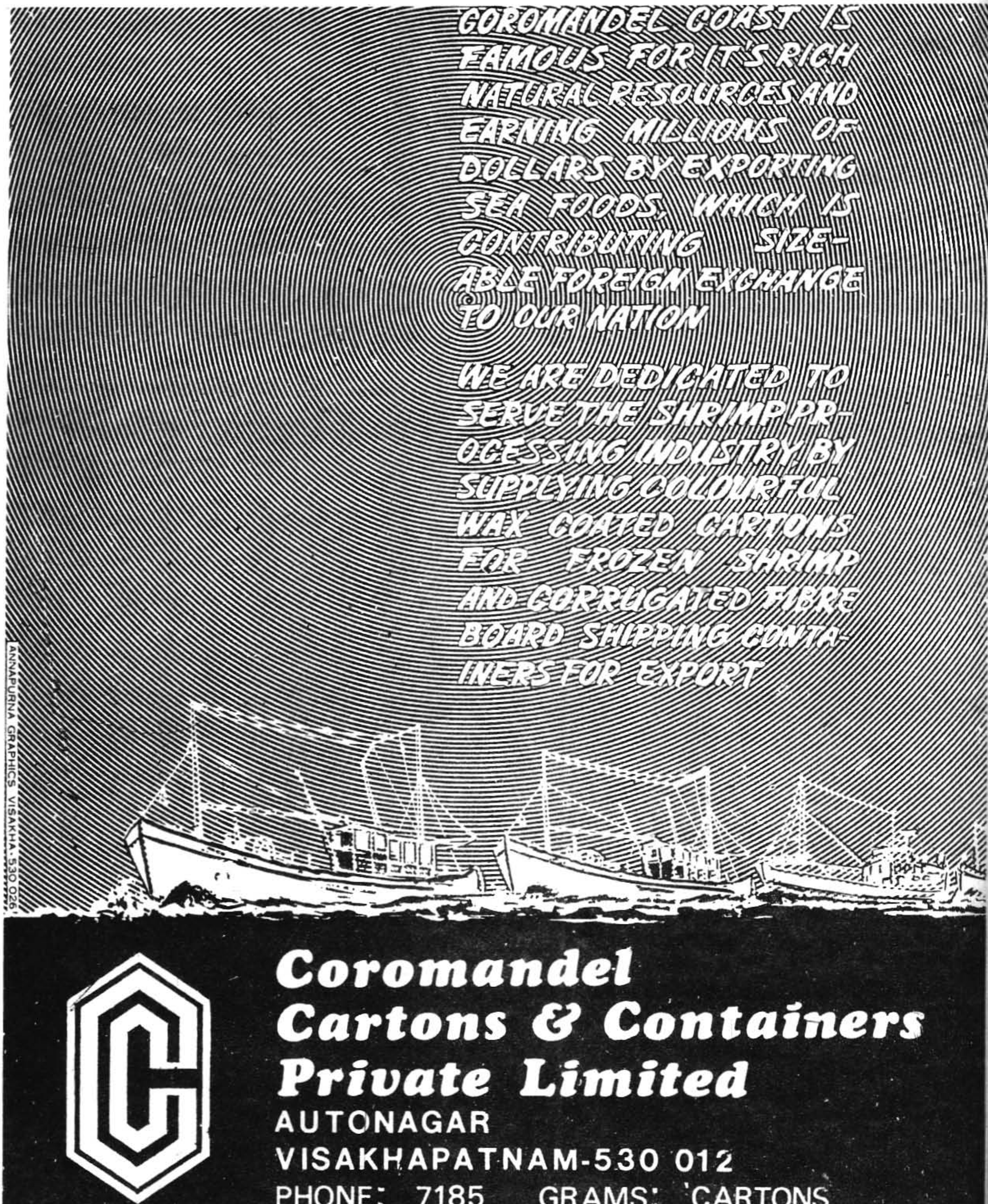

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Fig.7. **Showing the arrangements of laterite stone and gunny bags.**

is done by anchoring the free ends of the film around the pond by making a small trench. The free ends of the film are anchored inside the trench and sand is placed over it. The lining should not be tight. In order to make the lining fit inside the pond a small quantity of water can be pumped into the pond even before arranging the borders properly. After the completion of the lining the ponds can be bordered with a row of laterite stones (Fig.6) so as to give strength and protection to the lining. Once the lining is over water should be pumped into the pond immediately. The exposed portion of the lining from the level of water to the level where stones are arranged, is likely to get damaged easily. To prevent that the exposed lining can be covered by old gunny bags (Fig.7). The bottom of the ponds can be covered by a thin layer of sand so as to provide the culture animals with a substratum. This will also help to prevent the heat being absorbed by the black polyethylene lining causing rise in the water temperature. The fish farm should also be protected by a good fencing so as to prevent dogs and other animals from entering into the farm.

Efficiency of the lining: The volume of air space present in the sand provides a strong bed of uniform level, not permitting the sheet when compressed to penetrate into the sand. However, during the rainy season the underground water belt raises, the inflitration water accumulates below the lining and gives a cushioning effect to the sheet, thereby the upward thrust and downward pressure balance the sheet. During summer the retained moisture of the bottom soil is just sufficient to form a perfect hard bed and hence the sheet lies snug. This factor during harvesting will keep the sheet under compression causing no damage. During handling of the lined pond, especially while harvesting, any damage that may occur to the sheet could be repaired at the appropriate time with negligible cost and time.

