COMPARATIVE STUDIES ON THE ECOLOGY OF BOTTOM MACROFAUNA IN SEASONAL AND PERENNIAL FISH PONDS AND IN THE ADJACENT BACKWATERS

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CERTIFICATE

This is to certify that this Dissertation is a bonafide record of the work carried out by Shri **DALJEET SINGH** under my supervision and that no part thereof has been presented before for any other degree.

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PREFACE

The flora and fauna inhabit at or near the bottom or sub-bottom layer of aquatic ecosystem may be broadly considered as benthos. The studies on benthic communities, their distribution and abundance in space and time form an exciting field of brackishwater studies. The faunestic composition of tropical estuaries is represented by a wide spectrum of animals belonging to groups such as Polychaetes, Crustaceans, Molluscs, Nematodes, fishes etc. Benthos, for many years, has been a stepchild of ecology depending upon the thoughts generated by terrestial and water column colleagues. But with the increasing awareness on the complex relationship of benthic communities and the surrounding environment, in which they live, benthic ecologists have broken these feters and produced original research and hypothesis, now available to the whole ecological world. As the tropical estuary is a special ecological niche with a complex dynamic mixture of transitional conditions, the faunestic composition and their abundance too showed very interesting community structures and vary often with wide seasonal fluctuations.

A detailed knowledge of benthic animal communities and their interaction with the living and non living environmental parameters is one of the pre-requisites for determining the distribution and abundance of demersal fishes in an area.

Fifty percent of the world's commercial catch from sea, estuaries and backwaters consists of shellfishes and other demersal finfishes, whose main food source comes from the benthic organisms. Therefore, the distribution and abundance of benthic fauna has an intimate relationship with the availability of most of the ground fishes and shellfishes. This relationship is all the more vital in the estuaries, backwater, lagoons and swamps, which act as nursery ground for many species of fishes and prawns. Thus there is an imperative need to study quantitative and qualitative distribution and abundance of macrobenthos communities in these waters. A comparative evaluation on the ecology of macrobenthos in both the systems-the brackishwater region and fish/prawn farms may be useful in assessing the production potentials and the probable factors favouring or limiting production in these habitats.

Due to fast urbanisation and reclamation of vast areas of backwaters and estuaries, this habitat is constantly shrinking and pushed towards the sea. This drastically affected the physical, chemical and biological environments causing serious threats to fish/shellfish fauna. Added to this is the pollution caused by dumping large quantities of industrial effluents and domestic sewages into the estuaries and backwaters. Therefore, it will be all the more interesting to study the changes and damages to the benthic communities of this environment by a comparative evaluation of the past and the present conditions. At least to some extent these environmental damages and alterations created environmental perturbations in the network of canals connected to the backwaters and thereby the perennial and seasonal fish/prawn ponds.

The traditional fish/prawn culture practices were prevelent since ancient times in low lying fields adjacent to estuaries and backwaters in many parts of the country. These extensive traditional culture systems are characterised by non-selective stocking by trapping the seeds brought in by incoming tides, absence of supplementary feeding, multiple harvesting, little input and little management. Prawn and fish seeds feed on the benthic organisms. Thus the quality and quantity of benthic organisms decide the production obtained from culture ponds and the well being of cultured organisms, when artificial feeding is not resorted. The traditionally backward average Indian fish farmers, who practice this type of culture in inundated water stretches, cannot afford to spend for comparatively costly artificial feed. In such a circumstance it is advisable to make full use of the organic food naturally available in the environment for the culture practices.

Though there are different published accounts on the benthic animal community and their interaction with the environment, their spatial distribution, species abundance and seasonal fluctuations in coastal water, estuaries and brackishwaters, there has been little information available on the comparative studies of macrobenthos in the different ecosystems such as backwater and perennial and seasonal culture fields. The present attempt is to study the qualitative and quantitative abundance and ecology of bottom macrofauna in relation to different environmental parameters. It is also aimed to project a comparative account on the faunestic composition and their seasonal distribution and abundance in perennial and seasonal culture fields and adjacent backwater areas.

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Cell, Central Marine Fisheries Research Institute and the crew of Cadalmin for their kind help. I wish to express my gratitude to Dr. Peer Mohamed, Dr. A.Noble and Mr. N. Kurup for their encouragement and valuable help. I also stand in appreciation of Mr. Nandakumar, Mr. Raghavan and Mr. K. Balachandran for their timely help. My thanks are due to all the Senior Research Fellows and especially to Miss. Mary Mathews and Mr. Suresh for their enthusiastic help. My all colleagues especially Muthukaruppan, S., Sheela, S.K. and Saji Chacko made my task seem pleasant by their encouragement and help.

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INTRODUCTION

The estuarine habitat is characterised by a semi-enclosed coastal body with a free connection to the open sea and within which sea water is measurably diluted with freshwater derived from land drainage. The estuarine environment, with its potential role as nursery ground for many species of fishes and its natural fertility, has fascinated the attention of estuarine ecologists during the last few years. The distribution of estuarine benthic animals is dependant on the complex and periodically changing parameters that limit colonization to a restricted number of organisms, with a wide range of ecological adaptations. The benthic fauna is broadly divided into epifauna - which live at or on the substratum and infauna - which lie burried beneath the surface. Molander (1928) is of opinion that majority of individuals are found at the top 5-10 cms of deposits, probably except polychaetes which penetrate deep down to 15 cms or more depending on the type of substratum. Mare (1942) classified the bottom fauna into macrobenthos, meiobenthos and microbenthos. Macrobenthos are defined as those animals which are retained in 0.5 mm sieve, but samples from coarse sandy bottom may retain too large a volume of material. Therefore, this mesh size, for the classification, will depend both on the grades of deposits and size range of animals to be selected (Birkett and McIntyre, 1971). The lowest mesh size of sieve used for meiobenthos is 62 µ and the animals passing through the finest sieve used for meiobenthos comes under microbenthos.

The earlier studies on benthic fauna were made as early as 18th century (Muller, 1779) where "Naturalists dredge" was scientifically used to describe the new species and biology of benthic organisms. But the qualitative and quantitative studies of benthic fauna are comparatively recent and the classical example on the subject is the pioneering investigation in Danish water by Peterson and Jenson (1911) with the help of a grab of 0.1 m^2 and 0.2 m^2. Besides investigating the role of benthos in the economy of Fjords, Peterson (1913) put forward the concept of "animal community".

Later, workers like Davis (1923, 1925), Hagmeier (1925) and Stephen (1923, 1933 and 1934) used Peterson grab to apply the community concept to bottom fauna. Ford (1923) studied the animal community comprising the bottom fauna of English Channel; in the Adriatic sea by Vatova (1949); Zenkewitsch (1927) and Zenkewitch et al, (1928) extensively used Peterson grab to study animal community concept in

Atctic Sea; Thorson (1933, 1934) studied the benthos in the East Greenland waters; and in North America by Shelford et al. (1935). The inadequacy of benthos and sediment sampling in open sea by Peterson grab, prompted the benthos researchers to design a new quantitative sampler. This lacuna was filled by Thamdrup (1938) by designing Van Veen grab. This grab is having more mechanical advantage than other types of grabs and is closed by pull excerted by two arms was preferred in later investigations (Holme, 1964). The Van Veen grab brought about revitalization among the deterred benthos workers whose main aim was to study the qualitative and quantitative distribution of benthic communities, their specific relations to the type and nature of substratum and hydrographical parameters (Raymont, 1947, 1950; Sanders, 1956, 1960; Blacker, 1957; Birkett, 1959; Longhurst, 1959; McIntyre, 1961; Chamberlain and Stearns, 1963; Thorson, 1966; Lie, 1969, 1973, 1974; Boesh, 1972; Johnson and Brinkhurst, 1971 and Whitlatch, 1977).

Certain improvements in the techniques of sampling have been made both in the mechanics of obtaining the sample and its subsequent treatment on board the vessel and in the statistical analysis of the results (Lee, 1944; Ursin, 1960; Ellis, 1960). Holme (1964) reviewed the method of sorting the samples which vary from simple washing of the sample through a nest of sieve with a hose (Mc Neely and Pereyra, 1961) to the elaborate set up described by Durham (in Hartman,

1955) in which a mechanical shaker agitates a graded series of screens under a set of sprinkler heads. The easy sorting of live benthos is achieved either by floatation technique (Birkett, 1957) or by eluriation method (Lauff et al. 1961). Mc Intyre (1961) used staining technique for easy sorting of benthos.

In recent times greater emphasis is given to study the impact of industrial effluents, domestic sewage and solid wastes on the qualitative and quantitative distribution and abundance of benthic organisms particularly in relation to hydrographical and sedimentological parameters. Pearce (1976) extensively studied the distribution and abundance of benthic organisms in the outer New York bight and suggested alternate site for dumping sewer sludge and solid wastes. Crumb (1977) explored the potential relationship between number and standing crop of common organisms with the sediment. Wolff (1977) reviewed the mechanism causing high benthic secondary production and categorized them into three types - those in which the supply of dissolved nutrients from various sources cause high primary production, those which supply of particulate organic matter and those in which shallow nature of estuaries cause rapid sinking as well as rapid transport of particulate organic matter. Saila (1976) studied the animal-sediment relationship and concluded that highest biomass was associated with coarse grained sediment. The high biomass in coarse sediment is attributed to a few large suspension feeder molluscs. Fine and extremely coarse sediment represented stress habitat for most marine invertebrates with reference to commercially important bivalve.

Annandale (1907) initiated the benthic investigations in India by studying the fauna and flora of brackish water ponds of port canning and lower Bengal. Annandale and Kemp (1915) studied the ecology of fauna of Chilka lake. While studying the bottom fauna of Travancore coast, Kurian (1953) stated that salinity, temperature and physical nature of substratum affect the distribution and abundance of bottom macrofauna. Seshappa (1953) presented an account of bottom macrofauna of Malabar coast. Damodaran and Hridayanathan (1966) studied the benthos and the factors affecting their distribution and abundance in the mud banks of Kerala coast. The benthos of south west coast of India were extensively studied by Kurian (1967, 1969). Desai and Kutty (1969) gave a comparative account of marine and estuarine benthic fauna of nearshore regions of the Arabian Sea off Cochin. Neyman (1968) studied the benthos of the shelves in the northern part of the Indian ocean and concluded that benthic biomass in northern zone is higher than the southern region. The higher benthic biomass is attributed to higher primary productivity and higher phosphate content. Patnaik (1971) studied the seasonal abundance and distribution of bottom macrofauna in the Chilka lake. Desai (1973) studied the productivity of benthos in Indian Sea. Parulekar and Dwivedi (1972) presented a detailed investigation on the faunal composition and correlated it with bottom water salinity and nature of substratum in estuarine complex of Goa. Dwivedi et al. (1973) noticed a change in the ecology and production of intertidal fauna caused by intensive erosions and accretion processes due to wave action. Rao (1974) studied the seasonal abundance and distribution of bottom fauna in Pulikat lake. Parulekar et al. (1975) studied the benthic biomass and faunal composition in Zuari estuary. Parulekar and Wagh (1975) studied the quantitative distribution of bottom macrofauna in north eastern Arabian Sea shelf. Harkantra (1975) extensively studied the benthos of Kali estuary, Karwar, the fluctuation in biomass was attributed to difference in substratum characteristics and fluctuation in salinities. Raman et al. (1975) studied the hydrography in relation to benthic macrofauna abundance in Pulikat lake. Ansari and Harkantra (1977) found that the benthos of Bay of Bengal had not shown any appreciable change in biomass and population density, however a prominent relationship between type of sediment and density of animals was observed. Harkantra et al. (1980) studied the benthos of shelf region along west coast of India and discussed the animal-sediment relationship and the potential role of benthos in sustaining the demersal fisheries. Murugan et al.

(1980) investigated the benthic community, its distribution and abundance in Veli lake along the south-west coast of India. The benthic macro-fauna, their distribution and production and trophic relations of rocky, sandy and muddy shores of Goa and Malvan estuaries were discussed by Parulekar et al. (1980) and Parulekar (1981) respectively and highlighted the need to conserve the marine fauna. Varshney et al. (1981) investigated the benthos of Narmada estuary and reported that there was no consistent relationship between organic matter and faunal density.

In the Cochin backwater there has been a lot of studies on benthic fauna. Desai and Krishnankutty (1967) studied the bottom fauna of Cochin backwater. Devassy and Gopinathan (1970) analysed the benthic fauna of Vembanad lake along with planktons and disscussed their relation to temperature and salinity. Kurian et al. (1975) and Ansari (1977) studied the benthos of Vembanad lake. Pillai (1977) described the benthic faunal abundance and distribution in relation to sediment characteristics of Cochin backwater.

Though the Cochin backwater was investigated thoroughly for benthic ecology, there were very few published accounts on the ecology of benthos of perennial and seasonal fish/prawn culture ponds situated adjacent to the net work of canals of the backwater system. One of the early works of ecology of brackishwater fish pond is from Pillai (1954) who studied the 'Bheris' with special reference to fish culture practices and biotic interactions. Srinivasan (1982) and Sugunan (1983) studied the macrofauna and meiofauna respectively in the perennial and seasonal fish ponds of Vypeen island with special reference to hydrographical and sediment characteristics.

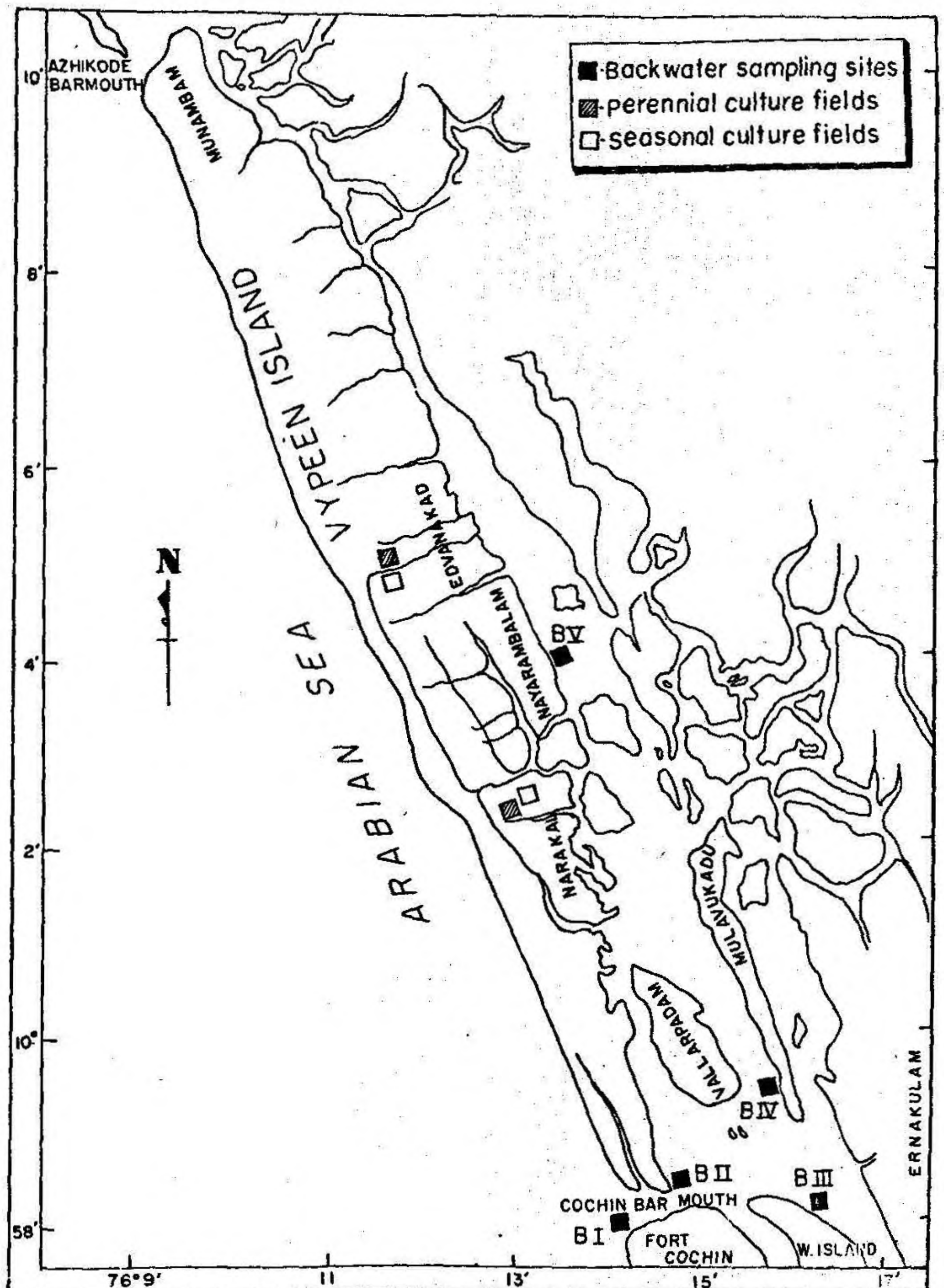
This review of literature on ecology of benthic communities reveals that a great deal of work has been done in backwaters and estuaries. Benthic fauna, in general, form the food of demersal organisms, especially of prawns and a few economically important fishes which pass their juvenile phase of life cycle in estuaries. Prawns constitute one of the important fisheries resources, the considerable amount of which is contributed by traditional culture practices. Traditionally prawn/fishes are cultured in 'Pokkali' fields from November to April, the year round traditional culture is practiced in perennial ponds and more recently even in the shallow canals of coconut grooves. In the traditional culture fields, both perennial and seasonal, the quality and quantity of the benthic organisms is one of the major deciding factor for the growth and production of prawns. Inspite of the awareness of the importance of prawns in country's economy, there has been not much concerted effort to study the benthic communities which form the food of these demersal organisms. The present study was carried out in culture fields in view of the significance of macrobenthos in trophic cycle. Besides studying the benthic communities of culture fields, their numerical abundance, factors controlling or favouring distribution and species composition is compared with benthic communities of adjacent backwaters.

S T U D Y   A R E A

The Cochin backwater area, a chain of brackishwater lagoons and swamps, is situated between latitude 9° 28' and 10°N, and longitude 76° 13' and 76° 31'E. It extends from Azhikode in the north to Alleppey in the south, with an area of about 300 sq.km. A channel of about 500 m width at Cochin gut makes a permanent connection with the Arabian Sea. This backwater is comparatively shallow with an average depth of 2-3 meters. It is deeper in harbour area, the depth of which is maintained at a minimum of 11 meters by constant dredging, as this region traverses the channel for ship transportation.

Two major rivers - Pamba in the south and Periyar in the north and four other rivers viz. Achankoil, Manimala, Meenachil and Muvattupuzha empty into the backwater system. The salinity fluctuations are due to relative difference between evaporation, precipitation, river run-off and tidal incursions. Adjacent to Cochin backwater system, there are several low lying fields which are seasonally used for paddy and fish/prawn culture. In addition to seasonal fields, there are coconut grooves and perennial water spreads all used for fish/prawn culture. All these culture systems are connected with backwater through a network of canals. The

Fig. 1. Map showing the study area and the location of stations.



■-Backwater sampling sites
▨-perennial culture fields
□-seasonal culture fields
AZHIKODE BARMOUTH
MUNAMBAM
VYPEEN ISLAND
ARABIAN SEA
EDVANAKAD
NAYARAMBALAM
NARAKAL
MULAVUKADU
VALLARPADAM
ERNAKULAM
COCHIN BAR MOUTH
FORT COCHIN
W. ISLAND
B I
B II
B III
B IV
B V
N
10'
8'
6'
4'
2'
10°
58'
76°9'
11
13'
15'
17'

Plate I :

a) Narakkal perennial culture pond

b) Edvanakad perennial culture pond


a

b

tidal effect on the backwater at Cochin region is mixed diurnal type, the two successive low and high water marks have an average height of 90 cm.

