

ratios of these two variables were considered the next best practical index for the growth as evidenced by the standard error shown in Table 1. More than 2 variables did not show any appreciable improvement in SE.

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### Some Aspects of Culture of Mullet (*Mugil cephalus*) & Pearl Spot (*Etroplus suratensis*) in Siridaon Fish Farm, Goa

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Results of a study on the culture of *M. cephalus* and *E. suratensis* in Siridaon Fish Farm are presented and the influence of ecological parameters on the growth is discussed. In spite of understocking the culture is economical and hence with proper stocking strategy the profit margin can be increased to higher level.

FISH farming, using traditional methods, is being practised in Goa since many years, and is proving quite economical<sup>1</sup>. Application of scientific methods in aquaculture, especially raft culture of green mussels in Goa has shown high yield of quality food at high margins of profit<sup>2</sup>. In these studies<sup>1,2</sup>, stress has been laid on environmental and biotic parameters in undertaking successful aquacultural programme. This paper presents variations in temperature, salinity, dissolved oxygen, phosphate (PO<sub>4</sub>-P), nitrate (NO<sub>3</sub>-N), dissolved carbohydrate (D-CHO) and particulate organic carbon (P.O.C.) with special reference to stocking, growth and harvesting of mullet (*M. cephalus*) and pearl spot (*E. suratensis*), during Oct. 1975 to Feb. 1977. Organic carbon in the sediment has also been investigated.

Siridaon Fish Farm (Fig. 1) measuring about 3.5 hectares is situated on the Siridaon river, a tributary of the river Zuari. The fish farm is surrounded by paddy fields and there is also dense

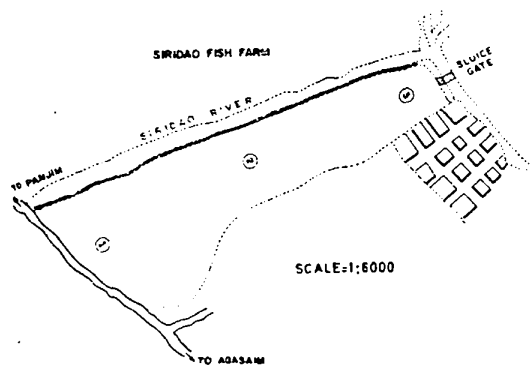


Fig. 1 — Siridaon Fish Farm, Goa with station positions 1 to 3

mangrove vegetation, especially on the 2 banks of the river Siridaon. The average depth of water in the farm is about 1 m and the water level is controlled through a single sluice gate situated in the eastern part of the farm. The Zuari estuary is highly productive at different trophic levels<sup>3,4</sup>.

Monthly sampling was done at 3 stations (Fig. 1). In the farm in July 1976, 1000 fingerlings of mullet (*M. cephalus*) and 1500 of pearl spot (*E. suratensis*) were stocked. The intake of water was done during spring and neap tides and draining of water was controlled through a fine mesh nylon netting, for preventing the escape of organisms. The whole population was harvested in Feb. 1977 using drag and cast nets. All analysis were done by standard procedures<sup>5,6</sup>.

Variations in different environmental parameters at 3 stations and at 2 depths, tested by *t* test, showed no significant difference between the stations. Maximum and the minimum water temperature value was recorded in April and December, respectively. Salinity varied markedly during the monsoon season (June to September) but the maximum value of 37.9‰ was recorded in March. Dissolved oxygen values did not vary significantly during the year. Variations in all the hydrological parameters were similar to those reported for Zuari estuary<sup>7</sup>. Dissolved carbohydrate cycle (Fig. 2) followed similar trend of variations, as in Zuari, where it is explained as a result of phytoplankton activity and a breakdown product of detritus<sup>8</sup>. Concentration of P.O.C. averaged from 540 to 4248 mg C/m<sup>3</sup> in September and June respectively. High values in June may be due to high land drain off due to heavy monsoon showers. It is clear (Fig. 2) that P.O.C. and soil organic carbon is significantly related to the fish stocking time. Low level of P.O.C. at the time of harvesting shows that fish was obviously feeding on planktonic as well as sedentary communities. High level of soil organic carbon at the time of harvest may be related to fish excreta. The direct source of organic carbon in fish farm, was from dense mangrove vegetation in the surrounding areas. The organic carbon in the soil is equally important as average depth of water in the farm is 1 m.