Relining and reconditioning the ponds: After every harvest the ponds have to be cleaned up properly so as to know the damages, if any, in the lining mainly in the bottom and submerged portions of the sides. Cleaning can be done by drying the pond, removing the sand and other dried up waste materials (Fig.8) or by flushing the lining with water and pumping it out. After cleaning, if holes or cracks are found in the lining, these can be sealed by an adhesive tape (Fig.9). When the lining goes beyond repairs the pond has to be relined by retaining the old lining as such, so that it will give additional strength to the new lining.

Water management: Sea water is pumped into the ponds by a 5 hp diesel pump with 3" suction and 2 1/2" delivery pipes. Flexible hoses are found more suitable than the rigid ones. The foot valve of the suction pipe is attached to a float anchored in the sea at a distance of 60 m from the surf. The float is connected to a teak wood post piled in the shore by a nylon rope of 25mm thickness. The distance between the pump and the surf is about 30 m. A plastic drum of 250 litre capacity covered by a nylon netting can be used as a float. The float is attached to a 5-toothed anchor wieghing 75 kg with an iron chain or with a thick nylon rope. The water is being filtered by allowing it to flow through a small meshed nylon netted frame kept at the delivery end so as to prevent the unwanted organisms from getting

Fig.8. **Cleaning the pond after the harvest.**

Fig.9. **Adhesive tape roles used for repairing the lining.**

into the pond (Fig.10) The water level can be kept at the desired height in the pond. In order to regulate the salinity in the pond, well water is being pumped by using a 5 hp electric pump and mixed well to avoid salinity stratification. The animals are stocked after about 10 to 15 days of storing water so as to allow the plankton and other food materials to develop therein.

Cultivable species and periodicity of culture: All types of cultivable fishes and prawns could be cultured here. Monoculture of either fish or prawn seems to be more suitable for this culture system. If polyculture or mixed culture is attempted the entire stock should be harvested on a particular day. If partial harvesting is made there is a chance of the lining getting damaged due to handling. In an year one fish culture and one prawn culture operation can be done successfully. If it is prawn alone three trials can be made without difficulties. Normally it is advisable to rear the fish from June/July to December/January and prawn from January/February. to March/April. This arrangement is suggested because the fish seed is available in plenty during the period May to July and prawns grow well during the summer months. Moreover, during the rainy season the pond water gets diluted because of continuous rainfall, which can sometimes affect the survival rate of prawn in the ponds. As the sea becomes rough during this season pumping sea water to increase the pond water salinity also becomes difficult. However, this problem is not found to be affecting the fish during this season.

EXPERIMENT

Eight polyethylene film-lined, pump-fed ponds (Fig.11) having a total area of 0.2 ha, were used for the present experiment. Area and depth of water of the different ponds are given in Table-I. Though the depth of the pond ranged from 1.5 to 1.75 m the water level could be maintained upto about a metre only. The ponds were got ready and fed with water by April-May, before the onset of S.W. monsoon. This period was chosen, because, the weather being dry, the maintenance processes like dewatering, cleaning, drying and, if necessary, relining or repairing of the lining were easy to be carried out. With the onset of monsoon, as the sea becomes rough, pumping seawater becomes difficult and expensive. Due to certain practical difficulties it was not always possible to maintain a steady salinity in the ponds in the present experiments. The experiments were conducted from July 1982 to February 1983 on the Milkfish, **Chanos chanos,** a hardy, euryhaline and fast growing species to study its growth, production and survival rates in the culture system.

Seed: Seed was collected from the tidal pools around Mandapam Camp during the months June and July, 1982. **Ola valai,** a kind of gill net, was used to gather the seeds to a corner of the pool and then they were hand picked or taken to the buckets by hand seives. Immediately after the collection they were transferred to hapas suspended in the fish farm at Mandapam Camp. After keeping them in hapas for a few days they were transferred to 'plasticraft' pools in the laboratory at Mandapam Camp for acclimatisation before packing. A total of 1760 seed was packed in four well oxygenated plastic bags, each bag containing about seven litres of water and then lifted to Calicut by road/rail. On reaching Calicut, after 21 hrs from the time of packing, a total of 37 nos were found dead in one of the bags. The seed stock contained three different size groups and were stocked in the different ponds as detailed in Table-I. Monoculture of milkfish was attempted in ponds C, E, F and G, mixed culture with **Etroplus suratensis** in pond A and B and polyculture with prawn, **Penaeus indicus** in pond H and with prawn and fish in pond D. The stocking density of milkfish ranged from 0.5 to $2.0/m^2$ of water area. (Area of pond refers

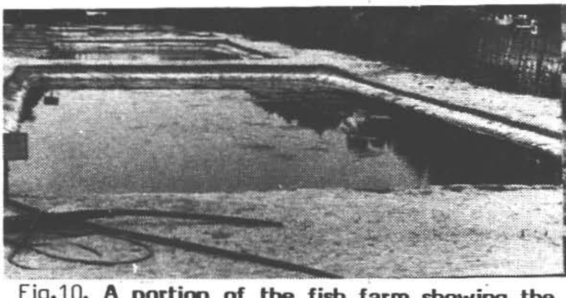

Fig.10. **A portion of the fish farm showing the pipe lines and the net used for filtering the water.**

Fig.11. **A general view of the fish farm and the fileld laboratory.**

to the area of water and not the entire pond.)