Studies on benthos and related hydrographical and sedimentological parameters were carried out at five different stations extending from Cochin barmouth to Narakkal along the backwaters (Fig. 1). The Station, B I was situated at the confluence of the sea; Station, B II was in marine zone of the backwater; Station, B III situated towards the southern side of Cochin gut just opposite to Malabar guest house; Station, B IV was near the Bolghatty island and Station, B V represented the backwater in the region between Narakkal and Edavanakad.

Benthos samples were also collected from perennial and seasonal culture fields at Narakkal, a fishing hamlet in the Vypeen island, about 10 km north-west of Cochin city and from Edavanakad about 5 km north of Narakkal. Materials for this investigation were gathered from two perennial fields and two seasonal fields. Out of the two perennial culture fields, one was experimental pond attached to Prawn Culture Laboratory (P C L) of Central Marine Fisheries Research Institute (designated as NP) and the other one was the traditional culture field at Edavanakad (designated as EP) (Plate 1).

Out of the two seasonal fields, one was at Narakkal (NS) and the other at Edavanakad (ES).

The pond, NP was formed by impounding the area by earthern bunds. The area of this pond is 0.6 ha., with an average depth of 0.75 m. It is connected to the feeding canal by a sluice gate of width 0.75 m. The sluice gate is provided with a velon screen to prevent the entry of unwanted fish or any other predators.

The pond (EP) is large having an area of 1.6 ha. and with an average depth of 1.12 m. This pond is connected to the canal by two sluice gates, each with a width of 0.70 m. This pond is characterised by some land intrusions on the south eastern boundry where coconut trees are planted. The earthern bunds are strengthened by planting mangrove plants.

The second type of ecosystem selected for the present study was seasonal or 'pokkali' fields, where prawn and other brackishwater fishes are cultured from November to April. In 'pokkali' fields samples could be collected only upto 15th June to study the availability of benthos and related parameters since paddy was cultivated in these fields after the fish/prawn harvest. These fields were comparatively shallow with an average depth of 0.25 m and two radiating canals from the sluice gate provided shelter to cultured organisms.

M A T E R I A L S   A N D   M E T H O D S

The samples for the present investigation were collected over a period from March 1987 to September 1987 except for the first fortnight of June. The Stations in the culture fields as well as backwaters were positioned with the help of prominent land marks and country crafts were used to collect samples from backwater near Narakkal and Edavanakad and perennial fields; whereas the relatively shallow seasonal fields at Narakkal and Edavanakad were sampled after getting into the water. The Institute's vessel 'CADALMIN' was used to collect samples from near Cochin bar mouth. The detailed methods adopted for collecting bottom macrofauna, sediment samples and bottom water are given below.

BOTTOM FAUNA:

The macrofauna is defined as those organisms which are retained in 0.5 mm sieve. Samples were collected by using a van-Veen grab, with an area of 0.04 m^2, at fortnightly intervals. As soon as the grab was hauled up, the quantity of the sediment inside the grab was checked. The incomplete samples were discarded and fresh samples were taken wherever applicable.

For separating the animals from the sediment sample, hand sieving method was employed. Sediment samples were screened through a 0.5 mm^2 standard circular seive. After a cursory examination, the residue from the sieve were preserved in 5 % formalin with Rose Bengal (1 gm/L) to provide colour contrast wherever necessary (Williams and Williams, 1974).

Further sorting of benthos was done in the laboratory by resieving and washing with tap water to remove formalin. The washed sample was put in a petri dish kept over a white porcelain tile for easy sorting. Stereomicroscope was used for identification of different groups upto species level. In order to compare the biomass at different stations the wet weight and numbers of organisms were converted into gms/m^2 and numbers/0.1 m^2 respectively.

BIOMASS:

For estimating the biomass the wet weight of different groups of macrobenthic fauna were taken after washing the preserved samples. Hall (1961) showed that changes in wet weight of biomass occured during preservation, within the first few hours and afterwards the change in wet weight became almost negligible. Therefore, in the present study the wet weight of macrofauna was always taken four weeks after preservation to give a uniform allowance for any possible weight change during preservation. All the organisms such as large prawns, fishes like <u>Cynoglossus</u>, Eels, gobids etc. which occur only rarely in the grab sample were not taken into account when biomass (wet weight) was estimated, however their numerical abundance was recorded.

SPECIES DIVERSITY

The diversity index is the measure of organisation of individuals in an ecological animal community in terms of species abundance qualitatively and quantitatively and their equitability or evenness or distribution among other species. For the present investigation of species diversity, 'Shannon diversity index' was used as is given in 'Ecology' edited by Odum (1963). The Shannon's index is derived from the following formula:

$$H = - pi \log_e pi$$

where,

H = Species diversity

Pi = proportion of individuals in population represented by the i^{th} of total number of species.

This function (H) has the attribute of being influenced by both the number of species as well as evenness and unevenness of individuals. The Shannon's index, 'H' is an index of diversity in that the higher the value greater the diversity and less the community is dominated by one or two types.

A portion of the sediment from the grab sample was removed (Davis 1925) for analysing the reactive mud phosphate, organic carbon and grain size. Nansen bottle was used for the collection of bottom water samples from near barmouth, whereas from culture fields bottom water samples were collected by immersing a closed bottle fitted at one end of a stick. After immersing the stick upto the bottom, the stopper was released by pulling a string attached to the stopper and the bottle was allowed to be filled with water.

Temperature was noted with the help of a thermometer having an accuracy of 0.1°C; but when the bottom water samples were collected with Nansen bottle, temperature was measured with reversing thermometer. pH of the bottom water was measured by using a digital pH meter.

CHEMICAL ANALYSIS OF WATER

Salinity: Salinity of bottom water was estimated by Mohr-Knudsen method as described by Strickland and Parsons (1968).

Dissolved oxygen: Water samples were collected in 125 ml oxygen bottles and fixed with Winkler A and B reagents.

Dissolved oxygen content was estimated by modified Winkler method as given by Strickland and Parsons (1968).

CHEMICAL ANALYSIS OF SEDIMENT

Reactive phosphorus: The reactive phosphorus is the sum total of water soluble and easily oxidisable phosphorus. This was extracted with 0.5 M sodium bicarbonate solution (Olsen *et al.* 1958) as is described by Jackson (1968). Reactive phosphorus was determined by method of Murphy and Riley (1962) as described by Strickland and Parsons (1968) for sea water analysis.

Organic carbon: The organic carbon contents were analysed by Black and Walkley's (1938) chromic-acid method. About 0.5 gm finely ground oven dried sample was taken in 500 ml conical flask, 10 ml of 1N dichromate solution was added followed by 20 ml of conc.H_2So_4. The hot mixture was allowed to stand for 30 minutes. Dilute the sample to 200 ml with distilled water and add 10 ml of conc. phosphoric acid, 0.2 gm of sodium fluoride and 1 ml of diphenylamine indicator. This was titrated against 0.4 N ferros ammonium sulphate to brilliant green end point. The titration procedure was repeated without sediment sample to get blank value. The percentage of organic carbon in the sediment was calculated as:

$$\% \text{ organic carbon} = \frac{3.951}{g} (1 - T/S)$$

where, T = Volume of Ferros ammonium sulphate used for soil sample

S = Volume of Ferros ammonium sulphate for blank

g = Sample wt. in gms.

GRAIN SIZE ANALYSIS

The sieve pipette method of Krumbein and Pettijohn (1938) as given in "Marine benthos" edited by Holme and Mc Intyre (1971) was followed for grain size analysis. Twenty five grams of oven dried sediment was weighed and transferred to a beaker containing 100 ml of 6 % H_2O_2 and kept overnight. Then heat the sample gently on water bath for 10-15 minutes. Small quantity of H_2O_2 was added again to remove the organic matter completely. The contents in the beaker were filtered through whatman No.42 filter paper. It was further washed with distilled water under gentle suction to remove any further electrolytes. The sediment from the filter paper was transferred into another beaker and 10 ml of hexametaphosphate (6.2 gm/L of water) was added in addition to 300-400 ml of distilled water. This was stirred and kept for soaking overnight.

Initial splitting of silt-olay fraction: Sediment in the beaker was again stirred and filtered through 62 µ sieve placed in a flat bottomed white basin. The sediment was wet sieved by agitating and puddling in the basin of water until most of the fine fractions were passed. The sieve was dried in oven at 100°C. The dried sieve was agitated over a large sheet of glazed paper and any material that passed through the sieve was transferred in the basin. The contents in the sieve were weighed which gave the sand fraction in sediment.

Pipette sample: The material in the basin were washed into a 1000 ml stoppered cylinder and volume was made to 1000 ml with distilled water. The cylinder was shaken to suspend sediment evenly throughout the water column and kept upright. A longstemmed pipette tip was immersed to a depth of 10 cm below the surface and exactly at 7 minutes and 44 seconds, a 20 ml sample was withdrawn and transferred to a 50 ml beaker and dried at 100°C. The weight of this was multiplied by 50 to find the weight of silt fraction in one litre of the sample. Then the percentage weight of sand and silt were added and deducted from 100 which gave the percentage weight of clay.

Statistical analysis: All the physio-chemical and biological parameters were statistically analysed for the estimation of correlation coefficient 'r'. The computed value of 'r' between any two variables were tested for significance both at 1 % and 5 % level. The value of 'r' was estimated by using the formula.

$$r = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right) X \left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$

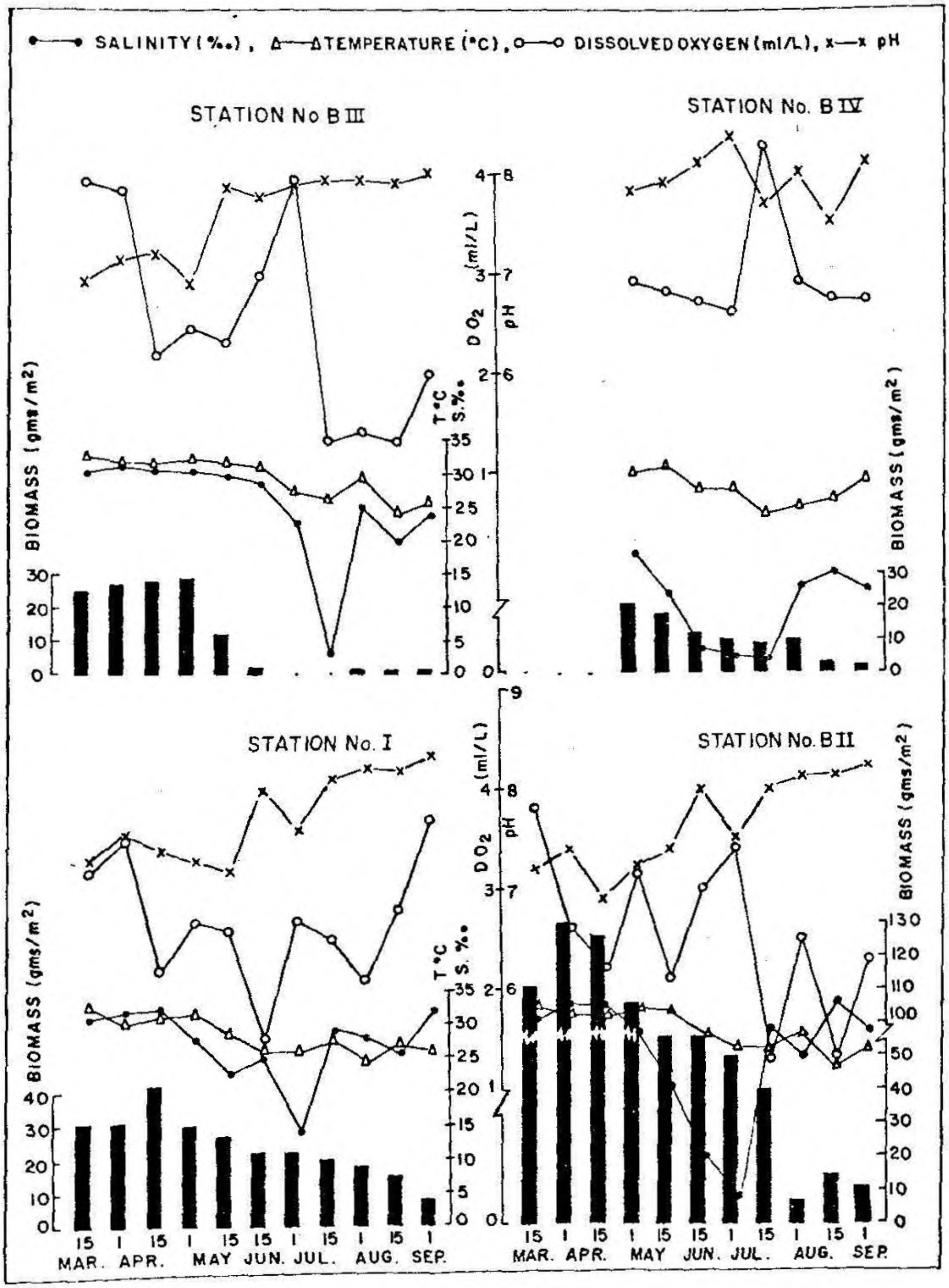
. . . .

R E S U L T S

HYDROGRAPHICAL PARAMETERS:

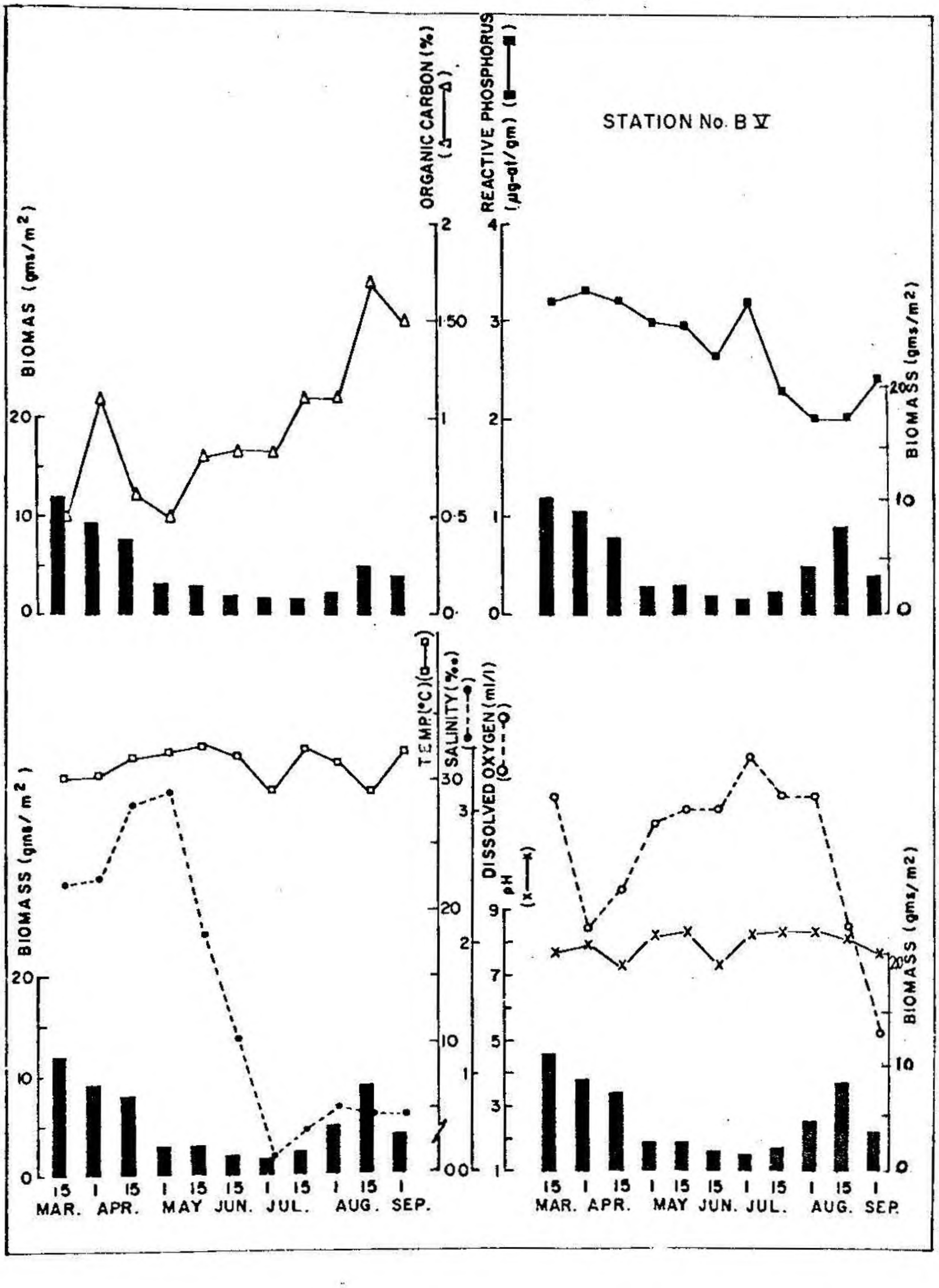
Salinity: In the culture fields, and backwater stations near the culture fields, peak values of salinity were observed during May 1; whereas in the backwater stations near the bar mouth, peak values during premonsoon were in April 15. In station B I salinity varied from as high as 32.48 ‰ in September to as low as 14.23 ‰ in July 1. In B II the fluctuation was between 33.20-4.52 ‰ the minimum being in July 1. In B III the maximum value (32.96 ‰) was recorded in April 15 with a minimum of 3.23 ‰ in July 1. In B IV as the work started only in the month of May, peak value of salinity was recorded in May 1 and minimum in July 1. In station B V salinity values ranged from 29.00 ‰ in May 1 to 1.75 ‰ in July 1. In traditional culture field EP salinity fluctuated between 29.78-1.25 ‰, the maximum recorded was in May 1 and minimum in July 1. In pond NP the range was from 29.1-1.25 ‰, with the maximum in May 1 and minimum in July 1. Along the backwater stations, nearer to the bar mouth, though the salinity values lowered due to high precipitation in south-west monsoon, there was immediate recovery as this region is under the heavy influence of tides. On the other hand, in the culture fields, once the salinity values lowered, the recovery was only gradual and not felt during the period of this study (Figs. 2, 3, 4).

Fig. 2. Seasonal variation of salinity temperature, pH and dissolved oxygen in relation to biomass (wet weight in gms/m^2) in backwater stations B I, B II, B III and B IV.



