

DISTRIBUTION OF ZOOPLANKTON IN SPACE AND TIME IN A TROPICAL ESTUARY

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ABSTRACT

The variations in zooplankton abundance in the backwaters from Cochin to Alleppey was studied for a year. The patterns of ecological distribution of various groups and species were essentially controlled by the hydrographic changes. The seasonal cycle encountered in the hydrographical conditions were exhibited by the zooplankton species also. Of the environmental factors salinity acts as the major factor determining the viability of the various species in the estuary. Except for a few low saline species higher abundance of most of the zooplankton organisms was encountered during the high saline pre-monsoonal period. The monsoons which periodically flush out the estuary and render it unstable for part of the year induce considerable changes in the environment and population. During the peak of the monsoon the water in the estuary became practically fresh and the total biomass of the zooplankton was greatly reduced. The gradual recovery during the post-monsoonal period attained its maximum by late pre-monsoon period.

INTRODUCTION

The backwaters of Kerala along with its network of anastomosing canals spread and extend almost throughout the coast line and form important areas of fisheries and other human use. It opens into the Arabian Sea at Cochin and this facilitates free mixing of sea water with the fresh water which originates from the rivers that empty into the backwaters. The regular tidal rhythm influences the mixing and flow patterns giving it the features of an estuary. Apart from the tides, the seasonal outbursts of the monsoons have great bearing in controlling the environmental factors and thereby the distribution of the organisms of the estuary.

The zooplankton of the estuary has been studied earlier by several authors. George (1958) has given an account of the general composition of the zooplankton. The biomass and the faunal composition has been studied by

Nair and Tranter (1971) and Menon *et al.* (1971); hydromedusae by Vannucci *et al.* (1970) and Santhakumari and Vannucci (1971); chaetognaths by Vijayalakshmi Nair (1971); copepods by Wellershaus (1969, 1970); species of the family Acartiidae by Tranter and Abraham (1971) and calanoid copepods by Pillai (1971) and Pillai *et al.* (1973). The seasonal and spatial distribution of the zooplankton covering a major portion of the backwaters from Cochin, where the estuary has direct connection to the sea, to Alleppey where it terminates into a large body of fresh water - the Vembanad Lake-forms the subject of this study.

MATERIAL AND METHODS

Zooplankton samples were collected from seven stations fixed along the backwaters from Cochin to Alleppey in every month of the year 1972. (Haridas *et al.*, 1973). The hauls were oblique from bottom to surface using a HT Net (mesh size 300 μ) with a flow meter attached. Hydrographic features such as salinity, temperature and oxygen were recorded along with it.

RESULTS

The salinity distribution underwent drastic changes during the span of the investigation. Based on it, the period could be divided into three seasons (Fig. 1). During the pre-monsoon period from January to April the influence of the saline water could be traced up to the head of the estuary. However, its magnitude decreased with the distance from the mouth. The water column was well mixed and no sharp differences in salinity occurred at any depth. The salinity values fell with the onset of the monsoon. Except in the bottom layers at the lower reaches salinity was low throughout the estuary. Towards the head, the water become practically fresh. Clear stratification of the water column was seen at the lower reaches marking off the extent to which the tidal influx could penetrate. The post-monsoonal period of November-December represented the period of gradual recovery of salinity starting at the mouth to merge into the pre-monsoonal conditions of the succeeding year. Eventhough the average temperature values fell with the monsoon, the differences were not much, ranging between 1°C to 2.3°C (Haridas *et al.*, 1973).

The seasonal and spatial fluctuations in the zooplankton distribution was reflective of the salinity changes in the estuary. The biomass and the total numbers of zooplankton (Fig. 2) at various stations were higher throughout the estuary during the pre-monsoon period. They fell during the monsoon

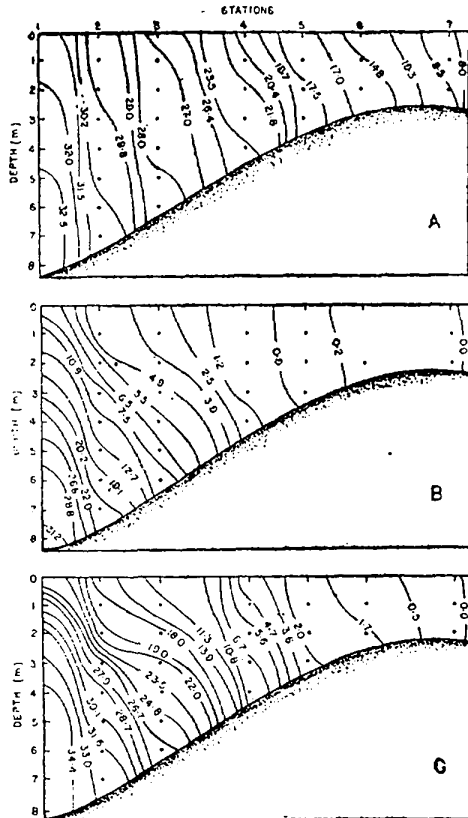


Fig. 1. Seasonal distribution of salinity from Cochin to Alleppey during the year 1972. A. Pre-monsoon (January - April), B. Monsoon (May - October), C. Post-monsoon (November - December).