Mean weight and length of *E. suratensis* and *M. cephalus* were recorded at the time of release and finally at harvesting. As seen in Table 1,

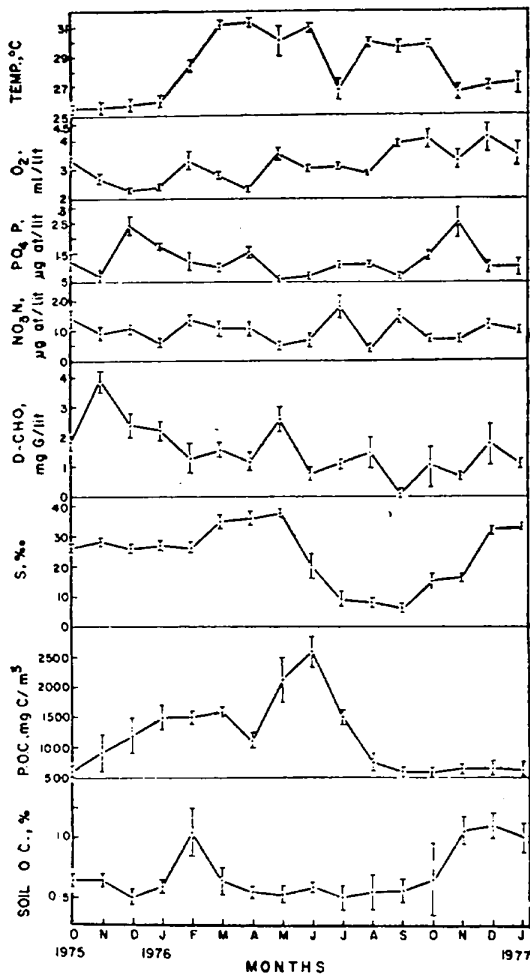


Fig. 2 — Seasonal variations in environmental factors

TABLE 1 — GROWTH OF FISH IN POLY-CULTURE SYSTEM

	<i>E. suratensis</i>	<i>M. cephalus</i>
Date of stocking	6-7-1976	30-7-1976
Date of harvesting	19-2-1977	19-2-1977
Number of days	227	203
Initial wt (g)	12.38	29.7
Final wt (g)	31.58	75.0
Daily increment/fish (g)	0.085	0.23
Initial standard length (mm)	55.1	116.2
Final standard length (mm)	105.6	193.2
Daily increment/fish (mm)	0.22	0.38

the mullets have grown at an average monthly rate of 11.78 mm. In case of pearl spot, the average increase in length within 227 days was 50.5 mm. Rate of growth of *M. cephalus* and *E. suratensis*, observed in the present study, is more than reported by Alikunhi<sup>9</sup>.

The total fish biomass at the time of release and harvest has been expressed in terms of gram carbon on the basis of organic carbon percentage in the

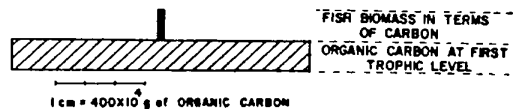


Fig. 3 — Model of fish stocking density

TABLE 2 — INVESTMENT RETURN AND PROFIT IN FISH CULTURE IN GOA

	Present study under stocking	Amount complete stocking
(A) COST		
(a) Direct cost		
i) Lease charges for fish farm	750	750
ii) Fish seeds	1400	7000
iii) Nets, mesh, screen etc.	150	150
Total	2300	7900
(b) Indirect cost		
i) Travel cost and overtime allowance of staff	200	200
ii) Depreciation of farm and other material	300	300
iii) Unforeseen expenditure	200	200
Total	700	700
(B) RETURNS	Total cost	3000
Value of fish	5250	26250
(C) PROFIT		
i) Value of fish	5250	26250
ii) Cost of production	3000	8600
iii) Gross profit	2250	17650
(D) RATE OF RETURN ON INVESTMENT %	75	205.23

fish tissue. The net increase in fish biomass during culture period between release and harvest was  $803.34 \times 10^3$  gC. Results show that the amount of organic carbon available at the primary trophic level in this farm over the year is  $8081.34 \times 10^4$  gC (calculated by integrating the area under the organic carbon curves). The level of secondary production for detritivorous fish like mullet<sup>10</sup>, which can theoretically be supported by this amount, for 6 months is  $4040.67 \times 10^3$  gC on the basis of the possible yield. Therefore, the fish fingerlings stock can be increased to 5 times (Fig. 3).