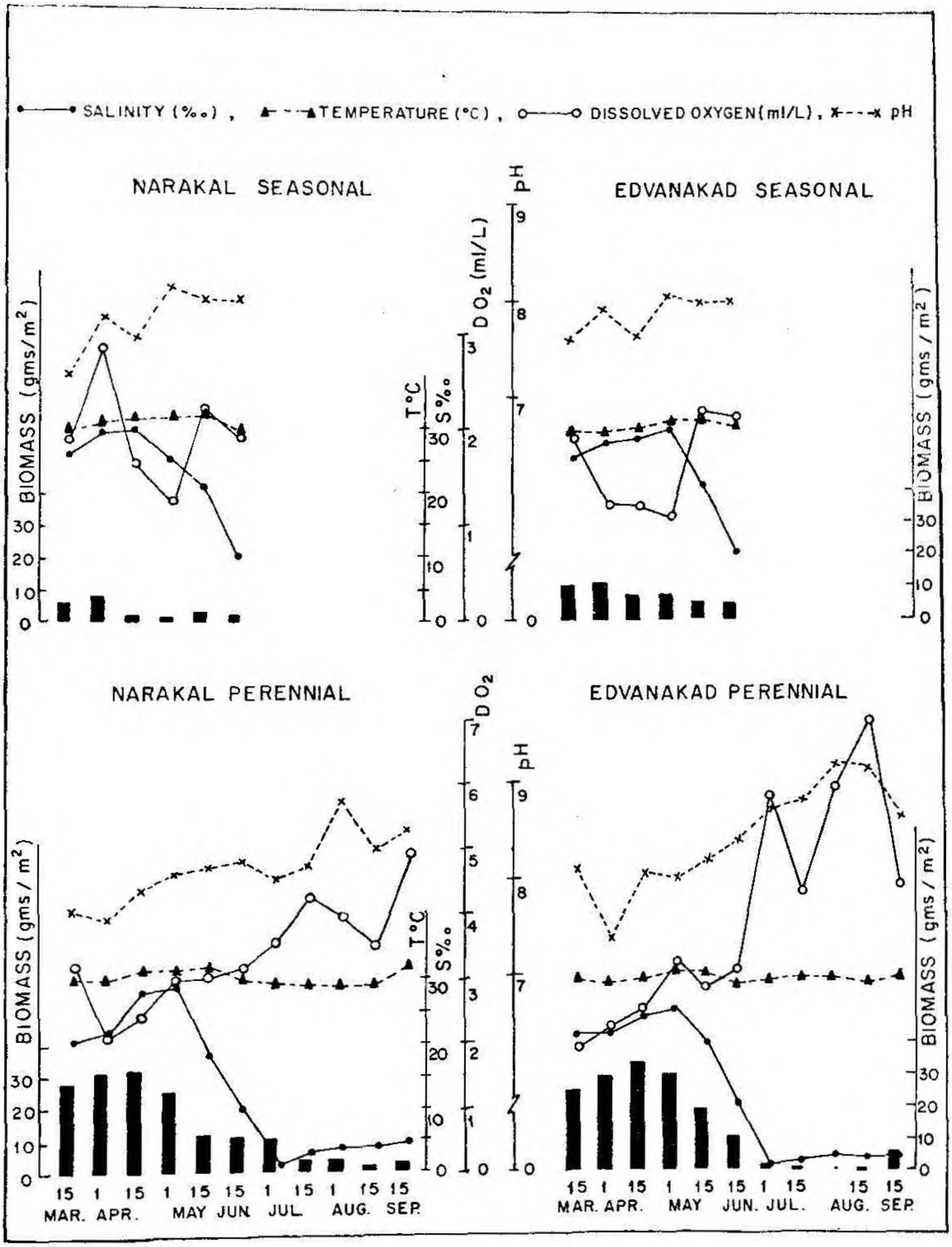
SALINITY (‰), TEMPERATURE (°C), DISSOLVED OXYGEN (ml/L), x—x pH
STATION No B III
STATION No. B IV
STATION No. I
STATION No. B II
BIOMASS (gms/m²)
T °C
S ‰
DO2 (ml/L)
pH
15 1 15 1 15 15 1 15 1 15 1
MAR. APR. MAY JUN. JUL. AUG. SEP.

Fig. 3. Seasonal variation of temperature, salinity, dissolved oxygen, pH, organic carbon, mud reactive phosphate in relation to biomass (wet weight in gms/m^2) in station B V.



STATION No. B V
BIOMAS (gms/m²)
ORGANIC CARBON (%)
REACTIVE PHOSPHORUS (µg-at/gm)
BIOMASS (gms/m2)
TEMP.(°C)
SALINITY (‰)
DISSOLVED OXYGEN (ml/l)
pH
15 1 15 1 15 15 1 15 1 15 1
MAR. APR. MAY JUN. JUL. AUG. SEP.

Fig. 4. Seasonal variation of salinity, pH, dissolved oxygen and temperature in relation to biomass (wet weight in gms/m^2) in stations N P, E P, N S and E S.


SALINITY (‰), TEMPERATURE (°C), DISSOLVED OXYGEN (ml/L), pH
NARAKAL SEASONAL
EDVANAKAD SEASONAL
NARAKAL PERENNIAL
EDVANAKAD PERENNIAL
BIOMASS (gms / m2)
T°C
S‰
DO2 (ml/L)
pH
15 1 15 1 15 15 1 15 1 15 15
MAR. APR. MAY JUN. JUL. AUG. SEP.
15 1 15 1 15 15 1 15 15 15
MAR. APR. MAY JUN. JUL. AUG. SEP.

Temperature: In the backwater station temperature remained more or less same upto May 15 and thereafter it registered a decreasing trend from June 15. In B I temperature fluctuated between 32.5°C in March 15 to 24.6°C in August 15. In B II the range was from 32.0-24.5°C with the maximum in March 15 and minimum in August 15. In B III temperature variation was between 32.5°C in March 15 to 24.6°C in August 15. In B IV as the sampling started only in May 1, the maximum value (31.00°C) was recorded in May 15 and minimum of 26.2°C in August 15. In B V, backwater station nearer to the culture fields, temperature fluctuation was around 32.2°C in May 15 and 29.0°C in July 1 (Figs. 2, 3, 4). In the culture fields also a general trend of lowering of temperature was noticed with the onset of monsoon. But the differences between maximum and minimum temperature was not as prominent as was observed in backwater stations. In NP temperature fluctuated between 32.20°C-29.00°C, the maximum being in May 15 and minimum in July 1. In EP temperature ranged from 31.90°C in May 1 to 28.5°C in August 15. In NS the fluctuation was narrow between 32.30°C-29.10°C with the maximum in May 15 and minimum in March 15. In ES also temperature variation was within 31.70-28.8°C with highest value in May 15 and the lowest in March 1 (Figs. 2, 3, 4).

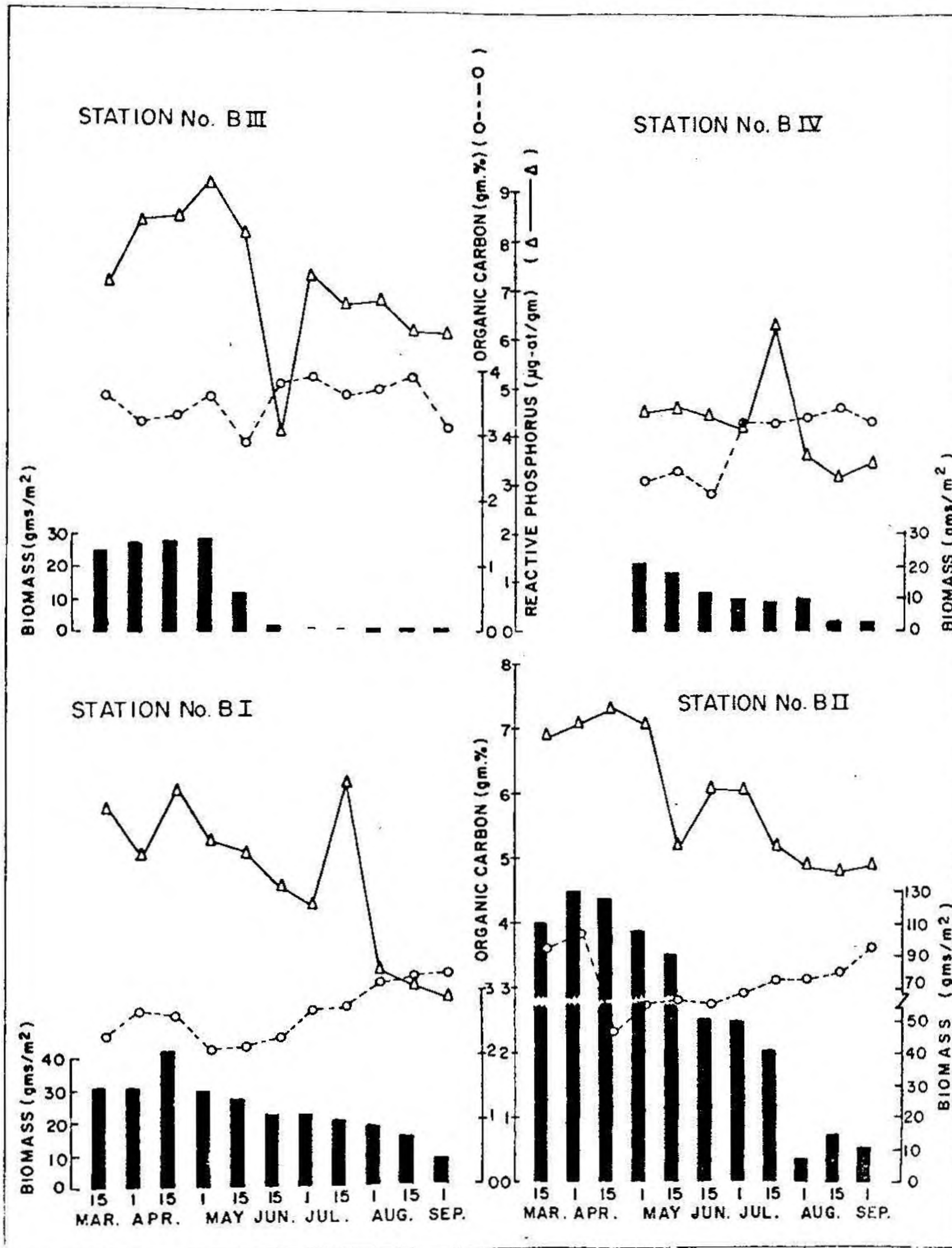
Dissolved oxygen: Observations on the dissolved oxygen content in culture fields and backwaters showed comparatively low values during premonsoon and with the onset of monsoon there was a general increase. In B I dissolved oxygen fluctuated between 1.57-3.78 ml/L during June 15 and September 1 respectively. In B II the lowest value was recorded in August 15 and July 15 and maximum in July 1 (3.41 ml/L). In B III dissolved oxygen concentration ranged from 1.49 ml/L in August 15 to 4.10 ml/L in July 1. In B IV it varied from 2.67 in July 1 to 4.37 ml/L in July 15. In B V the highest value was noticed in July 1 (3.41 ml/L) and the lowest of 1.38 ml/L in September 1. The dissolved oxygen content of NP ranged from 2.10 ml/L in April 1 to 4.90 ml/L in September 1. In EP the fluctuation was wide from 1.90 ml/L to 7.04 ml/L in March 15 and August 15 respectively. Amongst the 'Pokkali' fields, station NS showed dissolved oxygen values between 1.20-2.902 ml/L with minimum in May 1 and maximum in April 1. In ES the minimum value (1.12 ml/L) was recorded in May 1 and maximum of 2.30 ml/L was observed in May 15. Thus the perennial culture fields showed more dissolved oxygen content compared to other ecosystem studied. (Figs. 2, 3, 4).

pH: In the backwaters pH remained low during premonsoon, but with the onset of monsoon pH values registered an increasing trend. In B I pH was between 7.20-8.30, during May 15 and September 1 respectively. In B II the variation was from 7.20 in May 1 to 8.20 in August 1 and September 1. In B III pH values ranged from 6.9 in March 15 to 8.20 in September 1. In B IV, the peak value (8.20) was observed in July 1 and a minimum of 7.5 was recorded in August 15. In B V pH was within the range of 7.12 to 8.35, the minimum being in June 15 and maximum in July 15. In the culture fields, the peak values of pH recorded were much more than that in backwater stations. In EP the maximum value of pH (9.20) was observed in the August 15 and the minimum (7.40) in April 1. In NP pH fluctuated between 7.60-8.80, in April 1 and August 1 respectively. The values ranged from 7.20 to 8.15 in NS the minimum was in March 15 and maximum in May 1. In ES the pH fluctuation was between 7.60 in March 15 and April 15 to 8.05 in May 1 (Figs. 2, 3, 4).

SEDIMENTOLOGICAL PARAMETERS:

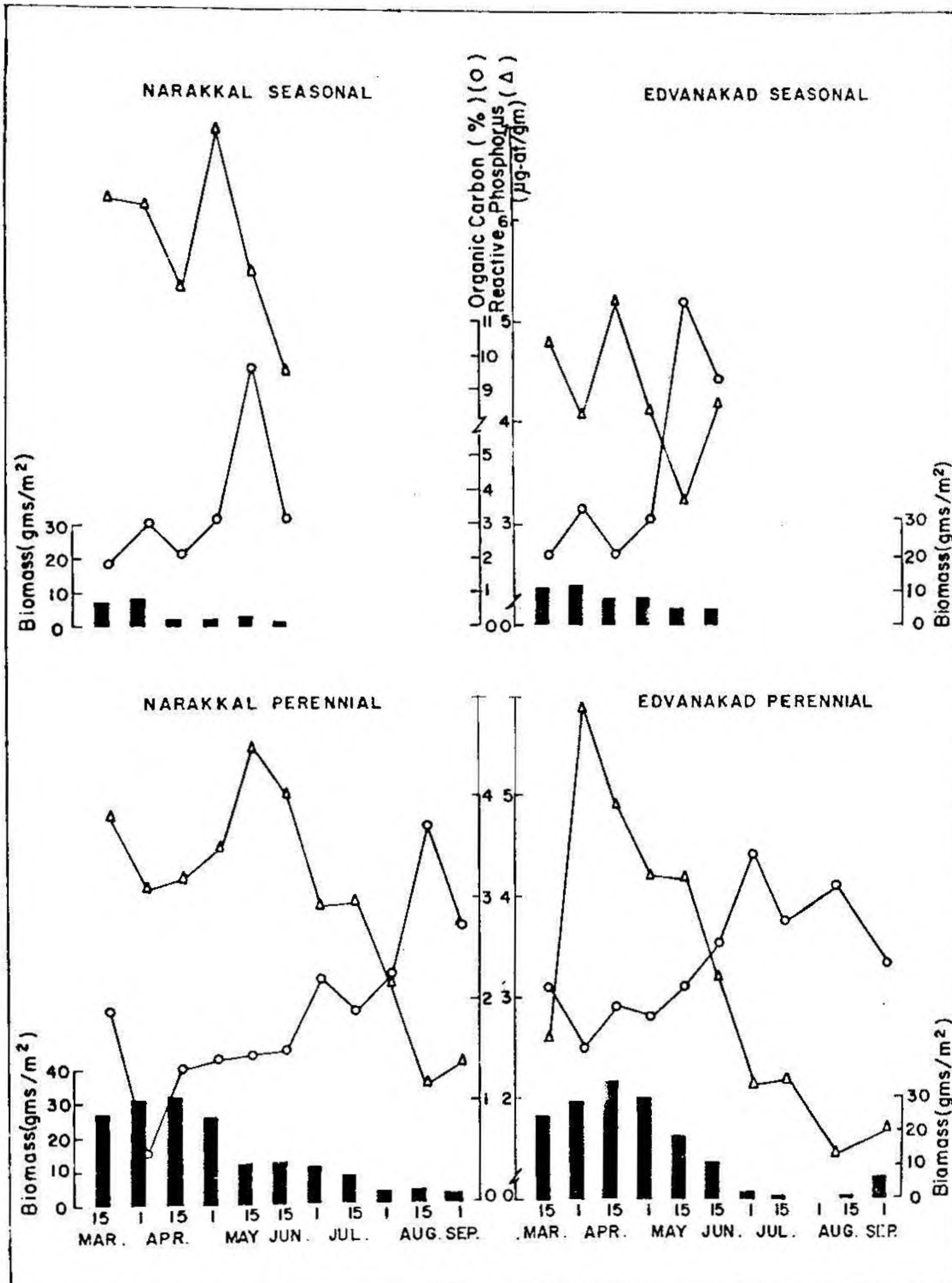
<u>Organic Carbon</u>: Analysis of organic carbon in the sediment showed relatively low values during premonsoon, but with the onset of monsoon the percentage composition of organic carbon registered an increasing trend. In B I organic carbon content fluctuated between 2.1-3.23 % with minimum in May 1 and maximum in September 1. In B II the values ranged from 2.31 % in April 15 to 3.81 % in April 1. In B III its percentage ranged between 2.91-4.96, the minimum being in May 15 and maximum in July 1. In B IV the range was from 2.13 % in July 1 to 3.40 % in August 15. Station B V, predominantly with a sandy substratum, showed less percentage of organic carbon. The maximum of 1.73 % was in August 1 and minimum being in March 15. In culture fields, the organic carbon

Fig. 5. Seasonal variations of organic carbon, mud reactive phosphate in relation to biomass (wet weight in gms/m^2) in backwater stations B I, B II, B III and B IV.



STATION No. B III
STATION No. B IV
STATION No. B I
STATION No. B II
ORGANIC CARBON (gm.%) (O---O)
REACTIVE PHOSPHORUS (µg-at/gm) (Δ——Δ)
ORGANIC CARBON (gm.%)
BIOMASS (gms/m²)
15 1 15 1 15 15 1 15 1 15 1
MAR. APR. MAY JUN. JUL. AUG. SEP.

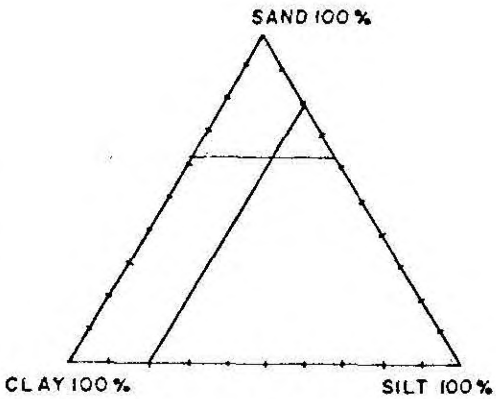
Fig. 6. Seasonal variation of organic carbon, mud reactive phosphate in relation to biomass (wet weight in gms/m^2) in stations N P, E P, N S and E S.


NARAKKAL SEASONAL
EDVANAKAD SEASONAL
NARAKKAL PERENNIAL
EDVANAKAD PERENNIAL
Organic Carbon (%) (O)
Reactive Phosphorus (Δ)
(µg-at/gm)
Biomass (gms/m²)
MAR. APR. MAY JUN. JUL. AUG. SEP.

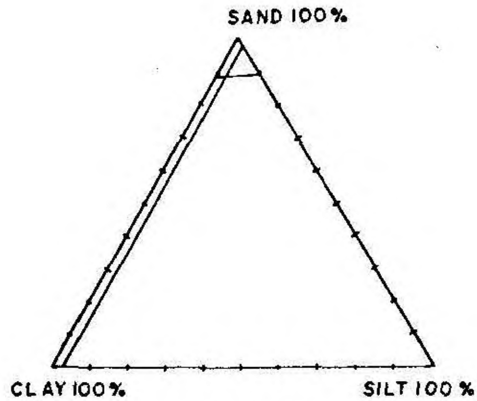
content followed the same trend as was observed in backwater stations. The organic carbon content ranged from 0.50-3.74 % in April 1 and August 15 respectively at station NP. In EP it fluctuated between 1.56 % in April to 3.61 % in July 1. The range of organic carbon content was from 1.8-9.5 % the minimum was recorded in March 15 and maximum in May 15 at NS. Similarly in ES, its fluctuation was very high and ranged from 2.10 % in April 15 to 11.56 % in May 15 (Figs. 3, 5, 6).

