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ABSTRACT

Studies on the macrofauna from the five selected stations spread over a distance of about 25 km. in the Cochin backwater showed that the benthic biomass was greater in the regions which were near the sea. The abundance of organisms decreased progressively towards the more estaurine zone. The bivalves, gastropods and polychaetes were the most predominant forms in the sample. The presence of larger bivalve, *Meretrix ovum* and the polychaete, *Diopatra neopolitana* at the stations near the sea considerably increased the benthic biomass at these stations. Organisms of lesser importance were crabs, fish, ophiuroids and sea anemones. Studies on meiobenthos which was restricted to the estuarine zone only showed a high degree of abundance of foraminiferans and nematodes. Foraminiferans were more abundant at stations nearer the sea suggesting their preference for marine conditions. The nematodes on the other hand were more dominant at stations away from the sea. An examination of the substrata at five stations showed that the conditions were different from one place to the other. A substratum of fine and coarse sand seems to support a denser benthic population.

The distribution and abundance of macro and meiobenthos when compared with the seasonal changes in physico-chemical conditions of the backwater was investigated. It appeared that perhaps the most important factor governing the quantitative distribution of benthos is the salinity. Settling stages of bivalves and gastropods, which are of purely marine origin, though appear in large numbers, do not survive in estuarine conditions. Areas of high salinity in the backwater are those which are rich in nutrients and chlorophyll and were found to support a denser benthic population.

INTRODUCTION

THE concept of bottom communities has formed the subject of intensive studies as part of the wider investigations on productivity at different trophic

levels. It is well recognised that the distribution and abundance of the benthic animals are directly related to the fisheries of that region. Many earlier authors have carried out intensive work on the bottom fauna and have showed that the study of bottom biomass helps to evaluate their utilization as food for the higher carnivores and fishes (Blegvad, 1930; Bristow, 1938; Jones, 1950, 1951 and 1956; Sanders, 1956; Stickney and Stringer, 1957 ; Mulicki, 1957; Konstantinov, 1960; Segerstrale, 1960).

In India some attempts have been made to study marine and estuarine benthic populations. In earlier works, Annandale (1907) and Annandale and Kemp (1915) have described the ecology of Gangetic delta and the Chilka lake respectively. Seshappa (1953) and Kurian (1955) studied the bottom fauna of the inshore and coastal region of the Malabar and Travancore areas respectively. Krishnamurthy (1966) and Rajan (unpublished) have studied the bottom fauna of Tungabadhra reservoir and Chilka lake respectively. By far, the investigations of Panikkar and Aiyar (1937) are the only well studied accounts of the estuarine bottom communities in India. However, these results were confined to the macrofauna only. No attempts have so far been made to study the meiofauna of Indian waters and as a result their importance as fish food has remained unknown.

The present investigations on the qualitative and quantitative aspects of both macro- and meiofauna of the Cochin backwater began in August 1965 and was extended over a period of one year to observe the seasonal variations in abundance. The division between the macro- and meiofauna as used here is purely arbitrary. All organisms which were retained by a 0·5 mm. sieve were included in the macrofauna whereas those which passed through this sieve but retained by a 0·062 mm. sieve were considered as meiofauna.

GEAR AND COLLECTING TECHNIQUES

In the present investigation two types of grabs were used for the collection of bottom samples. The first was similar to 'Petersen dredge' figured by Welch (1948) but differed slightly. It was more like the instruments described by Ursin (1954). The second, a ' Van veen grab ' was used in the later part of the investigation. It resembled the one described by Thamdrup (1938), but had slight modifications. The Petersen grab sampled 0·044 m^2, whereas the Van veen grab sampled 0·048 m^2. From the samples thus obtained the macrofauna were collected by washing the sediments through a 0·5 mm. mesh sieve. The sample was placed in between two sieves of the same mesh size (0·5 mm.) held tightly together by an iron frame and

this was lowered in the water from the boat so as to remove the sediments. This method of washing prevented the delicate organisms, like small polychaetes from damage. The forms which were retained in 0·6 mm. sieve were collected, identified and counted. The weight of different organisms was determined by drying them in an oven at 110° C. and this was expressed as dry weight. In tubiculous and shelled forms the tubes and shells were removed before their dry body weight was determined.

For the study of meiofauna, subsamples were obtained from the grab sample by inserting a plastic tube 1·85 cm. in diameter and 5 cm. in length from the top surface into the mud. These were preserved in 4–5% formalin and transferred to the laboratory where they were first passed through a 0·5 mm. sieve to remove any macrofauna present and then passed through 0·062 mm. sieve. The organisms which were retained in the latter were collected, identified and weighed. To facilitate comparison, the numbers and weights of animals per haul were converted into values per square metre. This allowed a fair comparison with quantitative surveys of the benthos from other areas (Thorson, 1957).

The hydrographical data were collected simultaneously from all the sampling stations.

General Physical Features of the Area

The Cochin backwater is a typical estuary of about 200 square miles. It has a narrow permanent connection with the Arabian Sea and on the northern and southern sides it receives two major rivers, the Periyar and the Pampa respectively. It also receives several small seasonal or semi-perennial rivers, tributaries and a complex system of canals and sewage drains. Some of these get connected with the sea during the monsoon season. The considerable influx of freshwater from all these sources results in highly dynamic hydrological conditions. These conditions make the backwater a very interesting environment for the study of productivity and fluctuation in total biomass.

Depth in the backwater varies from 1 to 5 metres except in the two dredged channels, namely, the Ernakulam wharf and the Mattanchery channel used for the passage of ships. The depth in these channels is maintained at about 12 metres.

Samples were collected for the present study at five stations from the northern extension of the backwater so as to represent different hydrographic and substratic conditions (Fig. 1). Stations 1 and 2 were situated in the

more saline zone of the channel which leads to the Cochin harbour and the other three stations at Bolghatty, Thevara and Aroor were situated in the southern portions of the Cochin harbour representing typical estuarine onditions.