Feed: A feed made out of coconut oil cake, groundnut oil cake and rice bran mixed in the ratio 1:1:1 was fed. Before feeding, the components were weighed separately for each pond and mixed properly by adding sufficient quantity of water to make it in the form of a dough. The feed thus compounded contained 28.13 to 30.47% carbohydrate, 24.15 to 28.00% protein, 5.71 to 7.59% fat, 8.48 to 8.74% moisture and 8.62 to 11.40% ash.

POND MANAGEMENT

Because of the non-permeable nature of the pond bottom, the excreta of the cultured animals, the excess feed along with the dead algae and other organic matter get accumulated in the bottom of the pond. This has to be removed periodically so as to give a healthy environment to the animals. Various methods, such as, aerating the pond, mixing the water with an air blower and pumping out the bottom water with diesel and electrical pump sets were tried. As none of them gave the desired benefit, siphoning out of a small quantity of water from the bottom of the pond with a 3" flexible hose was resorted to . While siphoning, which is normally done once in ten days, the inlet portion of the hose was moved along all over the bottom by a person getting into the pond. This method gave very good result. Hence

Fig.12. **Feed for the fish being served in a tray.**

it is better to have a lowlying area near the fish farm to facilitate siphoning easier. In the absence of the low lying area, one of the ponds without lining can be used for the purpose. The water loss that occurred due to siphoning and also due to evaporation was compensated by pumping in new water once in 10 days. (However, in the present experiment under report the ponds were cleared not by siphoning but by pumping).

Since it is an artificial environment the animals have to be fed regularly. While feeding, the feed should not be thrown into the pond as such. This will spoil the quality of water to some extent. So the method of keeping the feed in trays kept in the corners of the ponds was adopted. While avoiding wastage of feed to a certain extent, it was possible to find out the left-overs also in this method, so that the feed supply could be regulated to the optimum requirements. In the present experiment the fishes were fed at the rate of 5% of body weight at an average by adjusting the quantity in relation to weight change of the fish based on the periodical sample measurements. In the ponds in which mixed culture and polyculture were tried the feeding was adjusted in a way as to suit the requirements of other animals also. The feeding interval was once daily in all the ponds excepting ponds F and G in which the daily requirement was divided into two and given twice daily. To have a careful watch on the environmental conditions, the dissolved oxygen, salinity and pH were monitored weekly twice and temperature, both at the surface and bottom of the pond water, was recorded twice in a day at 1000 hrs and 1400 hrs. The fish was sampled once in a fortnight with a cast net to find out the periodical growth in length and weight. Harvesting was done by operating both cast net and drag net (Figs. 13 and 14) after reducing the

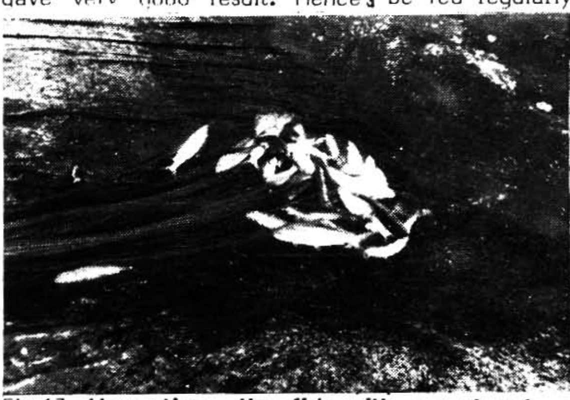

Fig.13. **Harvesting the fish with a cast net.**

Fig.14. **Harvesting the fish with a drag net.**

water level to the maximum possible limit by siphoning and pumping out of water. Data regarding the water characteristics gathered for the period of culture in the different ponds are given in Table II. Though careful monitoring was made to maintain the environment favourable for the fish by periodically pumping out the bottom water and by adding new water, sometimes when it was not possible to do so due to various reasons, the pond water developed phytoplankton bloom leading to the characteristic 'pea soup' appearance of water. During such times the fishes seemed to be gasping at the water surface especially during morning hours. One such instance was studied in detail (Table III) with the help of the Mobile Laboratory of the Central Marine Fisheries Research Institute.

Table-II Environmental parameters (ranges) recorded during the period in the different ponds

Ponds	Temperature (°C)	Salinity (%)	Dissolved oxygen (ml/l)	pH
A	27.0–38.0	0.2–44	3.3–4.6	8.3–9.1
B	28.0–39.0	0.2–6.8	3.2–4.7	8.5–9.1
C	27.0–39.5	1.8–6.9	3.0–4.6	8.8–9.2
D	28.0–39–5	0.9–29.5	3.6–4.5	8.4–9.1
E	28.0–39.0	0.7–18.3	2.8–4.9	8.3–9.1
F	28.0–39.0	0.2–19.1	3.7–5.3	8.8–9.2
G	27.0–39.0	5.9–19.1	3.1–5.3	8.8–9.2
H	28.0–38.5	4.5–29.2	1.4–4.6	8.6–9.1

Water and sludge were collected from the ponds for the determination of the chemical elements contributing the algal bloom and for the identification of the algae that caused the organic fertility in the ponds. The sludge consisted of fine silt and sand, detrital material, living and dead cells of phytoplankton, plant pigments and faecal pellets. Strong odour of sulphide was noticed from the sludge which was black in colour.