Reactive Phosphorus: In general during the premonsoon period, the reactive phosphorus was more or less uniform and with the onset of monsoon, it registered a declining trend. In B I the fluctuation of reactive phosphorus was between 2.96 µg-at./gm in September 1 to 6.23 µg-at/gm in July. In B II it ranged from 4.9 µg-at/gm in September to 7.34 µg-at/gm in April 15. The reactive phosphorus content varied from 4.12-9.12 µg-at/gm, the maximum being in May 1 and minimum in July 15 in station B III. In B IV the values fluctuated between 3.24-6.31 µg-at/gm with the maximum in July 15 and minimum in August 15. In B V reactive mud phosphate fluctuated between 2.01-3.30 µg-at./gm being minimum in August 15 and maximum in April 1. In NP, the reactive phosphorus content fluctuated between 2.2 µg-at./gm in August 15 to 5.30 µg-at/gm in May 15. Its range was from 0.50-5.92 µg-at/gm, with the highest value in April 1 and lowest in August 15 at station EP. In NS the variation was low and ranged between 4.5-6.67 µg-at./gm, the minimum being in June 15 and maximum in May 1. In ES the value was from 3.2 µg-at./gm in May 15 to 5.2 µg-at./gm in April 15 (Figs.3, 5, 6).

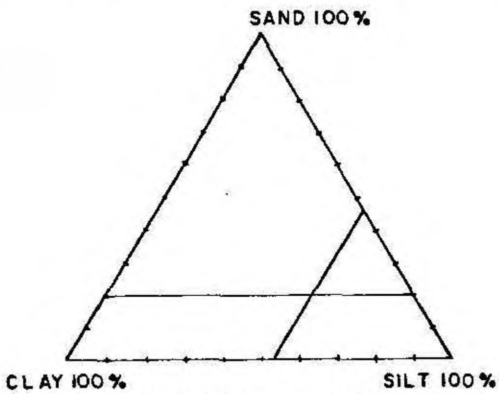
Fig. 7. Triangular diagram representing sediment zones in backwater stations B I, B II, B III, B IV and B V.



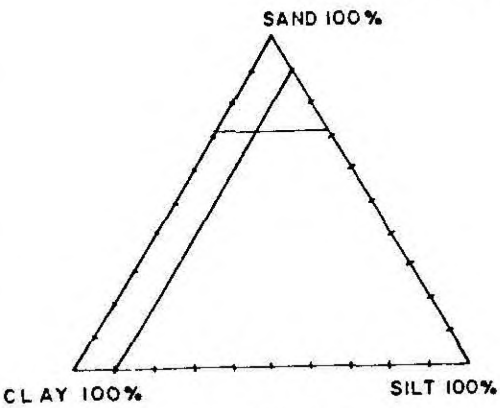
STATION No. B IV



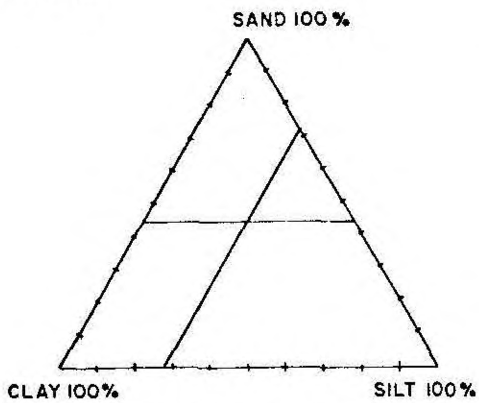
STATION No. B V



STATION No. B III



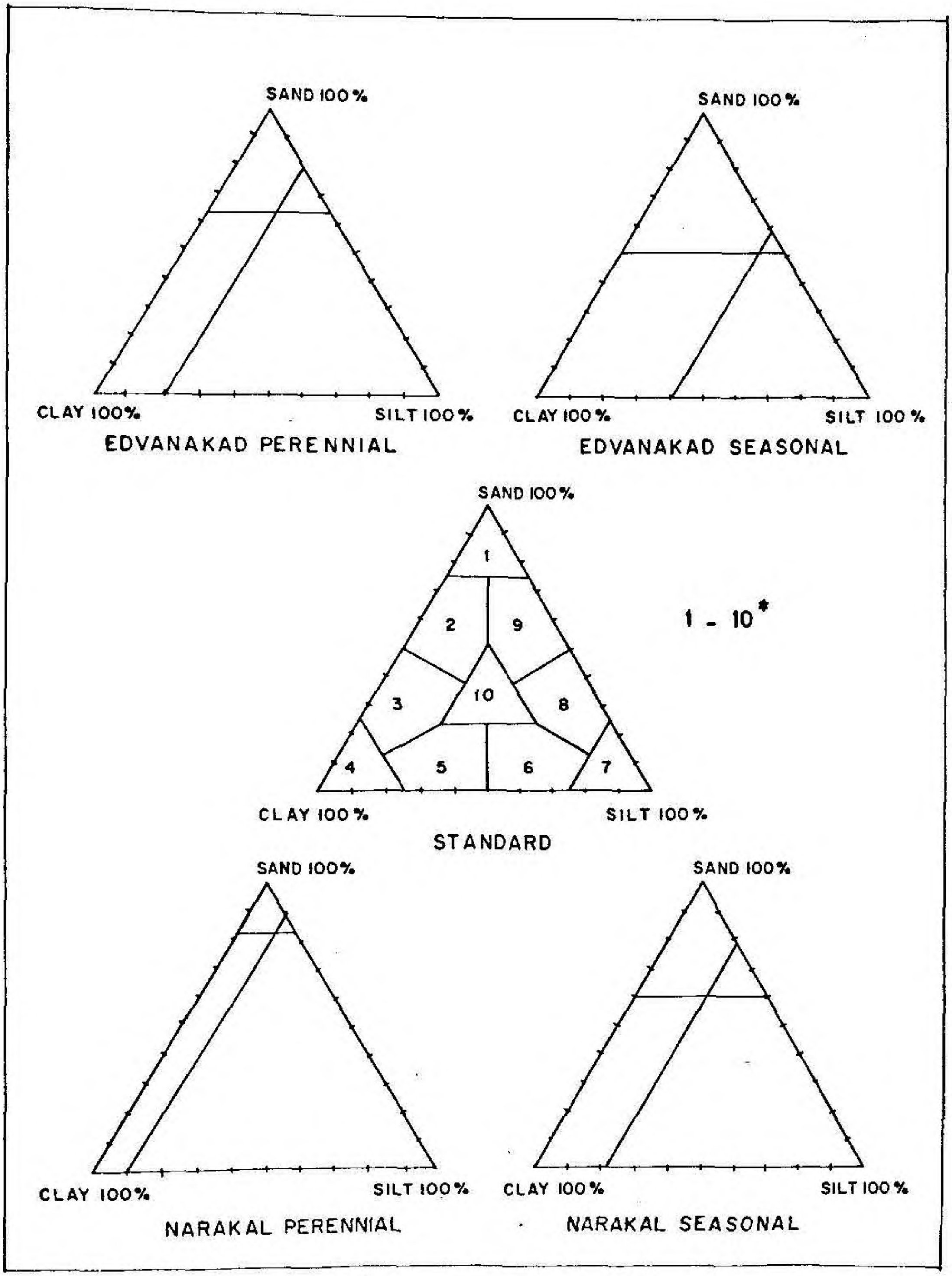
STATION No. B I



STATION No. B II

Fig. 8. Triangular diagrams representing sediment zones in culture ponds, N P, E P, N S and E S.

1 - Sandy	6 - Clayey silt
2 - Clayey sand	7 - Silty
3 - Sandy clay	8 - Sandy-silt
4 - Clayey	9 - Silty sand
5 - Silty clay	10 - Sand-silt and clay


SAND 100%
CLAY 100%
SILT 100%
EDVANAKAD PERENNIAL
SAND 100%
CLAY 100%
SILT 100%
EDVANAKAD SEASONAL
SAND 100%
1
2
9
3
10
8
4
5
6
7
CLAY 100%
SILT 100%
STANDARD
1 - 10*
SAND 100%
CLAY 100%
SILT 100%
NARAKAL PERENNIAL
SAND 100%
CLAY 100%
SILT 100%
NARAKAL SEASONAL

<u>Grain size</u>: The sediment of B I was of clayey sand type with 71.75 % of sand, 10.20 % of silt and 18.05 % of clay. In B II the sediment was sand-silt and clay type, with 43.3 % of sand and almost equal proportions of silt and clay. The nature of sediment in station B III was clayey silt type, with 20.31 % of sand, 54 % silt and 25.7 % of clay. In B IV, sediment was of silty-sand type, with 61.35 % of sand, 20 % of silt and 17.65 % of clay. The dominent component of sediment in B V was sand (88.20 %) and the percentage of silt and clay being 10 and 1.79 respectively (Fig.7).

The major component of sediment in pond NP was sand (82.82 %) with 10 % of silt and 7.18 % of clay. In EP the sediment was of silty sand type, composed of sand (63.05 %), silt (20 %) and clay (16.94 %). The sediment of Pokkali fields was silty sand type with 60 % sand and 22 % of silt. The sediment of ES was constituted by 51 % of sand and 41.5 % of silt (Fig. 8).

BOTTOM FAUNA

a) <u>Polychaete</u>: During the short period of investigation, seventeen species of polychaetes belonging to twelve genera were collected. The species composition of polychaetes in backwaters and culture fields showed marked differences. In station B I species such as <u>Ancistrosyllis constricta</u> and <u>Diopatra neopolitana</u> were present throughout the period of investigation, though their population registered a declining trend with the onset of monsoon. Dendronereis aestuarina was recorded only from June 15 to August 15. Lumbriconereis latreilli was present in the premonsoon but they disappeared during monsoon. Species such as Glycera sp., Paraheteromastus tenuis, Nereis sp., N.unifasciata, Prinospio pinnata, Perinereis cavifrons and Nepthys sp. were rarely recorded from this station. From B II A.constricta, Diopatra neopolitana and Lumbriconereis sp. were collected throughout the period of study. However, with the onset of monsoon their population density declined gradually. N.unifasciata, N.cavifrons and Nereis sp. were present only during premonsoon months of April-May. Perinereis cavifrons and Paraheteromastus tenuis formed the less common members in the list. Polychaetes were represented by a narrow spectrum of species in B III station. Diopatra neopolitana was recorded throughout the period of investigation except in June 15. Other species of rare occurrence were Lumbriconereis latreilli, L.simplex, Heteromastidus bifidus, N.unifasciata, Nereis sp. and Prionospio sp. In B IV mainly three species such as Dendronereis aestuarina, N.cavifrons and Prionospio pinnata constituted the polychaete population. Diopatra neopolitana and Heteromastidus bifidus were recorded only rarely. In station B V the polychaete population was represented mainly by D.aestuarina, Nereis. chilkensis. Other species of rare occurrence from this station were Perinereis cavifrons, Prionospio pinnata, Notopygos sp. and Paraheteromastus tenuis. The polychaete species spectrum in the culture fields was narrow compared to the backwater stations. In pond NP polychaetes were represented by Dendronereis aestuarina and Notopygos sp. In EP, a traditional culture field, the variety of species recorded were more than in NP (Experimental farm). Dendronereis aestuarina, Perinereis cavifrons, Prionospio pinnata were the main species recorded from EP. Rarely Notopygos sp. was also encountered in the sample. There was a wide variety of polychaetes such as D.aestuarina, Heteromastidus bifidus, N.cavifrons, N. chilkensis, Perinereis cavifrons constituted the bottom fauna of pokkali fields, ES. On the other hand, polychaete population was not recorded from NS during the course of this investigation.

b) Crustaceans: The species composition of crustaceans in the backwater stations were rich and varied. In general, the crustacean population registered an increasing trend upto June 15, and there after it declined. Dominant species recorded from station B I were Alpheus paludicola, Grandidierella gilesi. Apseudeus chilkensis, A.gymnophobia, Synidotea variegata and Cirolana fluviatilis showed patchy distribution. Young ones of Penaeus indicus, Metapenaeus dobsoni, M.monoceros and M. affinis were recorded from this station. The major species encountered in station B II were Cirolana fluviatilis, G. gilesi. Apseudeus gymnophobia and A.chilkensis. Alpheus malabaricus, A.paludicola and Synidotea variegata showed irregular distribution. Seeds of M.monoceros were present throughout the period of study. M.dobsoni and P.indicus occurred during premonsoon and monsoon seasons respectively. The major species from B III was A.gymnophobia but the isopod, Cirolana fluviatilis showed irregular distribution. from station B IV mainly two species of crustaceans like A. chilkensis and A.gymnophobia were collected. Isopods of the species Synidotea variegata was found only in August. The prawn seeds of P.indicus, M.dobsoni, M.monoceros and M.affinis were observed during monsoon period. In station B V tanids like A.gymnophobia and A.chilkensis constituted the crustacean population Grandidierella gilesi, an amphipod, was also recorded in the premonsoon months. From June 15 onwards Milita sp. also occurred in this station. Penaeid prawn seeds like P.indicus, M.dobsoni and M.monoceros had a sparse distribution. Only very few species of crustaceans were recorded from the culture fields both perennial and seasonal compared to backwater stations. In pond NP, crustacean population was constituted by Tanids like A. chilkensis and A.gymnophobia and amphipod, Melita sp. The amphipod, Grandidierella gilesi recorded from the adjacent backwaters was totally absent in NP. The pond NP being an experimental culture field, presence of penaeid prawn seeds of P.indicus, M.dobsoni and M.monoceros was natural. In the pond EP, A.chilkensis and A.gymnophobia were common except during July 1 and August 1. In pokkali fields ES crustacean constituted by A.chilkensis and A.gymnophobia. In the 'pokkali' field NS, during the period of investigation, crustacean were not encountered.

Table 1 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 2nd fortnight of March, 1987.

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
POLYCHAETES								
1. Ancistrosyllis constricta	20	2	-	-	-	-	-	-
2. Dendronereis aestuarina	-	-	-	150	24	45	-	8
3. Diopatra neapolitana	10	90	270	-	-	-	-	-
4. Lumbriconereis latreilli	3	40	27	-	-	-	-	-
5. Lumbriconereis simplex	-	-	-	-	-	-	-	-
6. Glycera sp.	5	-	-	-	-	-	-	-
7. Heteromastidus bifidus	2	-	-	-	-	-	-	-
8. Nereis unifasciata	3	-	15	-	-	-	-	17
9. Nereis cavifrons	-	-	-	-	-	-	-	-
10. Nereis sp.	5	-	10	-	-	-	-	-
11. Nereis chilkensis	-	-	-	-	-	-	-	13
12. Nephthys sp.	-	-	-	-	-	-	-	-
13. Perinereis cavifrons	6	-	-	-	-	145	-	2
14. Prionospio polybranchiata	-	-	-	-	-	-	-	-
15. Prionospio pinnata	-	-	25	25	-	170	-	-
16. Paraheteromastus tenuis	-	-	-	-	-	-	-	-
17. Notopygos sp.	-	-	-	36	112	-	-	-
TOTAL	54	132	347	211	136	360	-	40

Table 1 contd. 1

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
CRUSTACEANS								
1. *Alpheus malabaricus*	-	5	-	-	-	-	-	-
2. *Alpheus paludicola*	-	5	-	-	-	-	-	-
3. *Apseudeus chilkensis*	5	5	2	89	56	402	-	13
4. *Apseudeus gymnophobia*	-	-	-	52	12	202	-	12
5. *Corophium triaenonyx*	-	-	-	-	-	-	-	-
6. *Cirolana fluviatilis*	-	5	15	-	-	-	-	-
7. *Grandidierella gilesi*	-	3	-	-	-	-	-	-
8. *Synidotea variegata*	5	-	32	-	-	-	-	-
9. *Scylla serrata*	2	1	-	-	-	-	-	-
10. *Penaeus indicus*	-	2	-	-	-	-	-	3
11. *Metapenaeus dobsoni*	-	1	-	-	6	-	-	-
12. *M.monoceros*	-	-	-	-	-	-	-	-
13. *M.affinis*	-	-	-	-	-	-	-	-
14. *Melita* sp.	-	-	-	-	6	-	-	-
15. Squilla	1	-	-	-	-	-	-	-
TOTAL	13	27	49	141	80	604	-	28

Table 1 contd. 2

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
MOLLUSCS								
1. *Pandora* sp.	-	2	-	18	6	356	-	12
2. *Modiolus undulatus*	85	1879	5	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-
4. Gastropods	25	4	-	15	5	-	20	18
5. *Meretrix casta*	-	-	-	-	-	-	-	-
6. *Paphia* sp.	3	-	-	-	-	-	-	-
TOTAL	113	1885	5	33	11	356	20	30
PISCES AND OTHERS								
1. *Cynoglossus* sp.	1	-	-	-	-	-	-	-
2. *Anguilla* sp.	2	-	-	-	-	-	-	-
3. Gobids	2	-	-	2	2	-	-	-
4. *Nematodes*	15	25	12	17	60	-	25	25
5. Sea anemone	-	-	2	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-	-
7. Star fishes	2	-	4	-	-	-	-	-
TOTAL	22	25	18	19	62	25	25	25
Total population per 0.1 m^2 area	202	2069	419	404	289	1345	45	123

Table 2 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 1st fortnight of April, 1987.