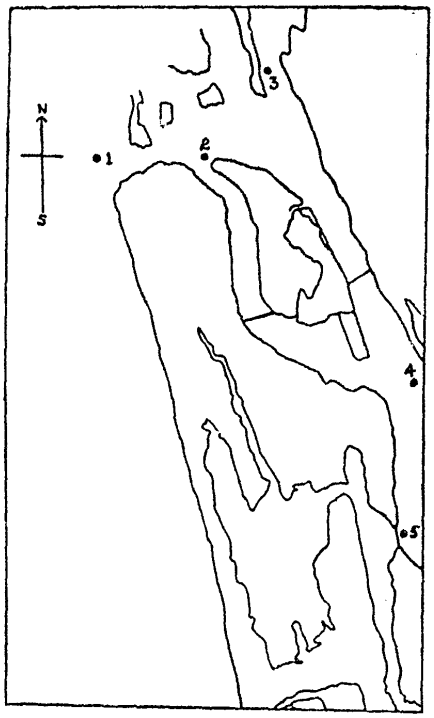

FIG. 1. Map of Cochin backwater showing the five sampling stations.

Hydrographic conditions.—Owing to large influx of freshwater especially during the monsoon months, wide fluctuations in the hydrographic conditions were observed at all the five stations. Some aspects of the hydrography have previously been studied by Ramamirtham and Jayaraman (1963), Cherian (1963), George and Kartha (1963) and Balakrishnan (1957). In the present investigation additional information on temperature, salinity, oxygen, etc., of both surface and bottom waters were collected at the five stations mentioned above by some of our colleagues. Their data show that the surface salinity remains fairly high in pre- and post-monsoon periods falling almost to freshwater conditions during the monsoon season. The bottom salinities are, however, less affected at stations 1 and 2 but a progressive decrease in the bottom salinity occurs from station 1 to station 5. The maximum bottom salinities observed during the year 1965–66 at station 1 (Barmouth) and station 5 (Aroor) were 35·41‰ and 33·06‰ and the minimum were 22·05‰ and 0·68‰ respectively. It is therefore clear that the fluctuations

in the bottom salinities were much wider at the southern stations than those of the northern stations. No significant difference was recorded in surface or bottom temperatures at the five stations, except for a slight decrease during the monsoon months (June–September), the range being 25°–32° C. The backwater generally remains well oxygenated throughout the year. During the monsoon months however the oxygen values are relatively low at the bottom.

The turbidity in the backwater remains high throughout the year and hence the euphotic zone becomes narrow (Qasim and Reddy, 1966).

SUBSTRATA

The grain size analysis of the sediments obtained from the five sampling stations are given in Table I. Medium and fine sand, shell and gravel were

TABLE I

Grain size analysis of the substrata of the five sampling stations in the Cochin backwater—Their percentage composition

Station No.	Gravel 2 mm.	Very coarse sand 2—1 mm.	Coare sand 1 to ·5 mm.	Medium sand ·5—·25 mm.	Fine sand ·25—·0625	Silt	Clay	Remarks
1. Barmouth ..	16·31	2·52	8·50	46·88	25·76	..	..	Medium and fine sand with shell gravel and coarse sand
2. Off Port Trust Building	..	..	0·22	1·41	67·51	11·92	18·88	Fine sand with clay and silt
3. Bolghatty ..	..	..	..	..	2·38	62·15	35·46	Silty clay
4. Thevara ..	..	..	4·54	34·57	22·62	12·53	25·73	Medium and fine sand with clay and silt
5. Aroor ..	..	..	10·59	36·16	34·40	9·89	8·96	Fine medium and coarse sand. Small amount of silt and clay

the major constituents of the sediment at station 1, whereas fine sand with some clay and silt predominantly occurred at station 2. The percentage of silt and clay was highest at station 3 and at stations 4 and 5 the sediment was predominantly sandy with little silt and clay at station 4. Coarse sand was obtained at stations 1 and 5. From these analysis it is clear that the substratum is not the same at all the five stations.

RESULTS

The qualitative and quantitative distribution of macro- and meiofauna at five stations throughout the period of observations are given in

TABLE

Numbers per m^2 of macro- and meiofauna collected at five stations in the

Sampling stations	Animal groups	1965				
		Aug.	Sept.	Oct.	Nov.	Dec.
1	Polychaetes ..	114	Not collected	591	489	477
	Bivalves ..	7773	,,	7386	2932	1773
	Gastropods ..	227	,,	796	2250	..
	Ophiuroids ..	23	,,	..	..	..
	Sea animones ..	..	,,	23	11	..
2	Polychaetes ..	Not collected	Not collected	..	2159	773
	Bivalves ..	,,	,,	4777	68	..
	Gastropods ..	,,	,,	2227	1739	841
	Ophiuroids ..	,,	,,	..	..	..
	Sea animones ..	,,	,,	..	1216	..
	Sipunculids ..	,,	,,	..	23	..
	Crab ..	,,	,,	..	..	46
	Fish ..	,,	,,	..	11	..
3 (Meiofauna)	Polychaetes ..	Not collected	..	..	91	..
	Bivalves ..	,,	..	..	..	..
	Gastropods ..	,,	..	1500	1523	1773
	Crab ..	,,	11	..	67	..
	Fish ..	,,	..	11	..	..
	Foraminifera ..	,,	360715	1872371	37187	Not collected
	Nematodes ..	,,	18594	3719	5578	..
	Copepods ..	,,	3719	..	..	..
	Gastropods ..	,,	3719	..	..	..
4 (Meiofauna)	Polychaetes ..	68	..	68	125	..
	Bivalves ..	34	..	296	..	..
	Gestropods ..	23	..	21685	13161	7296
	Ophiuroids ..	..	..	..	..	..
	Fish ..	..	23	..	..	..
	Foraminifera ..	..	3719	89249	306794	3719
	Nematodes ..	..	3719	7438	1860	..
	Sipunculids ..	..	..	..	..	..
	Bivalves ..	..	..	..	..	..
	Gastropods ..	..	..	11156	..	..
5 (Meiofauna)	Polychaetes ..	114	12	46	57	23
	Bivalves ..	68	..	1580	1591	227
	Gastropods ..	46	..	273	34	795
	Solen ..	..	..	..	..	..
	Faraminifera ..	Not collected	..	7438	7438	..
	Nematodes ..	,,	..	..	3719	..
	Gastropods ..	,,	1860	..	..	..
	Worm ..	,,	..	..	..	11156
	Bivalve ..	,,	..	..	..	..
	Ciliate ..	,,	..	..	..	..