An inventory of direct and indirect costs during the course of experiments was maintained. As seen in Table 2, the experimental fish farming wherein pond was understocked indicated a 75% rate of return as calculated from the ratio of costs to gross profits. If properly stocked the fish farming operations in Siridaon Fish Farm will yield a high rate of return of 205.23%. The returns can still be higher, if nursery and hatchery ponds are maintained for the production of fingerlings.

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### Particulate Iron, Manganese, Copper & Zinc in Waters of the Cochin Backwater

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Particulate matter from the Cochin backwater was analysed at close network of stations for Fe, Mn, Cu and Zn. Significant concentrations of Fe, Mn and Cu were found at the river mouth. These concentrations were higher than the values reported for similar environments in other regions of the country, which might be partly due to the domestic and industrial pollution in the area.

THE backwaters of Kerala, in general, are highly productive and form nursery ground for a variety of fish and shell fish in addition to their rich brackish water fishery. Besides, the backwaters offer considerable potential for the development of aquaculture. Ecological conditions in the backwater ecosystem affect not only its own resources but also those of the adjacent sea and the rivers. Hazards arising from the discharge of pollutants by industries (containing high concentrations of heavy metals) in these environments necessitate a regular monitoring of the levels of the heavy metals in the waters, mud and organisms. The primary objective of the present investigation is to collect some data on the heavy metal concentrations in the particulate matter of the Cochin backwater from the marine zone to the fresh water zone, on which there is no information. As larger quantities of heavy metals are transported by the river as particulate<sup>1</sup> the particulate matter has been analysed for various metal concentrations and compared with data reported for the waters from other parts of the country<sup>2-8</sup>.

Water samples from the surface and bottom were collected at various stations from the Cochin backwaters, from the marine zone to the freshwater zone, in March 1977. The station positions are shown in Fig. 1. Surface samples were collected using a plastic bucket and bottom samples using a Vandorn sampler. Water samples were stored in acid-cleaned plastic bottles and filtration was carried out as soon as the samples were brought to the laboratory. A suitable quantity of the sample was

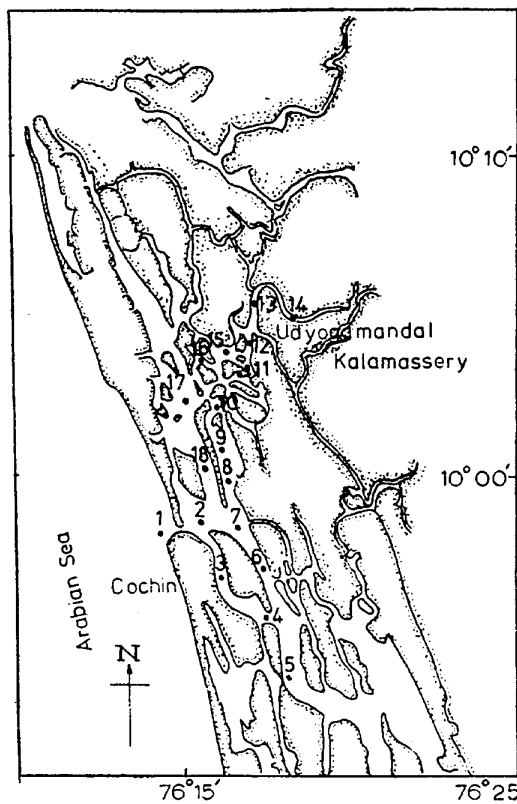


Fig. 1 — Station positions

filtered through 0.45  $\mu$  pore size membrane filter paper and the particulate matter retained on the filter paper was used for estimation of various metals. Wet digestion was carried out as described in the Manual of methods in aquatic environment research<sup>9</sup>. A blank determination was carried out in the same way with a blank filter paper. Metal concentrations were estimated in the digested sample using the Atomic absorption spectrophotometer (Hilger and Watts Atomspek H 1550). Metals estimated were iron, manganese, copper and zinc.

Sampling for the metal estimations in the Cochin backwater is made at closely spaced intervals from the estuarine mouth to 15 km upstream. The main source of freshwater in the Cochin backwater is from two large rivers: Periyar on the north and Pamba on the south. The backwater system is subjected to very wide ranges of physico-chemical conditions. During the south-west monsoon period (June-September), the estuary becomes dominant with freshwater, with brackish water or very nearly freshwater at the surface and with a tongue of saline water at the bottom. During the post-monsoon season there is a marked increase in the salinity and during the premonsoon period (March-May) the backwater becomes almost an extension of the adjoining sea with salinity values  $>30\text{‰}$ .

Concentrations of various metals are shown in Table 1. The data are compared with published information and interpreted (Table 2).