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
POLYCHAETES								
1. *Ancistrosyllis constricta*	32	1	-	-	-	-	-	-
2. *Dendronereis aestuarina*	-	-	-	260	30	76	-	10
3. *Diopatra neapolitana*	15	112	320	-	-	-	-	-
4. *Lumbriconereis latreilli*	2	32	25	-	-	-	-	-
5. *Lumbriconereis simplex*	-	-	-	-	-	-	-	
6. *Glycera* sp.	2	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	-	-	-	-	-	-	-	-
8. *Nereis unifasciata*	-	-	7	-	-	-	-	28
9. *Nereis cavifrons*	5	-	-	-	-	-	-	-
10. *Nereis* sp.	-	-	-	-	-	-	-	-
11. *Nereis chilkensis*	-	-	-	25	-	-	-	-
12. *Nephthys* sp.	6	-	-	-	-	-	-	-
13. *Perinereis cavifrons*	-	-	-	-	-	15	-	26
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-	-
15. *Prionospio pinnata*	-	-	25	-	-	30	-	-
16. *Paraheteromastus tenuis*	-	-	-	-	-	-	-	-
17. *Notopygos* sp.	-	-	-	-	140	-	-	-
TOTAL	62	145	377	285	170	121	-	63

Table 2 contd. 1

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
<u>CRUSTACEANS</u>								
1. <u>Alpheus malabaricus</u>	-	-	-	-	-	-	-	-
2. <u>Alpheus paludicola</u>	-	-	-	-	-	-	-	-
3. <u>Apseudeus chilkensis</u>	25	1	-	25	8	50	-	-
4. <u>Apseudeus gymnophobia</u>	-	-	-	2	2	200	-	25
5. <u>Corophium triaenonyx</u>	-	22	10	-	-	-	-	-
6. <u>Cirolana fluviatilis</u>	12	22	-	5	-	-	-	-
7. <u>Grandidierella gilesi</u>	2	-	12	-	-	-	-	-
8. <u>Synidotea variegata</u>	-	-	-	-	-	-	-	-
9. <u>Scylla serrata</u>	-	-	-	-	-	-	-	-
10. <u>Penaeus indicus</u>	-	2	-	-	2	-	-	3
11. <u>M.dobsoni</u>	-	1	-	-	16	-	-	-
12. <u>M.monoceros</u>	-	-	-	-	-	-	-	-
13. <u>M.affinis</u>	-	-	-	-	-	-	-	-
14. <u>Melita</u> sp.	-	-	-	-	-	-	-	-
15. Squilla	-	1	-	-	-	-	-	-
TOTAL	42	50	22	32	28	250	-	41

Table 2 contd. 2

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
<u>MOLLUSCS</u>								
1. *Pandora* sp.	-	-	-	18	16	400	-	29
2. *Modiolus undulatus*	102	2056	3	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-
4. Gastropods	25	2	-	25	6	-	108	16
5. *Meretrix casto*	-	-	-	-	-	-	-	-
6. *Paphia* sp.	4	-	-	-	-	-	-	-
TOTAL	131	2058	3	43	22	400	108	45
<u>PISCES AND OTHERS</u>								
1. *Cynoglossus* sp.	2	-	-	-	-	-	-	-
2. *Anguilla* sp.	-	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	2	-	102	2
4. *Nematodes*	20	25	16	18	14	-	-	14
5. Sea anemone	5	-	4	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-	-
7. Star fishes	1	-	8	-	-	-	-	-
TOTAL	28	25	28	18	16	-	102	16
Total population per 0.1 m^2 area	263	2278	430	378	236	771	210	165

Table 3 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different Stations during 2nd fortnight of APR., 1987

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
POLYCHAETES								
1. *Ancistrosyllis constricta*	20	2	-	-	-	-	-	-
2. *Dendronereis aestuarina*	-	-	-	182	140	51	-	8
3. *Diopatra neapolitana*	12	120	190	-	-	-	-	-
4. *Lumbriconereis latreilli*	1	-	-	-	-	-	-	-
5. *Lumbriconereis simplex*	-	2	25	-	-	-	-	-
6. *Glycera* sp.	-	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	-	-	-	-	-	-	-	29
8. *Nereis unifasciata*	-	3	-	-	-	-	-	-
9. *Nereis cavifrons*	-	5	-	-	-	-	-	-
10. *Nereis* sp.	-	5	-	-	-	-	-	-
11. *Nereis chilkensis*	-	-	-	12	-	-	-	15
12. *Nephthys* sp.	-	-	-	-	-	-	-	-
13. *Perinereis cavifrons*	-	7	-	-	-	-	-	-
14. *Prionospio polybranchiata*	2	-	-	-	-	150	-	-
15. *Prionospio pinnata*	-	-	-	-	-	-	-	-
16. *Paraheteromastus tenuis*	-	-	12	-	-	287	-	-
17. *Notopygos* sp.	-	-	-	-	-	-	-	-
TOTAL	35	144	227	194	140	488	-	52

Table 3 contd. 1

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
<u>CRUSTACEANS</u>								
1. <u>Alpheus malabaricus</u>	-	-	-	-	-	-	-	-
2. <u>Alpheus paludicola</u>	-	15	-	-	-	-	-	-
3. <u>Apseudeus chilkensis</u>	220	-	-	14	26	525	-	12
4. <u>Apseudeus gymnophobia</u>	-	1100	15	22	16	1863	-	16
5. <u>Corophium triaenonyx</u>	-	-	-	-	-	-	-	-
6. <u>Cirolana fluviatilis</u>	-	648	10	-	-	-	-	-
7. <u>Grandidierella gilesi</u>	13	9	-	5	-	-	-	-
8. <u>Synidotea variegata</u>	5	6	20	-	-	-	-	-
9. <u>Scylla serrata</u>	6	-	-	-	-	-	-	-
10. <u>Penaeus indicus</u>	-	-	-	-	-	-	-	-
11. <u>Metapenaeus dobsoni</u>	-	2	-	-	-	-	-	-
12. <u>M.monoceros</u>	-	1	-	-	-	-	-	-
13. <u>M.affinis</u>	-	-	-	-	-	-	-	-
14. <u>Melita</u> sp.	-	-	-	-	-	-	-	-
15. Squilla	-	-	-	-	-	-	-	2
TOTAL	244	1784	45	41	42	2388		30

Table 3 contd. 2

Name of species/Group	STATIONS							
	B I	B II	B III	B V	NP	EP	NS	ES
MOLLUSCS								
1. *Pandora* sp.	5	2	-	25	-	435	-	-
2. *Modiolus undulatus*	250	2500	-	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-
4. Gastropods	29	16	-	32	-	-	62	-
5. *Meretrix casta*	-	-	-		-	-	-	-
6. *Paphia* sp.	4	-	-	-	-	-	-	-
TOTAL	288	2518	-	57	-	435	62	-
PISCES AND OTHERS								
1. *Cynoglossus* sp.	1	-	-	-	-	-	-	-
2. *Anguilla* sp.	2	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-	1
4. Nematodes	15	22	14	22	-	-	-	6
5. Sea anemone	3	-	2	-	-	-	62	-
6. Sipunculoidea	-	-	-	-	-	-	-	-
7. Star fishes	2	-	7	-	-	-	-	-
TOTAL	23	22	23	22	-	-	62	7
Total population per 0.1 m^2 area	590	4468	295	314	182	3311	124	89

Table 4 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 1st fortnight of May, 1987.

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
POLYCHAETES									
1. *Ancistrosyllis constricta*	10	1	-	-	-	-	-	-	-
2. *Dendronereis aestuarina*	-	-	-	3	152	20	24	-	3
3. *Diopatra neapolitana*	6	60	102	-	-	-	-	-	-
4. *Lumbriconereis latreilli*	1	-	-	-	-	-	-	-	-
5. *Lumbriconereis simplex*	-	1	12	-	-	-	-	-	-
6. *Glycera* sp.	-	-	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	-	-	-	-	-	-	-	-	25
8. *Nereis unifasciata*	-	1	-	-	-	-	-	-	-
9. *Nereis cavifrons*	-	2	-	5	-	-	-	-	-
10. *Nereis* sp.	-	8	-	-	-	-	-	-	-
11. *Nereis chilkensis*	-	-	-	-	-	-	-	-	-
12. *Nephthys* sp.	-	-	-	-	15	-	-	-	-
13. *Perinereis cavifrons*	-	-	-	-	-	-	10	-	11
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-	-	-
15. *Prionospio pinnata*	2	-	-	103	-	-	15	-	-
16. *Paraheteromastus tenuis*	-	-	-	-	-	-	-	-	-
17. *Notopygos* sp.	-	-	-	-	-	6	-	-	-
TOTAL	19	73	114	111	167	26	49	-	39

Table 4 contd. 1

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
CRUSTACEANS									
1. *Alpheus malabaricus*	-	-	-	-	-	-	-	-	-
2. *Alpheus paludicola*	-	14	-	-	-	-	-	-	-
3. *Apseudeus chilkensis*	222	-	1	32	21	20	50	-	-
4. *Apseudeus gymnophobia*	-	500	26	61	16	1	200	-	-
5. *Corophium triaenonyx*	-	-	-	-	-	-	-	-	-
6. *Cirolana fluviatilis*	-	525	5	-	-	-	-	-	-
7. *Grandidierella gilesi*	25	2	-	-	10	-	-	-	-
8. *Synidotea variegata*	7	6	-	-	-	-	-	-	-
9. *Scylla serrata*	-	-	-	-	-	-	-	-	-
10. *Penaeus indicus*	-	2	-	-	-	-	-	-	-
11. *Metapenaeus dobsoni*	-	1	-	-	-	-	-	-	-
12. *M. monoceros*	-	-	-	-	-	-	-	-	-
13. *M. affinis*	-	-	-	-	-	-	-	-	-
14. *Melita* sp.	-	-	-	-	-	1	-	-	-
15. Squilla	-	-	-	-	-	+	-	-	-
TOTAL	254	1050	32	93	47	22	250	-	2

Table 4 contd. 2

Name of species/Group	STATIONS								
	B I	BII	BIII	B IV	B V	NP	EP	NS	ES
MOLLUSCS									
1. *Pandora* sp.	12	3	-	-	4	2	-	6	5
2. *Modiolus undulatus*	278	1025	-	-	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-	-
4. Gastropods	24	4	-	2	7	2	-	16	12
5. *Meretrix casta*	7	-	-	-	-	-	-	-	-
6. *Paphia* sp.	-	-	-	-	-	-	-	-	-
TOTAL	321	1034	-	2	11	4	-	22	17
PISCES AND OTHERS									
1. *Cynoglossus* sp.	1	-	-	-	-	-	-	-	-
2. *Anguilla* sp.	2	-	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-	-	-
4. Nematodes	10	22	25	25	18	13	-	24	3
5. Sea anemone	-	-	-	-	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-	-	-
7. Star fishes	-	-	-	-	-	-	-	-	-
TOTAL	13	22	25	25	18	13	-	24	3
Total population per 0.1 m^2 area	607	2180	171	231	243	65	299	46	61

Table 5 : Nemerical abundance of different species of macrobenthos per 0.1 m^2 area at different Stations during 2nd fortnight of May, 1987.

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
POLYCHAETES									
1. *Ancistrosyllis constricta*	8	1	-	-	-	-	-	-	-
2. *Dendronereis aestuarina*	-	-	-	1	50	12	3	-	3
3. *Diopatra neapolitana*	3	49	52	-	-	-	-	-	-
4. *Lumbriconereis latreilli*	1	7	-	-	-	-	-	-	-
5. *Lumbriconereis simplex*	-	2	11	-	-	-	-	-	-
6. *Glycera* sp.	-	-	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	-	-	-	-	-	-	-	-	24
8. *Nereis unifasciata*	-	-	-	-	-	-	-	-	-
9. *Nereis cavifrons*	-	-	-	1	-	-	-	-	-
10. *Nereis* sp.	-	-	-	-	-	-	-	-	-
11. *Nereis chilkensis*	-	1	-	-	-	-	-	-	-
12. *Nephthys* sp.	-	-	-	-	7	-	-	-	-
13. *Perinereis cavifrons*	-	-	-	-	-	-	13	-	-
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-	-	-
15. *Prionospio pinnata*	-	-	-	71	-	-	15	-	-
16. *Paraheteromastus tenuis*	-	-	-	-	-	-	-	-	-
17. *Notopyges* sp.	5	-	-	-	-	4	1	-	-
TOTAL	17	60	63	73	57	16	32	-	27

Table 5 contd. 1

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
CRUSTACEANS									
1. Alpheus malabaricus	-	-	-	-	-	-	-	-	-
2. Alpheus paludicola	-	17	-	-	-	-	-	-	-
3. Apseudeus chilkensis	287	-	2	42	31	34	4	-	-
4. Apseudeus gymnophobia	-	1560	32	91	17	6	105	-	-
5. Corophium triaenonyx	-	-	-	-	-	-	-	-	-
6. Cirolana fluviatilis	-	102	4	-	-	-	-	-	-
7. Grandidierella gilesi	81	1	-	-	21	-	-	-	-
8. Synidotea variegata	-	8	-	-	-	-	-	-	-
9. Scylla serrata	-	-	-	-	-	-	-	-	-
10. Penaeus indicus	-	-	-	-	-	02	-	-	-
11. Metapenaeus dobsoni	-	2	-	-	-	06	-	-	-
12. M.monoceros	-	-	-	-	-	-	-	-	-
13. M.affinis	-	-	-	-	-	-	-	-	-
14. Melita sp.	-	-	-	-	-	-	-	-	-
15. Squilla	-	1	-	-	-	-	-	-	-
TOTAL	368	1691	38	133	69	48	109	-	-

Table 5 contd. 2

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
MOLLUSCS									
1. *Pandora* sp.	2	2	-	-	14	2	10	6	4
2. *Modiolus undulatus*	181	102	-	-	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-	-
4. Gastropods	-	-	-	-	3	4	10	16	8
5. *Meretrix casta*	18	-	-	-	-	-	-	-	-
6. *Paphia* sp.	4	-	-	-	-	-	-	-	-
TOTAL	205	104	-	-	17	6	20	22	12
PISCES AND OTHERS									
1. *Cynoglossus* sp.	2	-	-	-	-	-	-	-	-
2. *Anguilla* sp.	3	-	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-	-	-
4. Nematodes	7	19	30	17	10	14	-	34	1
5. Sea anemone	-	-	-	-	-	-	-	-	4
6. Sipunculoidea	8	-	-	-	-	-	-	-	-
7. Star fishes	-	-	-	-	-	-	-	-	-
TOTAL	20	19	30	17	10	14	-	34	1
Total population per 0.1 m^2 area	610	1874	131	223	153	84	161	56	40

Table 6: Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations on 2nd fortnight of June 1987

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
POLYCHAETES									
1. *Ancistrosyllis constricta*	9	3	-	-	-	-	-	-	-
2. *Dendronereis aestuarina*	4	59	-	3	26	10	15	-	1
3. *Diopatra neapolitana*	-	1	-	-	-	-	-	-	-
4. *Lumbriconereis latreilli*	-	2	-	-	-	-	-	-	-
5. *Lumbriconereis simplex*	-	1	-	-	-	-	-	-	-
6. *Glycera* sp.	1	2	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	2	-	-	-	-	-	-	-	11
8. *Nereis unifasciata*	-	-	-	-	-	-	-	-	-
9. *Nereis cavifrons*	1	-	-	2	-	-	-	-	-
10. *Nereis* sp.	-	-	-	-	-	-	-	-	-
11. *Nereis chilkensis*	-	-	-	-	-	-	-	-	-
12. *Nephthys* sp.	-	-	-	-	06	-	-	-	-
13. *Perinercis cavifrons*	-	-	-	-	-	-	10	-	-
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-	-	-
15. *Prionospio pinnata*	-	-	-	35	-	-	13	-	-
16. *Paraheteromastus tenuis*	2	6	-	-	-	-	-	-	-
17. *Notopygos* sp.	-	-	-	-	-	4	-	-	-
TOTAL	19	74	-	40	32	14	38	-	12

Table 6 contd. 1

Name of species/Group	STATIONS								
	B I	BII	B III	B IV	B V	NP	EP	NS	ES
CRUSTACEANS									
1. Alpheus malabaricus	-	2	-	-	-	-	-	-	-
2. Alpheus paludicola	-	26	-	-	-	-	-	-	-
3. Apseudeus chilkensis	25	1150	-	25	25	60	39	-	-
4. Apseudeus gymnophobia	300	106	-	35	32	-	209	-	-
5. Corophium triaenonyx	-	-	-	-	-	-	-	-	-
6. Cirolana fluviatilis	-	12	-	-	-	-	-	-	-
7. Grandidierella gilesi	96	2	-	-	-	-	-	-	-
8. Synidotea variegata	-	13	-	-	-	-	-	-	-
9. Scylla serrata	2	-	-	-	-	-	-	-	-
10. Penaeus indicus	1	-	-	4	1	2	-	-	-
11. Metapenaeus dobsoni	2	-	-	1	2	2	-	-	-
12. M.monoceros	-	-	-	2	-	-	-	-	-
13. M.affinis	-	-	-	1	-	-	-	-	-
14. Melita sp.	-	-	-	-	38	26	-	-	-
15. Squilla	-	-	-	-	-	-	-	-	-
TOTAL	426	1311	-	68	98	90	248	-	-

Table 6 contd. 2

Name of species/Group	STATIONS								
	B I	B II	B III	B IV	B V	NP	EP	NS	ES
MOLLUSCS									
1. Pandora sp.	-	2	-	-	5	0	10	12	05
2. Modiolus undulatus	51	2	-	-	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-	-	-
4. Gastropods	2	2	-	5	2	4	10	3	6
5. Meretrix casta	2	-	-	-	-	-	-	-	-
6. Paphia sp.	2	-	-	-	-	-	-	-	-
TOTAL	57	6	-	5	7	4	20	15	11
PISCES AND OTHERS									
1. Cynoglossus sp.	3	-	-	-	-	-	-	-	-
2. Anguilla sp.	1	-	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	3	-	-	-	-
4. Nematodes	10	12	25	18	10	10	-	24	-
5. Sea anemone	-	-	-	-	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-	-	-
7. Star fishes	-	-	-	-	-	-	-	-	-
TOTAL	16	12	25	18	13	10	-	24	-
Total population per 0.1 m² area	518	1403	25	131	150	118	306	39	23

Table 7 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 1st fortnight of July, 1987

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
POLYCHAETES							
1. Ancistrosyllis constricta	2	02	-	-	-	-	-
2. Dendronereis aestuarina	8	-	-	1	12	6	0
3. Diopatra neapolitana	-	22	1	-	-	-	-
4. Lumbriconereis latreilli	-	7	-	-	-	-	-
5. Lumbriconereis simplex	-	8	-	-	-	-	-
6. Glycera sp.	-	3	-	-	-	-	-
7. Heteromastidus bifidus	-	-	-	-	-	-	-
8. Nereis unifasciata	-	-	-	-	-	-	-
9. Nereis cavifrons	-	-	-	4	-	-	-
10. Nereis sp.	-	-	-	-	-	-	-
11. Nereis chilkensis	-	-	-	-	-	-	-
12. Nephthys sp.	-	-	-	-	04	-	-
13. Perinereis cavifrons	-	-	-	-	-	-	10
14. Prionospio polybranchiata	-	-	-	-	-	-	-
15. Prionospio pinnata	-	-	-	19	-	-	-
16. Paraheteromastus tenuis	-	-	-	-	-	-	-
17. Notopygos sp.	-	-	-	-	-	40	-
TOTAL	10	42	1	24	16	46	10

Table 7 contd. 1

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
<u>CRUSTACEANS</u>							
1. <u>Alpheus malabaricus</u>	8	05	-	-	-	-	-
2. <u>Alpheus paludicola</u>	6	05	-	-	-	-	-
3. <u>Apseudeus chilkensis</u>	12	25	12	41	28	24	-
4. <u>Apseudeus gymnophobia</u>	9	50	13	16	29	02	-
5. <u>Corophium triaenonyx</u>	-	12	-	-	-	-	-
6. <u>Cirolana fluviatilis</u>	-	20	-	-	-	-	-
7. <u>Grandidierella gilesi</u>	102	3	-	-	-	-	-
8. <u>Synidotea variegata</u>	-	1	-	-	-	-	-
9. <u>Scylla serrata</u>	-	1	-	-	-	-	-
10. <u>Penaeus indicus</u>	1	-	-	-	-	2	-
11. <u>Metapenaeus dobsoni</u>	1	2	-	-	-	-	-
12. <u>M.monoceros</u>	-	-	-	1	-	-	-
13. <u>M.affinis</u>	-	-	-	1	-	-	-
14. <u>Melita</u> sp.	-	-	-	-	41	-	-
15. Squilla	-	-	-	-	-	-	-
TOTAL	137	124	25	59	98	28	-

Table 7 contd. 2

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
MOLLUSCS							
1. *Pandora* sp.	1	2	-	-	8	2	-
2. *Modiolus undulatus*	5	25	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-
4. Gastropods	-	2	2	1	1	34	400
5. *Meretrix casta*	-	-	-	-	-	-	-
6. *Paphia* sp.	1	2	-	-	-	-	-
TOTAL	7	31	2	1	9	36	400
PISCES AND OTHERS							
1. *Cynoglossus* sp.	4	1	-	-	0	-	-
2. *Anguilla* sp.	2	-	-	-	-	-	-
3. Gobids	-	-	-	-	3	-	-
4. Nematodes	15	12	27	28	10	10	-
5. Sea anemone	-	-	-	-	-	-	-
6. Sipunculoidea	1	-	-	-	-	-	-
7. Star fishes	2	1	-	-	-	-	-
TOTAL	24	14	27	28	13	10	-
Total population per 0.1 m^2 area	178	211	55	112	136	118	410

Table 8 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 2nd fortnight of July 1987