Tables II and III. It can be seen from the tables that some species numerically predominate over others. The criterion used for dominant species was whether it occurred in 50% or more hauls at a given station. The macrofauna could thus be classified into two groups, the dominant species

II

Cochin backwater, 1965–66

1966

Jan.	Feb.	March	April	May	June	July	Aug.
477	..	..	..	Not collected	Not collected	Not collected	1369
1773	2091	227	2182	,,	,,	,,	602
23	182	977	23	,,	,,	,,	104
..	..	..	..	,,	,,	,,	..
..	..	..	..	,,	,,	,,	..
Not collected	2477	1205	136	Not collected	25	..	353
,,	46	..	..	,,	8523	9022	809
,,	..	..	1114	,,	..	..	..
,,	..	..	..	,,	..	..	..
,,	..	..	..	,,	..	..	..
,,	..	..	..	,,	..	..	46
,,	..	..	..	,,	..	46	46
,,	..	..	..	,,	..	23	..
..	..	46	..	Not collected	..	166	62
..	46	..	..	,,	..	..	..
7977	409	1136	2477	,,	4341	..	519
..	..	..	..	,,	..	..	..
..	..	..	..	,,	..	..	..
237998	..	3719	762336	,,	..	..	118999
..	11156	..	..	,,	3719	..	..
..	..	..	..	,,	..	..	..
..	..	..	..	,,	..	..	3719
523	..	477	..	227	114	83	104
136	..	..	..	114	864	166	..
40500	5386	13159	10909	1273	932	..	17111
..	..	..	..	..	23	..	..
..	..	..	..	..	..	..	..
7438	..	11156	..	..	3719	..	349559
3719	275185	11156	14875	3719	14875	59499	26031
..	..	..	..	3719	..	..	..
..	26031	..	..	..	..	..	7438
..	..	11156	..	..	..	..	37187
..	114	..	23	..	136	685	104
1227	614	614	2318	2204	4796	5870	6782
364	909	46	136	137	3387	228	..
..	..	..	23	46	..	..	..
3719	..	..	..	3719	..	..	7438
..	3719	..	3719	70656	18594	..	3719
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	223122	7438
..	..	..	..	..	..	7438	..

and the associate or subsidiary species. The meiofauna can similarly be distinguished into following groups: temporary forms, permanent forms and occasionally occurring forms.

Composition of the fauna and thair numerical abundance.—The faunal composition at all the five stations studied could be broadly distinguished into two groups, namely those of marine origin at stations 1 and 2 and those which were estuarine forms and occurred at the southern stations 3, 4 and 5. The fauna at stations 1 and 2 were more or less similar and these therefore have been described together. The bivalve, *Meretrix ovum*, the gastropod, *Canculus clanguloides* and the polychaete, *Diopatra neopolitana* were most abundant at stations 1 and 2. *M. ovum* however was replaced by another bivalve, *Modiola striatus* at station 2 during the monsoon months. *M. ovum* was more abundant at station 1. However, data are lacking at this station for the monsoon months due to difficulties in sampling. *C. clanguloides* were more abundant in October–November period. The maximum as seen in Table II was recorded at station 1 in November and at station 2 in October. The large tubiculous polychaete, *Diopatra neopolitana*, was another dominant form at these two stations. Its population was denser at station 2 where the maximum number was recorded in December 1965.

The associate or subsidiary species appeared in some months at both the stations. Small settling stages of sea anemones occurred in samples taken during November 1965 at station 2, but these did not occur again. Similarly, four species of gastropods, *Nasa* sp., *Subulina* sp., *Murex* sp. and *Xanus* sp. occurred only once at station 1. Few sipunculids and ophiuroids were also found at station 2 during the post-monsoon period of 1965. Other species occurring occasionally were the crab, *Halicarcinus* sp. and the fish, *Tripuchin vagina.*

Samples for meiofauna were not collected at stations 1 and 2 since an undisturbed sample could not be obtained.

The macrofauna at stations 3, 4 and 5 were typically estuarine as they were not seen at stations 1 and 2. The dominant forms at these stations were bivalves, settling stages of gastropods and polychaetes. *Nuculana mauritiana*, a small bivalve, occurred in small numbers at station 3 (Bolghatty) only twice but it was more abundant at station 4 (Thevara) and station 5 (Aroor). Its maximum number was collected at station 5 in August 1966. Newly settled stages of gastropods were recorded in large numbers at stations 3, 4 and 5. These were more numerous at station 4 than at stations 5 and 3. The newly settled stages were found practically throughout the year showing

two peaks in their abundance, once during October and the other in January. Adult gastropods however were not found in any samples collected at these three stations. Three forms of polychaetes were found at stations 3, 4 and 5. These were *Nephthys* sp., *Lambrineris* sp. and *Glycera* sp. These polychaetes were small in size and occurred in smaller numbers. They were relatively more numerous at station 4. Their maximum numbers were recorded at station 4 during January and March.