Table-III Chemical and algal composition of water and sludge in two ponds having different levels of phytoplankton fertility.

Components		Pond in which fishes started gasping: Water	Pond in which fishes started gasping: sludge	Pond in which fishes were found normal: Water	Pond in which fishes were found normal: sludge
1. pH	S	7.7	–	8.0	–
	B	7.8	–	8.0	–
2. Dissolved oxygen (ml/l)	S	1.40	–	3.9	–
	B	1.96	–	5.04	–
3 Salinity (ppm)	S	5.55	–	14.39	–
	B	5.55	–	14.69	–
4. Phosphate as PO_4-ug. at/l		0.0461	–	Nil	–
5. Nitrite as NO_3-N ug. at/l		10.306	–	1.855	–
6. Amonia as NH_3-N mg/l		0.859	–	0.578	–
7. Nitrate as NO_3N ug.at/l.		104.00	–	Nil	–
8. SBC (Alkalinity) unit		4.9	–	2.7	–
9. Redox (Eh) condition		–	Reducing	–	Reducing
10. Nitrogen (% dry weight)		–	0.710	–	0.645
11. Phosphorus (% dry weight)		–	0.317	–	0.204
12. Organic carbon (% dry weight)		–	15.66	–	6.440
13. Sulphide		–	Present	–	Present
14. Colour		Greenish	Darkish	Greenish	Darkish
15. Algal composition					
1. Microcystis		–	–	Abundant	–
2. Blue green filaments		More	–	Rare	–
3. Chlorella		–	–	–	–
4. Synochocystis		Abundant	–	–	–
5. Nitzschia		Few	–	–	–
6. Chaetoceros		Rare	–	–	–

Note: S = Surface B = Bottom

From the analytical data it is evident that higher concentration of nutrients and phytoplankton blooms are responsible for the higher production of organic matter in the pond in which the fishes were found gasping. The build up of organic matter is mainly due to autochthonous contribution resulting from primary production within the ponds and allochthonous contribution from the pumping in of sea or ground water, faecal matter of the farming organisms and the artificial feed.

The data also show a serious condition of eutrophication and organic fertility in the above pond. The increased amount of Ammonia nitrogen and Nitrite nitrogen and Nitrate nitrogen may be due to nitrification under either very low oxygen concentration or anoxic condition. The occurrence of phosphate may be because of release from the sludge which is in a highly reduced state.

Table-IV The estimated parameter values

Ponds	No. of animals stocked	Harvested after (days)	Instantaneous mortality rate	Estimate of	Length	Weight
A	160	106	.00658	a	63.30143	1.59360
				b	0.01474	0.04759
				R^2	92.7	84.7
B	78	"	.009665	a	69.00878	2.40924
				b	0.01425	0.04428
				R^2	90.7	83.9
C	203	"	.007669	a	33.84629	0.40790
				b	0.02099	0.06072
				R^2	83.21	78.22
D	135	211	.00339	a	68.93631	2.40403
				b	0.00815	0.02510
				R^2	80.4	76.2
E	78	169	.008053	a	47.36201	0.95747
				b	0.01418	0.04133
				R^2	79.7	77.9
F	357	"	.001069	a	52.72260	1.34843
				b	0.01320	0.03844
				R^2	72.8	70.4
G	420	"	.000814	a	62.47676	2.28234
				b	0.01211	0.03495
				R^2	64.0	61.19
H	246	"	.001751	a	72.00022	2.71614
				b	0.01023	0.03186
				R^2	72.1	68.3

R^2 = Co-efficient of determination in percentage.

The low value in dissolved oxygen concentration indicates the absence of evolution of photosynthetic oxygen. Penetration of solar light into the water might have been inhibited by the algal bloom which has formed a layer on the water surface. The dissolved oxygen is used up by respiration of the algae and oxidation of organic matter. For this reason, during such seasons the fishes appeared on the surface and were in a state of asphyxiation. The sludge contained very high percentage of organic carbon, phosphorus and nitrogen, indicating accumulation of very high load of organic matter. The rate of oxidation of organic matter is slowed by the redox potential and this accounts for the accumulation of organic matter in the above pond. This phenomenon clearly shows that the pond bottom should be cleaned up regularly by siphoning as described above.

RESULTS

Growth: Growth rates of fish in the different ponds are given in Figs.15 and 16. Though the number of ponds in which the experiments were conducted are not sufficent for statistically treating the data, attempts have been made to study the growth rate in order to plan the future experiments. Accordingly the instantaneous growth rate of length and weight of fish were studied using the model.

$$Yt = ae^{bt}$$

Where **a** is the starting value, **b** is the instantaneous rate of growth, **t** is the time in days, **Yt** is the length or weight at time **t** as the case may be.

The values obtained for the different ponds are given in Table IV. From the Table it will clear that pond G has shown the instantaneous growth rate as 0.03495 which ranks third only among the ponds that have been harvested after 169 days. However, pond G had the maximum production (1819 kg/ha). This is mainly due to high survival rate (87.1%) in this pond indicating that more number of fish were available per unit area in this pond throughout the period of growth and hence each fish received relatively less amount of food. This might have been the reason for lower growth rate in this pond. Pond E recorded maximum instantaneous growth rate of 0.04133 and minimum survival rate of 25.6% in this group. This indicates that only less number of fish were available per unit area in this pond and hence each fish received relatively more amount of food. This may be the reason for higher growth rate in this pond. It may be noted here that the quantity of feed supplied to each pond was fixed taking into consideration the original number stocked. The reduced number due to mortality would have helped the surviving individuals to get more food. So it becomes necessary to assess the number available in each pond periodically.