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
POLYCHAETES							
1. Ancistrosyllis constricta	2	-	-	-	-	-	-
2. Dendronereis aestuarina	4	-	-	-	16	-	2
3. Diopatra neapolitana	-	12	1	-	-	-	-
4. Lumbriconereis latreilli	-	15	-	-	-	-	-
5. Lumbriconereis simplex	-	7	-	-	-	-	-
6. Glycera sp.	1	2	-	-	-	-	-
7. Heteromastidus bifidus	-	1	-	-	-	-	-
8. Nereis unifasciata	1	-	-	-	-	-	-
9. Nereis cavifrons	-	-	-	-	-	-	-
10. Nereis sp.	-	-	-	1	-	-	-
11. Nereis chilkensis	-	-	-	-	-	-	-
12. Nephthys sp.	-	-	-	-	01	-	-
13. Perinereis cavifrons	-	-	-	-	-	-	-
14. Prionospio polybranchiata	-	-	-	-	-	-	-
15. Prionospio pinnata	-	-	-	-	-	-	-
16. Paraheteromastus tenuis	-	-	-	09	03	-	-
17. Notopygos sp.	-	-	-	-	-	20	-
TOTAL	8	37	1	10	20	20	2

Table 8 contd. 1

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
CRUSTACEANS							
1. *Alpheus malabaricus*	18	12	-	-	-	-	-
2. *Alpheus paludicola*	20	13	-	-	-	-	-
3. *Apseudeus chilkensis*	8	231	-	21	04	-	-
4. *Apseudeus gymnophobia*	29	234	8	04	16	20	-
5. *Corophium triaenonyx*	-	-	-	-	-	-	-
6. *Cirolana fluviatilis*	-	2	-	-	-	-	-
7. *Grandidierella gilesi*	109	1	-	-	-	-	-
8. *Synidotea variegata*	-	-	-	-	-	-	-
9. *Scylla serrata*	-	3	-	-	-	-	-
10. *Penaeus indicus*	-	-	-	1	-	2	-
11. *Metapenaeus dobsoni*	-	-	-	-	1	-	-
12. *M.monoceros*	-	-	-	3	-	-	-
13. *M.affinis*	-	-	-	1	-	-	-
14. *Melita* sp.	-	-	-	-	21	-	-
15. Squilla	-	-	-	-	-	-	-
TOTAL	184	496	8	30	42	22	-

Table 8 contd. 2

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
MOLLUSCS							
1. *Pandora* sp.	2	1	-	-	12	-	-
2. *Modiolus undulatus*	16	12	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-
4. Gastropods	61	-	-	2	-	34	102
5. *Meretrix casta*	-	1	-	~~2~~	-	~~34~~	~~102~~
6. *Paphia* sp.	1	-	-	-	-	-	-
TOTAL	80	14	-	2	12	34	102
PISCES AND OTHERS							
1. *Cynoglossus* sp.	1	-	-	-	-	-	-
2. *Anguilla* sp.	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-
4. Nematodes	15	23	14	21	-	12	-
5. Sea anemone	-	-	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-
7. Star fishes	2	2	-	-	-	-	-
TOTAL	18	25	14	21	-	12	-
Total population per 0.1 m^2 area	290	572	23	63	74	88	104

Table 9 : Numerical abundance of various species of macribenthos per 0.1 m^2 area at different stations during 2nd fortnight of July 1987

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
POLYCHAETES							
1. *Ancistrosyllis constricta*	3	1	-	-	-	-	-
2. *Dendronereis aestuarina*	2	-	-	-	9	20	-
3. *Diopatra neapolitana*	-	3	1	1	-	-	-
4. *Lumbriconereis latreilli*	-	4	-	-	-	-	-
5. *Lumbriconereis simplex*	-	6	-	-	-	-	-
6. *Glycera* sp.	-	1	-	-	-	-	-
7. *Heteromastidus bifidus*	-	2	1	-	-	-	-
8. *Nereis unifasciata*	-	-	-	-	-	-	-
9. *Nereis cavifrons*	-	-	-	2	-	-	-
10. *Nereis* sp.	-	-	-	-	-	-	-
11. *Nereis chilkensis*	-	-	-	-	-	-	-
12. *Nephthys* sp.	2	-	-	-	-	-	-
13. *Perinereis cavifrons*	-	-	-	-	-	-	-
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-
15. *Prionospio pinnata*	-	-	-	7	15	-	-
16. *Paraheteromastus tenuis*	-	-	-	-	7	-	-
17. *Notopygos* sp.	-	-	-	-	-	-	-
TOTAL	07	17	02	10	31	20	-

Table 9 contd. 1

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
<u>CRUSTACEANS</u>							
1. *Alpheus malabaricus*	12	2	-	-	-	-	-
2. *Alpheus paludicola*	8	18	-	-	-	-	-
3. *Apseudeus chilkensis*	-	163	-	31	8	-	-
4. *Apseudeus gymnophobia*	15	1038	15	12	85	-	-
5. *Corophium triaenonyx*	-	52	-	-	-	-	-
6. *Cirolana fluviatilis*	-	-	-	-	-	-	-
7. *Grandidierella gilesi*	161	3	-	-	-	-	-
8. *Synidotea variegata*	-	-	3	1	-	-	-
9. *Scylla serrata*	1	-	-	-	-	-	-
10. *Penaeus indicus*	-	2	-	-	1	-	-
11. *Metapenaeus dobsoni*	-	1	-	-	1	-	-
12. *M.monoceros*	-	6	-	6	-	-	-
13. *M.affinis*	-	-	-	2	-	-	-
14. *Melita* sp.	-	-	2	-	31	-	-
15. Squilla	1	-	-	-	-	-	-
TOTAL	198	1285	20	52	126	-	-

Table 9 contd. 2

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
MOLLUSCS							
1. *Pandora* sp.	0	1	-	-	22	14	-
2. *Modiolus undulatus*	-	-	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-
4. Gastropods	71	-	-	-	03	-	10
5. *Meretrix casta*	1	-	-	-	-	-	-
6. *Paphia* sp.	-	-	-	-	-	-	-
TOTAL	71	1	-	-	25	14	10
PISCES AND OTHERS							
1. *Cynoglossus* sp.	1	-	-	-	-	-	-
2. *Anguilla* sp.	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-
4. Nematodes	10	-	-	14	5	32	-
5. Sea anemone	-	-	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-
7. Star fishes	1	1	2	-	-	-	-
TOTAL	12	1	2	14	5	32	-
Total population per 0.1 m^2 area	397	1743	12	109	265	234	29

Table 10 : Numerical abundance of different species of macrobenthos per 0.1 m^2 area at different stations during 2nd fortnight of August, 1977.

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
<u>POLYCHAETES</u>							
1. <u>Ancistrosyllis constricta</u>	4	1	-	-	-	-	-
2. <u>Dendronereis aestuarina</u>	-	-	-	-	8	14	-
3. <u>Diopatra neapolitana</u>	8	25	2	3	-	-	-
4. <u>Lumbriconereis latreilli</u>	-	2	-	-	-	-	-
5. <u>Lumbriconereis simplex</u>	-	5	-	-	-	-	-
6. <u>Glycera</u> sp.	-	1	-	-	-	-	-
7. <u>Heteromastidus bifidus</u>	-	-	1	1	-	-	-
8. <u>Nereis unifasciata</u>	-	-	-	-	-	-	-
9. <u>Nereis cavifrons</u>	1	-	-	2	-	-	-
10. <u>Nereis</u> sp.	-	-	-	-	-	-	-
11. <u>Nereis chilkensis</u>	-	-	-	-	-	-	-
12. <u>Nephthys</u> sp.	1	-	-	-	-	-	-
13. <u>Perinereis cavifrons</u>	-	-	-	-	-	-	-
14. <u>Prionospio polybranchiata</u>	-	-	-	-	-	-	-
15. <u>Prionospio pinnata</u>	-	-	-	8	4	-	2
16. <u>Paraheteromastus tenuis</u>	-	-	-	-	-	-	-
17. <u>Notopygos</u> sp.	-	-	-	-	-	-	-
TOTAL	14	34	3	14	12	14	2

Table 10 contd. 1

Name of species/Group	B I	B II	B III	B IV	B V	NP	EP
	STATIONS						
CRUSTACEANS							
1. *Alpheus malabaricus*	15	20	-	-	-	-	-
2. *Alpheus paludicola*	1	-	-	-	-	-	
3. *Apseudeus chilkensis*	6	-	-	21	23	-	-
4. *Apseudeus gymnophobia*	-	1122	-	35	141	100	24
5. *Corophium triaenonyx*	-	548	-	-	-	-	-
6. *Cirolana fluviatilis*	-	1	-	-	-	-	-
7. *Grandidierella gilesi*	207	6	-	-	-	-	-
8. *Synidotea variegata*	51	-	4	2	-	-	-
9. *Scylla serrata*	-	1	-	-	-	-	-
10. *Penaeus indicus*	-	1	-	-	-	-	-
11. *Metapenaeus dobsoni*	-	-	-	-	-	-	-
12. *M.monoceros*	1	-	-	6	-	-	-
13. *M.affinis*	-	-	-	8	-	-	-
14. *Melita* sp.	-	-	-	-	14	14	-
15. Squilla	1	-	-	-	-	-	-
TOTAL	282	1699	4	72	178	114	24

Table 10 contd. 2

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
<u>MOLLUSCS</u>							
1. *Pandora* sp.	2	1	-	-	48	87	-
2. *Modiolus undulatus*	-	7	-	-	-	-	-
3. Bivalve spats	89	-	-	-	-	-	-
4. Gastropods	5	-	-	8	-	-	3
5. *Meretrix casta*	2	-	-	-	-	-	-
6. *Paphia* sp.	1	-	-	-	-	-	-
TOTAL	99	8	-	8	48	87	3
<u>PISCES AND OTHERS</u>							
1. *Cynoglosus* sp.	1	-	-	-	-	-	-
2. *Anguilla* sp.	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-
4. Nematodes	-	-	4	15	27	19	-
5. Sea anemone	1	-	1	-	-	-	-
6. Sipunculoidea	-	2	-	-	-	-	-
7. Star fishes	-	-	-	-	-	-	-
TOTAL	2	2	5	15	27	19	-
Total population per 0.1 m^2 area	397	1743	12	109	265	234	29

Table 11 : Numerical abundance of various species of macrobenthos per 0.1 m^2 area at different stations during 1st fortnight of Sept., 1987.

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
POLYCHAETES							
1. *Ancistrosyllis constricta*	-	2	-	-	-	-	-
2. *Dendroneresis aestuarina*	-	-	-	16	52	22	-
3. *Diopatra neapolitana*	36	17	4	-	-	-	-
4. *Lumbriconereis latreilli*	6	50	-	-	-	-	-
5. *Lumbriconereis simplex*	-	-	-	-	-	-	-
6. *Glycera* sp.	-	-	-	-	-	-	-
7. *Heteromastidus bifidus*	-	-	1	-	2	-	-
8. *Nereis unifasciata*	9	10	-	15	3	-	-
9. *Nereis cavifrons*	-	-	-	-	-	-	-
10. *Nereis* sp	5	-	-	-	2	-	-
11. *Nereis chilkensis*	-	-	-	-	-	-	-
12. *Nephthys* sp.	-	-	-	-	-	-	-
13. *Perinereis cavifrons*	-	-	-	-	-	-	-
14. *Prionospio polybranchiata*	-	-	-	-	-	-	-
15. *Prionospio pinnata*	-	-	-	3	-	15	-
16. *Paraheteromastus tenuis*	-	-	-	-	-	-	-
17. *Notopygos* sp.	-	-	-	-	4	-	-
TOTAL	56	79	5	34	63	37	-

Table 11 contd. 1

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
CRUSTACEANS							
1. Alpheus malabaricus	25	-	-	-	-	-	-
2. Alpheus paludicola	17	-	-	-	-	-	-
3. Apseudeus chilkensis	-	5	5	27	8	8	8
4. Apseudeus gymnophobia	7	6	-	42	60	147	107
5. Corophium triaenonyx	-	245	-	-	-	-	-
6. Cirolana fluviatilis	6	15	-	-	-	-	-
7. Grandidierella gilesi	102	2	-	-	-	-	-
8. Synidotea variegata	-	10	4	-	-	-	-
9. Scylla serrata	2	-	-	-	-	-	-
10. Penaeus indicus	1	1	-	-	-	3	2
11. Metapenaeus dobsoni	1	2	-	-	-	2	1
12. M.monoceros	-	-	-	9	-	-	-
13. M.affinis	-	-	-	8	-	-	-
14. Melita sp.	-	-	-	-	14	87	-
15. Squilla	-	-	-	-	-	-	-
TOTAL	161	286	9	86	82	247	118

Table 11 contd. 2

Name of species/Group	STATIONS						
	B I	B II	B III	B IV	B V	NP	EP
MOLLUSCS							
1. *Pandora* sp.	4	2	-	-	104	75	-
2. *Modiolus undulatus*	40	25	-	-	-	-	-
3. Bivalve spats	-	-	-	-	-	-	-
4. Gastropods	-	-	-	6	-	3	30
5. *Meretrix casta*	8	2	-	6	-	3	30
6. *Paphia* sp.	-	-	-	-	-	-	-
TOTAL	52	29	-	6	104	78	30
PISCES AND OTHERS							
1. *Cynoglossus* sp.	1	-	-	-	-	-	-
2. *Anguilla* sp.	-	-	-	-	-	-	-
3. Gobids	-	-	-	-	-	-	-
4. Nematodes	89	12	-	41	12	-	21
5. Sea anemone	-	-	-	-	-	-	-
6. Sipunculoidea	-	-	-	-	-	-	-
7. Star fishes	-	1	-	-	-	-	-
TOTAL	90	13	-	41	12	-	21
Total population per 0.1 m^2 area	359	407	14	167	261	362	139

c) Molluscs: *Modiolus* sp. was collected from the stations B I, B II and B III with greater abundance in B II. Economically important bivalves like *Meretrix casta* and *Paphia* sp. were also recorded from near the bar mouth (station B I). *Pandora* sp. was yet another bivalve occurred both in culture fields and backwaters. Settlement of bivalve larvae was noticed with the onset of monsoon. Among gastropods *Littorina* sp. occurred frequently in culture fields.

d) Others: Fishes like *Cynoglossus* sp. and *Anguilla* sp. were recorded from near bar mouth stations and gobids from ponds. Nematodes occurred in large numbers from almost all the stations except pond, E P. The stenohaline organisms like sea anemone and stars fishes appeared during the regime of high salinity. Sipunoculoidea were also recorded from backwater stations. Numerical abundance of macrobenthos is given in Tables 1-11.

BIOMASS:

In station B I, biomass in terms of wet weight varied from 42.56 gms/m^2 in April 15 to 7.6 gms/m^2 in September 1. In B II it fluctuated from 130 gms/m^2 to 7.3 gms/m^2, the highest value was in April 1 and the minimum in August 1. In B III it ranged from 28.34 gms/m^2 in May 1 to nil in July 1 and July 15. In B IV maximum value was recorded in May 1 (10.51 gms/m^2) and minimum (1.82 gms/m^2) in September 1. In B V the biomass was within the range of 12.6 gms/m^2 in March 15 to 1.92 gms/m^2 in July 1. The biomass showed progressive declining trend from barmouth stations to upstream adjacent to culture fields. Comparatively low values of biomass were recorded in the culture fields. In pond N P the biomass fluctuated between 31.5-2.25 gms/m^2 with the maximum in April 15 and minimum in September 1. In pond E P the highest recorded biomass (34.20 gms/m^3) was in April 15. In 'Pokkali' field N S the values fluctuated between 8 gms/m^2 in April 1 to 1.25 gms/m^2 in June 15. The biomass in E S ranged between 12.12-5.00 gms/m^2 with the peak value in April 1 and minimum in June 15 (Figs.2, 3, 4).

<u>Population density</u>: The population for the sake of comparison is expressed in numbers/0.1 m^2 area. In backwater stations B I the population fluctuated around, 178-610/0.1 m^2, with the maximum and minimum in July 1 and May 15 respectively. In B II total population ranged from 211/0.1 m^2 in July 1 and 4468/0.1 m^2 in April 15. In station B III the population density varied from as low as 12/0.1 m^2 in August 15 to 430/0.1 m^2 in April 1. In B IV the maximum population recorded was 231/0.1 m^2 in May 1 and minimum (63/0.1 m^2) in July 15. The population numbers fluctuated between 74/0.1 m^2 in July 15 to 404/0.1 m^2 in March 15.

In the culture pond N P a minimum population of 65/0.1 m^2 was recorded in May 1 and maximum of 362/0.1 m^2 in September 1. In pond E P population density ranged from 10/0.1 m^2 in August 1 to 3311/0.1 m^2 in April 15. In the pokkali field N S the population fluctuated between 39-210/0.1 m^2, the minimum being in, June 15 and maximum in April 1. In 'Pokkali' field E S maximum of 165/0.1 m^2 was recorded in April 1 and minimum of 23/0.1 m^2 in June 15.

<u>Statistical Analysis</u>: In station B I, the correlation coefficient(r) values showed significant relationship at 5 % level between the variables biomass and pH (-0.7939), biomass and temperature (0.7006), biomass and organic carbon (-0.6852) and biomass and mud reactive phosphate (0.8883). The polychaete population was significantly correlated with dissolved oxygen at 5 % level. The correlation of molluscan population with pH (-0.6800) and temperature (0.626) and organic carbon (0.6289) was significant at 5 % level (Table 12).

Table (13) showed that in station B II, the correlations between biomass and the parameters like pH (-0.7687), temperature (0.8874) and reactive mud phosphate (0.8829) were highly significant at 1 % level. The correlation coefficient(r) value of the variable polychaete population with temperature (0.6803) and mud reactive phosphate (0.7842) was significant at 5 % and 1 % level respectively. Similarly, the molluscan population showed significant correlation at 1 % level with mud reactive phosphate (0.8585).

Table 12 : Correlation coefficient matrix of different environmental parameters, biomass and population densities in backwater Station, B I.

	S	$D.O_2$	pH	Temp.	Org. C	Mud PO_4-P	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	0.3047	1.00								
pH	0.0736	-0.1271	1.00							
Temperature	0.3199	0.0248	-0.7997**	1.00						
Organic carbon	0.1862	0.2638	0.7992**	-0.7009*	1.00					
Mud Rea. phosphate	0.1643	0.1700	-0.6847*	0.5976	-0.6947	1.00				
Biomass	0.1281	-0.2304	-0.7939**	0.7006*	0.6852*	0.8883**	1.00			
Polychaete population	0.5895	0.6651*	0.2267	0.3732	0.0302	0.0961	0.1311	1.00		
Crustacean population	-0.2848	-0.6739*	0.1250	0.1884	0.2340	-0.1236	-0.0458	-0.5701	1.00	
Molluscan population	0.3080	0.0392	-0.6807	0.6267*	0.6289*	0.5587	0.7479**	0.1174	0.2041	1.00

* Significant at 5 % level   ** Significant at 1 % level

Table 13 : Correlation coefficient matrix of different environmental parameters, biomass and population densities in backwater Station, B II.

	S	DO_2	pH	Temp.	Org C.	Mud PO_4-P	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	-0.3765	1.00								
pH	0.0789	-0.5259	1.00							
Temperature	0.1770	0.4249	-0.7290*	1.00						
Organic Carbon	0.3748	0.2413	0.0484	0.2456	1.00					
Mud Rea. phosphate	0.0790	0.5553	-0.6628*	0.7317*	-0.2799	1.00				
Biomass	0.1994	0.4211	-0.7687**	0.8874**	-0.2464	0.8829**	1.00			
Polychaete population	0.3789	0.4510	0.4742	0.6803*	0.0574	0.7842**	0.8110**	1.00		
Crustacean population	-0.1450	-0.4214	0.2580	0.0152	0.6341*	-0.2453	-0.1127	0.2973	1.00	
Molluscan population	0.4288	0.4112	-0.4750	0.7154*	0.0460	0.8585**	0.8545**	0.9097**	-0.1635	1.00

* Significant at 5 % level

** Significant at 1 % level

Table 14 : Correlation coefficient matrix of different environmental parameters, biomass and population densities in backwater Station, B III.