The subsidiary species comprised of the crab, *Xenophthalmus* sp. which was collected at station 3 during September and November and the fish, *Tripuchin vagina.*

It is evident from Table II that the macrofauna was poorest in September at all stations as very few organisms were recorded in this month, some sampling stations showing no forms at all. Such absence or poor representation of macrofauna could not be ascribed to sampling deficiencies as several attempts failed to yield more numbers. Some fishes, polychaetes and crabs were however collected during second fortnight of September. From October onwards there was a progressive increase in the benthic biomass at all stations.

As mentioned earlier the meiofauna was composed of the following three groups: (*a*) temporary settling stages of bivalves and gastropods, (*b*) permanent meiobenthos and (*c*) forms that occurred occasionally. In addition to the above three groups, meiobenthos also included some pelagic forms such as the foraminiferan, *Globigerina bulloides.* The occurrence of this species in the bottom samples may probably be accidental. Cole (1955) also noted that many holoplanktonic species were closely associated with benthos.

Temporary meiobenthos was comprised of settling stages of bivalves and gastropods although these did not occur regularly in the samples. Their occurrence in the meiofauna may be an indication of the spawning period of adults. Maximum numbers of bivalves occurred at station 5 whereas more gastropods were found at station 4. It is interesting to note that the maximum abundance of bivalves and gastropods in the meiofauna corresponded to their peaks in the macrofauna. The bivalves were represented mostly by *Nuculana mauritiana.*

Foraminiferans and nematodes were the dominant groups found. Five species of Foraminifera occurred in the sample. These were *Rotalia becccarii, Globigerina bulloides, Bolivina nobilis, Nonion* sp. and *Discorbis* sp.; of

which *R. beccearii* was most common. This species grows to a large size and these larger forms were occasionally collected in the sample. It is evident from Table II that the abundance of foraminiferans progressively decreases from stations 3 to 5. This probably suggests that they are of marine origin. At station 3, three peaks of abundance were observed during October, January and April and at station 4 only two peaks were found during November and August.

Nematodes were found in larger numbers at the two southernmost stations 4 and 5. This probably suggests that these are brackish-water forms. Out of these two stations the nematodes were more abundant at station 4. This may be due to differences in the nature of substratum. Although the substratum at stations 4 and 5 are predominantly sandy the percentage of silt and clay is much higher at station 4 and it seems that a sandy-silty substratum is conducive to the abundance of more organisms than a substratum of clean sand. The maximum number of nematodes at station 4 was observed during February and July. The scarcity of nematodes at station 3 may be due either to the proximity of this station to the sea or because of the clayey-silty substratum. Among the nematodes *Microlaimus* sp. seems to be the commonest form. In addition to the above two groups of the meiofauna several other organisms occurred occasionally in the samples. These were ciliates, copepods, sipunculids and other unidentified worms.

Determination of dry weight.—The values of dry weight of macro- and meiofauna collected during the period August 1965 to August 1966 are summarised in Table III and graphically shown in Figs. 2–5. The weights which express the dry weight/m^2 include only the dominant species. These were obtained after heating the specimen in an oven at 110° C., until the dehydration was complete and the weight became constant. Before dehydration the shells and tubes were removed and in case of smaller forms where it was not possible to remove the shells by dissection, these were dissolved in dilute HCl and washed before dehydration.

From Table III and Figs. 2–4, it is clear that the biomass or dry weight in gm./m^2 is greater at stations 1 and 2 than at other stations 3–5. The presence of large bivalves and polychaetes influences the dry weight of organisms per unit area which is considerably higher at stations 1 and 2. Between these two stations the biomass is greater at station 1. The weight per square metre is lowest at station 3 throughout the year, the maximum being in January and minimum in July, 0·25 gm. and 0·049 gm. respectively. The maximum biomass at station 4 was only 4·25 gm./m^2 in June. This

TABLE III

Weight per m² of macro and meiofauna collected at five stations in the Cochin backwater, 1965–66

Sampling stations	Animal groups	1965					1966							
		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
1	Polychaetes	2·2728	Not collected	11·8182	9·7740	9·5454	9·5454	0	0	0	Not collected	Not collected	Not collected	27·3768
	Bivalves ..	1011·2334	,,	960·9667	381·4753	230·6321	230·6321	272·0273	29·5678	283·8547	,,	,,	,,	78·1849
	Gastropods	0·04545	,,	0·1590	0·4500	0	0·0045	0·0363	0·1954	0·0045	,,	f,	,,	0·0207
2	Polychaetes	Not collected	Not collected	0	43·1870	15·4546	Not collected	49·5456	24·0910	2·7272	Not collected	5·0000	0	7·0516
	Bivalves ..	.	,,	621·5228	8·8702	0	,,	5·9130	0	0	,,	377·9500	378·9198	33·9711
	Gastropods	.	,	0·4454	0·3477	0·1681	,,	0	0	0·2227	,,	0	0	0
3	Polychaetes	Not collected	0	0	0·0272	0	0	0	0·0136	0	Not collected	0	0·0497	0·0186
	Bivalves ..	,,	0	0	0	0	0	0·2208	0	0	,,	0	0	0
	Gastropods	,,	0	0	0·0502	0·0585	0·2632	0·0135	0·0375	0·0817	,,	0·1422	0	0·0171
	Foraminifera	,,	3·3553	17·4167	0·3459	Not collected	2·2138	0	0·0345	7·1912	,,	0	0	1·1096
	Nematodes	,,	0·4374	0·0875	0·1312	,,	0	0·2624	0	0	,,	0·0875	0	0
4	Polychaetes	0·0204	0	0·0204	0·0375	0	0·1568	0	0·1431	0	0·0136	0·0340	0·0248	0·0311
	Bivalves ..	0·1657	0	1·4360	0	0	0·6627	0	0	0	0·5522	4·1972	0·8063	0
	Gastropods	0·0007	0	0·7155	0·4343	0·2407	1·3365	0·1775	0·4342	0·3600	0·0420	0·0307	0·5646	0·5746
	Foraminifera	Not collected	0·0345	0·8301	2·8537	0·0345	0·0691	0	0·1037	0	0	0·0345	0	3·2516
	Nematodes	,,	0·0875	0·1750	0·0437	0	0·0875	6·4748	0·2624	0·3499	0·0875	0·3499	1·3999	0·6124
5	Polychaetes	0·0340	0·0035	0·0136	0·0170	0·0068	0	0·0340	0	0·0068	0	0·0409	0·2053	0·0311
	Bivalves ..	0·3313	0	7·6775	7·7327	1·1045	5·9645	2·9822	2·9822	11·2663	10·6036	23·3059	28·5255	32·9604
	Gastropods	0·0015	0	0·0090	0·0011	0·0262	0·0120	0·0300	0·0015	0·0045	0·0037	0·1275	0·0075	0
	Foraminifera	0	0	0·0691	0·0691	0	0·0345	0	0	0	0·0345	0	0	0·0691
	Nematodes	0	0	0	0·0875	0	0	0·0875	0	0·0875	1·6624	0	0·4374	0·0875