Among the ponds which were harvested on the 106th day, Pond C recorded an instantaneous growth value of 0.06072 though the pond had a higher stocking density compared to the other two ponds. Two reasons may be attributed to this. One might be the stocking size. In Pond C the fishes were stocked at a length of 18 mm whereas in the other two ponds they were stocked at 53 mm length. It may be noted that in pond E also the fishes were stocked at the length of 18 mm only. This proves beyond doubt that milk fish may have to be stocked at a smaller length, around 18 mm, for getting better production.

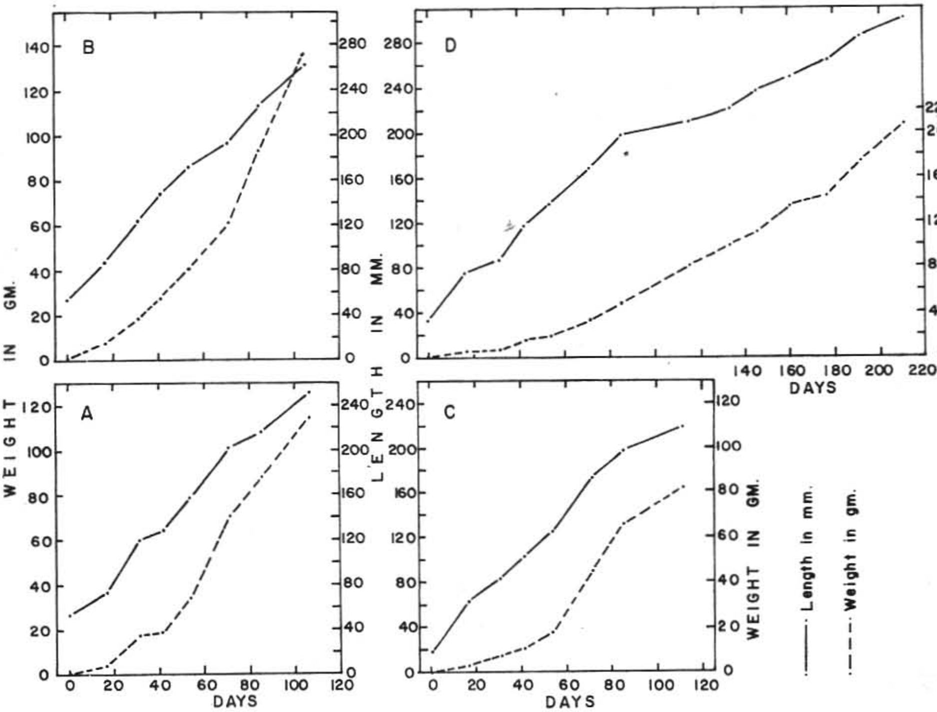

Fig.15. **Growth of fish in the different ponds.**

The other reason might be the presence of **Etroplus suratensis** (pearlspot) in ponds A and B. As mentioned earlier, in these ponds mixed culture of milk fish and pearlspot was made. The presence of **E. suratensis** would have affected the growth of **Chanos chanos** (milkfish) stocked in these ponds as a part of the feed was consumed by the pearlspot. This difference is noticed in the feed efficiency values also in these ponds. So it might be inferred that monoculture of milkfish would be more beneficial in this culture system.

The instantaneous growth rate (0.02510) was very low in pond D which was harvested on the 214th day of stocking when compared to the ponds which were harvested on the 106th and 169th days. This gives an indication to fix-up the probable period for harvesting milkfish to get the maximum yield in this culture system. Thus from the experiment it may be understood that harvest around 150 days after stocking seems to be a favourable time for harvesting milkfish.

Harvest details: The fish stocked in ponds A, B and C were harvested on the 106th day after stocking and in ponds E, F, G and H were harvested on the 169th day. Fish present in pond D was allowed to grow further as they did not reach the harvestable size at the time of harvesting other ponds and were harvested on the 211th day of stocking. Harvesting was done after dewatering the ponds and by operating both cast-net and drag-net.

Out of 1677 milkfish stocked in all the ponds a total of 1131 individuals were obtained at the time of harvest, thus giving an overall survival rate of 67.4%. The total quantity harvested was 210.2 kg. A sum of Rs.1215.90 (Rupees one thousand two hundred and fifteen and paise ninty only) was realised out of the sale. This being a preliminary experiment on milkfish culture, in this culture system the input-output ratio has not been worked out. Pond-wise harvest details are presented in Table I.

Survival and production: Normally survival rate depends on the period of experiment. If the duration of the experiment is more, the survival rate is expected to be less. However, in these experiments irrespective of the differences in the duration, survival rate has increased with the size of the pond (Fig.17 A) upto 450 m^2, above which a decrease is noted.

A similar trend is noticed in the case of production

rate also (Fig. 17 B). Of all the ponds, pond G having a total area of 420 m^2 gave a maximum production of 1819 kg/ha. Hence a pond area having 400-500 m^2 appears to be desirable for this type of culture system.