and increased at the lower reaches during the post-monsoon season. Crustacea constituted about 93% of the total annual zooplankton counts. An increase in the biomass seen at the mouth during the monsoonal period was owing to an influx of hydromedusae and ctenophores in large numbers following a break in the rains and a subsequent temporary increase of salinity in June.

Hydromedusae (Fig. 4, I)

Hydromedusae were present throughout the estuary in the pre-monsoon period. They disappeared when the salinity became low except for an influx,

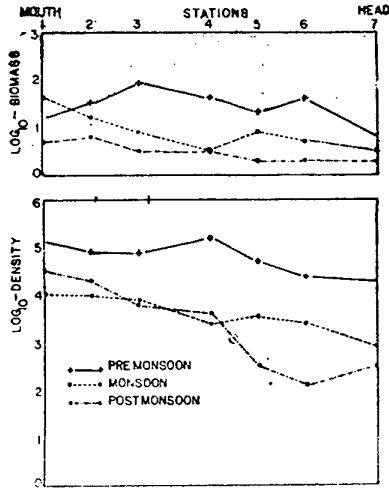


Fig. 2. Seasonal distribution of biomass (ml/100 m³) and density (no/100 m³) of total zooplankton from Cochin to Alleppey, 1972.

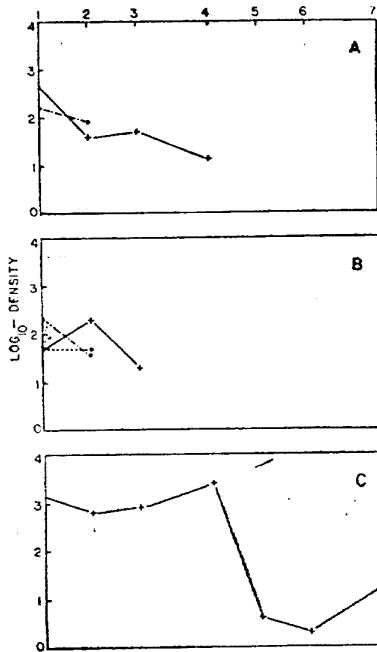


Fig. 3. Seasonal distribution of density (no/100 m³) of species of Chaetognatha from Cochin to Alleppey, 1972. A. *Sagitta enflata*, B. *S. bedoti*, C. *S. oceania*. (Description of lines and stations for figures 3 - 5 as in figure 2.).

presumably from outside the barmouth, in June. In December a few of them occurred at Station 2. The common species which constituted the majority of the hydromedusae were *Eutima commensalis*, *Eirene ceylonensis* and *Balckfordia virginica*. Their counts were higher at the middle reaches of the estuary.

Ctenophora (Fig. 4, A)

Their distribution was more or less similar to that of hydromedusae. *Pleurobrachia* sp. was the dominant form.

Chaetognatha (Fig. 3)

The species *Sagitta enflata* was present at the lower and the middle reaches of the estuary during pre-monsoon season. After being absent during the low salinity conditions they reappeared at the lower reaches in the post-monsoon period. *S. bedoti* also showed a similar kind of distribution except that they were present at the mouth in June. *S. oceania* occurred throughout the estuary during late pre-monsoon period and were present in large numbers at Stations 1 to 4.

Copepoda (Fig. 5)

Copepods were present throughout the backwaters in all seasons. However, consistent high numbers were recorded during the high saline period. Their numbers which fell with the monsoon began to increase again at the mouth regions during the post-monsoon period. Of the family *Paracalanidae*, the species *Acrocalanus similis* and *Paracalanus aculeatus f. major* were present in large numbers especially at the lower and middle reaches during high salinity regime. *Acrocalanus monachus* and *Paracalanus crassirostris f. cochinensis* also occurred during this period. The species *Centropages alcoki* and *C. trispinus* were present at the lower reaches in January and February. *C. tenuiremis* occurred in large numbers at the mouth in August. *Heliodiaptomus cinctus* and *Allodiaptomus mirabilipes* were two monsoonal species which occurred only during low salinity regime. *Pseudodiaptomus serricaudatus* was present throughout the estuary in the peak salinity month of April. In the other months of pre-monsoon and post-monsoon period it occurred at the lower and middle reaches. *P. annandalei* occurred at the lower and middle reaches of the estuary in most of the months. The species *P. mertoni* was encountered at the mouth when salinity was high. *P. binghami malayalus* was present in small numbers during the monsoonal period. Of the family Pontellidae, *Labidocera pectinata* was the common species and were frequent during the high saline period.