was so even when the numerical value of organisms was very high, for in this month small settling stages of gastropods become too numerous, and these do not contribute much towards total weight. The weight of animals per unit area is comparatively higher at station 5, which is the southernmost sampling centre, than that of the stations 3 and 4. Here the values obtained in June, July and August were 23·428, 28·428 and 32·99 gm/m^2 respectively. This was due to the presence of small bivalve, *Nuculana mauritiana*.

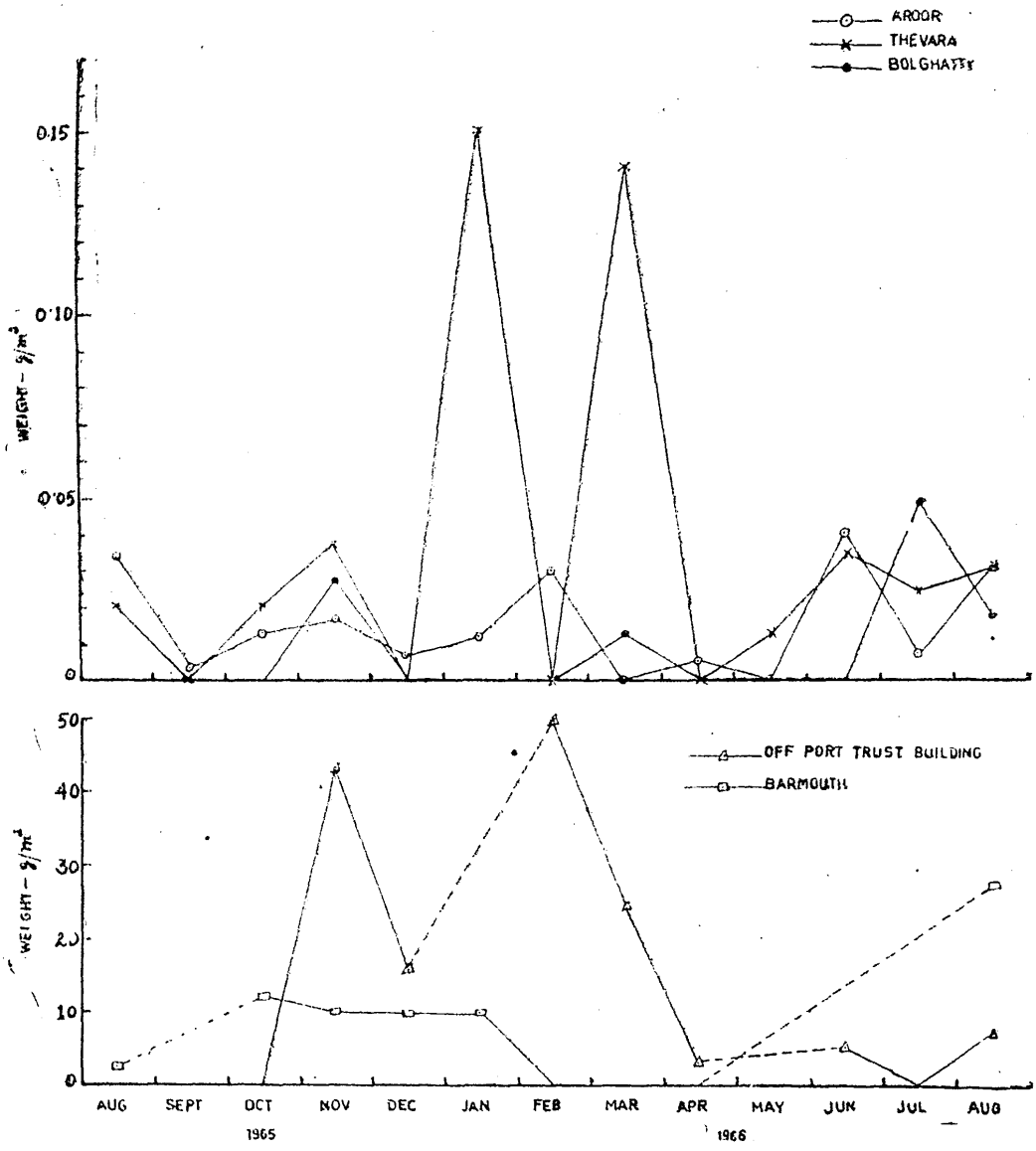

FIG. 2. Graph showing weight (gm/m^2) of polychaetes at the five sampling stations during 1965-66.