The experiment also shows that when the height of water is 100 cm both survival and production rates are higher especially for pond G (Fig.17 C & D). Though pond F also has 100 cm depth its production rate is less than that of pond G. This may be due to the stocking rate, in that, pond G gets 1.0/m^2 and pond F gets 0.5/m^2. In other words, pond F has half the stocking density of pond G. The size of pond G is roughly half of Pond F. Thus the number stocked in both the ponds remains more or less the same. In spite of this, survival rate was higher in pond G raising the point that whether pond G has any advantage over other ponds. The location of pond G and C is nearer to the sea than the rest. But pond C, in spite of its nearness to the sea, has not come up to the level of pond G in terms of survival rate and production rate. Pond C has a water height of 85 cm and stocking density of 2.0/m^2. Hence it may be gathered from the above that better survival and produc-

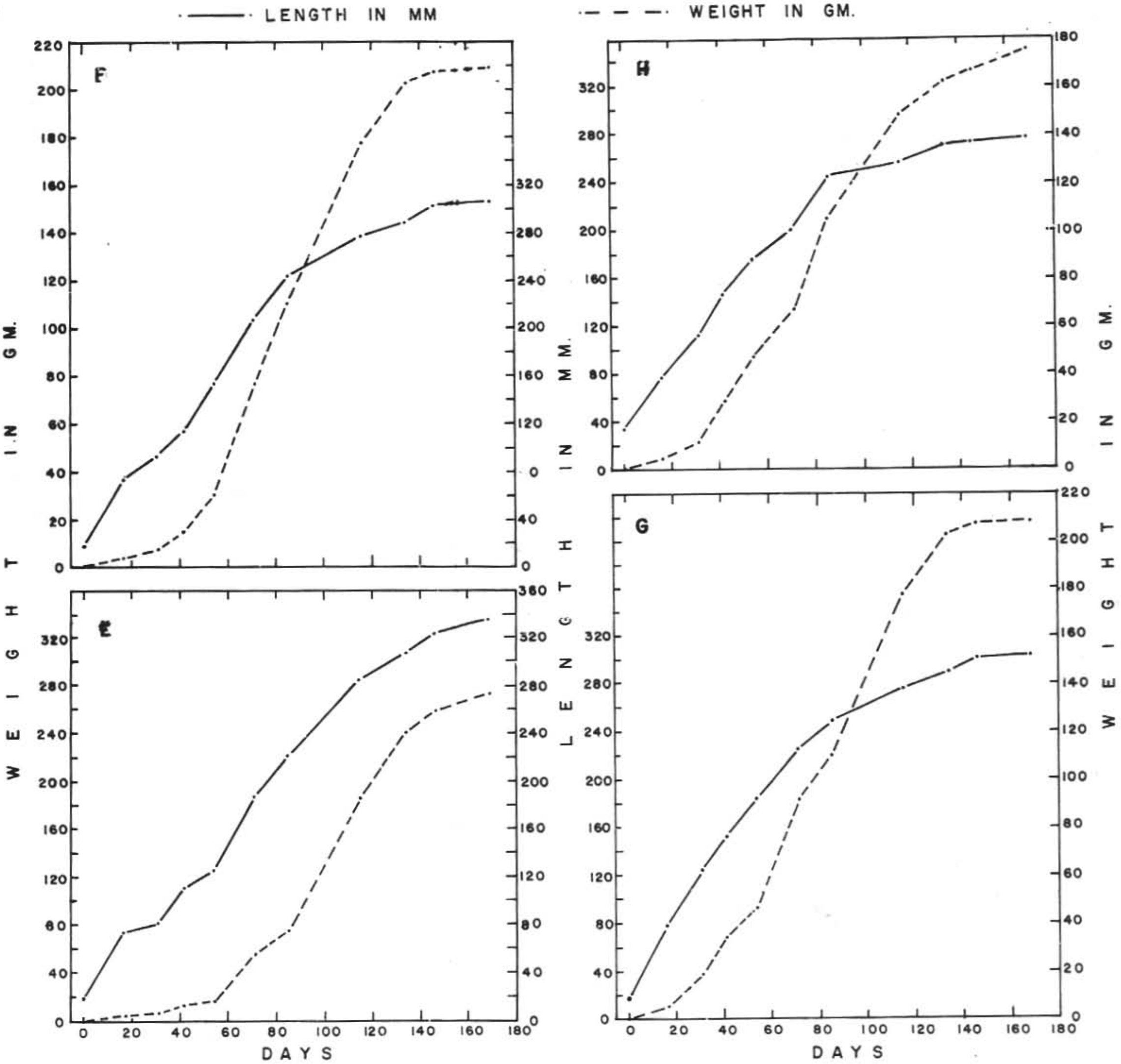

Fig.16. **Growth of fish in the different ponds.**

tion may be obtained from ponds having around 100 cm water depth with a stocking rate of 1.0-2.0/m^2.

Feed efficiency: Though the feed was kept in trays for feeding, the actual quantity consumed by the fish could not be recorded properly and hence the apparent feed efficiency was calculated based on the total feed supplied to each pond as given below.

Apparent feed efficiency = Total feed supplied (kg) / Total yield (kg.)

The quantity of feed supplied to each pond, the yield obtained from each pond and the apparent feed efficiency are given in Table I. The feed efficiency in pond G was 2.9342, the highest among all the ponds. This better feed efficiency might be due to the favourable survival conditions that prevailed in the pond as explained elsewhere. In ponds F, A, C and H also, the efficiency seems to be fairly good. In general, as seen from Fig.18, a relationship existed between feed efficiency and instantaneous growth rate in all the ponds excepting ponds E and D. It may be noted in this connection that pond E gave better instantaneous growth and a poor survival rate than all other ponds. This poor survival rate might be due to some mortality which would have happened soon after the stocking in that pond. Since the number of individuals available in the pond was not assessed during the periodical sample measurements the quantity of feed was determined based on the initial number stocked. This would have led to excess feeding, leading to wastage of some quantity of feed.