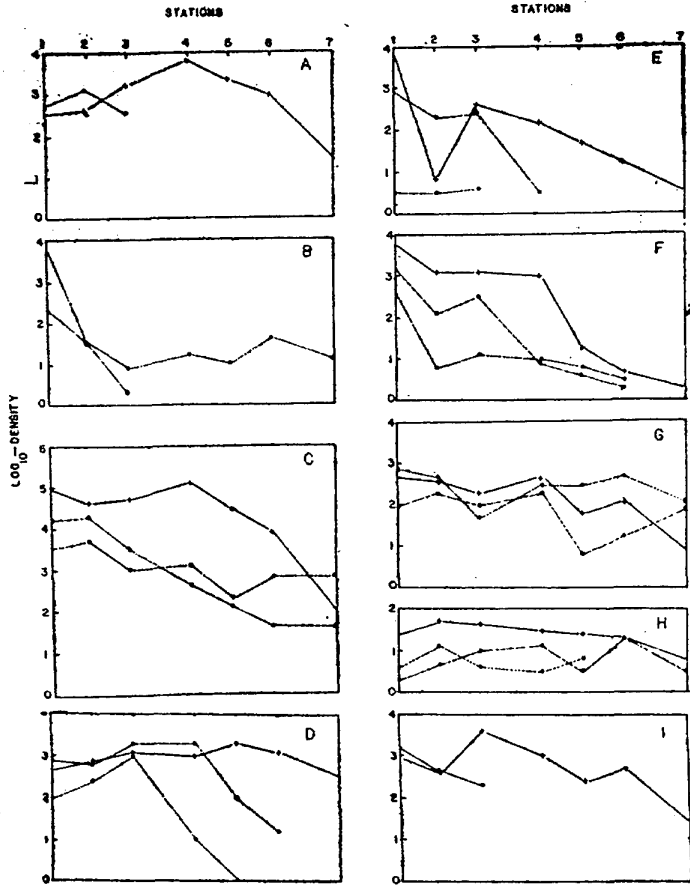


Fig. 4. Seasonal distribution of density (no/100 m³) of A. Ctenophora, B. Cladocera, C. Decapod larvae, D. Lucifer, E. Invertebrate eggs, F. Fish eggs, G. Fish larvae, H. Amphipod, I. Hydromedusae from Cochin to Alleppey.

The species of the family Acartiidae constituted the majority of the copepods of the estuary. The species *Acartia centrura*, *A. bilobata* and *A. spinicauda* extended throughout the estuary during pre-monsoon period. Their abundance dwindled during the low salinity period when they were restricted to the lower reaches. Though the species *Acartiella keralensis* occurred at all stations they were present in lesser numbers at the lower reaches during high salinity regime. Later they moved down the estuary

when the salinity became very low at the head. *Acartia plumosa* also showed almost same trends of distribution as that of *Acartiella keralensis*. *Acartiella gravelyi* which is a low saline species was absent in the pre-monsoon period. It occurred at all stations during the monsoon, and at stations where the salinity had not yet recovered in early post-monsoon season.