The weights of meiofauna were determined after dehydrating them in 95% alcohol. The results are summarised in Table III and Fig. 5. It can be seen from the figure that although the macrofauna is least abundant at

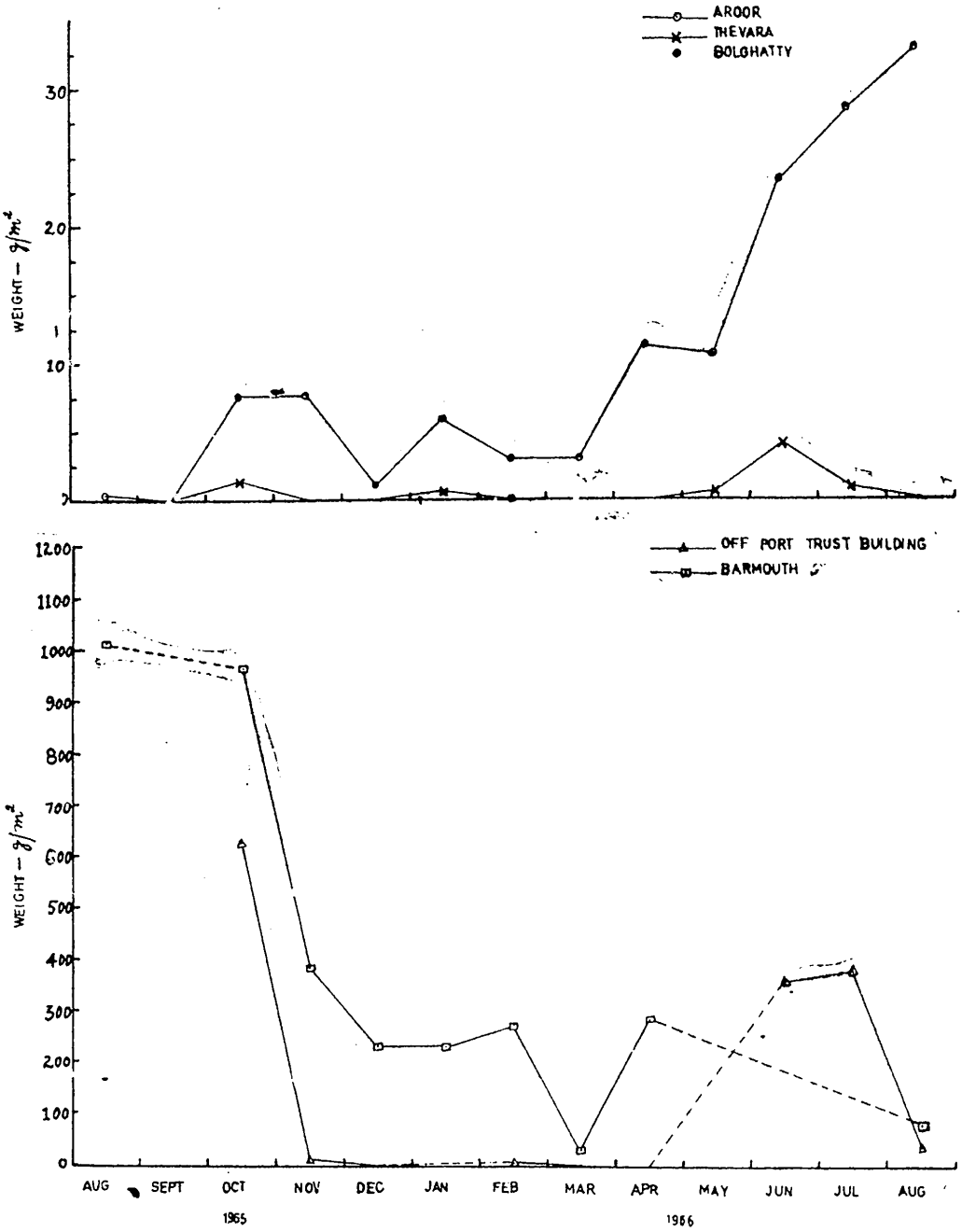

FIG. 3. Graph showing weight (gm/m²) of bivalves at the five sampling stations during 1965-66.

station 3 meiofauna is most abundant here and the maximum weight of meiofauna was recorded during October when the total biomass was 17·504 gm/m². The sample from station 3 collected during July did not show any animals. The meiobenthos was least abundant at station 5 and the maximum weight recorded in May was only 1·697 gm/m². However, it appears that in these three stations where macrofauna is comparatively poor, meiofauna is relatively richer and the latter may form an important constituent of the benthos in the food-chain relationship.