The poor feed efficiency observed in pond D might be attributed to the presence of **E. suratensis** and prawn. Though the quantity of feed supplied to the pond was determined based on the total animals present, there is a chance of a voracious feeder

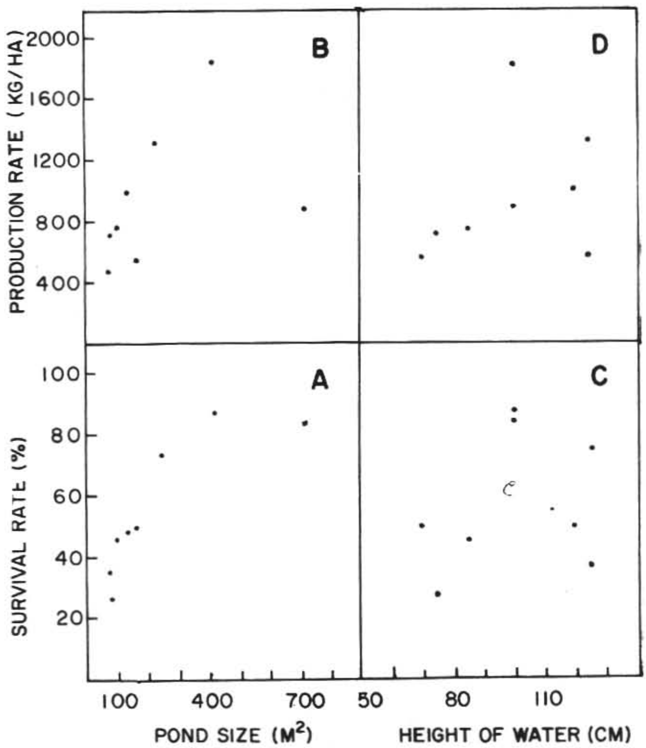

Fig.17.A. **The relationship between pond size and survival rate.**
B. **The relationship between pond size and production rate.**
C. **The relationship between height of water and survival rate.**
D. **The relationship between height of water and production rate.**

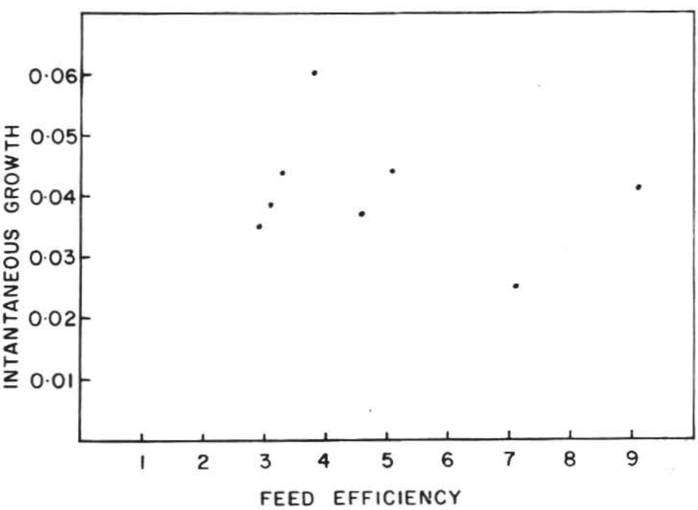

Fig.18. **The relationship between feed efficiency and instantaneous growth rate.**

like **E. suratensis** taking more food than **C.chanos.** The impact of this phenomenon was seen in the growth trend also (Fig 15-D). After the removal of **E. suratensis** from this pond for breeding purposes on the 123rd day of stocking **C.Chanos** an acceleration in the growth of **C.chanos** was seen. So, for getting better feed efficiency and growth rate monoculture of **C.chanos** is preferable in this culture system.

DISCUSSION

Tampi (1960) has observed at Mandapam a growth increment of 220 mm by one year in milkfish with a survival rate of 9-11% and production varying between 212 kg-455 kg/ha. From the Brackishwater Experimental Milkfish Farm at Jepara, Indonesia an estimated production of 1000 kg/ha/year in a manured pond with supplementary feeding (rice bran on alternate days) and 2000 kg/ha/year with pelletised high protein feed was reported (FAO, 1975). Ramamurthy **et al.** (1978) have observed the growth of milkfish in brackishwater ponds near Mangalore from 40 to 249 mm during 111 days at a stocking rate of 1000 no/ha. According to Anon (1978) in one of the experiments conducted at the brackishwater experimental fish farm of the Central Inland Fisheries Research Institute at Kakdwip on monoculture of milkfish an estimated production of 710 kg/ha was obtained by supplementary feeding. The fingerlings grew from 75 mm size to 323 mm size (236.9 g) in 150 days at a stocking density of 3000 nos/ha in a pond of 0.02 ha area. In another experiment on the monoculture of milkfish conducted at the Kakinada brackishwater fish farm of the Andhra Pradesh Agricultural University, Kakinada, the juveniles (75.0 mm/3.5 g) stocked at a rate of 5000 nos/ha in two ponds gave an average weight of 163.6 g with feeding and 337.5 g without feeding at harvest, after one year. However, the production rates were given respectively as 168 and 189 kg/ha/year and the low production was attributed to loss of stock due to predation by otters and suspected poaching. At Santhome Fish Farm belonging to the Government of Tamilnadu, as per the above report, in a mixed culture of milkfish with white prawn (**Penaeus indicus**), a net production of 1084 kg/ha/6 months of milk fish with feeding and 686 kg/ha/6 months without feeding was reported. It is also given in the above report that monoculture of milkfish in Goa yielded about 1000 kg/ha/7 months. Marichamy and Rajapackiam (1981) have reported the growth of milkfish in the polyculture experiments conducted in an experimental marine fish farm at Tuticorin as 304 mm in 12 months when the stocking size was 42 mm; 226.5 mm in 7 months when the stocking size was 50.5 mm; and 186 mm in 7.5 months when the stocking size was 29 mm. The survival rates given by them were 8.1% in the first experiment, 59.7% in the second experiment and 50.3% in the third experiment. Similarly the production rate also seems to be very low in the above experiments. It varied from 114.3 to 192.0 kg/ha/year.