	S	DO_2	pH	Temp.	Org. C	Mud PO_4-P	Bio-mass	Population		
								Poly.	Crus.	Moll.
Salinity	1.00									
D.oxygen	-0.2027	1.00								
pH	-0.4145	-0.5229	1.00							
Temperature	0.3680	0.4517	-0.8518**	1.00						
Organic carbon	-0.5746	-0.3059	0.7325*	-0.8469**	1.00					
Mud Rea. phosphate	0 2246	-0.2440	-0.5964	0.5381	-0.4327	• 1.00				
Biomass	0.5807	0.3994	-0.9205**	0.8569**	0.7436**	0.7258**	1.00			
Polychaete population	0.5408	0.5356	-0.9126**	0.7506**	0.6322*	0.5056	0.8715**	1.00		
Crustacean population	0.1718	0.2945	-0.7277*	0.7861**	0.6306*	0.7749**	0.7715**	0.4839	1.00	
Molluscan population	0.3348	0.7650**	-0.6641*	0.4121	0.1772	0.1523	0.4386	0.7382**	0.2666	1.00

Significant at 5 % level ** Significant at 1 % level

Table 15 : Correlation coefficient matrix of different environmental parameters, biomass and population densities in backwaters Station, B IV.

	S	DO_2	pH	Temp	Org. C	Mud PO_4-P	Bio-mass	Population		
								Poly.	Crus.	Moll.
Salinity	1.00									
D.oxygen	-0.3536	1.00								
pH	-0.3531	-0.4337	1.00							
Temperature	-0.3071	-0.1214	0.4207	1.00						
Organic carbon	0.0599	0.2137	-0.2435	0.6322	1.00					
Mud Rea. phosphate	-0.5358	0.8270*	0.1008	0.1890	-0.2312	1.00				
Biomass	0.1765	0.0052	0.1484	0.7215*	-0.4540	0.4173	1.00			
Polychaete population	0.0553	-0.2598	0.0963	0.7916*	-0.7056	0.1333	0.8163*	1.00		
Crustacean population	0.5283	-0.5496	0.1243	0.6958	-0.5395	0.2923	0.4528	0.7125*	1.00	
Molluscan population	0.1133	-0.2302	-0.3708	-0.5136	0.1139	-0.4331	-0.6210	-0.2235	-0.0633	1.00

* Significant at 5 % level ** Significant at 1 % level

Table 16 : Correlation coefficient matrix of different environmental parameters biomass and population densities in backwater Station, B V.

	S	DO_2	pH	Temp.	Org. C	Mud PO_4-P	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	-0.0165	1.00								
pH	-0.3417	0.2962	1.00							
Temperature	0.2102	-0.0492	-0.0972	1.00						
Organic carbon	-0.6651	-0.6404*	0.2093	-0.1142	1.00					
Mud Rea. phosphate	0.6694*	0.1067	0.1653	0.0661	0.5546	1.00				
Biomass	0.4071	-0.3392	-0.2929	-0.4443	0.0164	0.2453	1.00			
Polychaete population	0.8314**	0.2408	-0.3273	-0.0741	-0.4363	0.7062*	0.6392*	1.00		
Crustacean population	-0.4458	0.0536	0.0052	-0.5233	0.3182	-0.4200	0.3318	-0.4023	1.00	
Molluscan population	-0.0427	-0.9060**	-0.3328	0.1282	0.5413	0.4204	0.4154	0.2414	0.0511	1.00

* Significant at 5 % level ** - Significant at 1 % level

In station B III, the biomass was significantly (1 %. level) correlated with pH, temperature and organic carbon and the 'r' values were 0.9205, 0.8569 and 0.7436 respectively. Biomass and mud reactive phosphate showed significant (5 % level) correlation with 'r' value of 0.7258. Polychaete population was significantly correlated with pH (-0.9126) and temperature (0.7506) at 1 % level and with organic carbon (0.6322) at 5 % level. The crustaceans showed significant correlation with temperature (0.7861) and mud reactive phosphate (0.7749) at 1 % level and with pH (-0.7277) and organic carbon (0.6306) at 5 % level. The correlation between molluscan population and pH (r= -0.6641) was significant only at 5 % level (Table 14).

The correlation coefficient values for different parameters in station, B IV is given in Table 15. In this station the biomass was significantly correlated with temperature (0.7216) at 5 % level. Polychaete population was also found to be statistically correlated with temperature (0.7916) at 5 % level. Table 16 shows that in station B V the total biomass was not found to be significantly correlated with any parameters. The polychaete population showed significant correlation with salinity (r= 0.8314) and mud reactive phosphate (0.7062) at 1 % and 5 % level of significance respectively. Molluscan population was significantly correlated (-0.9060) with dissolved oxygen at 1 % level. In fish pond N P the biomass was statistically correlated with salinity at 1 % level with a 'r' value of 0.8879. The correlation coefficient showed high values between the parameters biomass and pH (-0.8510), biomass and dissolved oxygen (-0.8189)and biomass organic carbon (-0.7431) with high level of significance at 1 % level. Molluscs showed significant correlation with salinity(r= 0.6349) at 5 % level and with organic carbon (r=0.7997) and reactive mud phosphate (r= -0.8751) at 1 % level (Table 17).

Table 18 showed that the correlation coefficient values for the parameters biomass with salinities (r= 0.9754) dissolved oxygen (r= -0.8538), pH (r= -0.8890) and organic carbon (r= 0.8269) were highly significant at 1 % level in pond E P. Among the different animal populations polychaetes alone were significantly correlated (at 5 % level) with salinity (0.6715), dissolved oxygen (0.6715) and pH (0.6068).

The 'Pokkali' field, E S showed significant correlation between biomass and organic carbon at 5 % level. The relationship between all the other parameters both at E S and N S stations were statistically non-significant (Table 19-20).

Species diversity of polychaetes: The species diversity has been computed and the results of which are given in (Table 21)

Table 17 : Correlation coefficient matrix of different environmental parameters, biomass and population densities in Pond, N P.

	S	DO_2	pH	Temp.	Org. C	Mud PO_4-P	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	-0.7700**	1.00								
pH	-0.6039*	0.7260*	1.00							
Temperature	0.5143	-0.0498	0.0722	1.00						
Organic carbon	-0.6891*	0.6375*	0.5874	-0.2522	1.00					
Mud Rea. phosphate	0.5777	-0.5509	-0.5091	0.2493	-0.7514**	1.00				
Biomass	0.8879**	-0.8189**	-0.8510**	0.1675	-0.7430**	0.5630	1.00			
Polychaete population	0.5747	-0.6060*	-0.8033**	-0.0193	-0.5353	0.1056	0.8157**	1.00		
Crustacean population	-0.2760	0.5533	0.3203	0.4454	-0.5035	-0.5032	-0.3364	-0.1290	1.00	
Molluscan population	-0.6349*	0.5684	0.3501	-0.1784	0.7997**	-0.8751**	-0.6101*	-0.2786	0.6419*	1.00

* Significant at 5 % level ** Significant at 1 % level

Table 18 : Correlation coefficient matrix of different enviornmental parameters, biomass and population densities in Pond, E P.

	S	DO_2	pH	Temp.	Org. C	Mud PO_4-4	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	-0.8102**	1.00								
pH	0.3841	0.8810**	1.00							
Temperature	0.3675	-0.1990	-0.1517	1.00						
Organic carbon	-0.8342**	0.8379**	0.7777**	0.2831	1.00					
Mud Res. phosphate	0.7438**	0.7187*	0.8550**	-0.2128	0.6241*	1.00				
Biomass	0.9754**	-0.8538**	0.8890**	0.2586	-0.8269**	0.5236	1.00			
Polychaete population	0.6715*	-0.6715*	-0.6068*	-0.1762	-0.5502	0.5268	0.7677**	1.00		
Crustacean population	0.5796	0.4733	0.3577	-0.0441	-0.3939	0.4270	0.6416*	0.8508**	1.00	
Molluscan population	0.2776	-0.3892	-0.5039	-0.2943	-0.1194	0.5139	0.4520	0.7580**	0.5449	1.00

* Significant at 5 % level ** Significant at 1 % level

Table 19 : Correlation coefficient matrix of different, environmental parameters, biomass and population densities in 'pokkali field, NS.

	S	DO_2	pH	Temp.	Org. C	Mud PO_4-P	Bio-mass	Population		
								Poly.	Crus.	Moll.
Salinity	1.00									
D.oxygen	0.0728	1.00								
pH	-0.4157	-0.3175	1.00							
Temperature	-0.3723	-0.2751	0.5970	1.00						
Organic carbon	-0.2346	-0.1781	0.4512	0.6918	1.00					
Mud. Rea phosphate	0.7344	-0.0455	-0.1282	0.0461	-0.1402	1.00				
Biomass	0.5126	0.7861	-0.5422	-0.4536	-0.1457	0.4720	1.00			
Polychaete population	-	-	-	-	-	-	-	-		
Crustacean population	-	-	-	-	-	-	-	-	-	
Molluscan population	0.5821	0.6517	-0.0786	-0.0519	0.2354	0.2538	0.6377	-	-	1.00

Table 20 : **Correlation coefficient matrix of different environmental parameters, biomass and population densities in 'pokkali' field, ES.**

	S	DO_2	pH	Temp	Org. C	Mud PO_4-P	Bio-mass	Population Poly.	Population Crus.	Population Moll.
Salinity	1.00									
D.oxygen	-0.7119	1.00								
pH	0.2947	0.0395	1.00							
Temperature	-0.0899	0.1094	0.7200	1.00						
Organic carbon	-0.7536	0.7714	0.5366	0.5686	1.00					
Mud Rea. phosphate	0.3862	-0.4945	-0.3409	-0.6795	-0.6919	1.00				
Biomass	0.6007	-0.5100	0.2678	-0.6776	-0.8300*	0.4176	1.00			
Polychaete population	0.7202	-0.5538	-0.3622	-0.4831	-0.6101	0.2468	0.8545*	1.00		
Crustacean population	0.5857	-0.5057	0.6508	-0.7574	-0.7135	0.5846	0.8368*	0.9101*	1.00	
Molluscan population	0.3003	-0.1609	0.0911	-0.4430	0.2866	-0.0731	0.7828	0.6536	0.6225	1.00

* Significant at 5 % level ** Significant at 1 % level

Table 21 : Species diversity of Polychaetes

Sampling Dates	Station B I			Station B II			Station B III		
	N	n	H	N	n	H	N	n	H
15-03-1987	54	8	1.9360	132	3	0.6864	347	5	0.8214
01-04-1987	62	6	1.3352	145	3	0.5328	377	4	0.5730
15-04-1987	35	4	0.9500	144	7	0.6150	227	3	0.5473
01-05-1987	19	4	1.0937	73	6	0.6738	114	2	0.3364
15-05-1987	17	4	1.1874	60	5	0.6658	63	2	0.4631
15-06-1987	19	6	1.4658	74	7	0.8257	..	..	..
01-07-1987	10	2	0.5003	42	5	1.2866	1	1	0.0000
15-07-1987	8	4	1.2130	37	5	1.3015	1	1	0.0000
01-08-1987	7	3	1.0780	17	6	1.6347	2	2	0.6347
15-08-1987	14	4	1.0547	34	5	0.8820	3	2	0.6365
01-09-1987	56	4	1.0328	79	4	0.9747	5	2	0.5004

N - Polychaete population density, n - number of species, H - Species diversity

Table 21 contd. 1

Sampling Dates	Station B IV			Station B V			Station NP		
	N	n	H	N	n	H	N	n	H
15-03-1987	..	..	..	211	3	0.7970	136	2	0.4659
01-04-1987	..	..	..	285	2	0.2971	170	2	0.7659
15-04-1987	..	..	..	194	2	0.2320	140	1	0.000
01-05-1987	111	3	0.3066	167	2	0.3021	26	2	0.5402
15-05-1987	73	3	0.1456	57	2	0.3724	16	2	0.5623
15-06-1987	40	3	0.4608	32	2	0.3600	14	2	0.5982
01-07-1987	24	3	0.61599	16	2	0.5623	46	2	0.3872
15-07-1987	10	2	0.5223	20	3	0.5911	20	1	0.00
01-08-1987	10	3	0.5715	31	3	1.0463	20	1	0.00
15-08-1987	14	4	1.1163	12	2	0.6365	14	1	0.00
01-09-1987	34	3	0.9299	63	5	0.7062	37	2	0.3660

N - Polychaete population density, n - number of species, H - species diversity

Table 21 contd. 2

Sampling Dates	Station NS			Station EP			Station ES		
	N	n	H	N	n	H	N	n	H
15-03-1987	0	0	0.00	360	3	0.9805	40	4	1.2006
01-04-1987	0	0	0.00	121	3	0.5054	63	3	1.0193
15-04-1987	0	0	0.00	488	3	0.9108	52	3	0.6234
01-05-1987	0	0	0.00	49	3	1.036	39	3	0.7075
15-05-1987	0	0	0.00	32	4	1.0524	27	2	0.3488
15-06-1987	0	0	0.00	38	3	1.0851	12	2	0.2868
01-07-1987				10	1	0.00			
15-07-1987				20	1	0.00			
01-08-1987				0	0	0.00			
15-08-1987				2	1	0.00			
01-09-1987				0	0	0.00			

N - Polychaete population density; n - number of species; H - species diversity

In general, the species diversity registered a decreasing trend with the onset of monsoon. In station B I the maximum species diversity (1.9360) was recorded in March 15 and minimum (0.5003) in July 1. In B II species diversity remained more or less uniform upto May 15 and thereafter it fluctuated between 0.8820-1.6347 from July 1 to September 1 period. In B III station the diversity index was from zero in July 1 to 0.8214 in March 15. The species diversity in B IV remained low during May and August 1 but higher value was obtained in August 1 (1.1163). In March 15, species diversity of 0.7970 was observed after which it declined in station B V. There was varying species diversities in the culture systems as the system harbours only lesser number of species. In general, it followed a decreasing trend with the onset of southwest monsoon. In pond E P except for April 1, the values were more or less same upto June 15 and afterwards the value declined to zero, i.e., dominance of a single species. In pond N P, the maximum species diversity was in June 15 and minimum of zero from July 15 to August 15. In E S, it varied from 1.2006-0.2868, the maximum being in March 15 and minimum in June 15.

Species diversity of Crustaceans: In station B I, species diversity fluctuated between 1.2914 in March 15 to 0.4203 in April 15. In B II, it fluctuated between 1.9302-0.3183, the

Table 22 : Species diversity of crustaceans

Sampling dates	Station B I			Station B II			Station B III		
	N	n	H	N	n	H	N	n	H
15-03-1987	14	4	1.2914	27	8	1.93024	49	4	0.9063
01-04-1987	42	4	1.0002	50	7	1.1641	22	2	0.6887
15-04-1987	244	4	0.4203	1784	8	0.7745	45	3	1.0608
01-05-1987	254	3	0.4574	1050	8	0.8341	32	4	1.2324
15-05-1987	368	2	0.5270	1691	6	0.3183	38	4	0.9966
15-06-1987	426	6	0.8136	1311	6	0.45909	0.0	0.0	0.00
01-07-1987	137	7	0.9864	124	10	1.6565	25	2	0.6929
15-07-1987	184	6	1.2334	496	6	1.0363	8	1	0.00
01-08-1987	198	6	0.7166	1285	10	0.8190	20	3	0.7305
15-08-1987	282	7	0.8142	1699	7	0.7099	4	1	0.00
01-09-1987	161	8	1.2238	286	8	0.6454	9	2	0.6869

N - Crustacean population density; n- number of species; H - species diversity

Table 22 contd. 1

Sampling Dates	Station B IV			Station B V			Station NP		
	N	n	H	N	n	H	N	n	H
15-03-1987	-	-	-	141	3	0.7227	80	4	0.9227
01-04-1987	-	-	-	32	3	0.6561	28	4	1.05472
15-04-1987	-	-	-	41	3	0.9575	42	2	0.6645
01-05-1987	93	2	0.6437	47	3	1.03	22	3	0.3941
15-05-1987	133	2	0.6236	69	3	1.0666	48	4	0.8965
15-06-1987	68	6	1.1042	98	5	1.2075	90	4	0.7982
01-07-1987	59	2	0.6068	98	3	1.0828	26	3	0.2602
15-07-1987	30	4	0.9738	42	4	1.0271	22	2	0.3046
01-08-1987	52	5	1.0972	126	5	0.8623	-	-	-
15-08-1987	72	5	1.2607	178	3	0.6489	114	2	0.3724
01-09-1987	86	4	1.1708	82	3	0.7574	247	3	0.090695

N - Crustacean population density; n - number of species; H - species diversity

Table 22 contd. 2

Sampling Dates	Station NS			Station EP			Station ES		
	N	n	H	N	n	H	N	n	H
15-03-1987				604	2	0.6372	28	4	1.06095
01-04-1987				250	2	0.5004	41	3	0.8571
15-04-1987				2388	2	0.5267	30	4	1.06095
01-05-1987				250	2	0.5004	2	1	0.00
15-05-1987				109	2	1.0524	-	-	0.0000
15-06-1987				248	2	0.1573	-	-	0.00
01-07-1987				-	-	-			
05-07-1987				-	-	-			
01-08-1987				-	-	-			
15-08-1987				24	1	0.00			
01-09-1987				118	4	0.3807			

N - Crustacean population density; n - number of species; H - species diversity maximum being in March 15 and minimum in May 15. In B III, the species diversity showed an increasing trend from March 15 to May 1 after which it switched on to a declining phase. The maximum (1.2324) was in May 1 and minimum of zero was in June 15. In B IV, as the data pertained to a shorter period it was not possible to interpret the shift in species diversity, 'H' with respect to season. The maximum of 1.2607 was in August 15 and minimum (0.6068) was in July 1. In B V, it registered an increasing trend from 0.7227 March 15 to 1.2075 in June 15 after which it decreased with the minimum value of 0.6489 in August 15. In pond N P maximum 'H' value (1.0549) was observed in April 1 followed by a decreasing trend with the minimum value (0.2602) in July 1. In pond E P the maximum 'H' value (1.0524) was in May 15 with zero in August 15. In E S, maximum value (1.0609) was observed in April 15 and zero in May 1 and June 15 (Table 22).

D I S C U S S I O N

The physico-chemical features of estuaries are highly complex and dynamic which depend mostly on the influx of freshwater, precipitation, evaporation, structure components of bed, tides and macroclimate of the geographic region (Kinne, 1966). In order to understand the behaviour, distribution and abundance of bottom fauna in space and time it is essential to study the changing ecological parameters such as temperature, salinity, pH, dissolved oxygen and sediment characteristics. Jones (1950) opined that the nature of bottom sediment, salinity and temperature cause bottom fauna in littoral zone to be seggregated into groups. When salinity is more or less same, as is the case in deeper water, temperature plays an important role for controlling the distribution of bottom fauna. The hydrographical and sedimentological features of backwater and culture systems in the present investigation showed drastic changes with the onset of south west monsoon. Salinity of the Cochin backwater near bar mouth comes down to as low as 3.23 ‰ during this period, converting the backwater into a freshwater lake. The low benthic biomass production and relatively low species diversity during the southwest monsoon months in backwater as well as culture fields indicated the possibility of destruction of stenohaline species or their migration to adjacent sea.