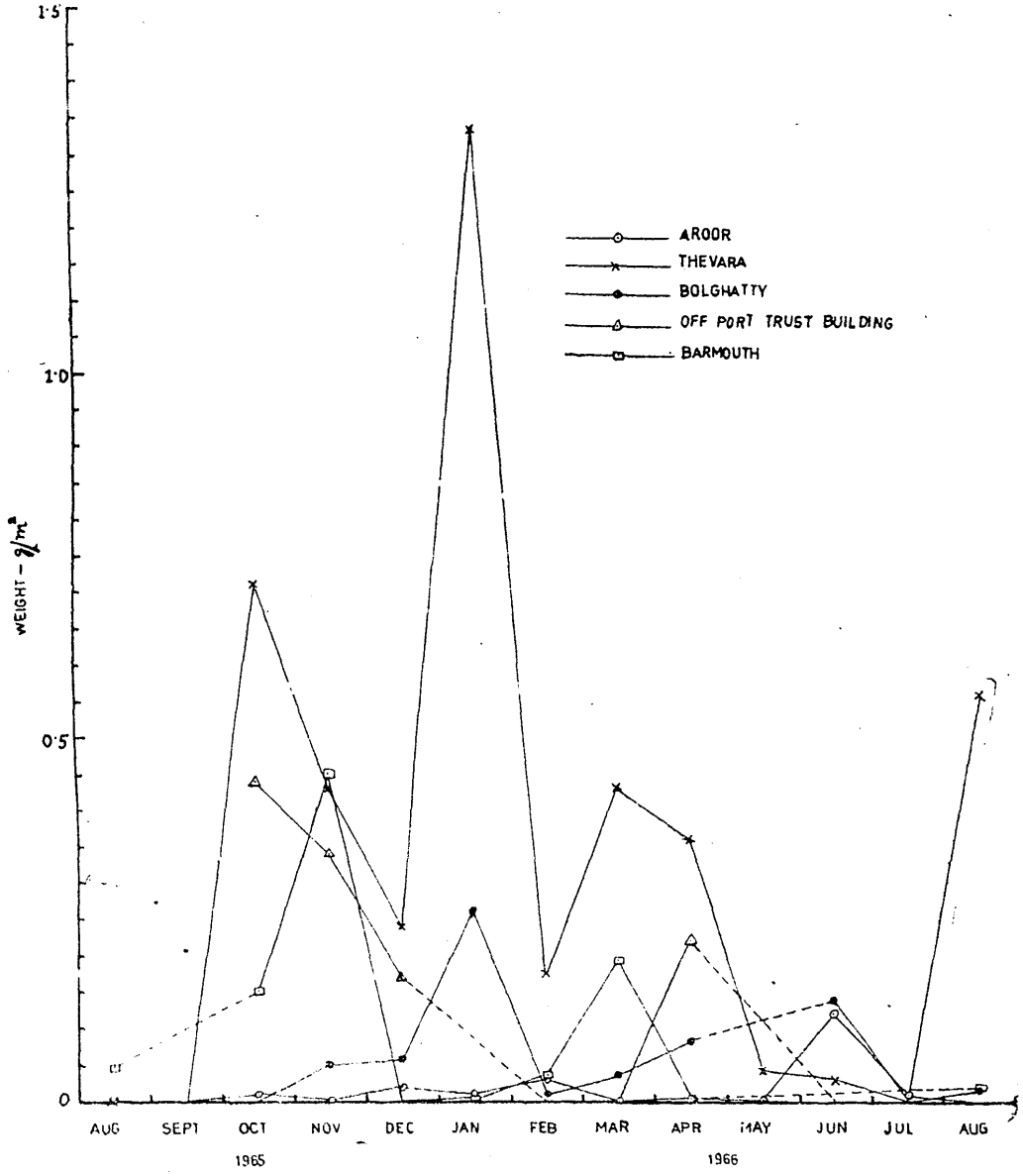

FIG. 4. Graph showing weight (gm/m²) of gastropods at the five sampling stations during 1965-66.

Foraminiferans showed two peaks in their weight once during October and the other during April. These corresponded to its numerical abundance. A greater biomass at station 3 was largely due to foraminiferans. The weight of nematodes recorded at station 4 was higher than the other two stations, the maximum being in February. At stations 3 and 5 it was considerably lower.

Many species discussed above seem to be distributed in groups. This might increase the sampling variability. Variations in the depth to which the grab penetrates may also be another factor. Hence for the precise estimates of standing crop and benthic productivity it is very desirable to have more extensive sampling.

Factors Influencing Distribution and Abundance of Benthic Fauna

The qualitative and quantitative studies of both macro- and meiofauna show variations in their distribution and abundance from one station to the other in the backwater which may probably be due to various biological and physico-chemical environmental factors. The possible biological factors seem predation, nature of reproduction such as the existence of pelagic phase in the life-history and the duration of life-span. Since very few predators were recorded in the samples, this factor alone may not be important in governing the variability of the estimates of biomass. It is well known that species with a pelagic phase and those with a shorter span of life are subjected to greater fluctuations. This may have some influence in introducing variability in the abundance of organisms such as the foraminiferans, nematodes. and probably the polychaetes and molluscs. The possible effects of other environmental factors such as salinity, temperature, oxygen, turbulence, etc., can be discussed as follows:

The temperature was more or less uniform at all the five sampling stations. It ranged between 25°–32° C. during the period of observation. Backwater is well oxygenated almost throughout the year, the oxygen values showed only a slight vertical gradient during monsoon months. It is therefore evident that temperature and oxygen may not be the limiting factors for colonization by the bottom communities in the more estuarine sections of the backwater.

However a marked difference in the salinity values of the surface water between the pre- and post-monsoon periods was recorded at all the stations. During the monsoon months the bottom salinities at stations 1 and 2 do not change much, whereas at the other three stations 3–5, the values decrease