Though the results of the present study cannot be compared with the above experiments, because of the difference in the culture systems, it can be compared with the works of Mohan and Nandakumaran (1980, 1981 a and 1981 b) to some extent. Mohan and Nandakumaran (1981a) have reported the growth of milkfish in this culture system as from 10-12 mm size to 250 mm size within a period of 96 days at a stocking rate of 1300/ha. But the overall growth in 234 days, as given by them, seems to be 346 mm only. In an earlier experiment in this culture system the same authors (Mohan and Nandakumaran 1980) have reared the fingerlings of milkfish in a pond of 0.01 ha area up to a size of 422 m in 526 days. But no stocking and production rates are given. From the same culture system Mohan and Nandakumaran (1981 b) have reported a production of 920 kg/ha/7 months of **C.chanos** which was stocked at the rate of 5600/ha when it was 82 mm (3.5 g) size. Here again the details given by the above authors regarding the production, survival and growth rates are not comparable because of various factors such as the difference in the duration of the experiments, stocking size, stocking density etc.

Comparing all the above mentioned experiments, the experiments conducted by the authors as reported in this paper have given a higher production rate of 1819 kg/ha/ in 169 days (3927 kg/ha/year) in a monoculture pond, 1308.9 kg/ha/169 days (2825 kg/ha/year) in a polyculture pond with the white **prawn, penaeus indicus** and 1007.4 kg/ha/211 days (1741 kg/ha/year) in a mixed culture pond with the white prawn, **P. indicus,** and fish, **E. suratensis.** Similarly a maximum survival of 87.1% was observed in monoculture, 74.4% in a polyculture pond and, 48.9% in a mixed culture pond. These results clearly show that the polyethylene film lined ponds developed at Calicut can be used as an efficient culture system for culturing **Chanos chanos.** Further studies are under way to know the performances of other types of finfishes and prawns in this culture system and also to know the economic feasibility of the system for mariculture.

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New Deep Sea Fishing Policy

According to Mr.Bhai Bhandarkar, General Secretary of the Maharashtra Machimar Kriti Samithi, the government's new policy to allow big companies to import large trawlers would ruin fishermen.

Those connected with fishing industry in Madras have expressed the view that the entry of big houses into deep sea fishing may well create a chaotic situation for the traditional industry.

Mr.Bhandarkar opposed the entry of foreign multinationals for fishing in the Exclusive Economic Zone as it amounted to robbing the seas and depriving hundreds and thousands of fishermen along the Indian coast from their rightful share of deep sea resources. He said that fishermen cooperatives should be helped by the nationalised banks to purchase larger fishing vessels which could be constructed by Indian shipyards. He lamented that big houses were being encouraged by the government to explore joint venture possibilities in fisheries field, with a huge share being allotted to the foreign collaborators.

Mr.Bhandarkar is reported to have been planning to meet the Union Minister of State for Agriculture Mr.Yogendra Makwana to present his views on the subject. He is of the view that the government should make a provision for the employment of a certain percentage of fishermen on vessels owned by big houses, so that they could acquire indepth knowledge of deep sea fishing techniques. He stated that the Central Institute of Fisheries Education, Bombay should play a nodal role in this respect.

Mr.V.K.Kurien, a prominent marine products exporter has expressed the view that larger houses who had earlier tried their hand in processing and marketing of fish products did not contribute much to the growth of the industry. They were rather keen in taking the benefits of taxation and liberal import licensing norms. He was of the view that the existing infrastructure facilities would hardly stand the pressure, once large houses start intensified fishing operations. Regarding the provision for chartering of fishing vessels for a period of 2 years as a prelude to joint ventures, Mr.Kurien is of the view that this has opened up a hit-and-run opportunity for shrewd operators to make a fast buck.

The Associated Chambers of Commerce and Industry welcomed the decision of the Union Government to allow MRTP AND FERA companies to go in for joint ventures in deep sea fishing. According to the Association, this would enable the country to utilise in a much better way the available high potential for the export of marine products.

The Association expressed the hope that clearance of joint venture proposals by the designated nodal agency i.e., the Ministry of Commerce, would be streamlined and made much more expeditious than at present. The same applies for the provision of financial assistance to the fishing industry for the acquisition of trawlers.

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