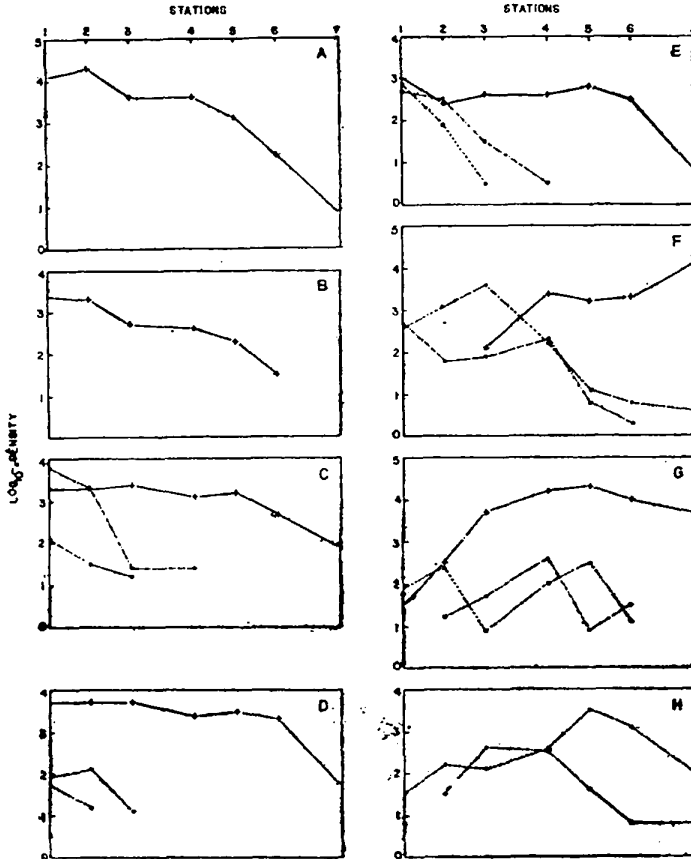


Fig. 5. Seasonal distribution of density (no/100 m³) of some common species of copepods from Cochin to Alleppey, 1972. A. *Acrocalanus similis*, B. *Paracalanus aculeatus*, C. *Acartia centrura*, D. *A. bilobata*, E. *A. spinicauda*, F. *A. plumosa*, G. *Acartiella keralensis*, H. *A. gravelyi*.

Cladocera (Fig. 4, B)

This group was present during monsoon and post-monsoon periods. *Evadne tergestina* and *Penilia avirostris* were the two species present in the estuary.

Amphipoda (Fig. 4, H)

Gammarid amphipods were present in small numbers in the estuary in all seasons. Higher abundance was noticed during the pre-monsoonal period.

Lucifer (Fig. 4, D)

The two species *Lucifer hansenii* and *L. typus* occurred throughout the estuary during high salinity period. Their distribution was restricted to the lower and middle reaches during the other seasons. Their numbers after being low in the monsoon increased again during post-monsoonal period.

Invertebrate eggs (Fig. 4, E)

Eggs of invertebrates were present throughout the estuary during high salinity regime. They occurred in small numbers at the lower reaches during the monsoons and increased by the end of the post-monsoon period.

Decapod Larvae (Fig. 4, C)

Large numbers of decapod larvae especially brachiuran zoea were present in the estuary. They constituted majority of the total annual zooplankton counts.

Fish Eggs and Larvae (Fig. 4 F, G)

The distribution of fish eggs showed higher abundance during pre-monsoon season. But the number of fish larvae were high in all seasons of the year and were present at all stations.

Other organisms as polychaete larvae, alima larvae, actinotroch larvae, cyphonautes larvae, ostracods, cumaceans and copelates were also present in some of the collections. The larvae occurred mostly at the mouth of the estuary during the high salinity regime.

DISCUSSION

Salinity acts as the major factor controlling the distribution of the organisms in the backwaters. The entire estuary becomes saline and rich in animal life during the pre-monsoonal period. About 90% of the common

species occurring in the estuary registered their peak abundance during this period. The optimum conditions in which most of these estuarine species flourish seem to be somewhat away from the mouth to the middle reaches as their densities were higher at these stations. This area represents a more stable environment when compared to the mouth which is subjected to disturbances due to tidal mixings.

The seasonal variations induced by the monsoons directly affect the salinity distribution. The salinity influx becomes restricted to the bottom layers at the lower reaches showing a two layered flow and the occurrences of the high saline species were restricted to this area. The estuary became scantily populated when compared with pre-monsoon period. Only a few low saline species and those tolerant to lesser salinities such as *Heliodiaptomus cinctus*, *Allodiaptomus mirabilipes*, *Pseudodiaptomus annandalei*, *P. binghami malaylus* and *Acartiella gravelyi* thrived in the middle or upper reaches of the estuary. A gradual repopulation of the estuary following a recovery of the salinity began in the post-monsoonal season. The "seeds" of zooplankton drifting in from the sea and the possible resting stages which may occur in the backwaters when the environmental conditions are adverse and spring back to activity when the salinity regains, breed and repopulate the estuary during the succeeding high salinity period.

The structure of associations of the zooplankton are also indirectly linked with salinity because the stability of the niches is controlled by its distribution. The distribution of various species undulates up and down the estuary depending on the salinity variations. Species having similar distribution can be assumed to invade similar niches. Tranter and Abraham (1971) have observed the coexistence of the species of the family Acartiidae in the backwaters. Based on the distribution, the various species of Acartiidae observed during this study also groups into *Acartia centrura*, *A. spinicauda* and *A. bilobata*; *A. plumosa* and *Acartiella keralensis* and *A. gravelyi* which is in conformity to the coexistence pattern outlined by them.

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