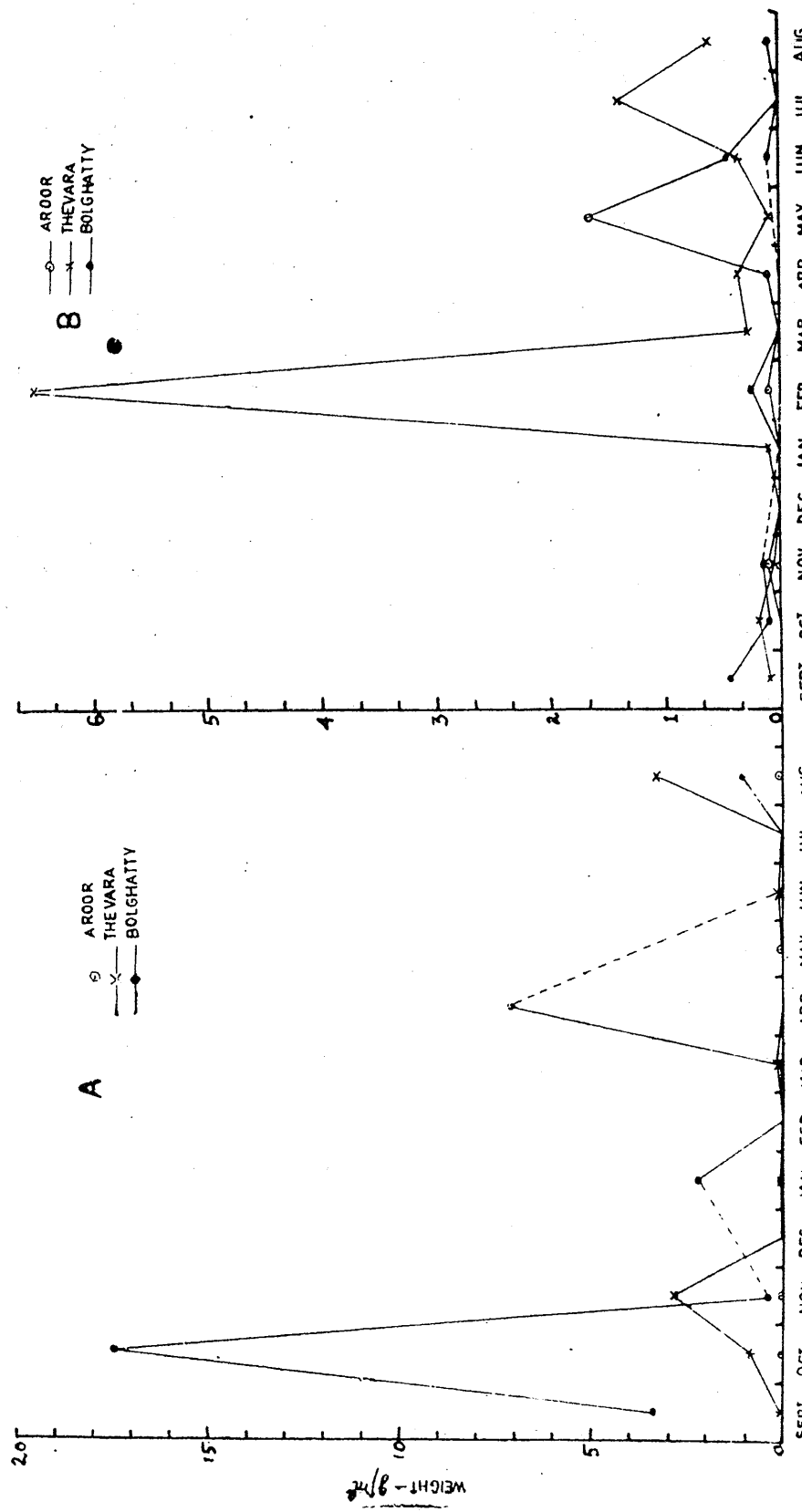

FIG. 5. Graph showing weight (gm/m²) at stations 3, 4 and 5 during 1965-66. A. Foraminifera. B. Nematodes.

considerably. Wide fluctuations in salinity therefore at stations 3–5 may be an important factor governing the faunal composition and abundance. Poor fauna at station 5 compared to station 1 is mainly due to the unstable salinity conditions at the former although the substrata at the two stations are more or less similar. The reason for the stations 1 and 2 having a more stable environment may be due to their nearness to the sea and also due to their being deeper than the other three stations. Seshappa (1953) observed that salinity of water governed the abundance of species considerably in the inshore regions of the Malabar coast during the monsoon months. When the salinity was low the benthic animal communities either disappeared or became very poor in abundance.

The nautre of substrata can be another important factor restricting the abundance of bottom fauna. Eggleton (1931) found complete absence of bottom animals on a substrata of clean sand. However, there are reasons to accept that if there is strong current bringing nutrients or if the productivity of the water column lying above is high then denser populations can exist. Panikkar and Aiyar (1937) observed absence of animals on substrata of thick clay and their greater abundance on loose substratum. The presence of clayey-silty substratum at station 3 may be greatly responsible for its having a poor fauna in comparison to other stations. The substratum at station 1 is composed of shell gravel, medium and fine sand whereas at station 2 it has fine sand with small amounts of silt and clay. The abundance of tubiculous polychaetes and large bivalves at these two stations probably indicates that these animals show a greater preference towards such substrata. It has been stated earlier that the macrofauna is poorest at station 3. This may be mainly due to changes in salinity or clayey-silty substratum. However it may be noted that from the meiofauna the foraminiferans were quite abundant at station 3 and these were less in numbers at stations 4 and 5. This may be due to their preference towards more saline environment.

At station 1 which is very near the sea there is always strong current. This water is therefore continuously replaced and so are the nutrients at this station. Abundance of larger filter feeding organisms like bivalves and polychaetes may therefore be attributed to a rich supply of nutrients in this area. Thorson (1934) from a study of the ecology of Scoresby Sound Fjord-complex states that communities located near the open sea benefit from a greater nutrient supply than those in Fjords stretching a 100 kilometres or more in length. McIntyre (1961) has observed that the area, where the chlorophyll content of the surface waters is high, supports a greater population of benthic animals due to the higher rate of deposition of organic

material from the upper waters on to the bottom. Qasim and Reddy (1966) have found that the plant pigment concentrations are higher at station 1 than at station 4 in the backwater. Their range of values are 4·20–7·40 mg./m^3 and 2·96–4·39 mg./m^3 at stations 1 and 4 respectively, from June to September. The results of observations on the rate of photosynthesis (unpublished) also indicate that the primary production is significantly higher at station 1 than at station 4. A greater content of chlorophyll at station 1 probably may contribute to a greater benthic biomass found in that area.

It therefore appears that higher salinity, favourable substratum and rich supply of nutrients lead to greater abundance of the bottom fauna, and probably the animal communities become more abundant where the interaction of all these factors results into a stable and favourable environment.

FOOD CHAIN RELATIONSHIP

The role of macro- and meiofauna in the food chain of the Cochin backwater is not clearly understood. The macrofauna in the backwater being filter or bottom feeders probably depend largely on detritus and plant material. They in turn may form the food of some predators like crabs and fishes. Cole (1955) has suggested that in the absence of benthic predators, meiofauna may not contribute much to the food chain. This seems to be true in the stations 3–5 of the Cochin backwater because of the relative scarcity of benthic predators. This is despite the fact that meiofauna is relatively more abundant than the macrofauna. With more data on the production at different trophic levels it may be possible to attribute the role played by benthos in the food chain.

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