Similar observations were made by Seshappa (1953) in nearshore waters off Calicut, Desai and Kutty (1967), Kurian (1969), Kurian et al. (1975) and Pillai (1977) and more recently by Anwar Batcha (1984) in Vembanad lake.

The peak values of temperature were obtained mostly during premonsoon but declined with the onset of monsoon. The seasonal variation of bottom water temperature in backwater stations near bar mouth was from 7 to 8°C and this wide range between the low and high temperature was attributed to incursion of cold and highly saline water from the sea through bar mouth (Sankaranarayanan and Qasim, 1969). According to Ramamritham and Jayaraman (1963) the upwelled water from the Arabian Sea finds its way into Cochin backwater through the main channel. The seasonal variation in bottom water temperature in stations away from bar mouth and perennial culture fields was only 3 to 3.4°C which is mainly due to river run off and rain fall during south west monsoon periods. According to Kurian (1972), the seasonal difference of temperature in the backwater was from 2 to 4°C and argued that temperature is not a deciding factor for the distribution of bottom macrofauna. Holme (1961) is of opinion that spawning in benthic communities depends upon temperature but the extent of the influence of temperature on spawning is not clear. The present attempt to correlate the bottom water temperature and abundance of macrofauna in terms of wet weight and population densities showed that biomass was positively correlated with temperature in stations B II and B III at 1 % level and in B I and B IV at 5 % level. In the culture fields neither the biomass nor the populations of polychaetes, crustaceans or molluscs were affected by temperature. These observations indicated that temperature around 28.20-32.30°C seems to be favourable for the growth and survival of macrobenthos.

Salinity showed high values mostly during premonsoon period. The precipitation and freshwater discharge into the ecosystem during monsoon reduced the salinity and the minimum recorded was in July 1 at stations B I, B II, B III, B IV and B V. But the range of salinity fluctuation during premonsoon and monsoon period was minimum in station B I, which is attributed to the highest tidal influx and closeness of this station to the sea. In the stations near the bar mouth immediate recovery of salinity was noticed which is due to strong tidal incursions; whereas the recovery of lowered salinity in culture fields was either not felt or negligibly slow during the period of this investigation. This was because of the long distance of the culture fields from bar mouth and less tidal influence and mixing. The correlation between the biomass and salinity showed that the 'r' values were statistically nonsignificant in backwater stations as well as in 'Pokkali' fields; whereas in perennial fields this relationship was highly significant. Kinne (1967) stressed salinity as an important master ecological factor which controls estuarine life. The distribution and abundance of estuarine worms were linked to their osmoregulatory ability by Oglesby (1969). Ramamirtham and Jayaraman (1963) and Jayasree (1971) studied the distribution pattern of salinity in Cochin backwater. The effect of salinity in benthic macrofauna has been worked out by Desai and Krishnankutty (1967), Kurian (1967, 1969), Pillai (1977) and Ansari (1977). Patnaik (1971) found no direct relationship between the biomass and salinity. Devassy and Gopinathan (1970) noticed an increase in biomass production from marine to freshwater zone during southwest monsoon. The absence of benthic fauna during July in station B III is attributed to wide fluctuation in salinities. Srinivasan (1982) and Sugunan (1983) studied the effect of salinity on benthic biomass in culture fields. They observed a gradual decrease in the biomass in different ecological systems like perennial and seasonal fields and coconut grooves along Vypeen Island area with the onset of monsoon.

The pH, too, showed seasonal fluctuations in both the culture systems as well as in backwaters. The pH remained more or less same during premonsoon period but with the onset of monsoon, these values increased. The peak value of pH varied from 8.2 to 8.35 in backwater stations and 8.8 to 9.2 in the perennial culture fields. The correlation between biomass and pH was statistically significant in stations B I, B II, B II, NP and EP. An inverse correlation between biomass and pH showed that alkaline medium was unfavourable for the growth of macrobenthic fauna, especially in perennial culture fields where the values were high. According to Nicol (1966) the pH may rise as high as 9.6 owing to activities of plants. Srinivasan (1982) and Sugunan (1983) studied the effect of pH in culture fields and noticed similar results. During the regime of high pH (9.2) the benthic biomass disappeared completely from the perennial culture field (E P).

The present investigation showed a general increase in dissolved oxygen concentration with the onset of monsoon. The high value of dissolved oxygen content in the beginning of monsoon in stations near bar mouth declined drastically to as low as 1.38 and 1.49 ml/L in B II and B III respectively in late August. This lowering of dissolved oxygen during the late monsoon months can be attributed to the incursion of highly saline oxygen deficient upwelled water into the backwater through the bar mouth. On the other hand, the dissolved oxygen content in the culture fields remained high throughout the period of study. This indicated that oxygen deficient upwelled water which was responsible for lowering of dissolved oxygen content in stations near bar mouth could not show its impact in culture fields and therefore, the dissolved oxygen contents remained as high as 7.49 ml/L and 4.9 ml/L in E P and N P respectively.

Moreover, the shallow nature of the ponds and more effective mixing of surface and bottom waters may also be responsible for the high oxygen content.

An inverse correlation between biomass and dissolved oxygen was obtained in perennial culture fields. But according to Spotte (1979) the dissolved oxygen content of more than 3 ml/L may not be a limiting factor for benthic animals. Therefore, the decline in benthic biomass of culture fields during monsoon months may not be due to dissolved oxygen content. The low dissolved oxygen content in bottom water of backwater stations may be a major factor responsible for reduction in species diversity as well as their population density. But the adult specimens of _Ancistrosyllis constricta_ and _Diopatra neopolitana_ were recorded throughout the period of study irrespective of the dissolved oxygen concentration of bottom water. This showed the adaptability of these animals to survive in very low oxygen content. Similar observations were made by Collip, 1920, 1921; Mitchell, 1912 and Moore, 1931. They found that _Nucula_ sp. has the ability to withstand anoxic conditions as long as 5 to 17 days. Dales (1958) while working on _Arenicola marina_ and _Owenia fusiformis_ suggested that these species survive anaerobic conditions by suspending their normal vital activities. This was confirmed by the absence of any change in the glycogen content of body in _O.fusiformis_. Lindeman (1942) observed that some of the animals could survive in anaerobic conditions for a longer period at low temperature ($0^{o}C$) but at higher temperature they could survive only for a shorter duration in the anoxic conditions. Damodaran (1973) emphasized the ecological significance of lowering of temperature with subsequent fall in dissolved oxygen concentration.

In the complex estuarine environment it is difficult to isolate the characteristics of sediment alone from other hydrographical parameters to study its effect on macrobenthos. The percentage of organic carbon in sediment showed seasonal variations. The values were as high as 3.23 % in B I, 3.81 % in B II, 4.96 % in B III, 3.40 % in B IV and 1.73 % in B V. The organic carbon content in station B III showed the highest value (4.9 %) during July, with a total absence of benthic fauna. Bader (1954) found increased in faunal bivalve concentration when the organic content was upto 3 % in the sediment, but above this level, bacterial decomposition resulted in oxygen depletion in overlying waters. In station B III molluscan population constituted only 0.6 % of the total population and it might be due to high organic carbon content. Polychaete population have constituted 68 % of the total population, this is attributed to the ability of polychaetes (Diopatra neapolitana) to survive well in substratum with high carbon content and low levels of dissolved oxygen concentration. Biomass was found to be significantly correlated with organic carbon at 1 % level in E P, N P and

B III, whereas in B I it was only at 5 % level. Polychaete population was significantly correlated with organic carbon only in B III.

Brett (1963), Mc Nulty *et al*. (1962), Sanders (1956, 1958), Kurian (1967), Pillai (1977) and Ansari (1977) showed intimate relationship between the feeding habits of benthic organisms and organic content of substratum. Sanders (1956) and Russel (1950) reported the close association of organic content with clay minerals except Kaolin. Thus the area with high fraction of clay supported high proportion of organic matter. In the present study too sediment with maximum clay (average of 25.7 % in B III) was found to hold maximum of organic carbon (4.96 %). Murthy and Veerayya (1972), while studying the sediments of Vembanad lake found the same relationship between organic matter and grain size. Sorokin (1978) observed that when the organic matter ranged from 4 to 8 % meiobenthic biomass was 50-200 g/m^2, while the ecosystems with 1-4 % of organic matter sustained higher biomass of 100-500 g/m^2. Kurian (1972) suggested high benthic productivity in estuaries due to high carbon content. The 'pokkali' fields showed high organic carbon content, which is due to decay of roots and stumps of paddy left to rot after harvest. Similar observations were made by Gopinathan *et al*. (1982), Srinivasan (1982) and Sugunan (1983) in 'pokkali' fields.

Higher values of mud reactive phosphate were obtained during premonsoon, but in monsoon periods the concentration of mud phosphate decreased considerably. Intense agitation of bottom mud during monsoon may help in the release of phosphate from the mud to overlying water. There was significant correlation between mud phosphate and biomass in station B I, B II and B III; whereas in culture fields the relationship was non-significant.

Seshappa and Jayaraman (1956) carried out investigation on the bottom mud of Calicut and concluded that the intense agitation or bottom churning during the monsoon helps to transfer the phosphorus from the mud to the overlying water. The increase in phosphorus concentration in overlying water was also attributed to large scale mortality and decay of benthic organisms. According to Damodaran (1973) mortality of benthic animals occurs during south west monsoon, but the magnitude of mortality of benthos off Cochin was not sufficient enough to justify a large increase in phosphorus concentration of bottom water which he noticed during southwest monsoon periods.

The significant correlation between biomass and mud reactive phosphate in B I, B II and B III indicated that macro-faunal population was affected by a fall in mud reactive phosphate probably through food chain. Suguman (1983) also found positive correlation between meiofaunal population and mud reactive phosphate in culture systems.

The sediment type is one of the important abiotic factors which plays important role in qualitative and quantitative distribution of organisms. The sediment near bar mouth (station B I) was clayey sand, with 71.75 % of sand and supported only 42.56 gms/m^2 of biomass. Kurian (1969) recorded similar observations from near bar mouth of Cochin backwater area. The station B II with 43.3 % of sand and almost equal proportion of clay and silt, supported the biomass as high as 130 gms/m^2. The muddy (B IV) and thick clay (B VI) substratum supported very poor faunal assemblage. In B IV and B III the molluscan population was only 2 % and 0.6 % respectively of the total population which can be attributed to rich clay content of the substratum.

In spite of the sandy substratum in B V and pond N P polychaetes constituted about 42 % and 32 % respectively of the total population. The dominance of Dendronereis aestuarina in these stations indicated that it can thrive well in sandy substratum unlike other species. This fact is further supported by the occurrence of D. aestuarina in B I which is characterised by clayey sand substratum with 71.75 % of sand. The preference of Dendronereis aestuarina for sandy substratum admixed with clay and silt had been observed by Desai and Kutty (1967) in Cochin backwater, Parulekar et al. (1975) in Goa estuaries and more recently by Ramachandran et al. (1984) in Mulki estuary.

The silty sand substratum of pond E P, supported three species such as D.aestuarina, P.cavifrons and Prionospio pinnata. The station E P had a polychaete population density of 114/0.1 m^2, whereas in N P with a sandy bottom, harboured only 58 polychaetes per 0.1 m^2 on an average.

Though the type of substratum was similar in 'Pokkali' fields N S and E S i.e. silty sand type, there was a complete absence of polychaets and crustaceans in N S. This shows the uneven distribution of macrobenthos in similar type of substratum, thus substratum alone may not decide the abundance and distribution of organisms in culture systems. Kurian (1967) and Ansari (1977) also recorded uneven distribution of macrofauna in similar type of substratum.

Panikkar and Aiyer (1937) recorded absence of animals in thick clayey substratum and abundance of fauna in loose substratum. Desai and Kutty (1967, 1969) observed abundance of polychaete and bivalves in medium sized sand with small amount of silt and clay which is in close agreement with the present observation. A definite relationship between macrofaunal groups and sediment characteristics has been established by Sanders (1958), Kurian (1969), Varshney (1981), Parulekar et al. (1975), Murugan et al. (1980).

Hallberg et al. (1973) concluded from his experiments that decomposition of organic matter and regeneration of nutrients is directly correlated with the input of organic matter to the bottom. Harkantra et al. (1980) found the dominance of detritus feeders like crustaceans in the shallow regions and mouths of estuaries and related it to the availability of detritus. In the present study also crustaceans were found to be abundant in shallow areas as well as barmouth regions. Molluscs had a limited distribution and they were found aggregated in different regions (as in station B II). More biomass was associated with fine sand with silt and clay, whereas soil with thick clay contains less biomass, similar observations were made by Desai & Kutty (1967) and Pillai (1977) from Cochin backwaters. Though polychaetes occurred in a wide variety of substratums they prefer fine sand with admixture of silt and clay. It is well known that polychaete larvae examine the substratum critically, before settling and postpone their metamorphoses until they find suitable place for adult life (Wilson, 1952).

In most of the stations high species diversity was observed during premonsoon season. But with the onset of monsoon a decline in species diversity was noticed. Gallardo (1963) found low benthic diversity off northern Chile and correlated it with oxygen depletion caused by upwelling. Buchanan (1958), Longhurst (1959) and Desai and Kutty (1967) have stressed that species diversity was low or moderate in tropical benthic communities. Various theories have been put forward based on competition (Williams, 1964), Predation (Paine, 1966) and productivity to explain difference in species diversity. According to Sanders (1968), persistance of stable environmental conditions cause high species diversity. According to Wade (1972) the benthic communities may have lower diversities if there is a physiological stress due to reduced oxygen level or fluctuating salinities. In the highly fluctuating environments, only those species which can withstand stress due to environmental conditions can survive, whereas when the physico-chemical conditions are stable and uniform, competition for food acts as a major factor for controlling species diversity. Intense competition or non equilibrium conditions in predator-pray relationship have also reduced the species diversity.

The present study showed low values of 'H' which may be attributed to reduction in number of species due to environmental stress. In station B I, *Lumbriconereis* sp., *Prionospio pinnata*, *Nereis unifasciata*, *Paraheteromastus tenuis* which were present in premonsoon disappeared during monsoon season. In B II, *Nereis unifasciata* and *N.cavifrons* disappeared gradually with the onset of monsoon. The zero value of 'H' in culture fields were either due to absence of any polychaete species or dominance of a single species. Similarly near the bar mouth crustaceans like *Cirolana* fluviatilis, Synidotea variegata which were present during premonsoon disappeared from June onwards. In B V the lowering in species may be due to disappearance of Grandidierella gilesi and thinning of crustacean population caused by changes in hydrographical and sedimentological features.

The mechanisms responsible for the fluctuations in species diversity is still a matter of dispute. Benthic communities at greater depths experience constant environmental conditions and thereby the species diversity remained almost high. The fluctuation, if any, is narrow and that too caused by other biological reasons like interspecific and intraspecific competitions. But shallow water culture fields with greater seasonal environmental fluctuations have a lower species diversity and likely to show marked fluctuations.

Besides natural changes, the lower gradients of Cochin backwaters was subjected to human activities like continuous dredging especially in harbour area. This human interference might have modified the ecological conditions and thereby the benthic fauna and their diversity.

Apart from all these physico-chemical parameters water circulation too played a significant role in the ecology of estuaries. Woodin (1976) observed that water circulation determines the drifting and settlement of larvae. Besides these it also acts as carrier of food and nutrients for the suspension feeder. The present study substantiates the above observation and found that lack of sufficient water circulation might be responsible for lesser faunal assemblage in culture fields. Settlement of Modiolus spats were observed during monsoon both at B I and B II. But nonavailability of Modiolus sp. during premonsoon period in B I can be attributed to heavy current prevailing in that area. Similar observations were made by Kurian (1972).

The present study suggests that species diversity and population density in culture fields were low when compared to backwater stations. The distribution and abundance of macrofauna in perennial culture fields is primarily influenced by salinity followed by pH, dissolved oxygen and organic carbon. In seasonal culture fields biomass was primarily affected by organic carbon and salinity played only secondary role. In backwater stations near the bar mouth the faunal assemblage was affected by a mud reactive phosphate, pH and temperature; salinity indirectly controlled the benthic population. Apart from physico-chemical conditions the nature of substratum also played vital role in the distribution and abundance of faunal assemblages.

A year round investigation of the hydrographical and sedimentological parameters and their relationship with the abundance and distribution of macrobenthic fauna along the various ecosystems may throw more light on this subject.

SUMMARY

1. A comparative study on macrobenthic fauna and the associated environmental parameters was carried out over a period of 6 months from March 15, 1987 to September 1, 1987 in perennial and seasonal culture fields and in adjacent backwaters.

2. Hydrographical data of these three ecosystems showed marked seasonal variations in the temperature salinity dissolved oxygen and pH. The temperature ranged from 28.5-32.2°C and 28.8-32.3°C in perennial and seasonal culture fields respectively; whereas the temperature showed a wide variation from 24.5°C-32.5°C in backwater stations. The peak values of pH ranged from 8.8-9.2 in perennial culture fields and from 8.05-8.15 in seasonal culture systems. In backwaters stations it ranged from 8.2-8.35. Immediate recovery of salinity was noticed in backwater stations near the bar mouth whereas in culture fields and backwater stations away from bar mouth, recovery of salinity was not felt during the course of this study. The upwelling phenomenon resulted in low oxygen concentration during late monsoon in backwaters. Perennial culture fields showed high oxygen concentration during monsoon season.

3. Sedimentological parameters like organic carbon, mud reactive phosphate and grain size were correlated with biomass. Five types of substrata were found to occur - clayey sand, clayey silt, sand-silt and clay, silty sand and sandy type.

4. Organic carbon varied from 0.50-4.96 %, maximum organic carbon was associated with sediment having high percentage of clay. Maximum reactive phosphorus (9.12 µg-at/gm) was also found to be associated with substratum having maximum of silt and clay.

5. Macrofauna was mainly constituted by deposit and detritus feeders. Polychaetes and crustaceans formed the bulk of population. Other groups recorded were nematods, bivalves, gastropods, fishes, prawn seeds, sea anemone, sipunculoidea and star fishes.

6. *Modiolus* sp. were found to be absent from areas with heavy underwater currents as well as substrate with high organic matter. Crustaceans showed no substrate preference but were found to be associated with the availability of food. *Dendronereis aestuarina* was found to be associated with sandy substratum admixed with silt and clay.

7. Biomass showed marked seasonal fluctuations and in certain stations destruction of biomass during south west monsoon periods was also noticed. Biomass as high as

130 gms/m^2 was noticed in backwater stations where as the maximum biomass recorded in culture fields was 34.20 gms/m^2. Maximum biomass was associated with fine sand with equal admixture of clay and silt. The substratum with thick clay supported less biomass.

8. Species diversity declined with the onset of monsoon in backwater stations as well as culture fields. Species diversity of polychaetes and crustaceans were more in backwater than in culture fields.

9. The biomass in backwater stations were found to be statistically correlated with mud reactive phosphate, temperature and organic carbon. In perennial culture systems biomass was mainly affected by salinity, followed by pH, dissolved oxygen and organic carbon. In seasonal fields, benthic faunal assemblages were mainly affected by organic carbon and salinity played a secondary role. Here substrate was not found to be the controlling factor for distribution and abundance of benthic fauna.

10. Besides physico-chemical environmental parameters human interferences like dredging was also one of the factors for changing benthic ecology as well as their species diversity.

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